Learning to Think Like a Doctor: The Development of Clinical Reasoning in Medical Students During Longitudinal Integrated Clerkships

By

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MBChB, DCH, MIPH(Hons)

Thesis
Submitted to Flinders University
for the degree of

Doctor of Philosophy

College of Medicine and Public Health

22 October 2024

Dedicated to the memory of

Dr Peter John Lyall

27 January 1954 - 23 April 2022

and

Dr John Geoffrey Moran AM

23 May 1951 - 27 February 2023

Both outstanding general practitioners, teachers, mentors and friends.

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ABSTRACT

Clinical reasoning (CR) is central to the safe practice of medicine, but despite scrutiny over the past few decades, there is still debate on what it is, how it develops, and the most effective ways for medical students to learn it. Longitudinal integrated clerkships (LICs) are becoming more accepted worldwide as an educational model for undergraduate training in medical schools. Anecdotal evidence suggests that students engaged in LIC models develop good CR, but how or why remains largely unknown.

Despite the lack of agreement in how CR is defined, when distilled down to its constituent components, it can be viewed as the process during which a clinician interacts with a patient to collect and interpret data relevant to the patient's presentation in order to arrive at a diagnosis (or a differential or provisional diagnosis) and to institute a plan of investigation and/or treatment. There are a number of difficulties in the learning and assessment of CR; these include it being an idiosyncratic, multifaceted, highly complex construct which is almost exclusively a cognitive process and is thus 'hidden' from view and not readily visible to either the learner or the assessor, and the numerous contextual factors that can have a strong influence on it. These difficulties present challenges not only to the teaching and assessment of CR, but also to research into this topic.

LICs can be broadly characterised by three core elements: a) student participation in the comprehensive care of patients over time, b) student participation in continuing learning relationships with patients' clinicians, and c) students meeting their core clinical competencies across multiple disciplines simultaneously through these experiences. There is no single agreed way of constructing a LIC model, and they can be constructed in various ways provided they meet the three core elements.

This research is aimed at seeking the answers to how and why LICs contribute to the development of good CR during undergraduate medical training. My original contribution to knowledge in this area is an in-depth analysis of the factors within the structure of LICs that lend themselves to the development of good CR in its students.

An initial scoping review of the literature showed that there was a lack of strong evidence linking the development of CR to LICs, so I conducted two quantitative tests of CR on medical students in the University of Wollongong (UOW) LIC program. The first test adopted a syntactic and semantic

content approach of clinical case presentations as a marker of CR ability, using student clinical log entries as a surrogate for clinical case presentations. The second test relied on the assumption that if LIC students are particularly well-supported in the development of their CR, their scores in the CR components of their end-of-LIC summative assessments would be better than the scores in the non-CR components of the same assessments. Although these two studies looked at measuring CR in two completely different ways, both were unsuccessful in showing any improvement in CR or better performance in CR-related assessments. With the benefit of hindsight, this was not particularly surprising.

The outcomes of these two quantitative tests provided me with the valuable insight that the influence of LICs on CR is complex and multi-dimensional and there is no straightforward linear cause and effect between them, and thus a linear causal or even a positivist approach is not the ideal one. This led to change in direction. The next phase involved revisiting the literature from a hermeneutic perspective, allowing for a richer and more comprehensive understanding of the topic. The questions posed during this review were broader and more inclusive compared to those in the scoping review. Although the evidence for the development of CR during LICs was limited and indirect, this approach opened new avenues of understanding and insight. This hermeneutic review clearly showed that there are strong ontological parallels between CR and LICs. It suggested that the unique characteristics of LICs should promote the development of more and stronger illness scripts and improved knowledge networks in medical students engaged in them, and that this, in turn, should lead to the improved development CR. It also showed that there is an almost complete lack of direct, robust evidence on how CR develops in students during LICs.

It became clear that a constructivist perspective would be ideally suited for determining the factors within LICs that better promoted the development of CR, and consequently a qualitative approach was adopted. Using the lens of complexity theory, I conducted semi-structured interviews with clinical preceptors and former students of the UOW LIC program to gain their insights into how CR develops during the clerkship. The main themes derived from these qualitative interviews were: 1) Student effectivities, 2) Relationships, 3) Affordances, 4) Outcomes, and 5) Growth in CR. These combined in a cascade of complex ways to create a learning environment for students that is conducive to the development of CR. Although all the themes were seen as important, the most noteworthy of these was the range of relationships that students develop during LICs. The quality of these relationships, and the range of affordances that

arise from them, are major points of difference between LICs and the traditional block rotation (TBR) structures of medical education.

These findings contribute important evidence to the observation that LICs are an effective educational approach for developing good CR. They confirm the strong ontological similarities between CR and LICs and highlight that immersing students with appropriate characteristics in settings with the unique LIC-specific affordances provides explanation for the strong effects that combine in complex adaptive ways to have a direct impact on the development of good CR. The triad of parallel consulting under supervision, seeing undifferentiated patients, and the handover of the patients to clinical preceptors at the conclusion of each patient interaction, on a background of the development of deep, meaningful relationships with clinical preceptors, is seen to be especially important in the development of CR in medical students engaged in LICs. It has the additional benefits of improving patient-centred attitudes, improving clinical skills, and improving communication skills in students, all of which contribute to the improvement in CR.

This research has several potential implications for the future of medical education, including a) the differences between exposure of medical students to a larger number of clinicians with a narrow content focus and a smaller number of clinicians with broader, more generalist range of content, b) graduates having been exposed to LICs in making career choices to train and work in primary care, and c) the significance of the adaptability and transferability of LICs from rural to urban settings.

DECLARATION

I certify that this thesis does not incorporate without acknowledgment any material previously submitted for a degree or diploma in any university; and that to the best of my knowledge and belief it does not contain any material previously published or written by another person except where due reference is made in the text.

Signed.....

Date.....22 October 2024.....

ACKNOWLEDGEMENTS

I am deeply indebted to many people who have tirelessly supported me through this journey of discovery.

The first acknowledgement must go to my superb supervisory team. Lambert Schuwirth, as my principal supervisor, has not only been great source of knowledge, sound advice and wise counsel, but has also been amazingly patient with me as I have tried (not always successfully) to juggle a full-time workload with this program of research. The other members of the team, Paul Worley, Judy Mullan and Ian Wilson, have also made a huge contribution to my learning journey over the years. The entire team has consistently challenged and encouraged me, and I have thoroughly enjoyed the intellectual stimulation of our discussions. My sincere thanks go to all of you.

There are others outside of the supervisory team who have assisted greatly. Christine Metusela went above and beyond in her assistance with analysis of the qualitative aspects of the research – thank you so much. Gregg Rowland (a former colleague and still a personal friend) and Lucie Walters have quietly but consistently encouraged me to keep going. Numerous other colleagues, too many to name individually, at the University of Wollongong Graduate School of Medicine have provided amazing support and encouragement and allowed me the luxury of time to devote to this research.

Clinical preceptors of the University of Wollongong longitudinal integrated clerkship program were incredibly generous with their knowledge and time by allowing me to interview them, as were former students of the program. Due to confidentiality provisions, I cannot name any of them, but you know who you are. My sincere thanks go to all.

Lastly, but by no means least, I know that my longsuffering wife, Maureen, has at times felt that I have been more devoted to my computer than to her. I am sorry for my many and prolonged ‘absences’ and I promise to make it up to you. My adult children have also provided constant encouragement – thank you. My thanks also go to Maggie, our Labrador pup, who has spent hours lying at my feet keeping them warm during late winter nights.

PRESENTATIONS AND PUBLICATIONS DURING CANDIDATURE

Conference presentations

Garne D, Schuwirth L, Worley P, Mullan J, Wilson I. How does clinical reasoning develop in medical students in a longitudinal integrated clinical clerkship? Consortium of Longitudinal Integrated Clerkships conference, Spokane, Washington, USA, 21-24 September 2023.

Garne D, Schuwirth L, Worley P, Mullan J, Wilson I. What are the factors in LICs that promote the development of clinical reasoning in medical students? Shoalhaven Rural Health Research Conference, Nowra, NSW, Australia, 18 March 2023.

Garne D, Schuwirth L, Worley P, Mullan J, Wilson I. Learning and Development of Clinical Reasoning in LIC students: An Exploration of Educational Theory and a Proposed Conceptual Explanatory Model. Consortium of Longitudinal Integrated Clerkships conference, Stellenbosch, South Africa, 10-13 October 2021.

Garne D, Schuwirth L, Worley P, Wilson I. The Language of Medicine: Validation of the use of written case studies for semantic and syntactic content for use as a marker of clinical reasoning ability. Consortium of Longitudinal Integrated Clerkships conference, Vancouver, Canada, 27-30 October 2019.

Garne D, Schuwirth L, Worley P, Wilson I. A Theoretical Framework for Studying the Development of Clinical Reasoning in Medical Students during Longitudinal Integrated Clerkships. Rogano meeting, Basel, Switzerland, 24-25 August 2018.

Garne D, Schuwirth L, Worley P, Wilson I. The development of clinical reasoning in medical students in LICs: What does the literature say? Consortium of Longitudinal Clerkships conference, Singapore, 23-25 October 2017.

Manuscripts in preparation

Garne D, Worley P, Mullan J, Wilson I, Schuwirth L. A scoping review of the development of clinical reasoning in medical students during longitudinal integrated clerkships.

Garne D, Worley P, Mullan J, Wilson I, Schuwirth L. A hermeneutic literature review of the development of clinical reasoning during longitudinal integrated clerkships.

Garne D, Mullan J, Metusela C, Worley P, Wilson I, Schuwirth L. What are the factors that influence the development of clinical reasoning during longitudinal integrated clerkships? A qualitative study.

GLOSSARY OF TERMS

Adult learning theory	The concept or study of how adults learn and how it differs from children
Affordances	The qualities of a workplace (or other learning environment) that promote learning opportunities for the engaged participant
Assumption	Something that is accepted as true or factual without proof
Axiology	The ideological system of beliefs, values and value judgements that researchers hold
Case specificity	See content specificity
Clinical clerkships	A formal, planned period of clinical experience and learning
Clinical placements	See clinical clerkships
Clinical preceptor	An appropriately qualified and trained health practitioner who guides the student's clinical experience and clinical training on behalf of the education provider
Clinical supervisor	See clinical preceptor
Cognitive biases	Errors in reasoning
Cognitive load	The theory which holds that the capacity of working memory resources available to humans and the number of elements that are able to be processed simultaneously is limited
Cognitivism	The group of theories in psychology that focuses on how the mind receives, processes, organises, stores, and retrieves information
Conceptual framework	A network of related concepts that help us to understand a particular phenomenon
Communities of practice	A group of people who share a common concern, a set of problems, or an interest in a topic and who come together to fulfill both individual and group goals
Complexity theory	Examines uncertainty and non-linearity and emphasises interactions and the accompanying feedback loops that constantly change systems
Constructionism	The belief that the world around us is socially constructed rather than being objective, and that meaning is derived from an interplay between the objective and the subjective
Constructivism	Cognitive processes on how the world is perceived at an individual level

Content specificity (also termed domain or case specificity)	The phenomenon of success in a solving a particular clinical problem not being a good predictor of success in solving the next one and is the variability a physician shows based on different content areas
Context specificity	The phenomenon of a clinician arriving at two different diagnoses for two different patients with the same condition
Context	The circumstances that form the setting for an interaction in terms of which it can be fully understood
Critical thinking	The process of judging what to believe or what to do in a given context
Criticalism	The presupposition that all knowledge is conjectural and that no belief can be certified, verified or validated
Curriculum	The selection of knowledge, skills and values that is taught within a given course of study
Development of expertise theory	How talent develops across a specified field or domain with clearly specified learning outcomes against which the expertise can be objectively measured
Discourse	Written or spoken communication or debate
Domain specificity	See content specificity
Effectivities	The actions an individual is able to perform in a specific context; in the context of LICs, it describes what participants are able to achieve with the affordances provided by the LIC structure
Encapsulation of knowledge	An abstract concept that means an amalgamation of mental models
Encoding specificity	The probability and efficiency of retrieving an item from memory being dependent on the similarity between the conditions of encoding (storing information in long-term memory) and retrieval
Epistemology	The philosophical study of the origin, nature and limits of human knowledge and how it is organised
Experiential learning	The process of learning by doing
Hawthorne effect	The phenomenon of research participants acting in a way that is consistent with their perception of the researcher's expectations during a study which then biases the outcomes of the research study
Hermeneutics	A philosophical approach that is concerned with the understanding and interpretation of texts
Heuristics	Mental shortcuts for solving problems

Humanism	A rationalist system of thought that attaches prime importance to human rather than supernatural matters
Idiosyncrasy	The variation between clinicians in illness scripts due to variations in learning and clinical experiences
Illness scripts	Amalgamated knowledge networks made up of data about a given illness or condition stored in long-term memory
Interleaved learning (also termed mixed learning)	Students learning and practicing multiple concepts together or cumulatively as opposed to learning each concept separately
Interpretivism	A research method in which actions or events are analysed based on the beliefs, norms or values of the society in which it takes place
John Henry effect	The bias introduced to an experiment when members of the control group are aware that they are being compared to the experimental group and behave differently than they typically would to compensate for their perceived disadvantage
Legitimate peripheral participation	Describes how newcomers to a community of practice or collaborative project become members of that practice or project
Materialism	The philosophical belief that nothing exists except matter and its movements and modifications
Metacognition	The process of thinking about how we think or reflect at a higher level of analytic and non-analytic processes
Mixed learning	See interleaved learning
Objectivism	The philosophical view that there is only one objective reality
Ontology	The philosophical study of existence, being and reality
Paradigm	A standard, perspective or set of ideas
Parallel consulting	The process of the student seeing an undifferentiated patient initially alone while the clinical preceptor is seeing a different patient, before presenting their findings to and having a discussion with the clinical preceptor
Patient-centred care	An approach that treats each person respectfully as an individual human being, and not just as a condition to be treated; it involves seeking out and understanding what is important to the patient, their families, carers and support people, fostering trust and establishing mutual respect.
Pedagogy	The method/s of how a curriculum is taught or delivered to students
Person-centred care	See patient-centred care

Phenomenon	A situation that is observed to exist or happen
Placements	See clerkships
Positivism	The philosophical system that recognises only that which can be scientifically measured or verified
Post-positivism	Retains the idea that truth should be considered objective but recognises that they are modified by individual values and experiences
Realism	The philosophical view that an object really exists and has certain attributes independent of what people may think about it
Reflection	Giving a topic or interaction serious thought or consideration
Regional Academic Leader	A clinician engaged by the University of Wollongong Graduate School of Medicine to provide academic leadership and pastoral care to Phase 3 students undertaking their Longitudinal Integrated Clerkship
Relativism	The philosophical stance that knowledge, truth and morality exist relative to culture, society or historical context and are not absolute
Script theory	An explanation for how information is stored in and retrieved from long-term memory allowing clinicians to integrate new information with existing knowledge
Self-directed learning	The process in which individuals take the initiative in determining their learning needs, developing learning goals, identifying resources for learning and implementing appropriate learning strategies
Semantic qualifiers	Paired opposing descriptors that can be used systematically to compare and contrast diagnostic considerations
Situated learning	A theory that explains an individual's acquisition of professional skills
Social anthropology	The study of human society and cultures through a comparative lens
Subjectivism	The belief that knowledge is subjective and that there is no external or objective truth
Syntactic content	Extent (length) of discourses in clinical case presentations
Undifferentiated patients	Patients who present with a new problem, where the nature of the problem and diagnosis are as yet undetermined
Zone of proximal development	The space between what a learner can do without assistance and what a learner can do with expert guidance or in collaboration with more capable peers

LIST OF ABBREVIATIONS

BOF	Best of five multiple choice questions
COREQ	Consolidated criteria for reporting qualitative research
CF	Current clinical preceptor and former student
CIC	Cambridge Integrated Clerkship
CLIC	Consortium of Longitudinal Integrated Clerkships
CLT	Cognitive load theory
CP	Clinical preceptor
CR	Clinical reasoning
EMQ	Extended matching questions
FS	Former student
GP	General practice/general practitioner
GSM	Graduate School of Medicine
LIC	Longitudinal integrated clerkship
MDT	Multidisciplinary team
OSCE	Objective structured clinical examination
NCR	Non-clinical reasoning
NSW	New South Wales
MEQ	Modified essay questions
P4P	Preparation for practice
PRISMA	Preferred reporting items for systematic reviews and meta-analyses
RAL	Regional Academic Leader
RBC	Rotation based clerkship
RCS	Rural clinical school
RIME	Reporter-interpreter-manager-educator framework
TBR	Traditional block rotation
UDRH	University Department of Rural Health
UOW	University of Wollongong

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CHAPTER 1:
INTRODUCTION

"WONDER IS THE BEGINNING OF WISDOM."
– SOCRATES (C. 470-399 BC)

This chapter presents the background and context of this study, highlighting two important aspects of medical education, namely the long-standing question of how medical students learn and develop clinical reasoning (CR), and the newer pedagogical approach in medical education of longitudinal integrated clerkships (LICs), and how these two are combined. It outlines the research topic, provides a background of why I am interested in this area, and gives some context to where this research was conducted and the boundaries of the research. It outlines the research questions, gives an overview of the research approach, and finally describes the structure of thesis.

THE RESEARCH TOPIC

This research deals with two important topics in undergraduate medical education: the learning of CR by medical students and LICs. These are important because CR is a process used by doctors in almost every clinical encounter that they have with patients. LICs are an emerging pedagogical approach that is becoming increasingly adopted by undergraduate medical education programs worldwide.

CR is central to the safe and effective practice of medicine, and it forms the core of medical professional competence and is central to everything that a doctor does (Norman 2005; Young et al. 2020; Durning et al. 2013a; Durning et al. 2013b; Connor, Durning, and Rencic 2020). However, despite close attention over the past two decades, there remains little agreement as to what it is and how it is defined, taught and assessed (Young et al. 2018b; Schuwirth, Durning, and King 2020; Schuwirth 2009). A number of theories that underpin CR processes have been proposed (Young et al. 2018a).

Despite the lack of agreement in how CR is defined, when distilled down to its constituent components, it can be viewed as the process during which a clinician interacts with a patient to collect and interpret data relevant to the patient's presentation in order to arrive at a diagnosis (or a differential or provisional diagnosis) and to institute a plan of investigation and/or treatment (Cleary et al. 2020; Torre et al. 2021).

One of the difficulties in the learning and assessment of CR is that being an idiosyncratic, multifaceted, highly complex construct which is almost exclusively a cognitive process, it is 'hidden' from view and is thus not readily visible to either the learner or the assessor (Schuwirth, Durning, and King 2020; Daniel et al. 2019; Gruppen 2017; Young et al. 2019). Another aspect of CR, especially in the clinical setting, is the numerous contextual factors that can have a strong influence on it (Cleland et al. 2021; Durning et al. 2012b; Konopasky et al. 2020b; Ramani et al. 2020). These difficulties present challenges not only to the teaching and assessment of CR, but also to research into this topic.

LICs are broadly characterised by three core elements: a) student participation in the comprehensive care of patients over time, b) student participation in continuing learning relationships with patients' clinicians, and c) students meeting their core clinical competencies across multiple disciplines simultaneously through these experiences (Worley et al. 2016). There is no single agreed way of constructing a LIC model, and they can range from sequential models with longitudinal themes and limited integration to fully integrated longitudinal models, with numerous variations between these two extremes (Hirsh et al. 2007).

This body of research focusses on how CR develops in students engaged in a LIC program. Although it was limited to one program, the intention was to make its findings generalisable to LIC programs more broadly.

REFLEXIVITY: WHO I AM, MY ROLE, REASONS FOR INTEREST IN LONGITUDINAL INTEGRATED CLERKSHIPS AND CLINICAL REASONING

As a medical practitioner with over forty years of experience in general practice/family medicine (GP), I have had a varied and interesting professional career which includes hospital practice, a two-year stint in the military, private medical practice, aeromedical primary care and emergency retrieval, and rural general practice locum work. My pathway into academia was unintended and unplanned, and happened by serendipity.

My current role is to manage the rural aspects of the graduate entry Doctor of Medicine (MD) program and curriculum of the Graduate School of Medicine (GSM) at the University of Wollongong (UOW) – a position that I have held for almost thirteen years. This includes oversight of the LIC in which all students in the program are required to participate as a compulsory part of the curriculum.

In the seven years prior to my current role, I was the Director of Clinical Medicine at the University of Sydney's Department of Rural Health (UDRH) in Broken Hill, a small mining town in outback New South Wales (NSW), Australia. This involved being responsible for the coordination and management of medical students undertaking clinical placements in the far west of NSW. The clinical placements of medical students were initially short-term only, varying from as little as four weeks to a maximum of eight weeks. It soon became clear to me that these short-term placements had little impact on the long-term career choices that students were making. They enjoyed their time in the region, but it did not take long for the positive impacts of the placements to fade after their return to the cities from which they came. They were, in effect, just 'medical tourists'.

The opportunity arose to address this problem by initiating a long-stay placement program for medical students coming to the Broken Hill region. A collaboration of three medical schools (the Universities of Adelaide, Sydney and Wollongong) was conceived which would allow up to four students from each of the three universities to undertake LICs of up to 12 months. The inaugural three students from UOW under this program arrived in Broken Hill in July 2009.

It quickly became apparent that these three (and other subsequent) students not only engaged with all the clinical and social opportunities on offer, but that their clinical abilities grew rapidly over the extended period that they were in the region, including their CR abilities. By the time they left Broken Hill, they were essentially functioning at a junior doctor level, and this piqued my interest. What was it about the LIC that enabled students to undergo this extraordinary developmental trajectory?

My interest in CR arises from the suboptimal experiences that I had as a medical student. My six-year undergraduate training consisted of the traditional British model of three years of medical sciences followed by three years of clinical sciences, but with little or no integration or connection between the two. There was a huge amount of didactic teaching and rote learning, but with little emphasis on how to apply any of this rote-learned knowledge to real patients. I was unaware of it at the time, but in retrospect I can see that this approach was very much couched in a realist ontology and an objectivist epistemology. I graduated after six years not knowing how to apply my knowledge to real patients and discovered, most likely by making too many mistakes, that my CR skills were poor. This was something that I had to develop in subsequent years through trial and error and making more, probably unnecessary, mistakes.

This was a complete contrast to what I observed in the LIC medical students in Broken Hill. Their medical sciences and clinical knowledge was highly integrated, and their CR skills and abilities grew rapidly. They were much further advanced in their CR abilities than I was at a similar stage of training. Was there something about the longitudinal nature of their placement that contributed to this development? The development of CR appeared to be better in a LIC environment than in other pedagogical models, and this led to the assumption that LICs result in better CR. However, this assumption and its plausibility needed to be tested. Comparative studies were found to be insufficient to test this, and it proved to be much better to critically examine the plausibility of the assumption.

I am fully aware that this presents both a strength and a risk to this research. A strength is that I have first-hand experience with both the traditional model of medical education and with LICs, and can fully appreciate the differences between these at both a practical level and a theoretical one. This allows me to analyse the qualitative data through the eye of experience, and to be able to see meaning and connections that I would not have been able to discover without those experiences. But it also means that I have had to be very careful not to become too invested in certain outcomes of the study – I had to constantly remain vigilant for this not to become a so-called partisan project. That reality check, the critical scrutiny of what the data really mean, what inferences and conclusions were warranted (and not just wishful thinking) has been an ongoing topic of attention by me and the members of my supervisory team.

CONTEXT AND BOUNDARIES OF THIS RESEARCH

This research was set within the context of one medical education program in Australia, that of the UOW. This is a four-year graduate entry program (i.e., applicants must have the minimum of a prior bachelor's degree to be eligible for entry into the program), with graduates receiving a Doctor of Medicine (MD) degree upon successful completion of the course. The prior degree can be in any field, which means that some (but not all) students have a prior health or medical sciences background.

The mission of the UOW medicine program is to develop a medical workforce for geographic areas of workforce need. The driver for this is the huge mismatch between access to medical care between metropolitan and non-metropolitan regions of Australia due to a medical workforce maldistribution.

The UOW program is structured around a LIC program, which is a compulsory part of the program for all students enrolled in it - this is in contrast to some other programs which have this as an option for some students within each cohort to choose. The program is divided into four distinct Phases. Phase 1 is 18 months in duration and covers the medical sciences and a significant introduction to clinical skills training. Phase 2 runs for the next 12 months (from the middle of Year 2 to the middle of Year 3) and is comprised of seven hospital specialty rotations and advanced clinical skills training. Phase 3 runs for the following 12 months (from the middle of Year 3 to the middle of Year 4) and is the LIC program. Phase 4 runs for the final six months of the course (from the middle to the end of Year 4), and is comprised of three six-week Elective, Selective and Pre-internship (PRINT) rotations.

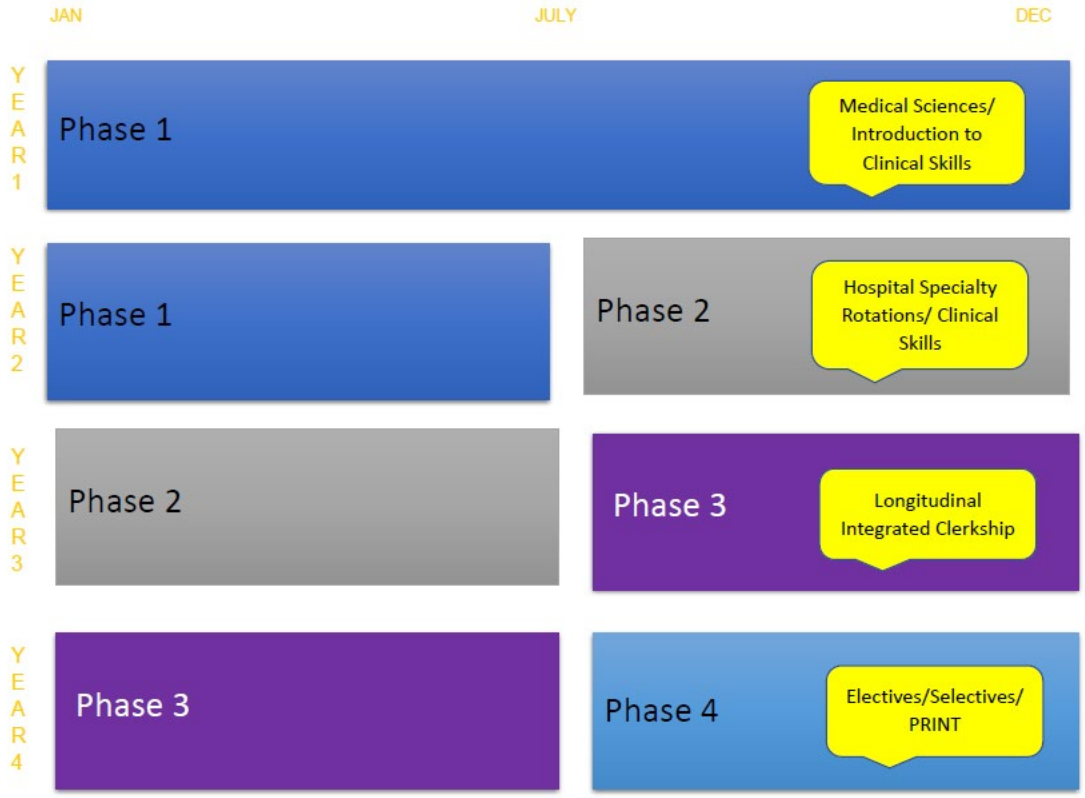

Figure 1.1: Outline of the structure of the UOW medical student program.

There are about 84 students in each UOW cohort, although this number does fluctuate somewhat from year to year. About two thirds of students undertake their LIC year in a rural setting, while the other one third do their LIC year in the regional setting of the Illawarra (Wollongong). At the time that this research was undertaken there were ten rural hubs (MM2+), but one has since been 'lost' due to changes to the Australian rurality classification system.

All students undertaking the Phase 3 LIC are hosted by one general practice for the duration of their 12-month placement and they spend roughly half of their clinical placement time in their

host practice. The other half of the clinical placement time is spent in the local hospital, mostly in the emergency department, but also some other opportunistic clinical placements (depending on local availability). The rationale for this approach is for students to be exposed to as many undifferentiated patients as possible on order to encourage them to attempt (under supervision) to work out what the underlying problems are with which patients are presenting and to formulate provisional management plans for these patients. Medical services in the larger hospitals are provided mainly by specialists, while those in the smaller ones are provided by mainly by general practitioners (GPs) and/or rural generalists. Some are provided by a mix of the two. Table 1.1 below provides a summary of the hubs, their rurality classification, numbers of students and hospital staffing arrangements.

Table 1.1: Geographic locality of UOW LIC hubs with Modified Monash (rurality) classification of each, indicative number of students in each, and hospital staffing arrangements.

Hub	Modified Monash classification	Indicative number of students	Hospital staffing arrangements
Illawarra	1	28	Specialist
Shoalhaven	3	12	Mix
Milton/Ulladulla	4	4	GP
Southern Highlands	3	6	Specialist
Grafton/Maclean	3/5	4	Mix
Lismore/Ballina	3/5	6	Mix
Murwillumbah	2/4/5	9	Mix
Mudgee	4	3	GP
Forbes	4	2	GP
Griffith/Leeton	3/4	6	Mix
Broken Hill	3/7	4	Mix

Notes: 1. As at the time this research was undertaken
2. Some clinical placements occurred in Modified Monash localities different to that of the town

As shown in the table above, each hub is different in terms of rurality classification, numbers of students, and types of clinical supervision that students are exposed to (especially in hospital settings). Students across the program are thus exposed to heterogenous clinical experiences during their LIC, depending on which hub to which they are allocated for the LIC. These heterogenous clinical experiences are not only *between* hubs, but also *within* hubs. However, I would argue that this heterogeneity applies not only to students undertaking LICs, but also to students in more traditional block rotation (TBR) clinical learning settings. As will be seen later in this thesis, any effect of workplace-based learning on the development of CR is highly complex and individual. This is why simple comparative studies proved not to have been meaningful.

Although this study was conducted in the UOW program only, the aim was to understand the principles of development of CR during LICs. With the realisation that any education, but in particular workplace-based education, is situated and contextual, it is more important to understand from a realist perspective *how* and *why* something works rather than merely *that* something works by adopting a causal comparative design. This approach makes the findings more adaptable and generalisable to LIC programs more broadly.

THE RESEARCH QUESTIONS

The anecdotal observations described above helped me to realise that medical students undertaking LIC clinical placements appeared to be highly engaged in learning processes during the course of the clerkship – this was true of all aspects of their learning, but especially in the development of their CR. This started raising some important questions in my mind. How do students engaged in a LIC learn? How does their CR develop? Is the development of their CR different from or better than that of students engaged in more traditional forms of medical education?

The final primary research question that evolved was:

> **What are the various unique program structures and other factors that come into play during LICs that interact with each other to foster and promote the development of CR of students participating in the program?**

OVERVIEW OF THE RESEARCH APPROACH

My initial approach to answering the questions of the development of CR in LIC students was to attempt to find quantitative answers to the *how much* questions from a positivist perspective. But the growing realisation that CR is a highly complex, multidimensional, idiosyncratic and unpredictable process made me abandon this perspective in favour of a more constructivist perspective and find answers to the *how* and *why* research questions utilising a qualitative approach.

STRUCTURE OF THE THESIS

This research became a journey of twists and turns, and this is reflected in the structure of the thesis. Chapter 2 presents a conceptual framework and the theoretical framework which informed the research. Chapter 3 presents a scoping review of the impact of LICs on the development of CR.

Chapter 4 comprises two small quantitative studies that sought to explore the impact of LIC on the development of CR from a positivist perspective. Chapter 5 is a comprehensive hermeneutic literature review on CR, on LICs, and on the intersection of these two constructs. Chapter 6 is a qualitative approach to the factors within LICs that contribute to and promote the development of CR during LICs. The final chapter, Chapter 7 presents the key findings of this research followed by a discussion and suggests some implications for the future of medical education more broadly, before presenting some final conclusions.

CHAPTER 2:
CONCEPTUAL FRAMEWORK

"WISDOM MUST BE INTUITIVE REASON COMBINED WITH SCIENTIFIC KNOWLEDGE."
– ARISTOTLE (384-322 BC)

This chapter presents an outline of the ontological and epistemological perspectives and assumptions of this research and how these are combined through theoretical lenses. It also outlines the axiological considerations that I needed to consider when conducting this research, and describes the theoretical underpinnings of this program of research. It concludes by describing the theoretical conceptual framework that underpins the research.

ONTOLOGICAL AND EPISTEMOLOGICAL PERSPECTIVES

In this section I will outline the ontological and epistemological assumptions that underpin my research. I am not trying to present an extensive summary of the literature, and this section is thus not intended as a systematic a literature review. Instead, I will describe relevant ontological and epistemological perspectives to illustrate how they have supported my thinking. Because this is not intended as a full literature review of the philosophy of science, the citations I have included are simply as illustrative examples of each of these positions. Many of the references used are therefore overview papers and not all are original sources.

Ontological assumptions

Within medical education research, there are two broad ontological positions that can be held: a realist position and a relativist one (termed 'anti-realist' by Hathcoat, Meixner, and Nicholas (2019)).

The realist ontological position holds that one single reality exists that can be studied, understood and experienced as a truth (Moon and Blackman 2014). It is the belief that reality, which exists 'out there', is driven by immutable natural laws (Tavakol and Zeinaloo 2004) and that knowledge is grounded in observable facts and strict rules of logic (van Baalen and Boon 2015).) Hay (2016) takes this a step further by stating that realism is independent of our knowledge or understanding, and Hathcoat, Meixner, and Nicholas (2019) posit that a realist ontology exists irrespective of the input of researchers. There are some softer sub-types of realism, including critical realism and historical realism. Critical realism holds that reality is assumed to exist, but that evidence is fallible

due to the complexity of the enquiry. Historical realism hold that reality is shaped by social, political, cultural, economic, ethnic and gender factors (Bergman et al. 2012).

The relativist ontological position, by contrast, argues that reality exists in the mind, with each individual creating his or her own version (Moon and Blackman 2014). McMillan (2015), for example, argues that this position holds that there are multiple realities. Because meaning is grounded in experience, knowledge can be derived from sources other than the senses, and reality is complex and context-dependent, a position agreed with by Bergman, et al. (2012).

Some authors hold that there is a third ontological position, namely criticalism. This position argues that reality may be objective or subjective, and that the truth is constantly contested by competing groups (McMillan 2015).

This research initially set out to answer the 'what' and 'how much' questions relating to the development of clinical reasoning (CR) by adopting a realist ontological position. However, for reasons that will later become clear, this proved to be unsatisfactory (see Chapter 4). As a result, the natural progression was to move to seeking answers to the 'how' and 'why' questions relating to the development of CR in medical students within the context of longitudinal integrated clerkships (LICs), and this approach adopted a relativist ontological position (Tavakol and Zeinaloo 2004) (see Chapter 6).

Epistemological assumptions

Similarly, there are two broad epistemological positions that can be held: an objectivist (or positivist) position and a subjectivist (or interpretivist) one.

The objectivist position holds that meaning exists separate to the operation of any consciousness and that truth is purely objective (Crotty 2020). Once committed to a realist ontology, the researcher is committed to an objectivist epistemology (Tavakol and Zeinaloo 2004). Radical objectivism holds that researchers simply provide an objective, value-free description of reality and that generalisable theory can be developed to accurately describe the world (Bunniss and Kelly 2010; Bergman, et al. 2012). Relative objectivism holds that objective knowledge, although the ideal, is not always accessible and cannot always be achieved, so it seeks to establish a probable truth (Bunniss and Kelly 2010; Bergman, et al. 2012).

By contrast, the subjectivist position holds that meaning comes from anything except the object to which it is ascribed (Al-Ababneh 2020). As Crotty (2020) describes, the object makes no

contribution to the generation of meaning, but meaning is imposed on the object by the subject; it is our interpretation of a phenomenon that provides meaning to it. It anticipates that there are multiple, diverse interpretations of reality which it gains by gathering a range of in-depth accounts in order to build a detailed picture of how a phenomenon is understood by those who have experienced it (Bunniss and Kelly 2010). Reality is made up of a multiple, constructed, interdependent whole which cannot be reduced to numbers (Tavakol and Zeinaloo 2004). Because medicine is a combination of natural science and human science (in other words, it is both a 'science' and an 'art'), it is impossible to decontextualise humans, and this makes objective measurements difficult or impossible. An alternative approach is thus needed – this has been termed 'epistemological responsibility' by van Baalen and Boon (2015).

As with ontology, some authors suggest that there can be a third epistemological position, that of constructionism. This position holds that meaning is derived from an interplay between the objective and the subjective, and that the objective and the subjective each partner in the generation of meaning (Moon and Blackman 2014; Al-Ababneh 2020). Meaning is not discovered but constructed, and different people construct different meanings even in relation to the same phenomenon (Crotty 2020).

Because this research sought to answer two different types of questions about the development of CR, it adopted two different epistemological approaches. The two small studies in Chapter 4, which attempted to provide quantitative measures of CR, used a relativist objectivist epistemology. The larger study in Chapter 6, which examined the development of CR in longitudinal integrated clerkships (LICs) qualitatively, adopted a subjectivist (or interpretivist) epistemological approach.

THEORETICAL LENSES ON HOW ONTOLOGY AND EPISTEMOLOGY ARE COMBINED

Medicine has traditionally adopted a positivist approach to research, and this historically included approaches to medical education research. This was rooted in what has been termed the 'First Scientific Revolution' dating back to Newton and Descartes, which took a very mechanistic view of the world (Irby 1990). This remains the best known and best understood research paradigm (Zaidi and Larsen 2018). However, this started changing with the advent of the 'Second Scientific Revolution' dating back to the start of the twentieth century. This gave rise to what has been termed *infomedicine*, which acknowledged the interdependence of physical, biological,

psychological, sociological, spiritual and cultural aspects, and this has ultimately filtered over the past few decades through to medical education research (Irby 1990).

The positivist paradigm is based on rules of logic and measurement, truth, absolute principles and prediction (Weaver and Olson 2006). It is important for answering certain questions that can be analysed quantitatively like, for example, measurable cause and measurable effect questions, in other words, the 'what', 'when', 'whether or not', 'how many' and 'how often' questions (Tavakol and Zeinaloo 2004). However, they are not suitable for studying questions about complex, unstable, non-linear social change. As Scotland (2012) points out, positivism attempts to reduce the complex to the simple by simplifying and controlling variables. This is difficult if not impossible to do in educational research, especially (as it turned out) research about the development of CR.

A post-positivist paradigm combines a realist ontology with an objectivist epistemology. This strives for objectivity, but recognises that complete neutrality is not possible and that 'truth' is merely an approximation (Zaidi and Larsen 2018). Like positivism, post-positivism relies on observation and measurement, and maintains that there is an objective 'truth' but that we are unlikely to find it (Young and Ryan 2020).

An interpretivist (or constructivist) approach, by contrast, is well-placed to study many medical education questions, especially those that explore complex and contextually dependent issues like CR. A constructivist paradigm is about how individuals perceive and create meaning from events (Rees, Crampton, and Monrouxe 2020), and the participants are seen as actors who play a role in the construction of reality (Bleiker et al. 2019). Within this paradigm, knowledge generation occurs when relevant insights emerge naturally through researcher-participant discourse (Bunniss and Kelly 2010). As a learning process, constructivism holds that learners must apply conscious thought about deriving meaning, and that the learner constructs their own knowledge through observation. Learning is a cognitive process that occurs through building on previous knowledge in collaborative environments, and much of the onus of this is on the learner (Alanazi 2016).

There are other research paradigms that have been described, such as sociomaterialism, constructionism, critical theory (MacLeod et al. 2020), pragmatism, subjectivism and critical realism (Scotland 2012; Ellaway, Kehoe, and Illing 2020), and postmodernism (Ellaway 2020). However, these paradigms were assessed as not being relevant to this research and are therefore outside the scope of this discussion. There is no one research approach or paradigm that is better

than another, but all are valid when used in context to answer the appropriate research question, and they thus carry different expectations for rigour (Bunniss and Kelly 2010; Varpio et al. 2021).

The two small studies described in Chapter 4, which applied quantitative measures to the development CR in students undertaking a LIC, combined a realist ontology with a relative objectivist epistemology to form a post-positivist paradigm (Bergman, et al. 2012). The larger qualitative study, found in Chapter 6, combined a relativist ontology with a subjectivist epistemology to form a constructivist paradigm. This recognises that that reality is relative and is constructed by those who experience it (Zaidi and Larsen 2018).

AXIOLOGICAL CONSIDERATIONS

The ideological system of beliefs, values and value judgements that researchers hold inevitably affects the research activities and their outcomes, and they have a responsibility to acknowledge this (Ellaway 2016). This requires the researcher to consider how and why their research is valued or deemed to be worthwhile (Varpio and MacLeod 2020). Ellaway (2017) holds the view that these issues should be debated and discussed, and that researchers need to develop a defensible ideological position in their scholarly endeavours. This, she states, is not a manifestation of moral superiority but rather one of responsible and moral autonomy, and scholars should endeavour to act as moral agents by directing their actions in reference to personal and professional codes and values.

My personal system of beliefs and values has been shaped by my upbringing, my education, and my interactions with fellow academics, researchers, and clinicians. As outlined in the section on reflexivity in Chapter 1, I believe that my CR abilities on graduation were rudimentary at best, and this was in stark contrast to what I have observed in current medical students and young graduates – this is what piqued my curiosity and generated my interest in delving into this topic. Over the past two decades, through a series of career choices and changes, I have become much more aware of the inequities in the delivery of and access to health services, especially amongst rural and remote populations and socially disadvantaged groups. Over a similar time period, I have become more and more convinced of the value of LICs in undergraduate medical education. However, as outlined in Chapter 1, I was conscious throughout this research journey that my personal experiences could have an influence on the inferences and conclusions drawn, and this has been an ongoing topic of attention between me and the members of my supervisory team.

Over the past few decades, as Western societies have become more focussed on materialism and material gain, I believe many have become confused between the pursuit of pleasure and the pursuit of happiness. They have become convinced that focussing on material gain will bring happiness and that success is measured by material possessions. This can, unfortunately, have a flow-on effect on medical education programs and, I suggest, unless medical schools have a strong social accountability mandate and a program structure that encourages students and graduates to pursue careers focussed on serving geographic areas of workforce need and social disadvantage, graduates can emerge with a focus on pursuing high income-generating careers.

This research has been driven by a combination of factors. These include my own personal curiosity about the development of CR because of the relatively poor development of my own CR as a medical student compared with that of current medical students, and an interest in and a desire to know what role LICs play in the development of CR. I believe that understanding this role may serve to better engage with faculty development of staff who are involved with longitudinal programs, inform medical educators who are interested in designing and developing longitudinal programs, provide a narrative for those who need to defend longitudinal programs, and assist those who are embarking on curriculum reviews.

THEORETICAL UNDERPINNINGS

Reasons for using theory in medical education research

Theories provide conceptual understandings of areas of study that are difficult to explain, which helps us to understand them better or even perceive them in different ways (Varpio and Ellaway 2021). They are abstract descriptions of the relationships between concepts that help us to better understand the world and provide researchers with a range of lenses to study complex problems and social issues (Varpio et al. 2020). This, it is suggested, allows findings to be translated to principles for policy makers, healthcare providers and educators (Reeves et al. 2008). Theory informs research design, magnifies and illuminates analysis and interpretation of the findings, and allows for new theory to be generated (Kelly 2010). Good programmatic research should foster both theory testing and theory building (Bordage 2007). But more than this, good medical education research underpinned by theory should have a positive impact on education practice and ultimately on patient care (Gibbs, Durning, and Van der Vleuten 2011) – this is medical education research as translational science (McGaghie 2010).

Theories used in modern medical education research

Before choosing a theoretical framework for my research, I sought to obtain a general overview of the theories used in medical education research. By doing this, I was able to make a more deliberate choice of which theories and theoretical frameworks best fitted my research questions and were, therefore, best to use for my research. My description here is thus not intended to be a detailed study of all possible theories used in medical education research but is rather an overview. As a result, many of the references used are, again, overview papers and not necessarily original sources.

Dong et al. (2021) have provided a helpful framework for a general classification of learning theories in medical education. They categorised them under three broad headings: 1) theories based on cognitive psychology, 2) theories based on humanistic psychology, and 3) theories based on social anthropology. These are outlined in Table 2.1 below.

Table 2.1: Learning theories relevant to modern medical education (modified from Dong, et al. (2021))

Theories based on cognitive psychology:
• Cognitivism
  – Learners' engagement in information processing
  – Knowledge construction and schemas
  – Cognitive load theory
  – Theory of multimedia learning
• Cognitive constructivism
• Generative learning theory
• Experiential learning
• Reflection
• Vygotsky's zone of proximal development

Theories based on humanistic psychology: • Adult learning principles • Self-directed learning • Bourdieu's theory of practice • Complexity theory • Human motivation theory/Maslow's hierarchy of needs • Mezirow's transformative learning theory
Theories based on social anthropology: • Communities of practice and situated learning • Cognitive apprenticeship • Social constructivist theory • Socio-cognitive career theory • Bronfenbrenner's bioecological model of human development

Theories based on cognitive psychology

Theories based on cognitive psychology cover the broad areas of cognitivism, cognitive constructivism, generative learning theory, experiential learning, reflection, and Vygotsky's zone of proximal development. Cognitivist theories include learners' engagement with information processing, theory on knowledge construction and schemas/script theory, cognitive load theory, and theory of multimedia learning.

The theory of learners' engagement with information processing holds that humans are intrinsically learning beings that continually seek, organise, code, store and retrieve information. It also holds that humans have a strong tendency to store and retrieve meanings instead of exact reproductions of what is experienced, and teaching is thus more effective if it helps students to construct meanings more efficiently. These meanings become more valid when they have relationships to other knowledge and experience and are more readily and quickly retrievable (McKeachie 1980).

Theory on knowledge construction and schemas/script theory includes the theory of expertise in medicine, which was originally proposed to describe the development of medical problem-solving. It holds that knowledge development and organisation evolves through a number of stages (Sweller, van Merrienboer, and Paas 1998; Sweller, van Merrienboer, and Paas 2019; Schmidt, Norman, and Boshuizen 1990; Schmidt and Boshuizen 1993). However, this has now been described to also include the development of CR (Chamberland et al. 2021; Schmidt and Mamede 2015; Charlin, Tardif, and Boshuizen 2000; Charlin et al. 2007).

Cognitive load theory holds that human working memory is very limited in the number of elements that it can process simultaneously and is also limited in the time that these are retained (Van Merrienboer and Sweller 2010; Leppink and van den Heuvel 2015).

The theory of multimedia learning essentially means learning from both words and pictures. It holds that humans have two channels for processing information, that working memory is limited (cf., cognitive load theory), and that humans support cognitive processing of incoming material (cf., learner's engagement with information processing and knowledge construction and schemas) (Mayer 2010).

Cognitive constructivism theory holds that individuals create their own new understandings and meaning-making based on the interaction between what they already know and the knowledge

with which they come into contact (Richardson 2003). Individual learners construct meaning of phenomena which are idiosyncratic, depending on the learner's background.

This aligns closely with Vygotsky's zone of proximal development, which posits that there is a zone between the actual level of development determined by independent problem solving and the level of potential development as determined by problem solving under guidance or collaboration with peers (Harland 2003). Although this is, in essence, a cognitive theory, it also overlaps to some extent with social constructivist theory (see below). Also closely aligned to Vygotsky's zone of proximal development is the generative learning theory, which proposes that learning involves actively constructing meaning from new information by mentally reorganising it and integrating it with existing knowledge (Chamberland, et al. 2021).

Experiential learning, which has long been widely accepted in medical education, emphasises individual learning in the workplace (Mann 2011). It is closely linked to reflection (Aukes et al. 2008; Tanner 2012; Sandars 2009), complements situated learning (Mann 2011)(see below), and is underpinned by constructionist philosophy (Yardley, Teunissen, and Dornan 2012b). These concepts are reflected in Kolb's learning cycle of concrete experience, followed by reflection, then abstract conceptualisation and active experimentation (Yardley, Teunissen, and Dornan 2012a), which has gained widespread acceptance in medical education.

Theories based on humanistic psychology

Theories based on humanistic psychology include adult learning principles, self-directed learning theory, Bourdieu's theory of practice, complexity theory, human motivation theory/Maslow's hierarchy of needs, and transformative learning theory.

Adult learning theory, which encompasses a whole range of learning principles, overlaps heavily with other theories. In the late 1960s, Knowles proposed the term 'andragogy', which he defined as the art and science of helping adults to learn, and this was supported by five assumptions about adult learning: 1) adults have an independent self-concept and can direct their own learning, 2) adults have a reservoir of life experiences that provides a rich resource for learning, 3) adults have learning needs closely related to changing social roles, 4) adults are problem-centred and interested in the application of knowledge, and 5) adults are motivated to learn by internal rather than external factors (Merriam 2001). Taylor and Hamdy (2013) have attempted to summarise this by proposing a multi-theories model which has five phases: 1) a phase of dissonance, 2) a phase of refinement, 3) a phase of organisation, 4) a phase of feedback, and 5) a phase of consolidation.

Self-directed learning theory, also proposed by Knowles, is a complex area. It is defined as a process where individuals take the responsibility for determining their own learning needs and formulating their own learning goals, and encompasses three main components: process (including skills and abilities), personal attributes (including critical reflection ability, enthusiasm, life experience, motivation and self-concept), and context (including concepts such as culture, power and learning environment) (Sawatsky et al. 2017).

Bourdieu's theory of practice holds the view that objectivist and subjectivist approaches should be integrated. In practical terms, for medical education this means that the 'outer world' (i.e., the curriculum) should be integrated with the 'inner world' (i.e., the professional values of students and graduates), and that these two are (or should be) inseparable (Varpio and Albert 2013; Balmer, Richards, and Varpio 2015).

Complexity theory has generated much disagreement and debate, and finding a definition for it has proved elusive (Cristancho, Field, and Lingard 2019; Nunn 2007). However, in its simplest terms, it looks at how complex, non-linear systems and processes can generate simple outcomes (Norman 2011).

Jack Maslow (1943), an American sociologist, was arguably the leader in the field of theory around human motivation. He proposed a hierarchy of needs depicting five levels: physiologic, safety, belonging, esteem and self-actualisation (Hale et al. 2019). He developed transformative learning theory to describe what happens when people change their worldview when their thinking is challenged by a disorientating dilemma which acts as a trigger for reflection (Christie et al. 2015; Mezirow 1994). He argued that every individual has a particular worldview, and that if this is ingrained, it can sometimes take a disorienting dilemma to get them to change this.

Theories based on social anthropology

There are several theories based on social anthropology. These include situated learning in communities of practice, cognitive apprenticeship, social constructivist theory, socio-cognitive career theory, and Bronfenbrenner's bioecological model of human development.

Situated learning in communities of practice was first articulated by Lave and Wenger (1991). This incorporates guided participation and sees learners as being legitimate peripheral participants in healthcare delivery teams (Artemeva et al. 2017). It emphasises the social learning that occurs in medicine, and has roots in constructivist theory (Cruess, Cruess, and Steinert 2018).

Cognitive apprenticeship holds that the cognitive parts of learning medicine are different to learning manual skills that can be observed, such as those learned by tradesmen. Because of this significant difference, the model of instruction in cognitive apprenticeship should be to make thinking visible (Collins, Brown, and Holum 1991).

Cognitive constructivist theory holds that each individual constructs their world of experience through cognitive processes. Social constructivism recognises that experience and learning is derived from and preceded by social influences (Young and Collin 2004).

Socio-cognitive career theory, which is based on Bandura's general social cognitive theory, emphasises the means by which individuals exercise personal agency in their career development process. It combines personal and contextual and experiential factors as influences of career choices (Han, Roberts, and Korte 2015).

Bronfenbrenner's bioecological model of human development explores the multiple factors that influence and shape learners. These include individual, microsystem, mesosystem, exosystem and macrosystem factors (Hamwey et al. 2019).

Theories on behaviourism, which originated in the early part of the twentieth century, hold that only what can be directly observed and measured is accepted, and concepts such as consciousness, meaning and emotion are excluded. This group of theories morphed into the theory of extreme behaviourism, which sees behaviour as being determined by the interaction of the individual and the environment with no place for personal development, meaning, understanding or identity (Illeris 2018). In my view, these theories have no place in modern medical education and will thus not be discussed further.

As can be readily seen, there is connection and much overlap between many of these theories, even between theories that sit within different categories. Therefore, theories cannot and should not be seen to exist in isolation.

Theoretical framework for this research

There is a range of theoretical lenses that can be used within both a constructivist paradigm and a positivist paradigm when designing research to examine the topic of the development of CR in LIC medical students. However, the theories which I considered the most appropriate for this research include:

1. Script theory/development of expertise theory

2. Cognitive load theory
3. Communities of practice theory
4. Situated learning theory
5. Legitimate peripheral participation theory
6. Complexity theory

I will describe each of these theories in more detail, and then I will explain why I considered these to be the most appropriate. I will also describe how they combine within the context of the development of CR in a LIC to form a theoretical framework for this research.

Script/development of expertise theory

Theory on knowledge construction and schemas/script theory includes the theory of expertise in medicine. This holds that CR evolves through four stages of knowledge development and organisation: 1) the first stage is the development of causal networks of biomedical knowledge; 2) this is followed by knowledge becoming encapsulated into concepts which include the causal networks; 3) the next stage is the development of illness scripts, which are mental representations of diseases; and 4) the final stage is enrichment of this knowledge by exposure to examples from real patients (instances) (Chamberland, et al. 2021; Sweller, van Merrienboer, and Paas 1998; Sweller, van Merrienboer, and Paas 2019; Schmidt, Norman, and Boshuizen 1990; Schmidt and Boshuizen 1993).

Cognitive load theory

This theory, first proposed by Sweller in 1988, was based on the model of working memory suggested by Hitch and Baddeley (Debue and van de Leemput 2014; Sweller, van Merrienboer, and Paas 1998; Sweller 1988). As mentioned above, cognitive load theory holds that human working memory is very limited in the number of elements that it can process simultaneously and in the time that it is retained – this applies to new information only and not to information that is retrieved from long-term memory (Van Merrienboer and Sweller 2010; Leppink and van den Heuvel 2015).

Three types of cognitive load have been described: 1) intrinsic load, the load associated with the task in hand and which is a direct function of the complexity of the task involved and the expertise of the learner, 2) extraneous load, which is the load not essential to the task and is a result of superfluous processes that do not directly contribute to learning, and 3) germane load, which is the load imposed by the learner's deliberate use of cognitive strategies to re-organise information

in order to store in in long-term memory, i.e. to learn (Van Merrienboer and Sweller 2010; Debue and van de Leemput 2014; Young et al. 2014). It should be noted that there has been some debate around this model, as researchers in this field differ on the conceptualisation of the different types of cognitive load, as well as on the nature of the relationship between them (Debue and van de Leemput 2014).

It is important to recognise the considerable overlap and synergy between cognitive load theory and other cognitivist theories such as the theory of knowledge construction and schemas/script theory. This interconnection is particularly relevant because scripts or schemas greatly reduce working memory load. Notably, even highly complex schemas can be dealt with as one element in working memory rather than many elements, as highlighted by Van Merrienboer and Sweller (2010). As will become apparent later, the overlap of these theories is of particular relevance to this research.

Communities of practice theory

Situated learning in communities of practice was first articulated by Lave and Wenger (1991). Communities of practice have been defined as groups of people who share an interest in a domain of human endeavour and engage in collective learning that creates bonds between them (Parboosingh 2002). Although not originally developed for healthcare settings, it fits very well into this space, and Cruess, Cruess, and Steinert (2018) believe that it has the capacity to encompass the multifaceted nature of medicine's knowledge base, including its foundations in biomedical science, the professional identity of physicians, and its rich mix of tacit and explicit knowledge. It incorporates guided participation and sees learners as being legitimate peripheral participants in healthcare delivery teams (Artemeva, et al. 2017). It has its roots in constructivist theory and emphasises the social learning that occurs in medicine (Cruess, Cruess, and Steinert 2018).

Situated learning theory

Communities of practice have been closely linked to the theory of situated learning through emphasising the social nature of learning. Learning is a social activity with the learner being situated in the community which is given authenticity because it is acquired in the same context to which it is applied (Cruess, Cruess, and Steinert 2018).

Legitimate peripheral participation theory

Closely linked to community of practice theory as well as situated learning theory, is the theory of legitimate peripheral participation, also proposed by Lave and Wenger (1991). It holds that the

learner undertakes experiential learning (or learning by doing) by becoming a member of a community of practice, initially as a legitimate peripheral participant (or novice member), and gradually moving closer to the centre of the group in a centripetal way to become a full member of the community (Cruess, Cruess, and Steinert 2018). As described by Bartlett, Rees, and McKinley (2017), students move from becoming 'knowledge leeches' to being accepted as contributors to the healthcare of patients.

Complexity theory

Complexity theory examines how complex, non-linear systems and processes can generate simple outcomes (Norman 2011). Three types of complexity have been described: algorithmic complexity, deterministic complexity and aggregate complexity (Cristancho, Field, and Lingard 2019). Although all three are concerned with how the nature of a system can be characterised by its constituent parts, the first two largely reflect a positivist stance. Aggregate complexity, by contrast, offers a representation of a phenomenon by describing relationships between entities like clinical teams and the interactions that students have with them. Phenomena, events and actors in these entities are viewed as mutually constitutive and dependent and emerge together in dynamic structures (Fenwick and Nimmo 2015).

How these theories combine to form a theoretical conceptual framework

For effective learning to occur, especially during LICs, I propose that there are three main domains:

1. The student
2. The learning environment
3. The clinical supervisor

The student

There are some who believe that CR can and should be formally taught (Round 1999). Schmidt and Mamede (2015) feel that formal instruction in CR is necessary due to the limited number and variety of patients that students are exposed to on placements in hospital wards during traditional block rotations (TBRs). However, an opposing view is that teaching CR as a generic skill that can be applied to any clinical problem lacks empirical evidence (Gruppen 2017). This is because CR is highly content, domain and context specific, and it depends on a minimum amount of underlying content knowledge. However, this knowledge is domain-specific, and the networks of knowledge and illness scripts that students are still in the process of developing are highly domain-specific and idiosyncratic (Schuwirth 2009; Schuwirth 2002). It is thus logical to conclude that standard

teaching approaches will not be effective for the generic, generalisable or hypothetical development of CR, and it can thus more effective for it to be learned rather than formally taught.

It is now accepted that the development of CR takes time, exposure to a diversity of patients, and the repeated practice of solving clinical cases (Hemmer et al. 2015). Students must be directly involved with clinical problem solving and also have opportunities for reflection (Chamberland et al. 2015). The process of reflection serves to reiterate the clinical encounter, engages students' metacognition (or thinking about their thinking), and strengthens and expands knowledge stored in long-term memory.

There are two theoretical models that fit well within this domain. These are: 1) cognitive load theory, and 2) the development of expertise theory.

As outlined above, cognitive load theory posits that human working memory is very limited in the number of elements that it can process simultaneously and in the time that it is retained – this applies to new information only and not to information that is retrieved from long-term memory (Van Merrienboer and Sweller 2010; Leppink and van den Heuvel 2015). When a student first commences clinical clerkships, they do not have much information within their long-term memory and there is a lot of new extraneous information being processed; cognitive load is thus very high. In the TBR model of clinical clerkships, there is likely to be much extraneous cognitive load at the start of every rotation as a result of having to settle into new clinical teams and environments, and this adds to the high overall cognitive load and, this theory suggests, detracts from learning.

The development of expertise theory (also known as script or schema theory) holds that the development of expertise in general and of CR in particular follows the four stages outlined above, namely causal networks of biomedical knowledge, knowledge encapsulation into concepts, the development of illness scripts, and enrichment of this knowledge. As students see exemplars of a range of clinical cases in real patients, it reinforces and expands the illness scripts and schemas stored in long-term memory which is, in theory, unlimited in capacity and can readily be retrieved when required (Young, et al. 2014).

Cognitive load theory and the development of expertise theory fit well together and are, I suggest, complementary. As expertise develops and grows, information retained in long-term memory increases, and as a result there is a corresponding decrease in cognitive load.

The learning environment

According to the definition of communities of practice given above, every healthcare delivery setting can be considered a community of practice, whether it be in a hospital inpatient setting, in a hospital outpatient setting, or in a healthcare setting in the community. This theory suggests that students learn in these communities by doing and by becoming legitimate peripheral participants, in other words they are accepted as a member of the healthcare delivery team. Not only does their expertise develop and grow, but so does their identity as a member of the group, which includes the acceptance of the norms and values of that group (Cruess, Cruess, and Steinert 2018). This makes an important contribution to the formation of students' professional identity.

The supervisor

For effective learning to occur, the manner in which the student is linked with the learning environment is critical to its success or failure. The clinical supervisor plays a key role in this process, and there are multiple factors that come into play. The clinical supervisor is simultaneously providing guidance to the student whilst also providing healthcare to his or her patients, and these demands can be seen to be in competition with each other. Other factors that come into play include the personalities of both the supervisor and the student, cultural issues, communication styles and learning styles. The ultimate goal of clinical supervision is to develop students into healthcare professionals who can adapt, transfer and apply their knowledge effectively, in other words, have good agility of thinking (Pront and Gillham 2017). Students learn by being situated in the community of practice, and in return make contributions to the community of practice as legitimate peripheral participants. This is all achieved under the expert guidance, direction, and mentorship of the clinical supervisor.

Pront, Gillham, and Schuwirth (2016) describe four key areas (or domains) for successful clinical supervision: 1) partnership, 2) nurturing, 3) enabling and 4) facilitating meaning. Partnership means establishing a good relationship and developing common views about the purpose of the supervision, and it includes communication, trust, and respect. Nurturing is about the supervisor's ability to assist the student to transition and socialise into a new learning context and to ensure that the student is established as part of the healthcare delivery team. Enabling is the ability of the supervisor to recognise, promote and encourage learning opportunities within the healthcare setting and to recognise the student as a colleague. Facilitating meaning includes the ability to understand how the learning world and the clinical world combine in importance and relevance to practice, as well as promoting an understanding of professional behaviour and critical thinking.

The relationship between student and preceptor, and ultimately between student and the learning environment is not linear but is, rather, a highly complex one. For this reason, I considered it important to include complexity as the underpinning theory because it encompasses the entire learning process, the relationships that situated learning brings, and especially within LICs, that they occur over time and without a pre-determined curriculum.

Figure 2.1 below depicts the relationship between the domains and the key theories that underpin each.

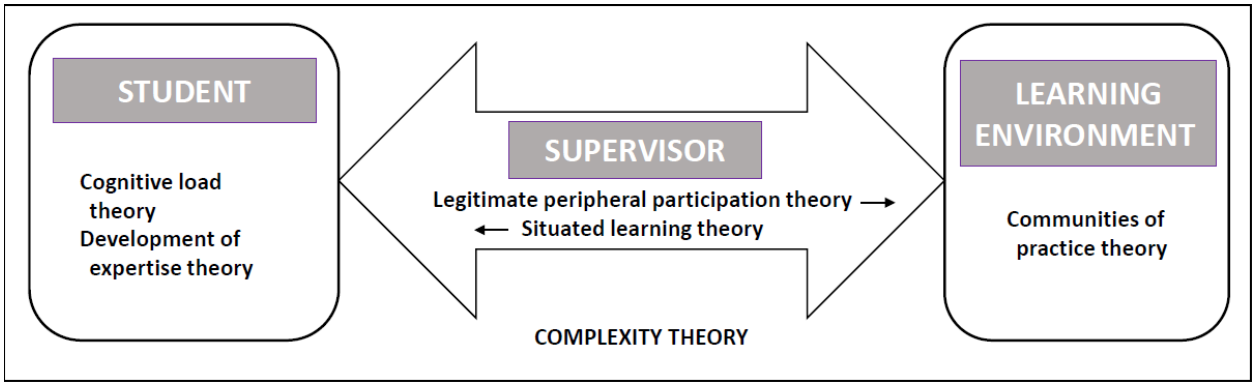

Figure 2.1: Theoretical conceptual framework for the development of clinical reasoning during longitudinal integrated clerkships

IN SUMMARY

The primary interactions in the development of CR in medical students occur between the student and the learning environment, and these are facilitated by the relevant clinical supervisor. There is a range of learning theories that inform this research: cognitive load theory and development of expertise theory for the student, community of practice theory for the learning environment, and legitimate peripheral participation theory and situated learning theory for the supervisor. These interact with each other in multi-faceted and complex ways, and thus complexity theory is seen as the underpinning theory that encompasses all these interactions.

CHAPTER 3:
SCOPING REVIEW OF THE LITERATURE OF CLINICAL REASONING IN LONGITUDINAL INTEGRATED CLERKSHIPS

"EDUCATION IS NOT THE LEARNING OF MANY FACTS, BUT THE TRAINING OF THE MIND TO THINK."
– ALBERT EINSTEIN (1879-1955)

This chapter outlines the initial scoping review of the literature on the development of clinical reasoning (CR) during longitudinal integrated clerkships (LICs) that was undertaken prior to the development of the quantitative studies described in Chapter 4.

INTRODUCTION

At the outset of this chapter, it is important to acknowledge and emphasise the pivotal role of CR in and importance to good medical practice. Although much of the interest in CR has been largely from the perspective of reducing medical error, it is often seen as an ability or a characteristic of individual clinicians. However, it is important to note that CR is domain (or content) specific, it is idiosyncratic, and it is highly context specific.

Domain or content specificity refers to the inability of predicting the performance of a clinician on a problem based on their performance in another problem, even within the same specialty (Mamede 2020; Swanson, Norcini, and Grosso 1987). Idiosyncrasy in CR refers to the fact that illness scripts which are stored in long term memory vary from clinician to clinician based on their unique history of learning and experience, despite having common foundational knowledge (Parsons, Wijesekera, and Rencic 2020; Bleakley et al. 2003). Context specificity refers to the phenomenon of a physician arriving at two different diagnoses for two different patients who have the same symptoms, findings and ultimately the same diagnosis (Durning et al. 2012a; Konopasky et al. 2020a). This means that CR is not formulaic or generic, and that it goes far beyond the individual characteristics of clinicians.

Due to the deeper relationships that develop between student and supervisor during LICs, coupled with the unique student/patient interactions that occur in this learning environment, they are by design intended to be more context-rich than traditional block rotation (TBR) clinical clerkships (Kelly, Walters, and Rosenthal 2014; Laksov, McGrath, and Josephson 2014; Bansal et al. 2020). Students participating in these models of medical education are immersed in clinical environments that offer many opportunities for situated learning. This immersion should theoretically provide

them with greater opportunities to develop illness scripts and, consequently, have improved levels of CR. It is, therefore, logical to question if LICs lead to better CR and explore what the published literature has to say about this.

To further explore the relationships between LICs and CR outcomes or comparing the impacts of LICs and traditional clerkships in terms of CR outcomes, I decided to conduct a scoping review of this topic. The articles were initially identified and selected by me in close communication with my main supervisor. In keeping with the overall purpose of scoping reviews, the purpose of this review was purely to describe the breadth of knowledge relating to this particular question, and it adopted a subjectivist epistemological approach (Thomas et al. 2020).

METHODS

This scoping study followed the framework set out by Arksey and O'Malley (2005). This framework outlines five distinct stages: 1) identifying the research question, 2) identifying relevant studies, 3) study selection, 4) charting the data, and 5) collating, summarising and reporting the results.

Stage 1: Identifying the research question

The research question that guided this review was: What direct impacts do LICs have on the development of CR in medical students who participate in them?

Stage 2: Identifying the relevant studies

The literature was searched using four online databases, limiting the search results to articles published in English. This was followed up by undertaking secondary searches of reference lists in articles found during the database searches as well as hand searched journals. The online databases searched were PubMed Central, Medline, ERIC and PsycINFO, and the search strategy developed was based on the research question and by workshopping the search terms.

Search terms for all four of the online databases were the same. In order to capture as many published articles as possible, they included the phrases and Boolean connectors as depicted in Table 3.1 below.

Table 3.1: Relationship of search terms and Boolean connectors (bold).

longitudinal clerkship* **OR** longitudinal placement* **OR** rural clerkship* **OR** rural placement*
AND
clinical reasoning **OR** clinical decision making **OR** clinical problem solving **OR** medical reasoning **OR** diagnostic reasoning **OR** diagnostic decision making

Stage 3: Study selection

Articles were excluded if the titles and abstracts did not meet the key words in the search strings. Inclusion was based on titles or abstracts that contained the reference 'clinical reasoning' (or an alternative phrase) in relation to longitudinal programs. There was no limitation in terms of year of publication or of study design. Full text articles that definitely or possibly met the inclusion criteria were downloaded and reviewed, which led to the next stage.

Stage 4: Charting of data

All extracted full-text articles were managed in an Endnote database file. A data form was developed using a Word document for each database, and the final articles selected were collated a separate Word document.

Stage 5: Collating, summarising and reporting of results

The scoping review findings are described narratively in the Results section below to provide insight into the content of each of the full-text articles examined.

RESULTS

Overview

The initial database search yielded 316 articles, of which six were duplicates (which were removed). A secondary search yielded an additional sixteen articles. After an examination of the titles and abstracts of these 326 articles, 300 were deemed to not meet the inclusion criteria. The remaining 26 articles were downloaded for examination of their full text. Of these, 13 were deemed not to meet the inclusion criteria and were excluded. This left 13 articles included in the final synthesis (see Figure 3.1 below).

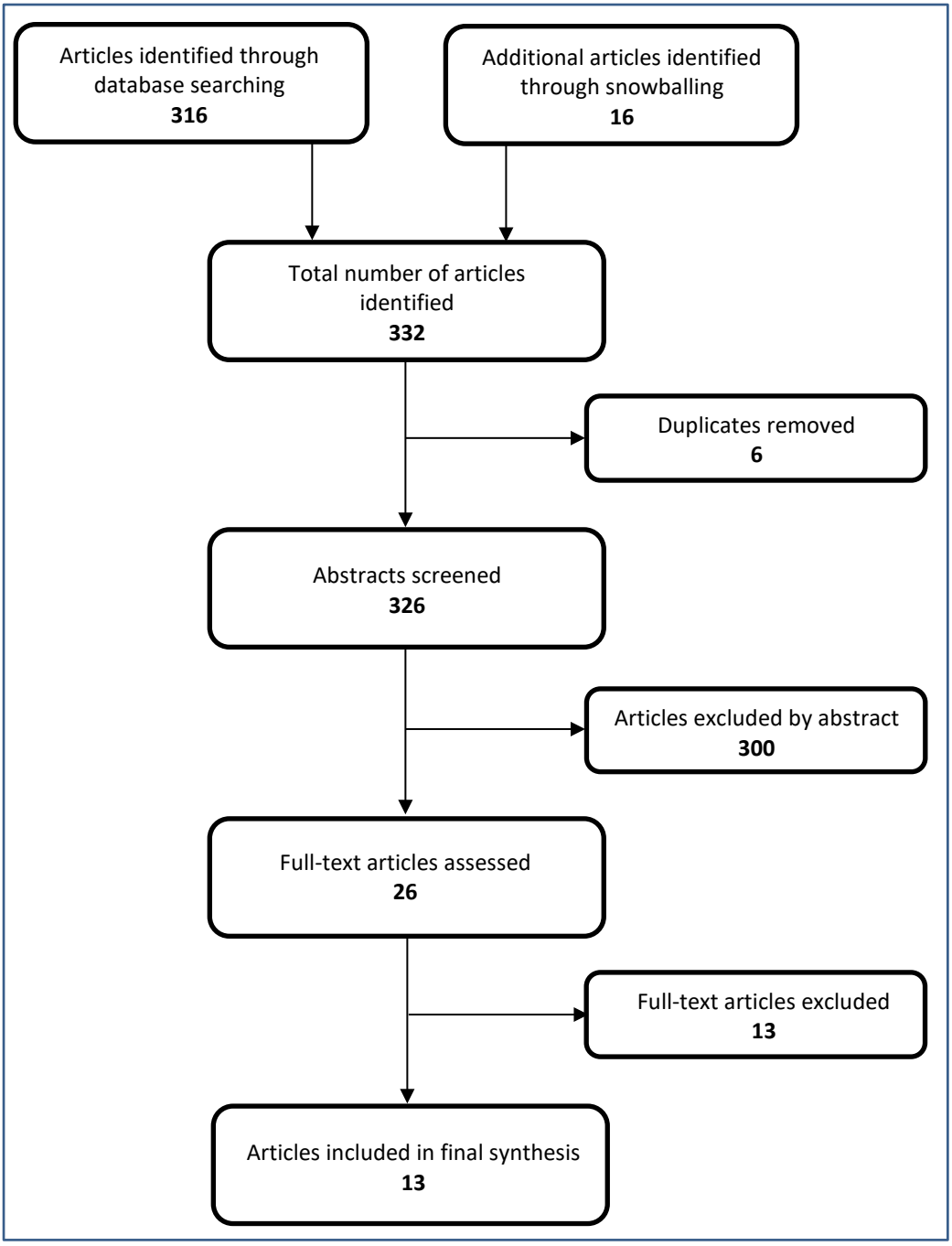

Figure 3.1: PRISMA diagram of document search.

Characteristics of the included studies

The literature on the development of CR during LICs as discussed in the 13 included articles were divided into two broad categories (see Table 3.2 below):

1. Articles that are author opinions claiming that there is a positive relationship between LICs and CR (three articles)
2. Studies directly examining the relationship between LICs and the development of CR (ten articles)

The second category also included three sub-categories:

a. Student self-reports (six articles)

b. Preceptor opinions or reports (three articles)

c. Both student self-reports and preceptor opinions or reports (one article)

Table 3.2: Summary of the 13 articles found examining the link between LICs and development of CR.

Theme	Sub-theme	Article	Study type	Outcome
Author opinions		Greenhill and Poncelet (2013)	Opinion	The LIC model promotes the development of CR
		Kelly, Walters, and Rosenthal (2014)	Opinion	The LIC model promotes the development of CR
		Greenhill and Walters (2014)	Opinion	The LIC model promotes the development of CR
Studies examining the relationship between LICs and CR	Student self-reports	Bansal, et al. (2020)	Mixed methods	Students reported that their CR had been broadened and improved
		Van Schalkwyk et al. (2014)	Qualitative	Students reported that their CR had been enhanced
		Banh, Ramirez, and Thabit (2014)	Likert scale survey	Students reported that the LIC model had improved their CR
		Walters et al. (2012)	Literature review	Reported an increased development of higher order cognitive skills
		Poncelet and Hudson (2015)	Literature review	Reported an increased development of higher order cognitive skills
		Greenhill et al. (2018)	Qualitative	Reported increase in clinical scepticism in LIC students compared with non-LIC students, which by implication results in improved CR
	Preceptor reports/ opinions	Teherani et al. (2009)	Qualitative	Reported an increase in CR, but comparable to non-LIC students
		Hauer et al. (2011)	Qualitative	Students all progressed in their CR development, but at different rates
		Campbell et al. (2017)	Modified Delphi	The longitudinal relationships between students and preceptors had a positive effect on CR
	Combination reports	Graham et al. (2019)	Online survey	Students reported a large increase in their ability to formulate differential diagnoses and management plans (in an intercalated emergency medicine degree, not a true LIC)

1. Author opinions

The first two of the three author opinion articles included in this review were descriptive commentaries on the nature of LICs and why these should theoretically lead to the development of better CR in students who participate in them (Greenhill and Poncelet 2013; Kelly, Walters, and Rosenthal 2014). Greenhill and Poncelet (2013) concluded that because students in LICs are immersed in socially connected communities and have a more patient-centred approach to medical practice, this leads to a different frame of reference to that of students in TBRs and thus a less cognitive learning approach in the development of CR. Kelly, Walters, and Rosenthal (2014) concluded that because learning of students in LICs is contextualised around particular patients and prevalent diseases and because is takes place in familiar and supportive educational and social environments, CR skills are able to mature.

The third author opinion article is a one-page perspective piece which posits that because students in LICs have a reduced cognitive load, this contributes to the development of CR (Greenhill and Walters 2014).

2. Studies examining the relationship between LICs and the development of CR

The range of studies examining the relationship between LICs and the development of CR were a combination of qualitative studies, quantitative studies, mixed method studies, literature reviews, and one Delphi-like study. They involved deriving information from students or preceptors, with one study including both students and preceptors.

a. Student self-reports

All the studies involving students were student self-reports in one form or another, and almost all were based on small student numbers in single programs.

A study from the United Kingdom, in which groups of 28 medical students undertook a 12-week hospital-based 'LIC' with GP-facilitated case-based discussions focussed on stimulating the development of CR. This program was evaluated utilising a 6-question 5-point Likert scale survey with free-text boxes to explain their rating after each question, as well as four qualitative focus group interviews using the same six questions as the survey (Bansal, et al. 2020). All 213 participating students were invited to respond to the survey, but is it not reported how many actually responded. Thirty-one students participated in the focus groups, but neither of these evaluation interventions were framed by theory. The study concluded that students reported that

their CR had been broadened and improved, but there is no clear evidence that the intervention was the direct cause of this effect.

Another study from South Africa used a qualitative approach for determining perceptions of eight students of their experiences, including the development of their CR (Van Schalkwyk, et al. 2014). Six of these students were involved in a TBR-type placement in a rural hospital, while just two were involved in a true LIC which, even for a qualitative study, is a very small number and there is no way of knowing if data saturation was reached. Although preceptors and other clinical staff were also interviewed, the study reported on student data only, which concluded that their CR had been enhanced. No distinction was made between the TBR students and the LIC students, and the study was not framed by any theory.

A study from the United States utilised a Likert scale survey of student perceptions of the development of their CR during an emergency medicine LIC (Banh, Ramirez, and Thabit 2014). The students self-reported that this longitudinal clinical exposure overwhelmingly contributed to the development of critical judgement and ability to formulate differential diagnoses/treatment plans. However, this quantitative self-evaluation does not indicate how the exposure brought this outcome about. This study was also not framed by any theory.

Two of the articles were literature reviews, and both reported on the development of student higher order cognitive skills but did not specifically report on the development of CR (Poncelet and Hudson 2015; Walters, et al. 2012). Walters, et al. (2012) concluded that in comparison with TBR students, LIC students have a range of well-developed skills, including greater preparedness in higher-order clinical and cognitive skills. Poncelet and Hudson (2015), in their review of the literature, agree with the stance of Walters, et al. (2012), but this is largely based on their article.

One qualitative study, which examined longitudinally the progress of a cohort of 20 students involved in a rural LIC, an urban community and hospital based model, and a TBR model, found that clinical scepticism was evident in LIC students and urban and community based model students, but not in TBR students (Greenhill, et al. 2018). Clinical scepticism, they posit, is something that develops covertly as CR and judgement develop, and that a lack of clinical scepticism implies that the context in which learning occurs influences the development of critical thinking.

b. Preceptor opinions/reports

Three studies focussed on the personal observations and perceptions of preceptors, two of them in single programs.

The first study was a qualitative analysis of interviews with preceptors who were able to compare their teaching experiences of LIC students with that of non-LIC students (Teherani, et al. 2009). The preceptors indicated that the CR of LIC students progressed over the course of the year, but that this improvement was comparable to that of students in non-LIC programs. It utilised a grounded theory approach to the qualitative analysis.

The second study used the Reporter-Interpreter-Manager-Educator (RIME) framework to evaluate preceptors' quarterly group discussions on student performance during a hospital-based LIC in the United States (Hauer, et al. 2011). All preceptors described students progressing in the development of their CR, albeit at different rates. This was ascribed to the longitudinal relationships with students that were able to be developed, but here was no comparison with non-LIC students.

The third article was a modified Delphi study of nineteen academics and preceptors involved in rural LICs who attended a workshop on their understanding of the teaching of CR (Campbell, et al. 2017). The workshop was deliberately planned to utilise a constructivist approach. A major finding was the quality of feedback that can be given as a result of the longitudinal relationships that develop during LICs, and that this was seen to have a positive effect on the development of CR.

c. Student and preceptor reports

One article reported on both student and preceptor perceptions of the development of CR (Graham, et al. 2019). This was a survey of students, former students and clinical preceptors of a year-long intercalated degree between the penultimate and final year in emergency care at one medical school in the United Kingdom. This program is not a true LIC as defined by the Consortium of Longitudinal Integrated Clerkships (Norris et al. 2009). However, its findings are still relevant to this discussion. Although numbers were relatively small, in the student and former student responses a large increase in the ability to formulate diagnoses and management plans for patients was perceived.

DISCUSSION

This scoping review aimed to review the published literature to determine what direct impacts LICs have on the development of CR in medical students who participate in them. What it found was that evidence to date for this development is weak, because it is based largely on opinions, perceptions and student self-reporting. However, nothing was found on 'how' and 'why' this could be so, or a study that demonstrates 'how much' of an impact LICs have on this aspect of student development.

This study has some limitations. The first is that the number of articles retrieved which met the inclusion criteria was relatively small. The second limitation was that the numbers of institutions that contributed to the literature on this topic and the geographic spread of these institutions was also small. In addition, the fact that as supervisor/student interactions are complex and adaptive, societal and generational cultural mores impact on these complex adaptive systems (Ogden, Kilpatrick, and Elmer 2023; Valentine et al. 2023)

This review has revealed a considerable gap in the published literature, with a lack of robust evidence of how this pedagogical approach to medical education works in terms of the development of sound CR. To contribute to filling this gap in the evidence, the next stage of my research was to focus on two studies to quantitatively measure the development of CR students in one LIC program – these can be found in the following chapter.

CHAPTER 4:
AN ANALYSIS OF TWO QUANTITATIVE STUDIES OF CLINICAL REASONING

"NOT EVERYTHING THAT CAN BE COUNTED COUNTS, AND NOT EVERYTHING THAT COUNTS CAN BE COUNTED."
– WILLIAM BRUCE CAMERON, 1969

This chapter describes two quantitative studies that were undertaken in an attempt to answer the *how much* questions about the development of clinical reasoning (CR) in longitudinal integrated clerkship (LIC) students from a realist perspective. It discusses the difficulties in using this approach and how it led to a different understanding of the development of CR within a LIC context, and a consequent change in direction of this research.

INTRODUCTION

As outlined in the preceding chapters, it is widely accepted that CR is a core function of good and safe medical practice. However, despite intensive interest and study over the past few decades, it remains an elusive concept to define and to measure (Young, et al. 2018b).

The availability of relevant knowledge and the ability to retrieve this knowledge when needed is a major factor in the CR process (Eva 2005). According to one theory, prototype theory, knowledge of a particular topic is structured in memory around key cases (scripts) or key examples (exemplars) (Schmidt, Norman, and Boshuizen 1990; Regehr and Norman 1996; Charlin, Tardif, and Boshuizen 2000; Bowen 2006; Charlin, et al. 2007; Durning, et al. 2013a; Delavari et al. 2020). The difference between strong and weaker clinical reasoners is found not in the thinking or problem-solving strategies used, but rather in the way that knowledge is organised and stored in long-term memory (Van der Vleuten and Newble 1995; Schmidt and Rikers 2007).

In an attempt to measure the development of CR during the LIC of University of Wollongong (UOW) medical students, two quantitative studies were explored. The first was to apply a method of measuring the semantic and syntactic content of clinical case presentations, developed by Bordage and colleagues during the 1980s and 1990s, to the written clinical log entries by UOW medical students. The second was to measure the CR components of UOW written and clinical examinations conducted at the conclusion of the students' LICs. This chapter describes these two approaches and the outcomes in terms of attempting to measure CR in students during and at the end of their LIC at UOW.

STUDY 1: A CROSS-SECTIONAL ANALYSIS OF STUDENT CLINICAL LOG ENTRIES FOR SEMANTIC AND SYNTACTIC CONTENT AS A MARKER FOR THE DEVELOPMENT OF CLINICAL REASONING

Introduction

Background

It has been proposed that the language used by clinicians provides insight into the way that their knowledge is organised and thus, by extension, insight into their CR processes (Eva et al. 2010). Research undertaken by Bordage and colleagues in North America during the 1980s and 1990s demonstrated that the semantic and syntactic content of clinical case presentations has a direct correlation with and is a reliable marker of CR abilities (Bordage and Lemieux 1991; Bordage et al. 1997). They counted the frequency of use of semantic qualifiers during clinical case presentations and found that there was a direct correlation between the number of semantic qualifiers used and CR expertise. By using this methodology, they were able to show that it was not only possible to distinguish various levels of mental processing within groups of novices (e.g., junior medical students), but that it was also possible to identify similarities between novices and experts who successfully solved a case (Bordage and Lemieux 1991).

Two theoretical frameworks underpin Bordage's work: structural semantic theory and syntactic theory. Structural semantic theory maintains that knowledge is given meaning through networks of relationships represented by dichotomous abstract qualifiers or axes, for example acute/chronic, immediate/delayed, proximal/distal, localised/systemic, etc. This captures the meaning assigned to the symptoms and signs. Syntactic theory, by contrast, captures the rules of inclusion of symptoms and signs (Bordage and Lemieux 1991).

From a structural semantic perspective, every symptom or sign can be divided into two levels:

- An elementary level (i.e., the 'substance')
- A deeper level (i.e., the 'form')

The main difference in the clinical discourses *between* strong and weak diagnosticians lies in their semantic competencies, which demonstrates the dynamic relationship between abstract qualities in interpretation of clinical data and the ability to generate accurate diagnoses. More experienced diagnosticians will use a greater number of distinct semantic axes in their case presentations than inexperienced diagnosticians. This method also makes it possible to distinguish various levels of competency *within* a group (e.g., students at the same level of training).

As a result of this work, Bordage proposed four categories of discourse based on two organisational dimensions: a semantic dimension measured by the number of semantic qualifiers used, and a syntactic dimension measured by the extent (length) of the discourses (Bordage 1994; Bordage, et al. 1997; Chang, Bordage, and Connell 1998; Bordage 2007). These four categories are:

1. Reduced (originally termed 'empty economy') – limited semantic content and limited discourses
2. Dispersed (originally termed 'empty dispersion') – limited semantic content and extended discourses
3. Compiled (originally termed 'full economy') – semantic richness and limited discourses
4. Elaborated (originally termed 'full dispersion') – semantic richness and extended discourses (see Figure 4.1 below).

There was initially a fifth category termed 'intermediate', which alternated between full and empty dispersion forms within a case (Lemieux and Bordage 1992), but this appears to have been abandoned in later work.

		Syntactic dimension	
		Limited	Extended
Semantic dimension	Limited	REDUCED	DISPERSED
	Rich	COMPILED	ELABORATED

Figure 4.1: Graphical representation of Bordage's categories of discourses in medical case presentations

Objectives

This study aimed to determine if the method developed by Bordage and colleagues of quantifying semantic and syntactic content of clinical case presentations could be applied to written case entries in the electronic clinical log by medical students engaged in the UOW LIC program. If this was determined to be a valid method of quantifying their CR, it could be used for wider analysis of the development of CR in students during this part of their clinical training years.

Methods

Study design

This was a cross-sectional analysis of medical student long case format entries in their electronic clinical log for semantic and syntactic content to determine their CR ability, in order to validate the method used by Bordage and colleagues to oral clinical case presentations.

Setting

All senior medical students at UOW participate in a year-long LIC distributed across 11 'hubs' (of varying sizes) within the state of New South Wales (NSW), Australia. Each hub has its own unique identity and range of learning opportunities (see Chapter 1 for a broader description on these hubs).

All students are required to keep an electronic clinical log for the duration of the LIC, the purpose being to encourage reflective thinking and as a mechanism for identifying gaps in their clinical experiences. Each LIC student undertakes a quarterly Student Performance Review (SPR) with their respective hub Regional Academic Leader (RAL), and an examination of a summary of the clinical log entries forms part of this review. The summary provides de-identified information on the number of patients seen, demographic information about the patients (age groups and gender), type of involvement with each patient (taking a history, performing a physical examination, observing a clinical interaction, patient education/counselling, assisting with a procedure, or undertaking a procedure), and type of clinical presentation (mapped to the 93 core clinical presentations). In making the entries, students are encouraged to think about the case as they enter it into the log. It is easy for the student and for the RAL to quickly determine if the student is missing out on having clinical contact with any particular age or gender demographics, types of clinical contact, and types of clinical presentations. The RAL has the capacity to grade a student at the time of each quarterly SPR to as Excellent, Satisfactory, Unsatisfactory with Recommendations, or Unsatisfactory. It thus forms part of their work-based assessment throughout the duration of the LIC.

The electronic clinical log system has long form and short form format of making entries. The long form format is to record patient encounters that are meaningful, challenging or that stimulate learning. Students are required to make at least one long case entry per week and as many short case entries as possible.

Participants

All 66 students undertaking their LIC from July 2018 to June 2019 were invited to provide consent for the de-identified long-form cases from their clinical log to be analysed (this was an unusually small cohort), and ten of the 66 students (15%) agreed to participate in this study. A condition of the ethical approval was that no further details of these participants (age, gender, location of LIC, etc.) was to be provided for confidentiality reasons. As some of the hubs have small numbers of students, it was considered possible to identify individual students if their hub locality was known. Ethical approval was provided by the UOW Human Research Ethics Committee (approval HREC2019/308).

Variables

Through their year-long LIC, the ten students collectively recorded a total of 301 long case entries in the clinical logs, averaging 30.1 cases per student. The 301 cases were extracted from the server and de-identified (in terms of both student and patient details) prior to being provided to me. Each entry was analysed for semantic content (number of semantic axes used) and syntactic content (total word count of each entry).

Statistical methods

The number of semantic qualifiers and the word count for each of the entries was averaged by student, and each was then ascribed to one of the four categories described by Bordage: 1) Empty Economy (semantically and syntactically poor), 2) Empty Dispersion (redundant syntax with low semantic content), 3) Full Dispersion (redundant syntax with semantic richness), and 4) Full Economy (reduced syntax with semantic richness). The boundary between the mean of each student's entries being semantically poor or rich was arbitrarily set at four semantic axes. The boundary between the mean of each student's entries being syntactically limited or extended was arbitrarily set at 100 words. A different standard for determining these cut-off points for these written records as compared to verbal presentations was made because written records are by nature bare-bones summaries of clinical cases whereas verbal presentations tend to be more expansive.

In a further step to determine the trajectory of any development of CR in the ten students, the semantic and syntactic content of the first and last entries of each student were compared to determine if there had been any significant positive change between the start and the end of their LIC.

Results

When categorised according to Bordage's four categories, three students were in the Empty Economy group, three in the Empty Dispersion group, three in the Full Dispersion group and one in the Full Economy group (see Figure 4.2).

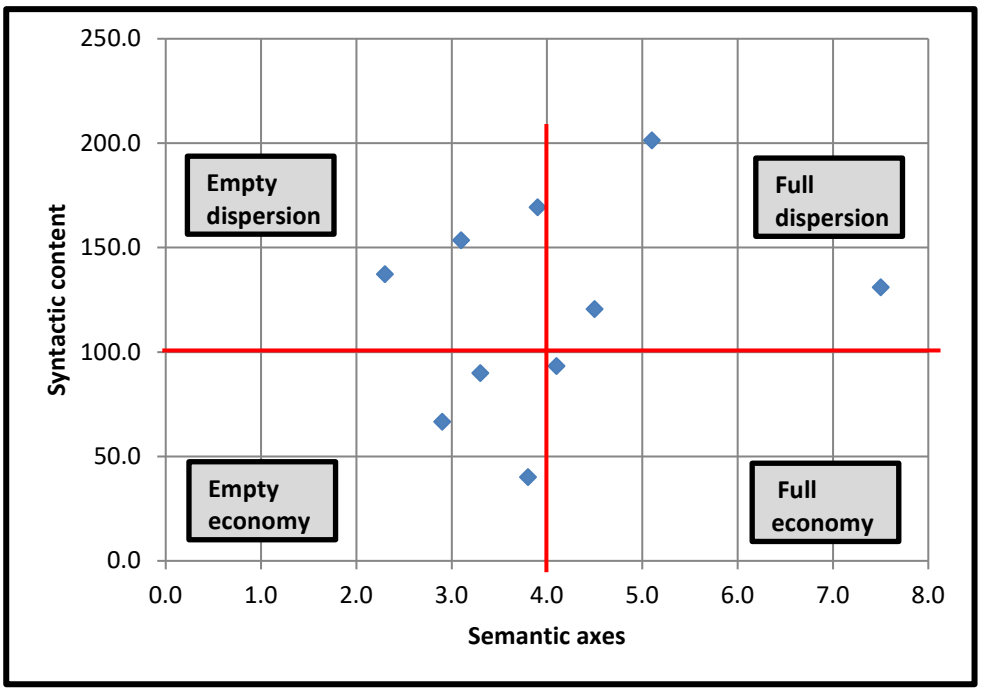

Figure 4.2: Distribution of students (n=10) by semantic and syntactic content

Four of the ten students were classified as having semantic richness in their clinical log entries, with a mean of 4.53 semantic axes per entry. The remaining six students were classified as being semantically poor, with a mean of 3.22 semantic axes per entry. The majority of the four students who had semantically rich entries fell into the Full Dispersion category (see Figure 4.3). This aligns closely with the findings of Bordage and colleagues.

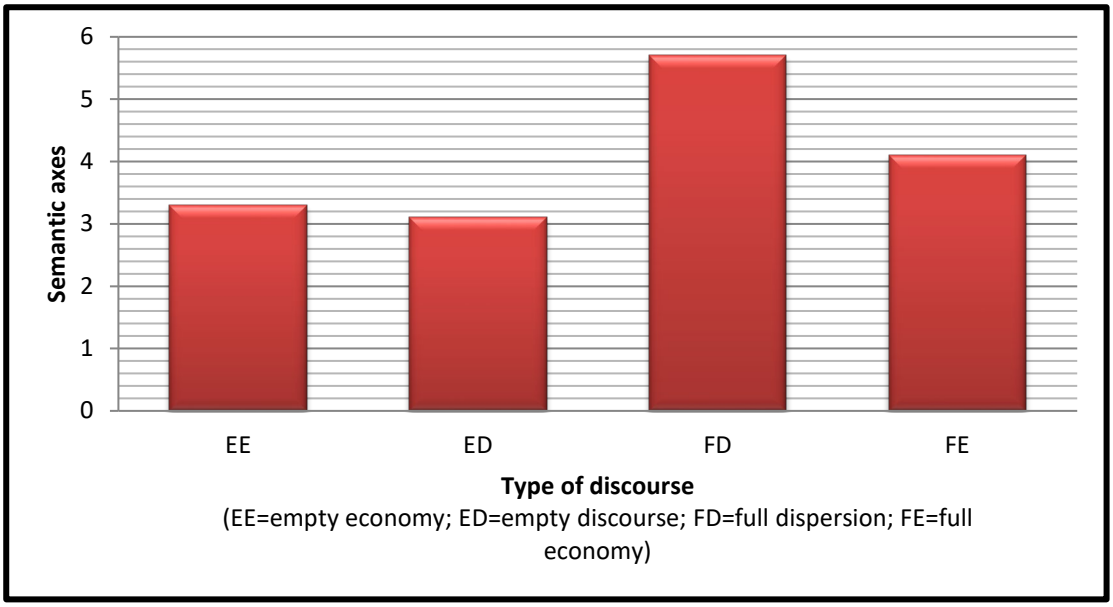

Figure 4.3: Mean number of semantic axes per case for each type of discourse.

When comparing the students' first long case clinical log long case entry with their last, one student had a significant increase in syntactic content, and another student had a significant increase in both semantic and syntactic content. The rest remained the same or had a decrease (see Table 4.1). The mean of these parameters across all ten students showed a decrease in both parameters.

Table 4.1: Comparison of semantic and syntactic content of first and last entries of student long entry clinical log cases.

Student	Semantic qualifiers		Syntactic content	
	First	Last	First	Last
1	7	6	39	30
2	10	5	87	61
3	5	6	46	29
4	7	6	28	45
5	13	4	74	27
6	7	6	46	31
7	7	12	64	123
8	11	8	130	37
9	36	14	244	50
10	36	23	141	81
MEAN	13.9	9.0	89.9	51.4

The Wilcoxon rank-sum test was used to compare the first and last clinical log entries of the ten students for semantic and syntactic content. The result of this for semantic content was $W = 9$ ($n = 10$), $p>0.05$, and this was thus not statistically significant. The result of this test for syntactic content was $W = 10.5$ ($n = 10$), $p>0.05$, so this was similarly not statistically significant. Overall,

therefore, there was no statistically significant difference between the groups for both semantic and syntactic content of the clinical log entries. These results are summarised in Table 4.2 below.

Table 4.2: Results of the Wilcoxon rank-sum test of first and last entries of student long entry clinical log cases.

	Semantic content	Syntactic content
W-value	9	10.5
Mean difference	8.9	28.9
Sum of positive ranks	46	44.5
Sum of negative ranks	9	10.5
Z-value	-1.8857	-1.7328
Mean (W)	27.5	27.5
Standard deviation (W)	9.81	9.81
Sample size	10	10
Critical value	8 (p>0.05)	10.5 (p>0.05)

Discussion

Although the proportions of students who were able to be categorised into Bordage's four categories showed findings similar to what he found, the limited number of clinical log entries makes this statistically dubious, and this was confirmed on statistical analysis. It is thus impossible to draw any definite conclusions about the development of CR from this small study. Similarly, it was not possible to demonstrate any meaningful increase in semantic or syntactic content between the first and the last long case clinical entries. I hypothesise that this was not due to a lack of development of students' CR abilities, but rather that they see that the requirement of having to make clinical log entries as a chore and do not take it seriously, despite the obvious benefits of this exercise that are repeatedly pointed out to them.

This study was thus unable to validate Bordage's method in an Australian setting using student electronic clinical log entries. Entries by students into an electronic clinical log as a requirement of the course should thus be regarded differently to students or other clinicians making verbal clinical case presentations to clinical preceptors or other groups.

The small number of students who agreed to participate was a significant limitation. However, the validity of the method has been demonstrated experimentally in the literature, so one conclusion could be that LICs do not promote CR as expected. However, another explanation is that students may have viewed the electronic clinical log requirement as a burden rather than a benefit to their development, and it is thus not an accurate record of the cases and thus of their CR.

Conclusion

This study was unable to validate the findings of Bordage and colleagues that semantic and syntactic content of clinical presentations is a valid marker of CR ability when applied in a naturalistic educational setting to compulsory student clinical log entries. LIC program directors and other academics who require students to engage in compulsory clinical log activities should closely examine their reasons for doing this and ask if the clinical log is achieving the outcomes that were intended. In particular, they should examine how clinical logs could be used to provide meaningful feedback to students in order to promote the development of their CR.

STUDY 2: A CROSS-SECTIONAL ANALYSIS OF THE CLINICAL REASONING VERSUS NON-CLINICAL REASONING COMPONENTS OF SUMMATIVE WRITTEN AND CLINICAL ASSESSMENTS OF LIC STUDENTS

Introduction

Background

There is considerable evidence from the published literature that LIC students emerge from these clerkships with good patient-centred attitudes and enhanced levels of professionalism, and make career choices based on workforce need (Levesque, Hovey, and Bedos 2013; Hirsh, Walters, and Poncelet 2012; Krupat et al. 2009; Walters, et al. 2012; Konkin and Suddards 2012; Zink et al. 2010; O'Donoghue, McGrath, and Cullen 2015; Walters and Brooks 2016; Gaufberg et al. 2014; Stevens, Wilkerson, and Uijtdehaage 2014; Playford et al. 2015; Campbell et al. 2019; Brown et al. 2021). However, as is clear from the scoping review in Chapter 3, there is little empirical evidence to support the assumption that LICs result in better CR.

The analysis of student clinical logs outlined in Study 1 failed to provide insights able to draw any valid conclusions about the development of their CR abilities. Consequently, I sought to find an alternative quantitative method to assess students' CR capabilities from a positivist ontological perspective.

An alternative approach is to look at differential performance (or attainment) in the CR components of assessment when compared to the non-clinical reasoning (NCR) components. It would be logical to assume that if students engaged in a LIC are particularly supported in the development of their CR, this would be reflected in higher or better identifiable scores in the CR components than in the NCR components of their assessments, or that the improvement CR components of assessment would be greater than that of NCR components. Although intuitively

one would expect higher scores on the CR than the NCR, total scores are not the best measure, because total scores are most likely determined by the relevance and difficulty of the test rather than the specific construct it measures. This is why research examining differences in constructs typically employs correlational approaches (Schuwirth, Van der Vleuten, and Donkers 1996).

Objectives

The purpose of this study was, therefore, to determine if UOW medical students, all of whom undertake a LIC, demonstrate differential attainment in the CR components of written and clinical examinations compared with the NCR components. If it was possible to demonstrate this with a small validation study, this could be followed up with a larger longitudinal quantitative study employing a causal comparative design.

Methods

Study design

This was a cross-sectional comparison validation study of the CR components and the NCR components in the summative written and clinical assessments of one cohort of LIC students at the end of the LIC.

Setting and participants

As all medical students at UOW are required to participate in a LIC as a standard part of the program, there is thus no control group within the cohort of students to provide a means of comparing LIC students with non-LIC students. However, even if such a control group were available, it would still not be possible to conduct a controlled comparative study. The reasons for this include: 1) the students would not be able to be blinded (giving rise to the Hawthorne effect and the John Henry effect – see below); 2) it would not be possible to separate the groups and prevent them from talking to each other; 3) it would be impossible to eliminate differences between clinical preceptors supervising the students; and 4) it would not be possible to standardise the patient mix encountered by students.

The Hawthorne effect is the phenomenon of research participants acting in a way that is consistent with their perception of the researcher's expectations during a study, which then biases the outcomes of that research study (Franz 2018). The John Henry effect refers to the bias introduced to an experiment when members of the control group are aware that they are being compared to the experimental group and behave differently than they typically would to compensate for their perceived disadvantage. This alteration renders the control group ineffective

as a measure of baseline performance and skews the results of the experiment (Gammon and Bornstein 2018) if the experiment is conducted from a realist/logical positivist perspective.

Data sources and variables

The summative assessment at the end of the LIC at UOW consists of three written examinations and an objective structured clinical examination (OSCE). The written papers are made up of a combination of modified essay questions (MEQ), best of five multiple choice questions (BOF), and extended matching questions (EMQ). Components of all these types of assessment methods are devised to have the capacity to test CR, or at least the outcomes of CR.

The written examinations and the OSCE for the cohort of students completing their LIC in June 2019 was used for this study. The content of these examinations, which covers both preclinical and clinical sciences, was divided into CR and NCR components. NCR components were made up of content knowledge, clinical and procedural skills, ethical and professionalism content. On scrutiny of the content of the EMQ, it was found that these were made up almost entirely of NCR content, so they were omitted from the study.

Scores for the CR components of the three question types (MEQ, BOF and OSCE) were compared with the NCR components of the same questions. This way, multiple correlations could be calculated.

Study size

There were 66 students who sat these examinations, and the data of all students were included in this study. Data were initially configured and recorded in Excel spreadsheets and exported to SPSS for statistical analysis of reliability.

Quantitative variables

The first set of correlations was between the CR and the NCR questions within each test. These correlations are between test components that only differ in type of construct (CR versus general factual knowledge). The second set of correlations was between CR components of the various assessment modalities, i.e., correlations between the CR components of BOF, MEQ and OSCE components and between the NCR components of these three assessment modalities. So here the correlations were only between differences in type of assessment but not in type of construct. The third set of correlations was between components of different constructs and different modalities. An overview of these correlations is provided in Table 4.2 below.

Reliabilities can be used to estimate what the correlation would have been if the reliabilities had been perfect. This is called a correction attenuation and it is calculated as follows:

$$R = \frac{R_{xy}}{\sqrt{R_{xx'} \times R_{yy'}}}$$

Table 4.3: Overview of correlations in this analysis

Components	Differences
CR BOF vs NCR BOF	Construct
CR MEQ vs NCR MEQ	Construct
CR OSCE vs NCR OSCE	Construct
CR BOF vs CR MEQ	Format
CR BOF vs CR OSCE	Format
CR MEQ vs CR OSCE	Format
NCR BOF vs NCR MEQ	Format
NCR BOF vs NCR OSCE	Format
NCR MEQ vs NCR OSCE	Format
CR BOF vs NCR MEQ	Construct and format
CR BOF vs NCR OSCE	Construct and format
CR MEQ vs NCR OSCE	Construct and format
NCR BOF vs CR MEQ	Construct and format
NCR BOF vs CR OSCE	Construct and format
NCR MEQ vs CR OSCE	Construct and format

Results

Table 4.3 below shows a correlation matrix between all components. The observed correlations are shown in the lower diagonal (shaded in green), while the true (or so-called disattenuated) correlations are shown in the upper diagonal (shaded in blue) – this will be discussed in more detail later.

Table 4.4: Correlation matrix between all components of the assessment

	BOF CR	BOF NCR	MEQ CR	MEQ NCR	OSCE CR	OSCE NCR
BOF CR		1.00	0.93	0.94	0.20	0.18
BOF NCR	0.520		1.00	1.00	0.25	0.09
MEQ CR	0.644	0.494		0.69	0.21	0.13
MEQ NCR	0.696	0.407	0.527		0.06	0.07
OSCE CR	0.135	0.081	0.147	0.042		1.00
OSCE NCR	0.122	0.030	0.094	0.054	0.776	

There were medium to high observed correlations between the CR and NCR components of each of the three types of questions: 0.52, 0.527 and 0.776 for the BOF, the MEQ and the OSCE questions respectively. These correlations were between components of the same format but different constructs (CR versus NCR)

There were medium correlations between the CR components of the BOF questions versus the MEQ (0.644) and the NCR components of the BOF questions versus the MEQ questions (0.407). However, there were low correlations between the CR components of the OSCE and each of the other two components (BOF: r = 0.135 and MEQ: r = 0.147). Similar low correlations were found between the NCR component of the OSCE and the other two assessment (BOF: r = 0.03 and MEQ: r = 0.054). Thus, these low correlations between the OSCE and all other assessment both on the CR and the NCR components suggests that it measures a different construct than the other two. However, this effect is the same for the CR and the NCR components. With correlation assessment components that are different in both construct and format, the lower diagonal (shaded green) of Table 4.3 shows medium correlations between all components, except, again, for the OSCE assessment.

When calculating correlations between assessment components, it is important to realise that unreliability of an assessment has an impact on the height of the correlation. Table 4.4 shows the reliabilities for each of the six assessment components.

Table 4.5: Reliabilities of each of the assessment components

Assessment component	Reliability
CR BOF (k=106)	0.670
NCR BOF (k=29)	0.145
CR MEQ (k=57)	0.723
NCR MEQ (k=45)	0.813
CR OSCE (k=18, CR components)	0.707
NCR OSCE (k=18, NCR components)	0.707

These so-called true or disattenuated correlations are shown in the upper diagonal in Table 4.3 (shaded in blue). It should be noted, however, that disattenuation can overshoot if the reliability of one or both components is very low. Examining these disattenuated correlations is important for our question, because if we seek to examine whether a certain component, specifically if CR versus NCR can be distinguished in the assessment dataset, one needs to understand whether a correlation is low because the two components are likely to measure different constructs, or

whether it is the result of unreliability of one of the components. In this case, unreliability was not the main cause for the low correlations between the OSCE components and the other assessment.

Discussion

There are two possible explanations for the high correlation found between the CR and the NCR components of the end-of-LIC assessments:

1. The CR components of the questions were not identified with sufficient accuracy, or
2. There is truly no difference, or in other words, students did not actually learn CR better than other parts of the curriculum.

In any case, the high correlation of CR versus NCR components in each of the three question types is a strong indication that we were not able to discern any difference between the performance of UOW medical students between CR and NCR components of assessment questions at the end of their LIC. This could be explained by the fact that although it is possible to measure clinical decision-making (CDM) by using written examination questions, it is much more difficult or even impossible to measure CR in this way. This is because CR is not a simple, linear process with a predictable outcome, which is what is needed for written tests like multiple choice and extended matching questions.

Conclusion

The hypothesis that medical students participating in LICs have better development of their CR than NCR aspects of their development by the end of their LIC was not able to be supported by the results of this study.

OVERALL DISCUSSION ABOUT THE TWO QUANTITATIVE STUDIES

These two small studies have looked at the measurement of CR in two completely disparate ways. They have both attempted to quantitatively measure the development of CR in students participating in a LIC, and both been unsuccessful in doing so. Because CR and its measurement has always been and remains difficult to quantify and measure, this is not particularly surprising, and a different approach was needed.

OVERALL CONCLUSIONS ABOUT REALIST APPROACHES TO THE MEASUREMENT OF CLINICAL REASONING

The conclusion that must be reached after conducting these two studies is that approaching the development of CR within LIC programs from a realist ontological perspective and a positivist

epistemological perspective is extremely difficult. This could be because CR is a domain-specific, multifaceted, complex, idiosyncratic, non-algorithmic, interactional phenomenon which is undertaken iteratively in the heads of clinicians and students, and this does not easily lend itself well to a realist/logical positivist approach.

A conclusion that can be drawn from the scoping literature review (see Chapter 3) and the two small quantitative studies in this Chapter is that CR is not the same as clinical decision-making (CDM). CDM is a data reduction process leading to a single correct answer, and hence it is possible to be tested with written and other statistical tests. CR, on the other hand, is the ability to understand a problem, ideally from various perspectives, and is therefore more holistic and relies on the agility of the clinician or student to explain and understand the situation from various perspectives.

It is not purely the LIC that creates improvement in CR, but rather the meaningful interactions between supervisor and student that this LIC structure provides that leads to this. Thus, to reach a more plausible conclusion as to why this could be, it became necessary to specifically explore further why and how LICs would foster CR ability in medical students. It would appear that the concept of CR and its relationship with the educational tenets of LICs are more complex than first seemed and not linear causal, and they may not be amenable to a realist/logical positivist perspective. Therefore, a change of direction in this research became necessary. The next chapter will describe an in-depth constructivist approach to exploring the literature to better understand these concepts from this perspective.

CHAPTER 5:
A HERMENEUTIC LITERATURE REVIEW OF CLINICAL REASONING IN LONGITUDINAL INTEGRATED CLERKSHIPS FOR MEDICAL STUDENTS

"WHERE IS THE WISDOM WE HAVE LOST IN KNOWLEDGE? WHERE IS THE KNOWLEDGE WE HAVE LOST IN INFORMATION?"
– T S ELIOT (1888-1965), IN CHORUSES FROM THE ROCK, 1934

This chapter describes a hermeneutic approach to reviewing the literature on clinical reasoning (CR) and on longitudinal integrated clerkships (LICs). It provides a conceptual model of CR and of LICs, and then offers an explanatory model of how CR develops in students undertaking LICs.

INTRODUCTION

CR always has been and remains a central component of good medical practice and is thus important for medical students to acquire prior to graduation from medical school. However, despite intensive interest and study over the past few decades, it remains an elusive concept to define, teach and assess.

This hermeneutic literature review aimed to produce a synthesis of the understanding from the published literature on CR, on LICs, and then to draw these two separate topics together in order to gain a clearer understanding of how medical students undertaking immersive LICs develop their CR abilities.

Much of the research on CR has been undertaken on medical students engaged in the more specialty-focussed traditional block rotation-based (TBR) models of education. But what about its development in students participating in LICs?

This review presents a conceptual model of CR, a conceptual model of how learning occurs in LIC models, and then draws the two together to propose a conceptual model of how CR develops in students participating in LICs.

METHODOLOGY

Design

To achieve the aim of the review, I chose to adopt a hermeneutic approach rather than a structured, systematic one. The published literature on CR and on longitudinal models of medical education is extensive, goes back many years, and is diverse with regards its perspectives on what

CR is, how it develops and how it is assessed. I was thus of the opinion that a hermeneutic approach would allow me to better make meaning of these different perspectives and to understand why they exist.

Hermeneutics is a philosophical approach that is concerned with the understanding and interpretation of texts (Illing 2010). It adopts the stance that there is no final understanding of the relevant literature, but rather a constant re-interpretation leading to a deeper and more comprehensive understanding of relevant publications (Boell and Cecez-Kecmanovic 2010). It does not assume that there is one single understanding that can be achieved but is focused, rather, on the process of developing an understanding or potentially multiple understandings (Boell and Cecez-Kecmanovic 2014). Prentice et al. (2020) describe texts as having 'horizons' which are comprised of its current knowledge, assumptions and beliefs. When a reader reads the range of texts on a particular topic, the various horizons fuse to broaden the horizons and facilitate a deeper understanding of the topic. Hermeneutics sees the literature review as an iterative process rather than a linear one, and as Smythe and Spence (2012) describe it, provides a way of being 'attuned' to the literature.

A hermeneutic approach to a literature search does not require the research question or questions to be fixed prior to starting the review, as is the case with more structured approaches. The iterative nature of the searching also helps to overcome the limitations imposed by the lack of coverage of the literature of individual databases.

Boell and Cecel-Kecmanovic (2014) describe a hermeneutic review as consisting of two interlinked cycles: the first is a search and acquisition cycle during which the relevant literature is acquired, read identified and refined, and the second is a cycle of analysis and interpretation leading to the development of an argument (see Figure 5.1 below).

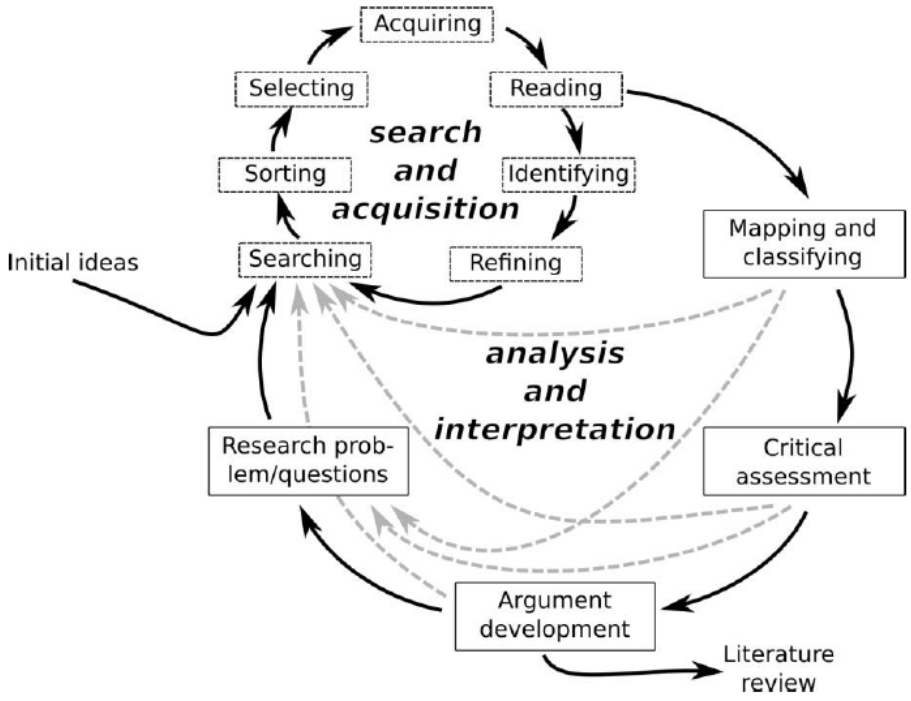

Figure 5.1: A hermeneutic framework for the literature review process consisting of two major hermeneutic circles (Boell and Cecek-Kecmanovic, 2014)

Greenhalgh, A'Court, and Shaw (2017) have a slightly different interpretation of this process by describing the first cycle as the literature acquisition and interpretation cycle and the second cycle as the argument development cycle. Ultimately, it makes little difference. The most important factor is that it is an iterative, non-linear process that leads to a deeper understanding of the literature. As Greenhalgh, A'Court, and Shaw (2017) write:

> Searching is systematic but flexible and iterative. As sources accumulate, it becomes necessary to interpret, clarify and understand emerging ideas and perspectives and to reject less relevant sources through progressive focusing.

Focus

As is usually done in a hermeneutic review, my initial ideas were formulated into a series of questions, which in this review fell into three broad categories: a) those about CR; b) those about LICs; and c) those specifically on the development of CR during LICs.

Although the first two categories had some obvious overlaps, they were distinct topics. The third category of questions was an attempt to draw the first two together (see Figure 5.2 below).

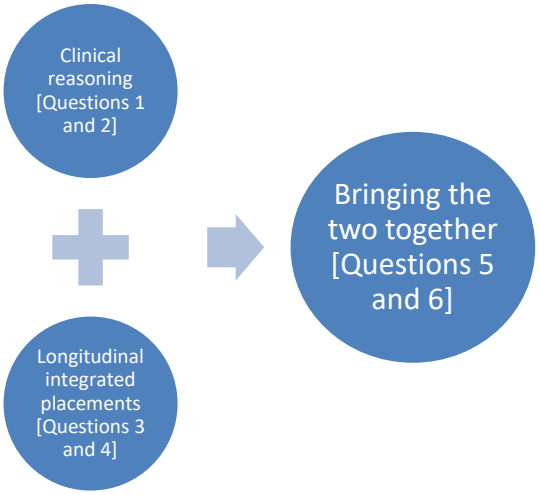

Figure 5.2: The interrelationships of the three categories of questions

Clinical reasoning

1. What is CR, and how does it differ from clinical decision-making and critical thinking?
2. How does CR develop and how is it measured/assessed?

Longitudinal integrated placements

3. What are LICs, what are their underpinning principles and their intended outcomes?
4. How do students learn during LICs, and does this differ from how students learn during TBRs?

Bringing the two together

5. How does CR develop in medical students undertaking LICs, are these programs good for its development, and does this differ from its development in students in more traditional educational programs?
6. How does the narrative of CR fit with the LIC educational model?

Stages of the review

Based on the model used by Valentine et al. (2021) in their hermeneutic review, this review followed the same three stages:

1. Literature search and compilation of evidence
2. Data extraction, analysis and interpretation
3. Development of a conceptual model

Stage 1: Literature search and compilation of evidence

I began my search for peer-reviewed published papers written in English on both CR and LICs in 2017. The decision to confine the search to the English language was based on the assumption that publications in other languages would be largely based on the English literature.

In order to gain as wide a reach as possible, I searched the PubMed, Medline, Web of Science and Academic Search Complete databases using the term 'clinical reasoning', and all papers pertaining to the description, teaching and learning, development, assessment, and research on CR were extracted. The only papers that I excluded were those written around case studies on CR and those written on CR in non-medical disciplines. I decided to exclude the latter group as this review concentrates on the development of CR in medical students, which has a different paradigm of learning and application to other health disciplines.

Using the same databases, I conducted a separate search using the terms 'longitudinal integrated clerkships' and 'longitudinal integrated placements' to search for papers on this educational model and extracted all papers on all aspects of this without any exclusions.

I then undertook snowballing by examining the reference lists in all the extracted papers, extracting further papers that had not already been found by the keyword search, as well as seminal searching by searching for articles by research leaders in the fields of CR and LICs.

Each of the extracted articles was read and analysed for answers to the key questions listed above. I then collated the references by year of publication and managed them in a series of Word tables, with a table for each of the key questions for which I sought answers, as well as in a general EndNote database.

The primary search was done over a 12-month period, but secondary searches were undertaken subsequently, and papers added to the database as new concepts developed and new publications appeared.

Stage 2: Data extraction, analysis and interpretation

Throughout the review process, I maintained a synthesis of the key questions, findings and arguments in the series of Word tables. There was a constant interplay between the Search and Acquisition, and the Analysis and Interpretation cycles as illustrated in Figure 5.1. The process ended when saturation had been reached.

Stage 3: Development of a conceptual framework

A conceptual framework has been described as a network of related concepts that help us to understand a particular phenomenon (Jabareen 2009). In this study it was developed through a qualitative hermeneutic interpretation of data derived from the literature and was aimed at providing an understanding of the literature. This is an important part of the hermeneutic literature review process.

I first developed a conceptual framework of CR, and then followed this by developing a separate conceptual framework of LICs.

Conceptualisation of clinical reasoning

From the search and the interpretation of the CR literature, I conceptualised the cognitive aspect of CR using the dual process theoretical model (Croskerry 2009a; Croskerry 2009b; Croskerry and Norman 2008; Croskerry et al. 2014; Norman and Eva 2010; Norman et al. 2014; Pelaccia et al. 2011). This model has been derived from research in cognitive psychology (Kahneman and Tversky 1982) as being at the core of CR. These two systems of the dual process model interact with each other, with each having its own inherent cognitive biases, but this is especially apparent during System 1 thinking (Croskerry 2009b; Mamede et al. 2014b). Cognitive biases are errors in reasoning (Wilcox and Schroeder 2015), or more accurately, failures of heuristics (Norman et al. 2017). A number of cognitive biases have been described, with some examples being representative bias, availability bias, overconfidence bias, confirmatory bias, illusory bias, base rate neglect and search satisficing (satisfying) (O'Sullivan and Schofield 2018).

The cognitive aspect of CR I then conceptualised as being encompassed by metacognition, which is the thinking about the thinking or reflecting at a higher level on the analytic and non-analytic processes. This serves as a safety mechanism against errors and biases that could occur during the cognitive part of the CR process (Marcum 2012). Monteiro and Norman (2013) describe it as:

> … a heightened analytic inspection of one's own thought processes.

Crebbin, Beasley, and Watters (2013) define it as:

> … the ability to know, understand and monitor one's own thinking, and is sometimes called mindfulness; this can function at either a conscious or a subconscious level.

The cognitive and metacognitive aspects of CR are in turn conceptualised as being encompassed by the contextual factors in which clinical encounters occur and the impact that these can have on the CR process. Looking at models like the dual process model of reasoning in isolation makes no

allowance for the interactions that occur between the physician, the patient and the environment (McBee et al. 2015). This gives rise to the concept of context specificity, which has become increasingly recognised as being a significant factor in the CR process (Durning et al. 2011).

Clinical contextual factors affecting CR have been divided into three groups: physician factors (e.g., fatigue, experience, neurobiology, self-regulation, well-being), patient factors (e.g., acuity of illness, complexity of problems, language proficiency, challenging the physician's credentials), and encounter factors (e.g., common vs. atypical presentation, diagnostic suggestion, ambulatory or inpatient setting, electronic medical records, support systems) (Durning, et al. 2012b). Emotions, both positive and negative, can have a significant impact on these contextual factors, and can give rise to affective biases that can lead to errors in CR (Konopasky et al. 2020d). Epstein (2013) refers to the combined use of intuitive thinking (System 1), analytical thinking (System 2) and affect (context) as "whole mind" decision-making.

The final, outermost part of this conceptual model is the agility and flexibility of thinking on the part of the student or clinician involved in the clinical encounter. It is conceptualised as the outermost layer, as flexibility is required to navigate all the elements contained within it. As far back as 2005, Eva called for flexibility in CR to allow for adaptations specific to the demands of the specific situation as a mechanism for dealing with context specificity (Eva 2005). This view is supported by Ark, Brooks, and Eva (2006).

The concept of agility and flexibility is well summarised by Durning, Trowbridge, and Schuwirth (2020):

> … better clinical reasoning is not characterized by having a single best answer but rather by who is most flexible in navigating a complex process and thus has the broadest repertoire of strategies. When one reasoning strategy does not work, the expert performer will quickly adapt to the contextual requirements and select another strategy (or strategies).

A diagrammatic representation of a conceptual framework of CR is illustrated in Figure 5.3 below.

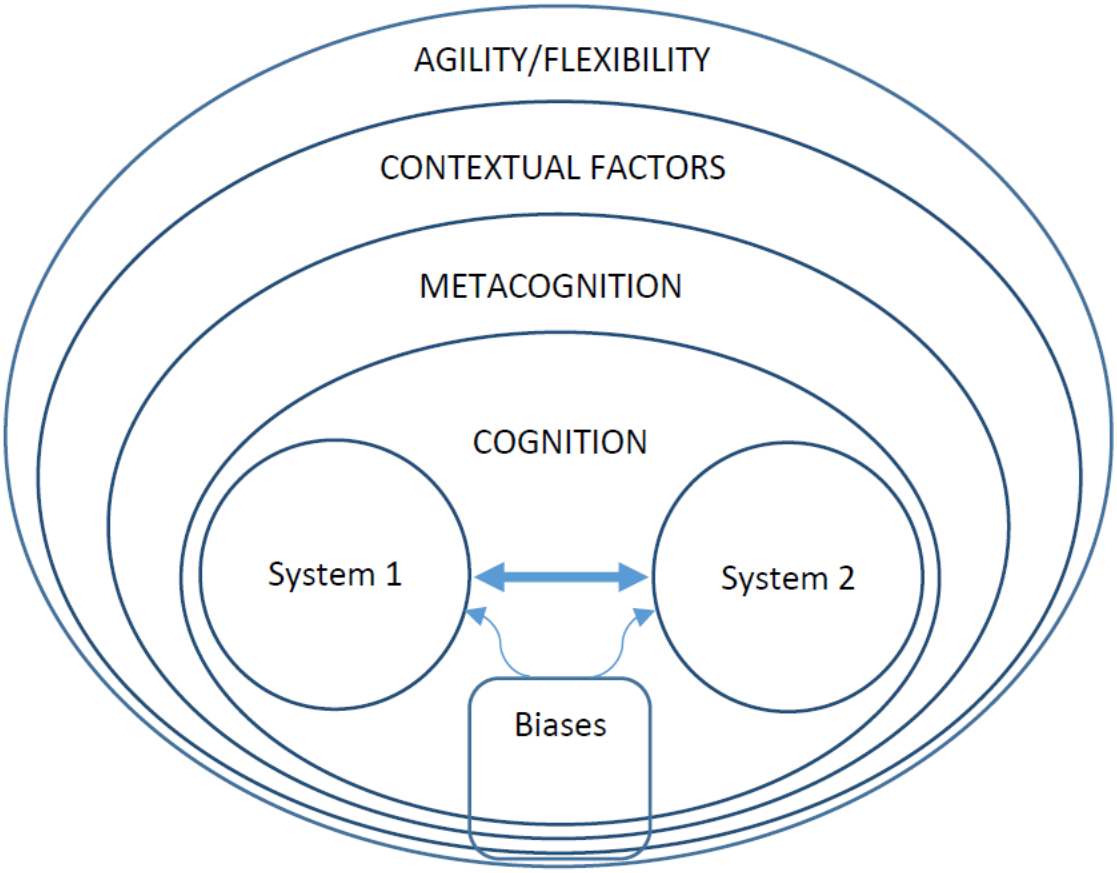

Figure 5.3: Conceptual model of clinical reasoning.

The rationale for developing this conceptual model of CR as presented is that the dual processing model of thinking, with its inherent biases, is now widely accepted by the medical education community as being the cognitive core of CR. This is moderated by metacognition, which is the high-level reflection on the part of the clinical reasoner on the analytic and non-analytic cognitive processes that occur during the CR process. The cognitive and metacognitive processes are in turn influenced by the contextual factors in which the clinical encounter takes place. The final layer of the conceptual model is the agility and flexibility of thinking which is necessary, and which has the potential to impact on all the other processes that take place. All these various layers can be influenced by biases, but this is especially true of System 1 thinking (which can be affected by cognitive biases), and context (which can be affected by affective biases).

Conceptualisation of longitudinal clinical clerkships

From the LIC literature, I conceptualised the core of LICs as three overlapping domains: continuity, relationships and concurrent learning.

Continuity is a key fundamental principle of LICs, and this includes a number of sub-domains, namely continuity of supervision, continuity of patient care and continuity of curriculum (Hirsh, et al. 2007). It allows for student learning of comprehensive patient care over time, which is an ideal way for students to learn about illness as opposed to disease, as well as learning about good chronic disease care management (Weston, Brown, and Stewart 1989). As these authors point out, symptomatic disease (which is what students learn during specialty rotations) is the overlapping part of the illness spectrum between asymptomatic disease (e.g., undiagnosed hypertension) and illness without disease (e.g., grief). This ultimately makes the patient the focus of the learning rather than the disease.

Hirsh et al. (2007) make the point that learning should be embedded in caring for patients rather than diseases, and this has the added benefit of students learning from their patients the impacts that illness has on their lives and that of their families (Walters, et al. 2012). Continuity of supervision in longitudinal placements allows for constructive global feedback and allows the early identification of students who may not be progressing as expected (Campbell, et al. 2017).

By way of contrast, there is a distinct lack of continuity, which Irby (2007) describes as discontinuity, during traditional specialty block rotations found in the more traditional models of education, where the focus of the learning is on the disease rather than on the patient. The nature of these short-term and often anonymous relationships with preceptors, patients, peers and place can give rise to anxiety and frustration in students (Hauer et al. 2014; Hauer et al. 2012a; Hirsh, Walters, and Poncelet 2012; Irby 2007).

Irby (2007) eloquently describes the student learning experience in large tertiary centres thus:

> …mentoring relationships either are fragile or do not exist, and the progressive advancement of student competencies is not well guided across the curriculum. Students complain about having to start all over again with each new specialty-specific rotation. The constant churning of people and sites leaves students feeling overwhelmed by what they do not know about each specialty and struggling to understand their new roles, new tasks, and new coworkers. Unfortunately, we chronically underestimate the powerful influence of these changing contexts on learners' thoughts, actions, and values. Context matters, because learning from experience accrues from being immersed in and acculturated to a community of practice, and experiential learning is strongly influenced by issues such as the patient census, time sensitivity in the environment, and multiple and conflicting commitments of participants. Discontinuity creates an inefficient and disjunctive system that produces great frustration and anxiety in learners and great challenges for teachers.

Hirsh et al. (2007) agree with this position:

> Promoting educational continuity is complicated by the traditional division of the core clinical clerkship experience into a disconnected series of independently governed, discipline-specific, randomly ordered, sequential blocks, each characterized by largely *ad hoc* patient assignments and poorly coordinated learning objectives.

The longitudinal model of clinical clerkship provides the capacity for students to develop deeper, more meaningful relationships with their clinical supervisors, with the patients that they see, with their peers and with the community in which the placement occurs, factors that may all have a beneficial effect on student engagement and learning (Worley et al. 2006). The concept of a deep relationship between clinician and patient in primary care settings is reinforced by Stolper et al. (2021):

> … the interactions between GP and patient also influence diagnostic reasoning. The patients' fears and concerns, prior knowledge and thought processes all interact with their perception of how they feel, act and participate in the decision making with their GP.

Although they were referring to general practitioners (GPs), because much of the clinical contact that students have with patients in LICs occurs in primary care settings, they are more likely to be exposed to the same patient lived experiences and apply this to the management of clinical problems than students who have the majority of their clinical contact in large tertiary hospitals.

The longitudinal model of learning involves concurrent learning, where students learn and practice multiple concepts together or cumulatively as opposed to learning each concept separately. This has been shown by several educators and researchers to facilitate the transfer of learning (Kulasegaram et al. 2017; Hatala, Brooks, and Norman 2003; Rohrer 2012). This will be discussed in more detail later.

Surrounding the three core concepts of continuity, relationships and concurrent learning is the immersion that students experience during LICs. They become immersed into the clinical teams with which they work and from whom they learn, and the acceptance of students as part of the clinical team during LICs, together with the opportunity to observe and experience clinical encounters in the context of unique doctor-patient relationships, has a powerful influence on their satisfaction with the placement. This, in turn, has beneficial outcomes with regards their learning (Hauer, et al. 2012a; Hauer et al. 2012b). Students describe becoming a legitimate part of the health care delivery team in which they are embedded – the legitimate peripheral participation described by Lave and Wenger (1991), Hauer, et al. (2014), and Hauer, et al. (2012a).

Apart from immersion into clinical teams, immersion in special settings and community engagement means that students can engage with the local community in which they are placed in a deeper and more meaningful way than if they were for a shorter period of time (Worley et al. 2000; Bartlett, Rees, and McKinley 2017).

The ultimate aim of the longitudinal model of medical education is to have transformative effects on the thinking of students who participate in them. There is evidence to show that students who participate in LICs sustain higher patient-centred attitudes (Teherani, Irby, and Loeser 2013). In a study by (Hauer, et al. 2012b), they found that the longitudinal model of learning promoted better and more patient-centred learning by challenging and motivating students to take on more advanced roles with their patients. It is also transformative in terms of the development of a stronger sense of social accountability, and this has an impact on future career choices and decision-making (Walters, et al. 2012; Hirsh, Walters, and Poncelet 2012; Greenhill and Poncelet 2013).

A diagrammatic representation of a conceptual framework of LICs is illustrated in Figure 5.4 below.

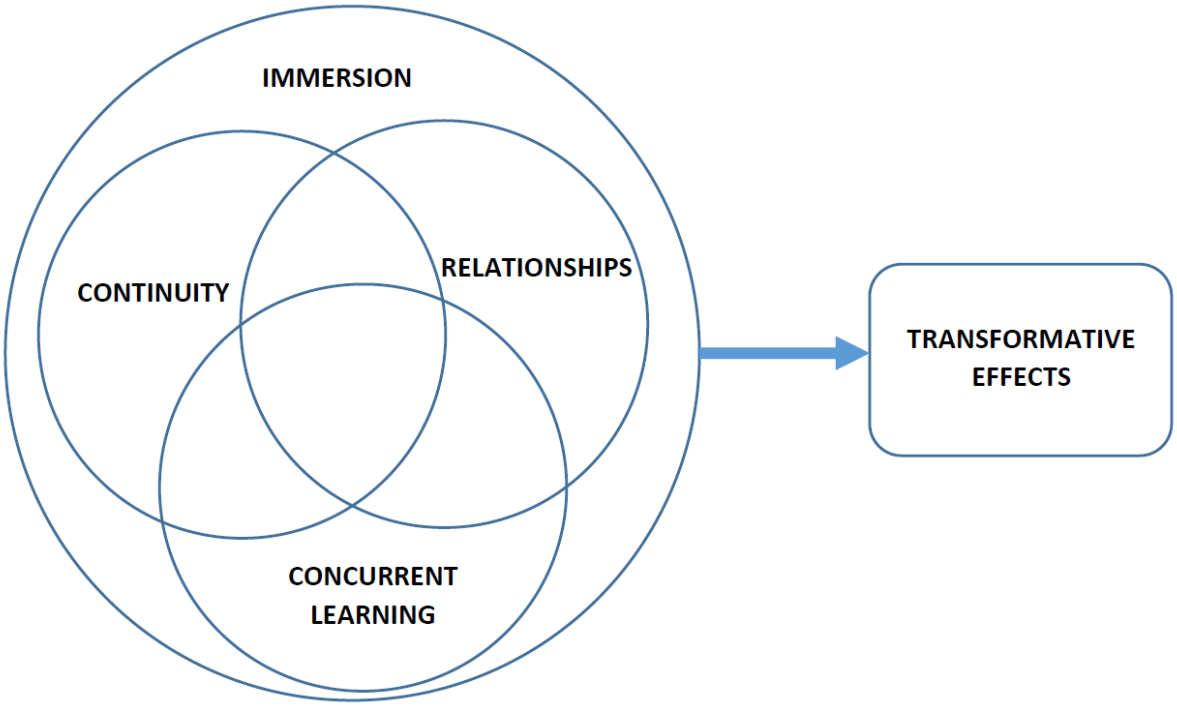

Figure 5.4: Conceptual model of longitudinal integrated clerkships.

RESULTS

Saturation for the CR questions was reached after reviewing 396 papers, and saturation for LIC questions was reached after reviewing 212 papers. There were just three papers that dealt explicitly with the development of CR in LICs, but a further 19 papers alluded to this implicitly.

What is clinical reasoning?

How we think and reason has historically belonged to the realm of philosophy, specifically the philosophy of science. It is defined by Koufidis et al. (2021) as:

> … making claims (conclusions) on the basis of known information (premises).

Research into CR over the past few decades has showed that it is far more complex than originally thought (Durning, et al. 2013b). Being an idiosyncratic, multifaceted, highly complex construct, further compounded by the fact that it is 'hidden' due to it taking place in clinicians' thinking, it has historically been difficult to define (Pelaccia, et al. 2011; Morris and Campbell 2015; Pelaccia et al. 2017). There are several definitions which vary widely and which do not converge (Durning, et al. 2013a; Daniel, et al. 2019; Young, et al. 2020; Kononowicz et al. 2020; Torre, et al. 2021). It is so nebulous and misunderstood that it has been described by some as a 'black box' (Sandhu and Carpenter 2006).

To further compound this issue, CR is also known by several synonyms like clinical problem solving, clinical decision making and clinical judgement (Norman 2005; Morris and Campbell 2015; Young, et al. 2019). This will be discussed in more detail later.

In addition to the lack of consensus around a definition of CR, there is little consensus regarding the essential characteristics or components of good reasoning in clinical practice (Norman 2005; Loughlin et al. 2012; Seidel, Campbell, and Bell 2015) and there is much debate about how it is constituted (Marcum 2012). As Gruppen (2017) states:

> … clinical reasoning is a vast, complex construct that is described and used in different ways by different people, and it has been used to describe a wide variety of activities. There is no generally accepted definition of clinical reasoning and, indeed, many articles about clinical reasoning never define it explicitly; it is often assumed as a universally understood construct.

Young, et al. (2019) agree with this view by describing CR as:

> … a multidimensional construct with a wealth of associated language and a multiplicity of both implied and inferred meanings, rather than a singular unified commonly understood construct.

Due to the many potential implied and inferred meanings, they rightly suggest using caution when teaching and assessing CR.

Despite the apparent confusion and divergence of opinion around the definition and nature of CR, when it is distilled down to its constituent components, it can be viewed as the process during which a clinician interacts with a patient to collect and interpret data relevant to the patient's

presentation in order to arrive at a diagnosis (or a differential/provisional diagnosis) and to institute a plan of investigation and/or treatment.

Clinical reasoning as a cognitive process

In its broadest terms, there is general agreement among many authors that at its core CR is a cognitive process during which clinicians collect and process information in order to arrive at a diagnosis and institute a management plan for their individual patients (Van der Vleuten and Newble 1995; Ajjawi and Higgs 2008; Rahayu and McAleer 2011; Stieger et al. 2011; Ghafouri et al. 2012; Braude 2012; Marcum 2012; Audetat et al. 2013; Uy et al. 2014; Hrynchak, Takahashi, and Nayer 2014; Durning et al. 2014; Guerrasio and Aagaard 2014; Durning et al. 2015a; Sim et al. 2015; Seidel, Campbell, and Bell 2015; Durning et al. 2015b; Dong et al. 2015; Hemmer, et al. 2015; Islam et al. 2015; Chang et al. 2016; Raupach et al. 2016; Pelaccia, et al. 2017; Jost et al. 2017; Young, et al. 2018b; Pinnock et al. 2019; Daniel, et al. 2019; Plackett et al. 2020; Rencic et al. 2020a; Rencic et al. 2020b; Zheng, Li, and Lajoie 2020; Connor, Durning, and Rencic 2020; Boyle et al. 2020; Young, et al. 2020; Kononowicz, et al. 2020; Pelaccia et al. 2020; Torre, et al. 2021). Some of these authors do not specifically call it a cognitive process but nonetheless imply that it is.

There is also general agreement that the cognitive processes of CR are complex. For example, while acknowledging the debate about what constitutes CR, Marcum (2012) writes:

> … there is general agreement that clinical reasoning represents a multidimensional and complex process involving both non-analytic and analytic cognitive processes…

Cleary, et al. (2020) agree when they write that CR:

> … can also be viewed as a complex, dynamic and often uncertain process…

Islam, et al. (2015) describe it along similar lines as:

> A complex process that uses cognition, metacognition and discipline-specific knowledge to gather and analyse patient information, weigh alternatives and evaluate the best treatment regimen.

Some authors, while acknowledging the complexity of CR, regard it as a linear categorisation or data reduction process. For example, Regehr and Norman (1996) describe CR as a 'deliberative act' involving the eliciting of features of the patient that are then incorporated into the diagnostic rule. They illustrate this concept as follows:

> … if the patient has chest pain, and it is crushing in character, and radiates down the left arm, then it is probably a heart attack.

In a similar vein, Eva (2005) and Pinnock and Welch (2014) describe CR as a process of sorting through the cluster of features presented by a patient.

Rencic, et al. (2020a) describe CR similarly as a stepwise, categorisation process:

> Clinical reasoning is the cognitive steps leading up to and including establishing the diagnosis and/or treatment of a patient.

Others describe CR as less of a linear but nonetheless unidirectional process. For example, Rahayu and McAleer (2011) describe CR as:

> … a cognitive process by which the information contained in a clinical case is synthesised, integrated with the clinician's knowledge and experience, and used to diagnose and manage the patient's problem.

Posel, McGee, and Fleiszer (2015) are in general agreement with this position by writing:

> Clinical reasoning in medicine is the critical analysis of patients' symptoms, signs, laboratory results and imaging to support the determination of a diagnosis and the planning of appropriate treatment.

Balslev et al. (2015) describe CR as a non-linear internal narrative:

> Clinical reasoning is the argumentation that clinicians use while diagnosing clinical cases…

By contrast, some take this concept a step further by explicitly describing CR as an iterative, cyclical process. For example, Van Schalkwyk et al. (2020) describe CR as:

> … a cyclical process during which a doctor collects and deductively interprets patient information in light of biomedical and clinical knowledge in order to establish a hypothesis which is then refined as additional supporting and detracting information is considered until a diagnosis and management plan can be postulated.

There is agreement with this by Zheng, Li, and Lajoie (2020) when they describe CR as:

> … the recursive and dynamic thinking processes by which clinicians collect evidence, process information, understand patient problems, plan or implement treatment, evaluate outcomes, and reflect the learning process.

Cook, Sherbino, and Durning (2018) and Konopasky, et al. (2020a) maintain that CR is an integrative process, using clinical information, biomedical knowledge and contextual factors to make decisions about patient care. Cleary, et al. (2020) describe it as gathering and integration of clinical information and medical knowledge to make meaning of patients' problems, a position agreed to by Ilgen, Eva, and Regehr (2016), who make the valid point that clinical diagnostic reasoning should have as its goal much more than applying a diagnostic label. Patients, they posit, are better served by using the diagnostic process to make meaning of their particular situation:

> … drawing satisfaction from "making a diagnosis" treats diagnosis as a solution (i.e. as the endpoint of a problem solving activity), while using diagnosis as a clinical reasoning aid treats diagnosis as a way of making meaning of the situation in order to better understand and manage a problem.

They take this concept of meaning-making a step further by writing of this as part of the CR process:

> … involve placing a deliberate emphasis on seeking to understand patients' lived experiences with their illnesses – independent of whether these symptoms can be categorized by traditional disease taxonomies – and stressing the importance of communication between the healthcare team and patients regarding symptom evolution and responses to therapy. This patient-centered approach has potential to foster empathy and reduce premature closure, given the need to consider multiple perspectives. Second, we would look for instructional designs that emphasize the learning value inherent in complex or ambiguous problems, rooting these experiences in a genuine curiosity concerning how our patients' narratives and physical presentations evolve over time. In doing so, we can be explicit that uncertainty is acceptable and inevitable for all of us, and further, that the act of making decisions or seeking new information provides rich learning opportunities for clinicians and the systems that support them.

All these authors agree, either explicitly or implicitly, that CR is a complex cognitive process to elicit and interpret clinical information in order to arrive at a diagnosis (or at least a differential diagnosis) and institute a management plan during each patient encounter. However, as described above, how this cognitive process actually works varies from a linear, data reduction, categorisation process through to an iterative, cyclical process of constant data collection, integration and meaning making to construct a narrative around each patient. I would argue that this meaning making considers not only on individual patient requirements and circumstances, but also draws on exemplars stored in long-term memory, and may even serve to allow the clinician to be better able to store the current patient details in long-term memory.

However, although these viewpoints may vary, there is general agreement that CR requires a solid base of biomedical knowledge, experience, the ability to elicit information and communicate well, the ability to recognise the potential biases, the capacity to reflect, and the recognition that contextual factors are important in the CR process.

Clinical reasoning as a cognitive and a metacognitive process

CR can be seen as much more than simply a cognitive process, however, and metacognition may be seen as an important part of the thinking process. The term 'metacognition' was initially introduced by educational psychologists in the 1970s (Flavell 1979), and although its initial application was in the area of child educational psychology, the principles laid down then are equally applicable to adult psychology in general and the CR process in particular. As described by Efklides (2014):

> ... monitoring and control are considered the two functions of metacognition that are inextricably connected between them and with cognition. However, if control is to be effective then (a) monitoring should accurately represent cognition; (b) control should inform cognition as to what needs to be done, particularly when automatic processing fails, and (c) control decisions should be appropriate for the person's goals, task demands and situational characteristics.

Metacognition is generally defined as the process of thinking about how we think. Yet, this precise relationship with cognition and reflection is a matter on which not all authors agree. For example, Calder et al. (2012) describe metacognition as a process that is used to address cognitive biases. According to these authors, this is especially useful when a clinician is aware of his/her style of decision-making (rational vs. experiential) to counter the abundant and different biases that may be present in both styles.

Some authors take this further by regarding metacognition as a process that constantly monitors the other cognitive processes. Marcum (2012) describes it thus:

> Metacognition is defined as the capacity to think about analytic and non-analytic processes at a higher level of cognitive reflection.

He explains that the purpose of cognitive reflection is to monitor CR and ultimately normalise clinical decisions. In other words, for clinicians to recognise that they cannot possibly know everything and should thus have an awareness of what they do not know (i.e., known unknowns as opposed to unknown unknowns).

Audetat, et al. (2013) imply that metacognition and reflective thinking can be seen as distinct from each other, but unfortunately they do not explain this distinction. I consider that it may be the difference between 'reflection in action' as a component of metacognition and 'reflection on action' as a separate process:

> Clinical reasoning is the set of complex thought and decision-making processes underlying clinicians' choices and actions in specific medical problem-solving contexts, clinical reasoning requires an array of cognitive, metacognitive, emotional, reflective thinking and relational skills.

By contrast, Azer, Guerrero, and Walsh (2013) specifically state that they see self-reflection as an inextricable part of the metacognitive process, but clearly seem to refer to 'reflection in action':

> Self-reflection is a metacognitive process that can occur at all stages of an encounter…; it helps the learner to understand both the self and the situation.

Consequently, they see self-reflection as a part of metacognition and stress that it is an important ability for medical students to acquire, a view agreed to by others (Sandars 2009; Uygur et al. 2019).

Several medical education studies have demonstrated that structured reflection has a positive effect on cognitive processes and diagnostic accuracy, especially when dealing with complex clinical cases (Mamede, Schmidt, and Penaforte 2008; Mamede et al. 2012; Mamede et al. 2014a;

Ribeiro et al. 2021). However, given the fact that they refer to structured reflection, this seems to relate more to 'reflection on action' rather than 'reflection in action'.

Charlin et al. (2012) imply that clinicians are required to have a conscious awareness of the process by referring to metacognition as:

> … an individual's knowledge concerning his/her own cognitive processes; in practice this implies that the clinician is aware of encounter goals and verifies that his/her cognitive processes and actions are contributing to the achievement of the goals of the encounter.

This is a view shared by Mamede et al. (2010), especially in complex cases dealt with by experienced clinicians.

By way of contrast, Crebbin, Beasley, and Watters (2013) imply that metacognition can be conscious or subconscious:

> Metacognition is the ability to know, understand and monitor one's own thinking, and is sometimes called mindfulness; this can function at either a conscious or a subconscious level.

In summary, there is general agreement amongst these authors that metacognition (thinking about thinking) is a meta-phenomenon in CR that can act as a safety mechanism to guard against unwanted cognitive biases and is thus an important part of sound CR. But, as it is assumed to take place simultaneously with the cognitive processes of CR, this means that it is a contextual and situated phenomenon.

This suggests that metacognition cannot and should not be subconscious, because if it is allowed to become thus, it will be vulnerable to the same cognitive biases as System 1 (non-analytic) thinking. Recursively, this would defeat its purpose as a check against cognitive biases. I concur with the view of numerous authors who see reflective thinking as being a part of metacognition and reject the view of Audetat, et al. (2013) who imply that these are somehow different. Reflective thinking is, in essence, 'thinking about thinking' and the two cannot be separated.

Clinical reasoning as an ability

The American Psychological Association's Dictionary of Psychology (APA 2020) defines the term 'ability' as:

> … the existing competence or skill to perform a specific physical or mental act. Although ability may be either innate or developed through experience, it is distinct from capacity to acquire competence.

The same source makes a distinction between 'ability' and 'aptitude' when it defines aptitude as:

> … the capacity to acquire competence or skill through training. Specific aptitude is potential in a particular area (e.g., artistic or mathematical aptitude); general aptitude is potential in several fields. Both are distinct from ability, which is an existing competence.

CR is described by a number of authors as an ability. For example, Williams et al. (2011) describe it as:

> … the ability to organise and use medical knowledge and reasoning ability to diagnose medical problems.

Yudkowsky et al. (2015) describe it in a similar way as:

> … the ability to judiciously gather patient data through a history and physical examination.

Ducos et al. (2015) agree by stating that CR is:

> … the ability to organise various pieces of information from multiple datasets.

Both Connors and Siner (2015) and Kelekar and Afonso (2020) hold that CR is the ability to sort through a cluster of features presented by a patient and accurately assign a diagnostic label. All these authors agree that this 'ability' entails the capacity to use various pieces of data as building blocks for the CR process.

By contrast, Gee, Anakin, and Pinnock (2017) describe this 'ability' as an outcome of the process when they write:

> … the ability of physicians to become efficient diagnosticians.

If one were to apply the American Psychological Association's definition of 'ability' to CR, it could be argued that the authors who regard CR as an ability imply that it is an innate competence which can be developed or shaped by experience. However, it is not clear that this is the position that they are taking; it is more likely that they are approaching CR from a complexity and unpredictability perspective rather than a linear cognitive one. The literature is silent on whether some individuals have a greater aptitude than others to learn or acquire CR competence.

Describing CR as an ability is distinct from describing it as a cognitive (and metacognitive) process as discussed above. It implies that it is series of actions which are carried out (in either a linear or in a recursive manner) in order to achieve a particular result.

Clinical reasoning as a skill

The American Psychological Association's Dictionary of Psychology (APA 2020) defines the term 'skill' as:

> … an ability or proficiency acquired through training and practice.

This definition implies that a skill is something that can be acquired, and differs from the definition of ability, which seems to focus more on it being an innate competence. The term 'skill' is often used to describe motor activities such as complex movements, but it can be equally used when describing cognitive or behavioural activities.

Audetat, et al. (2013) suggest that CR is a multifaceted process which encompasses a wide range of skills:

> Clinical reasoning is the set of complex thought and decision-making processes underlying clinicians' choices and actions in specific medical problem-solving contexts, and requires an array of cognitive, metacognitive, emotional, reflective thinking and relational skills.

Some authors go further by assigning a value judgement to the definition of CR. They describe it as being distinct from simple straightforward knowledge or pure algorithmic problem-solving. For example, Sim, et al. (2015) refer to CR as:

> … a high-level, complex cognitive skill. Because clinical reasoning involves synthesising details of patient information into concise yet accurate clinical assessment, it is a higher order thinking skill.

Both Daniel, et al. (2019) and Richmond et al. (2020) refer to CR as a skill, a process or an outcome where clinicians observe, collect and interpret data to diagnose and treat patients. A salient component of this approach to defining CR is that it involves not only the stringing together of information, like in CR as an ability and the data reduction approach to categorisation as a cognitive process, but it also requires a value judgement of each of the pieces of information in order to be successful.

A skill is something that can be viewed from two perspectives: some see it as a something that can be learned and mastered, while others see it is something that is never fully mastered but is continually being honed and refined. For example, when writing on expertise in general (but which can be applied to expertise in CR), Clardy and Schwartzstein (2015) hold this view:

> A related concept to expertise is mastery, the continuous refinement of one's knowledge and skills. As with adaptive expertise, mastery is dynamic; it requires one to reflect upon one's performance on a regular basis to determine what was done well and what can be improved.

Anakin et al. (2020) interpret CR as:

> … a skill that medical students must develop in order to sort through information about a patient efficiently in order to arrive at a diagnosis and to construct a treatment plan.

This accords with what currently occurs in medical education; how, when and the best way of achieving this during medical courses and programs is the subject of much speculation and debate. Specifically, how this occurs during LICs is largely unknown (more on this later).

Clinical reasoning as a context-influenced process

In some curricula, CR is assumed to be something that can be taught and learned generically and independently of content and context. However, the role of context has long been recognised in educational research (Perkins and Salomon 1989). Although the influence of the context in which clinical encounters occur has been recognised for some time by medical education researchers as a factor which has an impact on the CR process, it is only in recent decades that its potential to have a significant and direct impact on CR has become a mainstream assumption (Baig, Violato, and Crutcher 2009; Eva 2003; Eva et al. 2004; Hobus et al. 1987; Regehr and Norman 1996; Koens et al. 2005).

The influence of context in CR is often expressed by applying the concept of context specificity. Durning, et al. (2012b) describe context specificity thus:

> Context specificity is the phenomenon invoked to explain low correlations in performance across different clinical problems for a given physician or medical student, i.e. varying performance across situations (cases); some have remarked that this is the 'one truth in medical education research'.

Context specificity is one of the manifestations of encoding specificity, which is the probability and efficiency of retrieving an item from memory being dependent on the similarity between the conditions of encoding (storing information in long-term memory) and retrieval (Regehr and Norman 1996). In practical terms, this is manifested by a physician seeing two identical patient presentations from a content perspective (the same histories, physical examinations, laboratory results and diagnosis) yet arriving at two different diagnostic decisions. In other words, something other than case content is driving the physician's decisions leading to unwanted variation in physician performance (Konopasky et al. 2020c).

The factors that lead to this unwanted variation have become known as context specificity, and can arise from the physician, and/or the patient, and/or the environment (Ramani, et al. 2020). Examples of physician factors include cognitive load, knowledge base, experience, motivation, fatigue and well-being. Examples of patient factors include authenticity, personality type, diagnostic suggestion, acuity of illness, type of presentation and language barriers. Examples of environmental factors include length of appointment, setting, staffing levels and utility of the electronic health record (Durning, et al. 2013a; Konopasky, et al. 2020b; Konopasky, et al. 2020a).

Audetat, et al. (2013) describe CR as occurring in specific medical problem-solving contexts, while Pelaccia, et al. (2017) specifically state that context has a major effect on CR. Cook, Sherbino, and Durning (2018) take this a step further by writing:

> Clinical reasoning is the integration of clinical information, medical knowledge and contextual factors to make decisions about patient care.

Context specificity thus suggests a major difference in the perception of CR. Where the concepts of process, ability and skill define CR purely as a characteristic of the person, context specificity acknowledges the situatedness and interaction between the person and their context as essential for the phenomenon.

Young, et al. (2018b) agree that contextual factors are important:

> The integration of knowledge and contextual information (gathered through history, physical, labs, etc.) to form a cognitive representation of the problem/situation with the goal of adjusting that representation with additional information and understanding to reach a judgment or decision (about diagnosis, risk, or therapy, typically).

Rencic, et al. (2020b) even argue that CR is comprised of both cognitive and physical processes and that the clinician is required to adapt to interactions with the patient and the environment:

> The cognitive and physical processes that emerge as a healthcare professional consciously and unconsciously adapts to interactions with the patient and environment to solve problems and make decisions by collecting and interpreting patient data, predicting potential outcomes, weighing the benefits and risks of actions, and accounting for patient preferences to determine a working diagnostic and therapeutic management plan to improve a patient's well-being.

Rencic, et al. (2020a) have described a definition of CR that includes these contextual factors as follows:

> Clinical reasoning is the phenomena that emerge through the interplay between the cognitive and physical processes of the healthcare professional consciously and unconsciously adapting to interactions with patients and their relations, team members, raters (when applicable), environments, and tasks with the purpose to solve problems and make decisions by continually collecting and interpreting patient data, prognosticating, weighing the benefits and risks of actions, and understanding patient preferences in order to develop a diagnostic and therapeutic management plan that aims to improve a patient's well-being.

From this perspective, the situatedness and interaction are not merely 'brain' activities but involve conscious and unconscious physical factors as well.

Woods and Mylopoulos (2015) contend that the cognitive dimension of CR lies in the integration of knowledge and patient care:

> The physician who adaptively makes use of his or her knowledge during the course of patient care is actively integrating knowledge and activity: there is no divide. From this perspective, the key for defining the cognitive dimension of expertise lies in understanding and fostering the integration of activity and knowledge, and context specificity is simply a powerful example of this form of integration.

This is an important extra insight, as it suggests that it would be impossible to separate the process of the person from the interaction and impact of the context. In other words, CR is not an ability or skill that a person has, or a linear process, but something that happens in the here and now in the specific context. This has considerable implications for how we think about education and assessment. These authors also maintain that focusing on the context in which clinical encounters occur makes it possible to study expert development more deeply and in a more nuanced, holistic way.

Although the immediate physician/patient/environmental factors in which clinical encounters occur are important, the contextualisation of the clinical encounter can be taken a step further by considering the impact a patient-centred approach can have on the CR process. Ilgen, Eva, and Regehr (2016) hold the view that:

> …involve placing a deliberate emphasis on seeking to understand patients' lived experiences with their illnesses – independent of whether these symptoms can be categorized by traditional disease taxonomies – and stressing the importance of communication between the healthcare team and patients regarding symptom evolution and responses to therapy. This patient-centered approach has potential to foster empathy and reduce premature closure, given the need to consider multiple perspectives. Second, we would look for instructional designs that emphasize the learning value inherent in complex or ambiguous problems, rooting these experiences in a genuine curiosity concerning how our patients' narratives and physical presentations evolve over time. In doing so, we can be explicit that uncertainty is acceptable and inevitable for all of us, and further, that the act of making decisions or seeking new information provides rich learning opportunities for clinicians and the systems that support them.

I would thus argue that contextual factors go further than just the physician/patient/physical environment factors that come into play during a clinical encounter. Seeking to understand the whole-patient narrative as more than simply a disease process is an important aspect to this also.

As opposed to how CR was viewed and researched in previous decades, which was to focus on its cognitive aspects, there is currently little doubt as to the importance of the influence of context on CR processes. This is important in both clinical and medical education settings, where much of the assessment of CR occurs in artificial environments (e.g., OSCEs, written examinations) rather than in clinical settings with real patients (Rencic, et al. 2020b). However, this should be interpreted beyond the immediate physician/patient/environmental factors and should also take patients' lived experiences into account, an element that is often lacking in the high-pressure environment of modern medicine and in medical education assessment.

Flexibility and agility of thinking in clinical reasoning

The term 'flexibility' in the context of CR is used slightly differently by different authors. Durning et al. (2016) define flexibility in thinking during CR quite broadly:

> Flexibility in thinking refers to the use of a variety of thinking means or processes that can be applied during a diagnostic event.

They go on to say that it can also be applied during reflection (i.e., metacognition):

> … the degree of flexibility in thinking requires a variety of strategies to creatively approach a given clinical problem, and, as such, requires a tolerance for ambiguity and a reflective understanding of the practice, both during the clinical-reasoning process (reflection in action) and retrospectively (reflection on action).

Ark, Brooks, and Eva (2007) are somewhat more specific when they use the concept of flexibility to apply it interchangeably between analytic and non-analytic reasoning. A study done by them showed that novices are more successful when they are specifically instructed to more flexibly use it in this way:

> … explicit instruction to utilise both analytic and non-analytic forms of diagnostic reasoning can improve novice clinicians' diagnostic accuracy.

Eva (2005) agrees, but adds that flexibility is also required to adapt to different situations as required by the context:

> … awareness of the prevalence of context specificity has highlighted the need to provide students with an array of strategies that might better position them to flexibly adapt as the situation demands.

He goes further by equating flexibility with expertise:

> … re-conceptualise the construct of expertise to that of an amorphous entity that might best be defined as flexibility regarding the ways by which solutions to clinical problems can be derived.

Durning, Trowbridge, and Schuwirth (2020) agree:

> Better clinical reasoning is not characterised by having a single best answer but rather who is most flexible in navigating a complex process and thus has the broadest repertoire of strategies; when one reasoning strategy does not work, the expert performer will quickly adapt to the contextual requirements and select another strategy (or strategies).

Schuwirth, Durning, and King (2020) use the term 'agility' to describe a similar process:

> Clinical reasoning occurs as a narrative, either as in internal dialogue, or between physician and others; consequently, the distinction between a good/poor clinical reasoner does not lie merely in the identification of the single best solution, but rather the extent to which the reasoner can agilely utilise a repertoire of strategies and demonstrate situation awareness to convey their message.

Although there are some minor differences in the way that flexibility/agility of thinking is interpreted, there is broad agreement that this concept is an important component of CR. The way that I interpret this is that it applies not only to the cognitive and metacognitive aspects of CR, but

also to the contexts in which CR processes occur. Those who have the ability to be more flexible or agile in their thinking will be more successful clinical reasoners. It is one of the hallmarks of CR expertise, not only in terms of navigating the cognitive aspects of CR, but also in terms of dealing with its contextual aspects.

Diagnostic and management reasoning

Much of the published literature focuses on the diagnostic aspects of CR. However, it is now widely accepted that CR encompasses both diagnostic reasoning, which is arriving at a diagnosis or explanation for a patient's problem (Olson et al. 2020), and management reasoning, which is the process of making decisions about patient management including treatment, follow-up, further testing and allocation of scarce resources (Norman 2005; Eva 2005; Rahayu and McAleer 2011; Durning, et al. 2012b; Pinnock and Welch 2014; Durning, et al. 2014; Guerrasio and Aagaard 2014; McBee, et al. 2015; Durning, et al. 2015b; Yudkowsky, et al. 2015; Posel, McGee, and Fleiszer 2015; Dong, et al. 2015; Hemmer, et al. 2015; Capaldi et al. 2015; Connors and Siner 2015; Islam, et al. 2015; Wu et al. 2016; Chang, et al. 2016; Raupach, et al. 2016; Pinnock, Fisher, and Astley 2016; Pelaccia, et al. 2017; Jost, et al. 2017; Young, et al. 2018b; Cook, Sherbino, and Durning 2018; Daniel, et al. 2019; Rencic, et al. 2020a; Rencic, et al. 2020b; Konopasky, et al. 2020a; Connor, Durning, and Rencic 2020; Ramani, et al. 2020; Soh et al. 2020; Richmond, et al. 2020; Van Schalkwyk, et al. 2020; Olson, et al. 2020; Parsons, Wijesekera, and Rencic 2020; Zheng, Li, and Lajoie 2020; Young, et al. 2020; Kelekar and Afonso 2020; Kononowicz, et al. 2020; Anakin, et al. 2020; Cleary, et al. 2020; Torre, et al. 2021).

Ilgen, Eva, and Regehr (2016) make the intuitively valid point that making a diagnosis should not be regarded at the endpoint of CR. Instead, they argue, should be used as a way of making meaning of the situation:

> … drawing satisfaction from 'making a diagnosis' treats diagnosis as a solution (i.e., as the endpoint of a problem solving activity), while using diagnosis as a clinical reasoning aid treats diagnosis as a way of making meaning of the situation in order to better understand and manage a problem… Given the problems inherent in emphasizing diagnosis as the goal of thinking, how might we shift toward more effectively emphasizing the diagnostic process as an aid to thinking, an ongoing exercise of interpretation and 'meaning-making'?

Although diagnostic and management reasoning are seen as distinct processes, they are inextricably related and there is (or should be) a natural progression from one to the other. Both are required for good patient care. This does not imply that it is possible to make a definitive diagnosis during every patient encounter, and practitioners are often faced with an element of

uncertainty (O'Riordan et al. 2011). However, diagnostic reasoning is used regardless of whether it has been possible to arrive at a definitive diagnosis or not.

How does clinical reasoning differ from clinical decision-making and critical thinking?

Clinical decision-making

As with problems in defining CR, there is also a lack of consensus in the literature about what clinical decision-making actually is. As Pelaccia, et al. (2020) point out:

> In the literature, many terms are used to describe clinical reasoning, including 'critical thinking', 'problem solving', 'diagnostic reasoning', and even 'decisionmaking'. Many authors use them interchangeably, whereas others do not.

Jackson and Kleitman (2014) hold this position:

> Decision-making is a complex process of making choices in order to achieve goals, and identifying the psychological constructs that contribute to this process can be of great importance... The decision-making process involves making judgements that inform decisions. Judgements are our beliefs or predictions and they vary in the extent to which they are an accurate reflection of reality (accuracy).

Some authors do not make a clear distinction between clinical decision-making and CR and appear to imply that these are one and the same process. For example, Ajjawi and Higgs (2008) use these terms synonymously:

> In broad terms, clinical reasoning is the thinking and decision-making processes associated with professional practice, and that decision-making is either/both the product or process of clinical reasoning.

Morris and Campbell (2015) also imply that there is no difference between these:

> Clinical reasoning is known by several synonyms, e.g. problem solving, decision making and judgement.

Pelaccia, et al. (2017) concur:

> Clinical reasoning is the thinking and/or decision-making processes that are used in clinical practice to diagnose and treat patients.

Kononowicz, et al. (2020) also hold a similar view:

> Clinical reasoning is understood as the thinking and decision-making processes associated with clinical practice.

By way of contrast, others hold the view that although clinical decision-making is part of CR, it is not synonymous with it. For example, Mamede et al. (2007) write:

> Successful clinical problem solving is defined by judicious judgements and effective decision making.

Ghafouri, et al. (2012) hold this view:

> Clinical reasoning is a scientific method of medical thinking includes two parts: medical enquiry and clinical decision making.

Marcum (2012) is firm in his view that these processes are not synonymous:

> Clinical reasoning is often associated with but is not identical to diagnostic reasoning, clinical decision making or judgement, or medical problem solving.

In a detailed definition of CR, Audetat, et al. (2013) describe it as:

> … the set of complex thought and decision-making processes underlying clinicians' choices and actions in specific medical problem-solving contexts, clinical reasoning requires an array of cognitive, metacognitive, emotional, reflective thinking and relational skills.

They have the view that there are two major theoretical paradigms for the cognitive processes used in CR: decision-making and problem-solving. Decision-making, they believe, is concerned with the diagnosis and possible errors leading to misdiagnosis, which means that reaching a diagnosis means updating opinions with imperfect information. Problem-solving, on the other hand, views diagnostic reasoning as a process of hypothesis-testing and solutions to complex problems are found by generating a limited number of hypotheses during the diagnostic process and subsequently using them to direct the collection of data. Kiesewetter et al. (2013) agree with this view when they write:

> The clinical reasoning process involves medical decision-making on one hand and problem-solving on the other hand.

Wu et al. (2014) hold the view that CR is the sum of clinical problem solving and diagnostic reasoning, while Wells (2015) contends that decision-making (often when the evidence in incomplete), together with evidence and critical thinking are components of CR.

Other authors take this a step further by describing CR and clinical decision-making as being distinct from each other but complimentary, and that CR comes first to solve the problem and then clinical decision-making is used to assign a final diagnosis and a course of treatment. For example, Hruska et al. (2016) write:

> Reasoning and decision-making stages are distinct from one another in that clinical reasoning is the activity prior to or during attempts to solve a medical problem, whereby a clinician weighs and sorts through assessment details obtained from medical history, physical assessment and test results; subsequent to this, decision-making is the stage during which the clinician chooses between competing options or courses of action to assign a final diagnosis and determine the plan of care.

Pelaccia, et al. (2020) describe CR as the cognitive processes that underpin decisions, in other words, the thought processes occur first and are then followed by the clinical decision-making processes. Schuwirth, Durning, and King (2020) agree:

> Clinical decision-making focusses on the final decision, while clinical reasoning focusses on the thought process and the decision.

However, they add that diagnostic decision-making is not the same as other forms or decision-making or of CR, and is likely to be prone to different types of errors:

> Diagnostic decision making is a convergent process involving a broad collection of information that is ultimately summarised into one (or two) best solutions; clinical reasoning, by contrast, often involves the concurrent identification of multiple 'good' solutions, and is thus a non-linear, divergent and often unpredictable process.

Once again, there is a divergence of views on what clinical decision-making actually is. There are, however, compelling arguments to be made for the differences between CR and clinical decision-making. CR is a creative, divergent task that requires agility and flexibility on the part of the clinician. Clinical decision-making, on the other hand, is a convergent, categorisation task. In reality, they are related but separate, and the CR process almost always precedes the clinical decision-making process in each clinical encounter. Clinical decision-making is relatively easy to observe and assess, whereas with CR this is much more difficult.

Critical thinking

Facione and Facione (2013) report that a Delphi study from 1990 defined critical thinking as:

> Process of reflective judgement which manifests itself in reasoned consideration of evidence, context, methods, standards, and conceptualizations for the purpose of deciding what to believe or what to do.

Critical thinking is a process of judging what to believe or what to do in a given context (Facione 2000) and goes far beyond medicine.

But what about critical thinking in medicine? The literature once again fails to deliver any consensus on what critical thinking in medicine actually is, especially in the context of CR. Gupta and Upshur (2012) conclude:

> … there is no uniform definition of critical thinking or reasoning in medicine… critical appraisal, critical reasoning and critical thinking, while sharing common elements, encompass a heterogeneous range of skills, attributes, dispositions and habits.

Some regard critical thinking and CR as being the same process. For example, Ross et al. (2013) maintain:

> Critical thinking is the ability to identify a problem, select and evaluate pertinent information, recognise assumptions, formulate appropriate hypotheses, and draw valid conclusions and critical inferences.

When applied to a clinical setting, this description is very similar to the cognitive processes of CR.

Clardy and Schwartzstein (2015) imply that they regard CR and critical thinking as being synonymous when they write:

> Critical thinking incorporates attributes of the thinker as well as the thought processes, i.e. what they know as well as how they think.

By way of contrast, others regard critical thinking as one component of CR. For example, Facione and Facione (2008) regard it thus:

> Critical thinking and reflective problem-solving are the two cognitive processes involved in clinical reasoning.

Wells (2015) agrees:

> Critical thinking is one component of clinical reasoning, but they are not the same.

A number of authors take the view that critical thinking equates to the metacognitive part of the CR process. For example. Chiu and Cowan (2012) write:

> Critical thinking is the mode of thinking in which the thinker improves the quality of their thinking by skilfully analysing, assessing and reconstructing it. It is self-directed, self-disciplined, self-monitored and self-corrective thinking, and presupposes assent to rigorous standards of excellence and mindful command or their use. It entails effective communication and problem-solving abilities as well as a commitment to overcome our native egocentrism and sociocentrism.

Azer, Guerrero, and Walsh (2013) view it as being beyond cognitive skills and being comprised of two main components: cognitive skills and the affective domains of reasoning and attitude:

> Critical thinking is a purposeful process that involves self-regulation, analysis, evaluation, interpretation, conceptualisation, and methodological assessment as a learning approach.

Dwyer et al. (2014) agree:

> Critical thinking is a purposeful, self-regulatory judgement which results in interpretation, analysis, evaluation and inference, as well as explanation of the evidential, conceptual, methodological, criteriological or contextual considerations upon which that judgement is based.

Papp et al. (2014) define critical thinking as:

> … the ability to apply higher-order cognitive skills (conceptualisation, analysis, evaluation) and the disposition to be deliberate about thinking that leads to action that is logical and appropriate.

Once again, there is a divergence of opinion about what critical thinking is in the context of CR and what role it plays. The dominant view is that although it forms (or should form) part of the CR process, it is not the same. It incorporates elements of reflection and metacognition, and it would be most appropriate to consider it in this manner. Not all thinking can be considered critical thinking, and excess reliance on intuitive thinking is a characteristic of an unreflective thinker.

How does clinical reasoning develop?

The start of specific research into the development of CR was arguably the seminal work by Elstein and colleagues during the 1970s (Elstein, Shulman, and Sprafka 1978), and this formed the basis of

the earliest model of CR (Monteiro and Norman 2013). They worked on the assumption that experts were better problem-solvers than novices and they sought to uncover the processes behind this in order to improve training. This led to the later development of the hypothetico-deductive reasoning model that emerged from research in two centres in North America – Michigan State University and McMaster University (Norman 2005). This theory holds that when faced with a new case, doctors generate a set of hypotheses that they later use to test against the data presented (Eva 2005).

However, this proved problematic in that the process was too general, and it transpired that all the research subjects were doing the same thing regardless of their level of training or experience. Experts tended to generate better hypotheses, but not more or quicker ones, and the accuracy of their early hypotheses was a strong predictor of their final diagnosis. This implied that good CR was dependent on content knowledge rather than general problem-solving abilities. Furthermore, content specificity was high, which meant that success in solving one case was a poor predictor of success in subsequent cases (Norman 2005; Norman, Young, and Brooks 2007).

This realisation resulted in a change in direction in CR research during the 1980s, when attention turned to solving the dilemma of content specificity. Researchers became interested in how knowledge is organised, sorted, stored and recalled from memory, and how pattern recognition (nonanalytic reasoning) occurs.

Content specificity (also known as case specificity or domain specificity) is the phenomenon of success in a solving a particular clinical problem not being a good predictor of success in solving the next one and is the variability a physician shows based on different content areas (conditions) (Norman 2006; Durning, Trowbridge, and Schuwirth 2020; Mamede 2020).

Rencic, et al. (2020a) describe it as:

> … the intra-physician differences in content knowledge across different domains.

This phenomenon can lead to differences in CR performance, even within the same specialty area (Konopasky, et al. 2020a).

There is now broad agreement that the development on CR starts with a solid biomedical knowledge base, which gets encapsulated into memory/thinking, then organised into illness scripts and exemplars which then leads to better System 1 (non-analytic) thinking (Norman,

Young, and Brooks 2007; Delavari, et al. 2020). Encapsulation of knowledge is an abstract concept that means an amalgamation of mental models.

Successful CR is dependent on rich, content-specific knowledge organised into illness scripts, together with a variety of strategies to solve a given medical problem together with a tolerance for ambiguity and uncertainty, and the ability to reflect on practice (Boshuizen and Schmidt 1992; Schmidt and Boshuizen 1993; Durning, et al. 2013b). These illness scripts, which are a product of past experiences and knowledge, are dynamic and are modified by each new clinical encounter. They are amalgamated knowledge networks made up of data about a given illness or condition stored in long-term memory (Charlin, Deschenes, and Fernandez 2021). These allow clinicians to build a representation of a given clinical situation and allow the construction of a meaningful interpretation of that or similar situations (Charlin, Tardif, and Boshuizen 2000).

As theorised three decades ago by Schmidt and Boshuizen (1993):

> … [medical] students acquire rich, elaborated causal networks explaining the causes and consequences of disease in terms of general underlying biological or pathophysiological processes. However, through extensive and repeated application of knowledge acquired and, particularly, through exposure to patient problems, these declarative networks become encapsulated into diagnostic labels or high level, simplified causal models explaining signs and symptoms. In this encapsulation process, low-level, detailed concepts are clustered together, resulting in higher level concepts. These higher-level concepts replace the elaborate causal networks in expert clinical reasoning.

Two years later Van der Vleuten and Newble (1995) wrote:

> Expert reasoning is strongly connected to knowledge, but it is not simply the knowledge itself, but the way that the knowledge is stored – the expert clinician accumulates knowledge in the context of concrete medical problems in a process that enhances the chance of effective retrieval; with increasing experience the need for clinical reasoning (i.e. analytic reasoning) diminishes as the mental processes become automated in patterns or scripts.

A decade later, Eva (2005) wrote:

> The earlier students begin to accumulate a mental database of cases, the sooner they will develop a firm foundation on which to allow non-analytic processes to contribute.

Eva recognised that the learning of biomedical sciences is important to assist in generation of accurate hypotheses and should remain part of medical training, but that the Flexnerian way of having to master these before proceeding to learn clinical problems was outdated and inappropriate. He held that practicing CR with clinical cases should proceed in a way that mimics the eventual use of the resulting knowledge, i.e., it is better to learn from actual patients rather than from textbook cases in which the diagnosis is already known as a result of the chapter topic. He proposed that ‘mixed’ practice, in which students see cases of multiple categories mixed

together (as opposed to blocked practice in which students work through a block of cases from one diagnostic category before proceeding to the next) is pedagogically optimal.

According to Bowen (2006):

> Only after learners make new connections between their knowledge and specific clinical encounters can they also make strong connections between clinical features and the knowledge stored in memory... Experience with patients is essential for establishing new connections in memory between learned material and clinical presentations, for developing illness scripts, and for developing the ability to reason flexibly with the use of analytic reasoning and pattern recognition.

Lining up a clinical encounter to what is already known helps to store that event in memory more meaningfully, and this helps to improve pattern recognition and transfer of knowledge. The pattern recognition, which develops through repeated clinical experience, thus results in better non-analytic reasoning which is essential to the development of diagnostic expertise.

Schmidt and Rikers (2007) further developed this theme:

> Through education and experience, students acquire more and more relevant concepts and develop richer and more meaningful relationships between them, i.e. knowledge expansion.

They maintain that students rapidly develop mental structures of elaborate causal networks that explain the causes and consequences of disease in terms of general underlying biological or pathophysiological processes. It is through extensive and repeated application of knowledge acquired, particularly through exposure to patient problems, that change occurs and knowledge becomes encapsulated, and as students begin to see real patients, their encapsulated knowledge is reorganised into illness scripts which are then stored as exemplars of a particular illness.

Charlin, et al. (2007) agree:

> Illness scripts develop as students are exposed to real patients, and in their first encounters they apply both biomedical and clinical knowledge. Script acquisition is of utmost importance at the beginning of a medical career, and illness scripts require continuous updating as a result of changes in the diseases themselves and the population a doctor deals with.

Creating a clinically useful knowledge base is thus a multistage process (Williams, Klamen, and Hoffman 2008), and students progress through several stages in this process as described by Rahayu and McAleer (2011):

> … in acquiring expertise in medicine, students progress through several transitory stages, characterised by distinctively different knowledge structures underlying their performance. The stages include development of elaborated causal networks (knowledge accretion and validation); compilation of elaborated networks into abridged ones (encapsulation); emergence of illness scripts; and storing patient encounters as instance scripts (instantiated scripts).

Schuwirth (2009) agrees with this developmental process, but hastens to add:

> Semantic networks and illness and instance scripts are highly idiosyncratic, which makes it logical why experts disagree on the optimal way to solve a medical problem. Typically they agree on the solution to arrive at, but not on how to get there.

Mamede, et al. (2007) maintain that the two types of reasoning (analytic and non-analytic) result from different kinds of knowledge used for diagnosing cases, and medical expertise development entails a process of knowledge restructuring. Clinical teaching should thus provide students with multiple reasoning strategies that could enable them to work through problems in different situations, and this includes recognising when more reflection is required.

Ajjawi and Higgs (2008) bring the perspective that learning to reason has a frame of reference of professional socialisation, which is an individual's journey of professional development and a social, acculturation process occurring within a professional group and context. This introduces the concept of CR being learned not in isolation, but as a social, collaborative activity. This means that it could be enhanced by the collaboration and guidance of peers, mentors, role models and patients.

Audetat, et al. (2013) agree that building strong knowledge structures and representations is important, but add that integrating the teaching of communication techniques and CR in a clinical setting significantly fosters the development of CR.

While the progressive development of illness scripts in students, especially in the early stages of their training, is important, some authors feel that encouraging students to reflect while diagnosing patients' problems fosters the enrichment of relevant illness scripts. A study undertaken by Mamede, et al. (2014a) concluded that:

> … structured reflection was more effective in fostering learning than simply providing a diagnosis or a differential diagnosis. Students who reflected on the cases in the learning phase performed better… The effect of reflection on diagnostic performance was substantial and appeared both on novel exemplars of the same diseases and on diseases that were not among the cases seen in the learning phase but that were plausible alternative diagnoses for them… Because students were not exposed to any "new" knowledge, where might the observed effect of reflection come from? Our explanation is that reflecting while diagnosing the cases in the learning phase restructured mental representations of diseases that the students already had in mind. Reflection required students to match in detailed fashion the patient's signs and symptoms with the illness script of the disease initially considered as a possible diagnosis, evaluating the degree to which findings were compatible with the presentation typically associated with that disease and identifying discrepancies.

As a result of these and other observations, some recommend the teaching of a deliberate reflection strategy (Schmidt and Mamede 2015; Audetat et al. 2017; Chamberland, et al. 2021). For example, after conducting a narrative review of the literature, Schmidt and Mamede (2015) concluded:

> If pathophysiological knowledge – through repeated application – has become encapsulated and rudimentary illness scripts emerge in memory, the focus in the teaching of clinical reasoning could shift to deliberate reflection as a tool for learning how to differentiate among various diseases and between the often subtle variations in how disease expresses itself.

Despite the intensive research on CR over a considerable period of time, the evidence on how clinicians develop and maintain CR competence remains limited and consensus regarding this remains elusive (Durning, et al. 2013b; Capaldi, et al. 2015). There is, however, some agreement on the steps that the learner must negotiate in order to build a knowledge base of sufficient capacity to become a successful clinical reasoner. The aspect of professional socialisation by interaction with others is a significant factor that is not always recognised.

Specific methods of learning and teaching clinical reasoning

As with almost everything pertaining to CR, there is little consensus on the best methods for students to learn and medical schools to teach and encourage its development in their students (Levine 2014; Pinnock, et al. 2019; Torre, et al. 2021).

As Papa and Li (2015) write:

> Contemporary medical education has yet to create a codified, evidence-based approach to training to or assessing the diagnostic capabilities of medical students, residents or practitioners.

Some medical education researchers are of the opinion that CR should be formally taught in medical schools. For example, Schmidt and Mamede (2015), while recognising that research in the area is lacking, are proponents of this approach:

> *[Medical schools]* cannot rely on clerkships or rotations as the breeding ground for this skill. The variety of cases offered to students is simply too limited, and the provision of feedback and coaching too haphazard, to trust the professional environment to provide a solid base for the development of this aptitude. Medical educators need to do more and in a more systematic fashion. The establishment of a clinical reasoning curriculum as part of undergraduate training is in our view long overdue.

One study done by Round (1999) was reported to show that students who had participated in a formal CR teaching intervention had better outcomes when measured by the Diagnostic Thinking Inventory than students who had not. However, there are several limitations to this study and the results should be interpreted with caution. A major limitation is that the Diagnostic Thinking Inventory assumes that CR is a simple, linear process and that it can be measured as a more or less stable personality characteristic, whereas the reality is that it is a complex and recursive process as outlined above, and it fails to capture this.

An international survey conducted by Kononowicz, et al. (2020) found that while 53% of schools surveyed used lectures to teach CR, only 37% of respondents felt that this was a method of

instruction that should be used. A literature review from the United Kingdom that was undertaken as part of recent consensus statement on the teaching of CR in undergraduate medical education found that there was a general lack of effectiveness for the teaching of the general thinking processes used in CR (Cooper et al. 2021). However, they did recommend specific teaching strategies to build knowledge and understanding.

Other researchers take the view that CR should not be formally taught but that it should rather be learned in clinical or simulated settings. An article by Khin-Htun and Kushairi (2019) lists twelve tips for developing CR in medical students, and not one of the twelve includes formal CR instruction.

It is clear from the literature that most CR experts and researchers agree that it is not a simple, linear process, but that it is complex, multifaceted, iterative, recursive and influenced by social interaction and the context in which the clinical encounter occurs. It requires agility, flexibility, expertise and feedback. None of this can be formally taught in a classroom, lecture room or workshop setting. The conclusion that I draw is that it is best learned in a clinical setting with the learner observing, practicing and receiving appropriate feedback from those with expertise and experience, with a wide variety of patient presentations.

As Schuwirth (2002) points out:

> Logically, it would then appear that just as there is no way of teaching practice experience, neither is there any simple generic 'trick' or algorithm with which to teach clinical reasoning. Rather, clinical reasoning can only be learnt within the context to which it is to be applied.

An examination of the literature reveals that a wide range of methods is currently in use to facilitate the development of CR. These are summarised in Table 5.1 below.

Table 5.1: Summary of methods currently used to enhance the acquisition of clinical reasoning in students.

Setting	Method	Technique
Clinical (work-based) setting	Clinical exposure (especially early) with feedback Repeated practice Social learning (with preceptors and peers) Interleaved learning Work-based assessment with feedback Morning report	One minute preceptor (OMP) SNAPPS Teaching on the Run Deliberate reflection Learning good communication techniques Think aloud techniques Development of critical thinking ability Scaffolding of curriculum Self-explanation Situated learning/situated cognition Direct expert-student interaction/role modelling Deliberate practice Grand rounds

Setting	Method	Technique
	Integration of the curriculum	M&M meetings Curiosity Mini-CEX Learning to cope with ambiguity and uncertainty Interprofessional learning Peer learning Parallel consulting Bedside teaching
Simulated setting	Artificial intelligence (including computer-based programs)/ simulation Simulated patients Clinical skills teaching Integration of the curriculum	Deliberate reflection Good communication techniques Think aloud techniques Development of critical thinking ability Scaffolding of the curriculum Self-explanation Situated learning/situated cognition Computer-based cognitive mapping Virtual patient cases Curiosity Learning to cope with ambiguity and uncertainty Interprofessional learning Peer learning Whole-case and serial cue approaches
Classroom/tutorial setting	Problem-based/cased-based learning Formal lecture/teaching programs Integration of the curriculum	Good communication techniques Development of critical thinking ability Scaffolding of the curriculum Concept mapping Lectures on clinical reasoning processes, bias and debiasing strategies Learning to cope with ambiguity and uncertainty Deliberate reflective thinking techniques Peer learning Clinical reasoning modules Whole-case and serial cue approaches Jigsaw technique

It is likely that students learn CR through various combinations of these, but the best way of achieving this is unclear (Pinnock, et al. 2019). It is thus highly likely that multiple strategies are required. As Torre, et al. (2021) note:

> … success in clinical reasoning is fostered by having multiple strategies and flexibility in strategy use. However, the specific strategies that are most effective in the teaching and assessment of clinical reasoning at different stages in a learner's development remain undefined.

The cognitive forcing strategy method was a program of metacognitive training designed to be used at the novice level to decrease the impact of cognitive biases in the future. It was promoted and used in the past but was subsequently found by two studies to be ineffective and it has subsequently fallen out of favour (Sherbino et al. 2011; Sherbino et al. 2014).

How is clinical reasoning measured or assessed?

Methods devised and used to assess CR are multiple and heterogenous as medical educators and researchers have attempted to develop methods to score this highly complex construct which is, in the main, hidden from view. Following a scoping review of the literature, Daniel, et al. (2019) developed three categories of assessment: workplace-based (i.e., clinical) settings, simulated clinical environments, and non-workplace-based settings. For the purpose of this review, I have adapted these three categories to assessment in clinical (work-based) settings, assessment in simulated/small group settings, and assessment in written, oral or clinical examinations. To these I have added a fourth category: assessment in experimental settings.

These methods are summarised in Table 5.2 below.

Table 5.2: Summary of methods used to assess clinical reasoning in students

Setting	Method	Comments
Assessment in clinical (work-based) settings	Morning reports	
	Post-encounter forms (PEF)	
	Patient note-scoring rubric (PNS)	
	Formal work-based assessment (WBA)/performance-based assessment (PBA)/direct observation (e.g. mini-CEX, DOPS)	
	Informal monitoring in the workplace	
	Clinical handover	
	Clinical case assessment	
	Clinical tutor reports	
	Think aloud protocols	
	Chart stimulated recall (CSR)	
	Patient summary statements (PSS)	
	Written notes	
	Self-regulated learning microanalytic protocols	
	Global assessment	
	Interpretive summary, differential diagnosis, explanation of reasoning, alternatives (IDEA) tool	Uses students' new patient admission notes
	Long cases*	
Assessment in simulated/small group settings	PBL/CBL scenarios with case write-ups	
	Simulation	
	Virtual patients	
	Objective structured clinical examination (OSCEs)	With or without post-encounter forms
	Extended clinical examinations (ECEs)	A variation of OSCEs
	Videotaped student performance analysis	
	Think aloud protocols	

Setting	Method	Comments
Assessment in written, oral or clinical examinations	Key features problems (KFPs) Extended matching questions (EMQs) Script concordance tests (SCTs) Modified essay questions (MEQs) Multiple choice questions (MCQs) Short answer vignette exam (SAVE) Long answer essay questions Oral case presentations Oral examinations/viva voces Patient management problems (PMPs)** Clinical Integrative Puzzle (CIP) Measuring Analytic Thinking in Clinical Healthcare (MATCH)	
Assessment in experimental settings	Functional magnetic resonance imaging (fMRI) Linguistic inquiry and word count software (LIWC) Clinical reasoning tasks (CRT) Summary statement assessment rubric (SSAR) ASCLIRE (assessing clinical reasoning) Semistructured interviews using cognitive task analysis (CTA) Oral multidisciplinary clinical case discussions Cognitive reflection test (CRT) plus actively open-minded thinking scale (AOT) Clinical reasoning problems (CRPs) Clinical reasoning survey incorporating the Self-Assessment of Clinical Reflection and Reasoning (SACRR) Diagnostic Thinking Inventory (DTI)*** Clinical reasoning inventory (CRI) Modelling using Typified Objects (MOT) model REI-40 psychometric tool Diagnostic learning objectives in the logbook Clinical reasoning tests (CRTs) Ethnographic studies	Used to interpret think-aloud data A norm-referenced computer-based test A method for studying and describing complex reasoning and knowledge that experts use to perform complex tasks Uses a jury of 3-5 teachers More data is needed to verify the construct validity of this Measures clinical reasoning by self-assessment Can be used to test specific parts of learners' clinical reasoning processes Validated in a range of diverse populations to determine decision-making style Measures only the ability to make a differential diagnosis

Setting	Method	Comments
	Self-regulated learning microanalytic protocols Concept mapping Clinical data interpretation (CDI)	

* Long cases have been largely abandoned due to the small, non-standardised and unrepresentative sample of student behaviour that is observed (van der Vleuten & Newble, 1995)
**These have fallen out of favour due to poor case specificity and intermediate effects (Schuwirth, 2009; Hrynchak, Takahashi & Nayer, 2014)
*** One study demonstrated no correlation between students' scores in clinical reasoning using virtual patients and their Diagnostic Thinking Inventory scores (Fida & Kassab, 2015)

Many of these methods assess the *outcomes* of the CR process without actually assessing the reasoning *process* itself. The indicator of success with various methods of teaching the diagnostic process has classically been diagnostic accuracy with little emphasis on the need to develop a sound underlying reasoning process, and valid and reliable methods of identifying and evaluating CR characteristics remains elusive (Schuwirth 2009).

There appears to be general agreement that, despite the multitude of methods, there is no single form of assessment of CR that is superior, and the ideal is to use multiple different and complimentary methods to achieve this. It is clear that CR cannot be accurately measured by assessing performance on a single case or problem (Van der Vleuten and Newble 1995). LaRochelle, Dong, and Durning (2015) have suggested that the assessment of CR should be longitudinal and commence prior to the clinical training years.

Despite the multiple perspectives (which are all valid) and a divergence of opinion around the definition and nature of CR, when it is distilled down to its constituent components, CR can be viewed as the process during which a clinician interacts with a patient to collect, weigh and interpret data relevant to the patient's presentation in order to arrive at a diagnosis (or a differential/provisional diagnosis) and to institute a plan of investigation and/or treatment.

Longitudinal integrated clerkships – what are they, what are their underpinning principles and what are their intended outcomes?

The term 'longitudinal integrated placements' is used interchangeably with 'longitudinal integrated clerkships', which is derived from terminology used in North America and Europe. In this review, for ease of use and to avoid confusion, the term 'longitudinal integrated clerkship' or its acronym 'LIC' will be used.

As reported by Norris, et al. (2009), in November 2007 the Consortium of Longitudinal Integrated Clerkships (CLIC) came to the following consensus definition of LICs:

> A longitudinal integrated clerkship is characterised by being the central element of clinical education whereby medical students (1) participate in the comprehensive care of patients over time, (2) participate in continuing learning relationships with these patients' clinicians, and (3) meet the majority of the year's core clinical competencies across multiple disciplines simultaneously through these experiences.

In the Australian context, the LIC model for medical students was developed in rural settings and embodies three key features:

a. Integration of experiences across community and hospital settings, but with a focus of training in community (ambulatory) settings;
b. Clerkships occurring over a longer period of time than the traditional short-term rural ones; and
c. Clerkships occurring in geographic areas of need, namely in regional, remote and rural settings.

Although, historically, LICs in Australia were developed for rural settings with a key outcome of addressing rural workforce shortages, interest is now being shown in developing these for urban settings with key outcomes of community engagement and social accountability (Mahoney, Campbell, and Garner 2011).

There is no single agreed way of constructing a LIC – these range from sequential models with longitudinal themes and limited integration to fully integrated longitudinal models (see Figure 5.5 below).

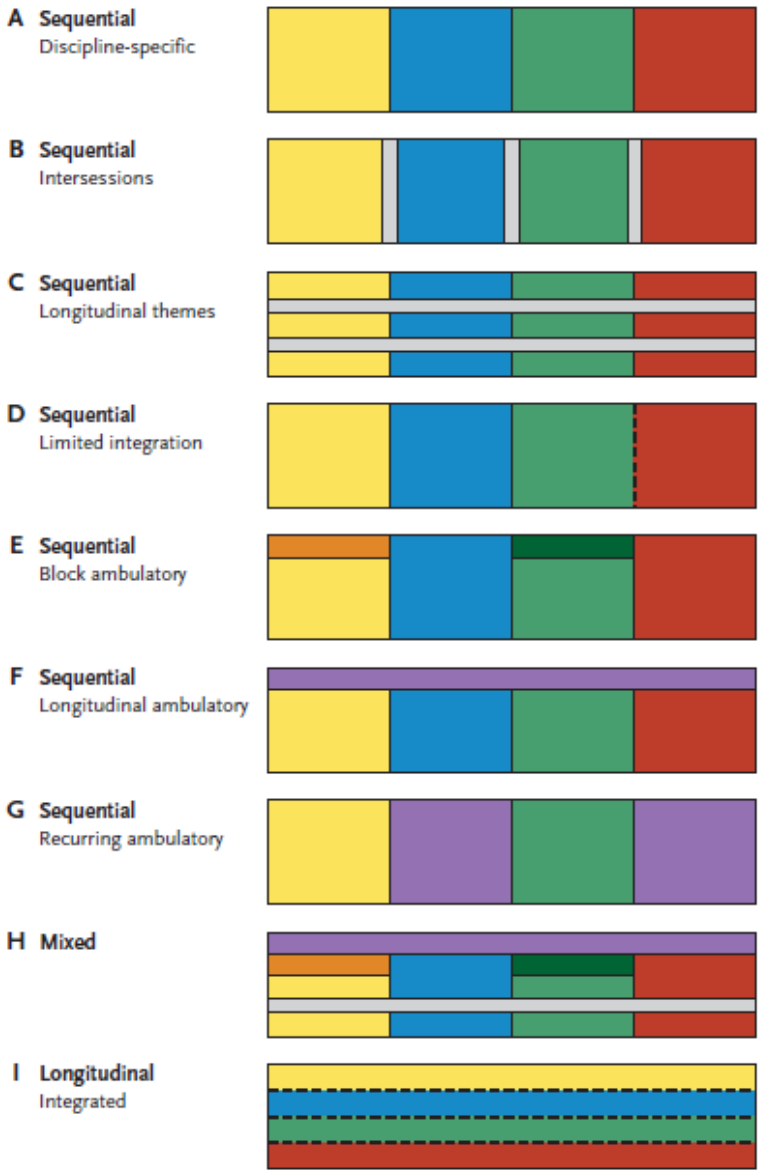

Figure 5.5: A schematic comparison of various types of clerkships ranging from the traditional model (A) to the fully integrated model (I) (from Hirsh, et al. 2007).
Reproduced with permission from Hirsh, D. A., B. Ogur, G. E. Thibault, and M. Cox. 2007. 'Continuity' as an Organizing Principle for Clinical Education Reform. *New England Journal of Medicine* 356, no. 8 (Feb 22): 858-866, copyright Massachusetts Medical Society

A question is frequently asked regarding how long a clerkship needs to be in order to qualify as a longitudinal clerkship. There is no agreed answer to this. Definitions of what constitutes the terms 'longitudinal' and 'integrated' vary, depending on the setting and the context. Some authors regard as little as eight weeks (Ogrinc, Mutha, and Irby 2002) as being sufficient to meet the definition of longitudinal. However, a survey of the members of CLIC in 2007 showed that the shortest clerkship duration was 5½ months, and the median duration was 40 weeks (Norris, et al. 2009).

A typology review done by Worley, et al. (2016) provides a good overview of types and durations of clerkships in the various LIC programs around the world. They found these programs had grown exponentially in number over the previous two decades. They were also able to group the types of programs into three types: a) amalgamative (which are shorter, cover less than half of the core disciplines, are treated as one of many rotations in a rotation-based course, and can be in any of the last three years of the course); b) comprehensive (which comprise a full academic year, covers all disciplines, have limited brief in-patient discipline-specific experiences, and usually occur during the penultimate year); and c) blended (which, as the name implies, is a blend of amalgamative and comprehensive models).

Underpinning principles of longitudinal models

Although there are numerous variations of longitudinal integrated clerkship models, they all share the same underlying principles.

These core underpinning principles are:

1. Continuity
2. Immersion
3. Transformative effects

Continuity

The principle of continuity is in terms of continuity of curriculum, continuity of preceptor supervision, continuity of learning with peers, continuity of systems and settings, and continuity of student idealism (Hirsh, et al. 2007; Wamsley et al. 2009; Couper, Worley, and Strasser 2011; Stevens, Wilkerson, and Uijtdehaage 2014; Ellaway, Graves, and Cummings 2016; Asgarova, MacKenzie, and Bates 2017).

As Hirsh, et al. (2007) write:

> Continuity of the learning environment fosters both patient-centeredness and learner-centeredness by establishing more opportunities for connections with patients ("continuity of care"); by integrating important educational themes across clinical specialties, focusing on the developmentally appropriate attainment and assessment of core clinical competencies, and promoting the connection between science and clinical medicine ("continuity of curriculum"); and by enhancing supervision, role modeling, and mentoring ("continuity of supervision").

Immersion

Immersion in special settings and community engagement means that students can engage with patients and the local community in which they are placed in a deeper and more meaningful way

than if they were there for a shorter period of time (Worley, et al. 2000; Bartlett, Rees, and McKinley 2017).

Worley, et al. (2000) illustrate this by writing:

> … enable students to integrate their learning of the different medical disciplines in a way that reflected the reality of community practice based on relationships developed with patients, families and communities. This provided opportunities to participate in the ongoing care of patients in their communities in a way that could not be provided for students based in the teaching hospitals.

A study done by Bonney et al. (2014) found that students in one LIC program who engaged more with the community had a more positive overall response to the clerkship. Of particular note was a sense of belonging reported by students that had an impact on their learning and thinking:

> … a synergistic relationship between factors resulted in a sense of belonging, which created a rich learning environment for students and motivation to return to a non-metropolitan community for clinical practice.

Transformative effects

An intended consequence of such clerkships is to have a transformative effect on students' thinking in terms of seeing patients as people and members of families and communities and not simply as a disease. It is also transformative in terms of the development of a stronger sense of social accountability that has an impact on future career choices and decision-making (Walters, et al. 2012; Hirsh, Walters, and Poncelet 2012; Greenhill and Poncelet 2013).

A narrative review done by Walters et al. (2012) found that:

> Evidence suggests these [LIC] programmes provide students with greater opportunities to develop higher order clinical skills, interprofessional teamwork skills and a more patient-centred approach to their practice.

Philosophical views of longitudinal clerkships

The various models of LICs also share two broad philosophical views that support the three underlying principles listed above. These are a deontological view and a teleological view.

The deontological, or value-based view, holds that a patient-centred approach and social accountability are values that we should allow students to experience during their training, and that these experiences will influence their attitudes to patients and their career choices within medicine (Worley, et al. 2000; Hirsh, et al. 2007; Walters, et al. 2012; Teherani, Irby, and Loeser 2013; Girotti et al. 2015).

The teleological, or pragmatic view, on the other hand, holds that the development of flexibility and agility in thinking and reasoning that is possible in LIC models allows students to apply more

bespoke clinical solutions to their patients (Eva 2005; Walters, et al. 2012; Kelly, Walters, and Rosenthal 2014). This gives rise to the assumption that these students, or the graduates of programs that provide exposure to a longitudinal model, will have better CR skills and abilities than those who train in more traditional programs.

These two views are not mutually exclusive, and it is possible, and indeed desirable, for elements of both to co-exist simultaneously and be complementary. As Walters et al. (2012) write:

> In a complex adaptive health care system, it is important for doctors to have the cognitive capacity to balance and engage a positivist, reductionist, scientific view of illness and the constructivist, integrative, patient-centred stance of an empathetic clinician. Longitudinal integrated clerkships seem to negotiate this paradox in medical education more effectively, with LIC students seeking to move freely between these complementary viewpoints.

Intended outcomes of longitudinal clerkship programs

Although LICs were initially developed as a response to rural workforce shortages, their intended outcomes go beyond this. They also have outcomes that address medical education issues, as well and patient and population issues.

Workforce imperatives

There is a growing body of evidence to show that graduates who are exposed to LIC models during their training, especially in rural settings, are more likely to make career choices to work in settings for workforce need (Roberts et al. 2012; Playford, Ng, and Burkitt 2016; Weston et al. 2018). In addition, there is evidence to show that exposure to primary care during undergraduate training has a beneficial effect in making career choices in primary care, especially in the context of LICs (Amin et al. 2018).

Rural educational models, both LICs and the more traditional ones, allow students to consider career options that they would otherwise not be aware of or considered. A study done by (Eley et al. 2012) Eley et al (2012) reported:

> A major advantage of the RCS [rural clinical school] scheme, and other rurally focused medical training, is that it opens students' eyes to another career often not previously considered. Indeed all students reported they would choose to attend a RCS again if given the opportunity, and many found their rural training instilled a desire to spend some time working in a rural location, if not now, in the future.

Not only does it allow students to consider rural career options, but it also engenders deep interest in this. Roberts et al. (2012) report:

> Despite the 'career barriers' described by our participants, they collectively expressed a deep interest in and motivation to practise medicine in rural communities.

A further workforce benefit that has been proposed is that by providing medical education in areas of need, the youth living in these areas actually witness first-hand the training of young doctors, and this gives them the previously unrealised perception that there could be local educational opportunities for them also (Figueiredo et al. 2019; O'Sullivan and Chater 2019).

Medical education imperatives

As medical care has moved progressively over the past two decades from an inpatient hospital setting to a community one, the training of medical students has followed (Ogrinc, Mutha, and Irby 2002). A major priority of undergraduate medical education programs, irrespective of which model of education is utilised, is to produce junior doctors with a broad and sound base of knowledge, skills and abilities who are work-ready for internship. However, over the past few decades as medicine has become more sub-specialised, patient care has shifted from less inpatient to a more outpatient-focussed model, and hospital stays have become increasingly shorter and reserved for patients with more complex problems. This has had a negative impact on undergraduate medical education in hospital settings. Although writing about the North American model, (Whitcomb 2005) expounds the following view that could apply anywhere in the developed world:

> Now, many of those responsible for the clinical education of medical students recognize that assigning students to teams caring for patients on the inpatient services of major teaching hospitals – the traditional approach that has dominated the teaching of clinical medicine for decades – is no longer the best way to promote students' learning of clinical medicine. The reality is that the kinds of patients admitted to those services, the increasingly specialized nature of the services, the dynamics of care provided on the services, and the composition of the teams to which the students are attached have all changed dramatically in recent decades. These changes have had a major and often negative effect on students' ability to learn clinical medicine. Among other things, students generally do not encounter (in sufficient numbers, or at all) the kinds of patients they should for optimal learning, and their role as members of the inpatient team has become increasingly marginalized. The end result is that students assigned to those teams are no longer having a meaningful apprenticeship experience.

A key feature of LIC models is the departure from teaching in large hospitals with contact with a large number of specialists with a narrow content focus, to a model where a smaller number of generalists provide training in a broader range of content. This provides graduates with the broader base of skills required for work as junior doctors. As McLaughlin et al. (2011) write:

> Evidence suggests that, despite this shift away from serial specialist training, LIC students perform as well as, if not better than, RBC [rotation-based clerkship] students on most objective evaluations of knowledge and clinical skills.

An important intended outcome of LIC programs is the type of professional identity that students develop during these programs. Evidence is emerging to show that students in LIC programs do emerge with some differences, such as being more reflective, being more patient focussed, having

a greater sense of social justice and accountability, and having more involvement in patient advocacy (Huang and Malinow 2010; Konkin and Suddards 2012; Gaufberg, et al. 2014; Walters and Brooks 2016).

The results of a qualitative study conducted by Konkin and Suddards (2012) found:

> If students are to learn to be caring physicians, they need experiences that give them the opportunity to explore their feelings, reason through a medical problem and take responsibility… Longitudinal integrated clerkships make this possible by providing time for relationships to develop with patients, preceptors and other health professionals. An ethic of caring requires physicians to be willing to listen to patients with empathy and compassion, and to take responsibility. Students… are forming their own relationships with patients and their families, while seeking guidance and support from their preceptors. Through the experience of being with patients, often over extended periods of time and at critical moments in the care of patients, students are learning to care: to advocate, to empathize, to attend to needs, however small; in other words they are learning to be receptive and responsible.

Walters and Brooks (2016) illustrate this concept as follows:

> Patient-focused learning engenders in students the ideal of holistic comprehensive care and the development of robust clinical reasoning skills. If this concept of integration is poorly understood, we risk creating clinical placements that are 'grated' with microblocks timetabled into ever smaller time periods, in much the same way that maths and biology are taught at high school. We propose that integration of specialty disciplines within the patient care experience also supports students in developing clinical reasoning skills through opportunities for contextual inference.

A study undertaken by Gaufberg, et al. (2014) revealed that not only did these differences emerge during or soon after the LIC, but that they persisted at for least 4-6 years after completion of the LIC:

> We hypothesise that CIC [Cambridge Integrated Clerkship] graduates' clerkship experiences may help to 'immunise' them against the adverse influences of advanced graduate and postgraduate training. We propose that three factors in their clerkship experiences may contribute to the sustained patient-centredness: (i) relational learning; (ii) reflection on practice; and (iii) advocacy as a professional duty… Evidence exists that LICs advance our profession's social accountability mission and can address workforce distribution. Our findings contribute to the evidence that LICs stimulate learners to become the humanistic doctors and agents of change our society demands and deserves.

Patient and population imperatives

The traditional structure of organising medical students' clinical education around a series of rotations in hospital departments and/or clinical specialties reflects the needs of the department or specialty rather than that of the students or the patients (Medalie, Mettee, and Stevens 1997). Students have transient contacts with both medical teams and patients, and patients have shortened stays and fragmented contact with the health care system (Bell et al. 2008). This model is assumed not to adequately prepare students to meet the complex healthcare needs of an ageing population with increasing levels of chronic illness.

As Teherani, et al. (2009) articulate:

> Marked by disjointed and brief experiences coupled with insufficient integration among specialties, core clinical education in medical schools does not optimally prepare trainees to meet the complex health care needs of a chronically ill and aging society. Moreover, in ambulatory care settings, teaching is characterized by brief student–faculty interactions that focus on management and treatment over teaching and feedback.

LICs have the potential to better prepare graduates for practice, and the unique hands-on learning that this model provides gives greater insights into patient cultural and contextual factors that ultimately leads to the provision of better individual and population health care. This is designed to produce doctors who are more aligned to societal, healthcare system and individual patient needs. A study by Daly et al. (2013a) found:

> The breadth of this *[longitudinal integrated]* placement provides an excellent opportunity to enhance the holistic skills required for internship and gradually increase responsibility, with students feeling they are ‘‘more than students’’ providing service to the community as well as just being taught.

They concluded:

> This study suggests that... a longitudinal clinical placement in a rural setting provides opportunities to enhance self efficacy and competencies that facilitate P4P *[preparation for practice]*, but students need the skills to make the most of available opportunities.

How do students learn during longitudinal clerkships and does this differ from how students learn during traditional block rotations?

The ways in which LIC programs enhance student learning, when compared with students engaged in more TBR-based programs, can be broadly categorised into five groups:

1. Multiple repeated exposure to clinical cases
2. Encoding specificity
3. Retrieval of information from long-term memory
4. Mixed or interleaved learning
5. Meaningful learning relationships

The boundaries between these categories are not clearly defined, and there is some considerable overlap between them. The first four deal with Aristotle’s ‘logos’ (logic/reason) domain, while the fifth relates to his ‘ethos’ (credibility/trust) and ‘pathos’ (emotion) domains (Arvanitis and Karampatzos 2011).

A conceptual framework of the factors that contribute to student learning during LICs is illustrated in Figure 5.6 below.

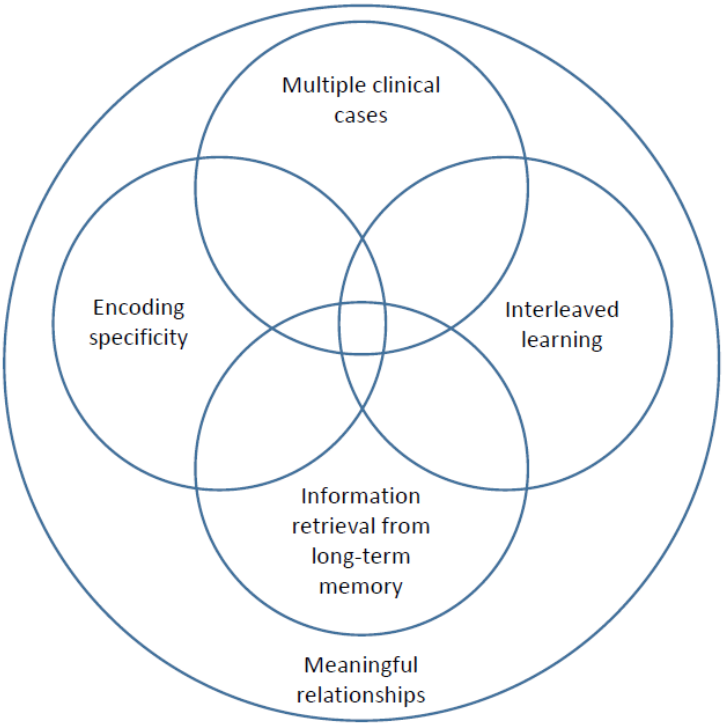

Figure 5.6: Conceptual framework of the factors that contribute to student learning in longitudinal integrated clerkships.

Multiple repeated exposure to clinical cases

There is little doubt that medical students in LIC programs have opportunities to interact with greater numbers of patients and have more opportunities for direct contact with them, especially undifferentiated patients, than those in more traditional programs (Zink et al. 2008; Shahi et al. 2015; Roberts et al. 2017; Campbell, et al. 2017; Latessa et al. 2017). This is not to say that students in TBR clerkships do not interact with patients, but the nature of these interactions is different. Patients seen by students during TBR clerkships often have more serious medical problems, but by the time the students see them these problems have frequently been filtered and sorted by the treating teams. As a result, student interaction with these patients is often brief and mechanistic.

Students in LICs, by comparison, have deeper interactions with undifferentiated patients that are unpredictable and more complex, and this more closely parallels the CR process. They also have more opportunities to see the same patients more than once, which provides opportunities to experience first-hand how diseases resolve or worsen.

As Roberts, et al. (2017) write:

> Student engagement in LICs arises from consistent, wider, and more direct access to patients and can be enhanced through structured systems of supervision and through the provision of authentic roles for students in clinical teams.

Drawing on the cognitive sciences in the field of expertise development, it is now widely accepted that good clinical learning and the development of CR takes time, exposure to multiple examples and the repeated practice of solving clinical cases, and that students must be involved with problem solving and have opportunities for reflection (Chamberland, et al. 2015). The higher the volume of patients seen, the greater the success in academic achievement (Hemmer, et al. 2015), and through the repeated exposure to patients and the extensive and repeated application of knowledge acquired, particularly through exposure to patient problems, changes occur in the thinking of students as knowledge becomes encapsulated and illness scripts develop (Schmidt and Rikers 2007).

A further important aspect to the repeated solving of clinical cases for the development of expertise is feedback, especially immediate feedback. Ericsson (2007) writes:

> A fundamental prerequisite for improvement of performance accuracy through practice is the availability of valid immediate feedback… In numerous… domains it has been possible to identify special practice activities (deliberate practice) that performers' teachers or the performers themselves design to provide opportunities to improve particular aspects of their performance in an environment that allows gradual refinement after problem solving and repeated variations with immediate feedback… A subsequent review was able to demonstrate that increases in the amount of practice (meeting the criteria for deliberate practice) were associated with increases in performance.

This type of deliberate practice and immediate feedback is a key feature of LICs and is heavily intertwined with the strong relationships that develop between student and clinical preceptor (more on this later).

The ability for students in LICs to see more patients is due in part to the context of community primary care settings in which it occurs. As Campbell, et al. (2017) found:

> The primary care context was seen as important in shaping clinical reasoning for two reasons: first, there are no limits to diagnostic possibilities amongst patient presentations in primary care, and, second, the psychosocial aspects of the undifferentiated patient presentation contribute significantly to how and what conditions patients bring to their doctors.

This repeated exposure of students to undifferentiated patients, as well as the parallel consulting model that is frequently used in longitudinal clerkships in primary care settings, is seen as important in shaping the development of CR. Thus, the logical conclusion to be drawn is that the ontology of LIC models as a complex, multi-faceted, iterative process much more closely mirrors that of the CR process than the ontology of TBR models found in large teaching hospitals, where

student contact with patients is frequently brief and mechanistic, and their thinking and reasoning linear.

Encoding specificity

Encoding specificity is the probability and efficiency of retrieving an item from memory being dependent on the similarity between the conditions of encoding and those of retrieval. The educational implication of this is that it is best to make the learning environment and the application environment as similar as possible. For example, learning about a particular clinical problem from a patient will make it easier to retrieve information about that problem from memory than learning about the same problem in a different context, for example from a textbook.

This is a significant rationale for community-based medical education, where substantial parts of LIC programs tend to occur, where much of the instruction takes place in patient care and community settings (Regehr and Norman 1996) and where more clinical problems are seen in real patients. By comparison, when medical education largely or exclusively takes place in large teaching hospitals where a small proportion only of medical care it provided, students learn in settings that are different to where much of medical care is provided. Encoding specificity is thus more limited in these settings.

Retrieval of information from long-term memory

The total time hypothesis states that the amount learned is directly and linearly related to the total amount of time spent learning. Furthermore, the more often a piece of information is retrieved from long-term memory, the easier it becomes to retrieve that piece of information again (Regehr and Norman 1996). Due to the longitudinal learning of all disciplines simultaneously during LICs, there is greater potential for this to occur during this model than during TBRs.

The vaccination theory proposed by Postman and Weingartner (1969) states that once students have been taught and tested on a specific body of knowledge, they become ‘immune’ against that body of information, which is what tends to occur in programs with a TBR structure. However, students need to be challenged to retrieve and use information repeatedly (‘booster shots’) and in circumstances where they might not have predicted the information to be necessary, as occurs during LICs.

Mixed or interleaved learning

Mixed or interleaved learning involves students learning and practicing multiple concepts together or cumulatively as opposed to learning each concept separately. This has been shown by several educators and researchers to facilitate the transfer of learning (Kulasegaram, et al. 2017; Rohrer 2012; Hatala, Brooks, and Norman 2003). Learning is most durable when study time is distributed over a greater period of time, and the interleaving of different types of practice problems markedly improves learning (Rohrer and Pashler 2010).

On writing on retrieval of information from memory, Hruska, et al. (2016) hold this view:

> Dispersed learning and repeated testing also appear critical in refinement of knowledge structures and for developing accurate retrieval of relevant information from long term memory.

Experimental psychological research has demonstrated that interleaved learning results in an improvement of test scores when compared with block learning (Taylor and Rohrer 2010). This has been translated to medical education outcomes where students learn in an interleaved fashion, as occurs in LIC models, have improved acquisition of knowledge as measured by examinations (Worley, Esterman, and Prideaux 2004; Ogur et al. 2007; Hansen and Simanton 2009; Poncelet et al. 2011).

When one studies the structure of LICs, it is clear that concepts are encountered and learned by students in random, unpredictable and repeated ways. The structure of specialty TBRs, on the other hand, allows mainly for concepts to be encountered and learned by students in a highly structured, predictable and time-limited way. This, then, leaves little doubt that there is low potential only for the interleaved learning of multiple concepts simultaneously during these TBRs.

Meaningful learning relationships

With increasing specialisation and subspecialisation in medicine, together with changes to the types of patients admitted to large teaching hospitals with more complex medical problems and shorter length of stays, trainees often lose the personal touch that is so often needed by patients. Christakis and Feudtner (1997) made the following observations more than two decades ago, and the situation is likely to have deteriorated further since then:

> … the healing touch in major medical centers rarely lingers. Patients suffer – and so too do those who desire to be healers. Such a situation can hamper trainees' capacity to build long-term relationships with patients, as most of them spend much of their formative years experiencing patient-physician relationships as mere temporary matters, lacking the deeper human connection that can be the most rewarding aspect of practicing medicine. Similarly, the interactions of students and residents with each other and with the medical and nursing staffs are also limited engagements, typically divided into time periods of shifts and monthlong rotations... What kinds of personal interactions do we wish to classify as merely functional encounters as opposed to richer, more meaningful relationships? How will we… nourish and protect relationships and not simply glorify or confuse encounters with true relationships?

It is clear that the acceptance during LICs of students as part of the clinical team, together with opportunities to observe and experience clinical encounters in the context of unique doctor-patient relationships, especially in rural settings, has beneficial outcomes with regards their learning. This is a major shift from the situation encountered by students in major teaching hospitals.

As the study by Campbell, et al. (2017) found:

> Longitudinal clinical placements provide continuity of supervision and the opportunity for constructive global feedback to the learner. Over time, appropriate, constructive and well-directed feedback about clinical performance and clinical decision-making can assist the learner to develop an increasingly sophisticated approach to history-taking, interpretation of information and clinical management decisions. This is more easily achieved with longitudinal placements… Under the apprenticeship model of longitudinal placements, students who are not progressing as expected are able to be identified early in the placement.

This continuity of supervision provides the capacity for students to develop deeper, more meaningful relationships with their clinical supervisors, which may also have a beneficial effect on student learning (Worley, et al. 2006)(Worley et al, 2006). Fuller, Lawson & Beattie (2021) found that these stronger relationships lead to greater entrustment by clinical supervisors. Fuller, Lawson, and Beattie (2021) found that these stronger relationships lead to greater entrustment by clinical supervisors:

> Parallel consulting in General Practice is a fundamental structural component of many LIC programs that is often facilitated by only one or a small number of supervisors for the duration of a LIC program, allowing for the development of a stronger personal connection and associated higher degree of trust to be attained. Parallel consulting, by nature, places students into a situation of active participation from early in their LIC year, as students typically perform the clinical assessment of a patient alone, prior to their supervisor joining them to review and discuss further management.

The continuity of patient care, of curriculum and of clinical supervision are important factors in student learning in these settings (Hirsh, et al. 2007). Additionally, the multiple relationships that develop are seen to be a key ingredient, as articulated by O'Doherty et al. (2022):

> … triangular relationships between students, GP supervisors and patients within LICs are the central drivers of success for this model of clinical education. These relationships are nested in a set of important supporting relationships involving other supervisors, the medical school and university, the practice clinical and administrative team as well as peers.

The relationships enabled by LIC models promote the development of social learning systems. These are comprised of synergistic and complementary learning spaces in which students engage and participate in multiple communities of practice and provides for a range of student learning experiences that contribute to clinical learning and the development of a more sophisticated professional identity (Daly et al. 2013b). Connectivity is seen as an important enabler of this process (Roberts, et al. 2017). The potential for this to occur in during specialty TBRs in teaching hospitals is far more limited.

An additional factor in relation to LIC models is that students, once they have initially settled into the program that occurs once only, then have the opportunity for uninterrupted learning. Conversely, students engaged in programs that require them to participate in multiple, short, unrelated clinical rotations have to go through this initial settling-in process (with its associated high cognitive load) at the start of each rotation, which means that their learning and development is interrupted multiple times during their clinical training.

In summary, all five of the categories listed above are characteristics commonly found in LICs but are much less common in the TBRs taking place in large academic medical centres. These categories describe the major differences in learning by students in longitudinal and block rotation models.

How does clinical reasoning develop during longitudinal clerkship programs?

There is some limited implied or indirect evidence that CR develops well in students on LICs. However, the direct evidence about how and why this is so is almost non-existent (see the scoping review in Chapter 3). Kelly, Walters, and Rosenthal (2014) theorise that both CR and communication skills mature during LIC models (but without providing evidence to back their theory:

> … outcomes of these LICs have been positive. Students gain strong communication skills and excellent clinical reasoning and management skills… the learning of medicine is contextualized around particular patients and prevalent diseases; it occurs in a familiar, supportive medical education and social environment; consequently, critical clinical reasoning and communication skills mature.

A survey conducted by Snow, Gong, and Adams (2017) found that preceptors reported more frequent opportunities for students to practice CR, have feedback provided more frequently, and were asked questions more frequently which served to promote their thinking.

Campbell, et al. (2017), on reporting on the results of a workshop conducted to explore preceptors' experiences of the effects on medical students of seeing undifferentiated patients on

the development of their CR, found that the apprenticeship-type model that LICs provide promotes good social and learning relationships, a safe and supported environment, and continuity of patient care and supervision, all of which allowed for constructive, well-directed feedback. They saw meaningful longitudinal preceptor/student relationships as being key to the development of CR:

> Development of a professional relationship between the student and the supervisor enables the student to observe the decision-making processes of an experienced clinician, or group of clinicians, over time, with the opportunity to discuss both analytical and non-analytical reasoning strategies.

There was agreement in this group that students learn CR from patients and preceptors in the environment of an understanding of the context of the clinical encounter.

How does the narrative of clinical reasoning fit with the longitudinal educational model?

The accepted theory of the development of CR is that it is a process that starts with a good grounding in the biomedical sciences together with early clinical exposure to encapsulate that knowledge, followed by the development of illness scripts and exemplars as the result of further clinical exposure. This, in turn, results in the development of improved CR.

The ontology of CR as a complex, multi-faceted, iterative process aligns well with that of LICs, which exposes students to complex, multifaceted clinical experiences that require them to think iteratively. The relationships that develop between student and preceptor, student and clinical teams, student and patients, student and fellow students, and student and place provides the additional benefits of continuity, multiple opportunities to practice CR with undifferentiated patients, better opportunities for feedback, experiencing first-hand how illnesses develop or improve over time, and social learning environments.

By contrast, students engaged in traditional serial, short-term specialty block rotations are exposed to contacts that are more mechanistic, with differentiated patients in whom much of the clinical complexity has already been solved. Relationships with preceptors, patients and fellow students is often fleeting or non-existent, and good feedback can be problematic. In addition, there is little scope for experiencing the progress over time of illnesses in individual patients.

A qualitative study done by Bing-You et al. (2018) found that students on TBRs received far less feedback from faculty than students on LICs. Students on TBRs gained the majority of their feedback from residents, who they regarded more as peers than as faculty. The duration of LICs,

by contrast, allowed for better relationships with faculty, and this enhanced feedback opportunities. They concluded:

> Not surprisingly, the longitudinal aspect of the LIC facilitates an easier establishment of stronger relationships in which students seek feedback from faculty. Although medical students may be able to obtain sufficient feedback on traditional inpatient block rotations, such feedback will be predominantly from residents rather than from faculty members, who transition often and are less present than residents. There may be a higher quality of feedback in the LIC model, which may be partly related to the increased opportunities for feedback compared with the block model. Also, the busy clinical environment of a typical inpatient block rotation presents a barrier to effective feedback.

The development of CR thus accords more fully with the philosophy and underpinning principles of LICs than with TBRs.

In LICs, a key intended outcome is for students to regard patients as individuals, members of families and members of the community rather than as a disease – in short, patient centred care. This deontological view is a key feature of this model (Worley, et al. 2000; Hirsh, et al. 2007; Walters, et al. 2012; Teherani, Irby, and Loeser 2013; Girotti, et al. 2015), and the patient thus becomes the focus and the integrating factor rather than the disease, the discipline or the specialty.

Campbell, et al. (2017) saw the continuity of LICs as vital to this process:

> Longitudinal clinical placements provide continuity of supervision and the opportunity for constructive global feedback to the learner. Over time, appropriate, constructive and well-directed feedback about clinical performance and clinical decision-making can assist the learner to develop an increasingly sophisticated approach to history-taking, interpretation of information and clinical management decisions.

DISCUSSION

This hermeneutic review has revealed that CR is a complex, multifaceted cognitive process. The accepted theory underpinning CR is that there are two systems of cognition at play – analytic thinking and non-analytic thinking – which work synergistically to assist clinicians to develop solutions for individual patient presentations. Metacognition plays a role, as does the context in which the clinical encounter occurs as well as the ability of the clinician to think agilely and flexibly.

It has also shown that although longitudinal models of clinical placement are a relatively new pedagogical approach to medical education, students engaged in these programs perform academically as well (or sometimes better than) their peers who are engaged in more traditional specialty rotation-based programs. Students also appear to have a more patient-centred approach

to their practice and to CR and have a stronger sense of social accountability. However, much is still unknown about how and why this is the case.

This review has reinforced the view that, despite its importance to medical practice and despite concerted interest by medical educators and researchers over recent decades, CR remains an elusive concept to define, teach and assess. This is largely because it is a process that almost exclusively occurs in clinicians' thinking and is thus hidden from direct view (Pelaccia, et al. 2011; Morris and Campbell 2015; Pelaccia, et al. 2017). Despite these difficulties, there is consensus that CR is, in its broadest terms, a multifaceted, complex, cognitive process (Marcum 2012; Gruppen 2017; Young, et al. 2019). It involves (or should involve) the use of metacognition as a safety mechanism to guard against biases and error (Charlin, et al. 2012; Marcum 2012; Audetat, et al. 2013; Azer, Guerrero, and Walsh 2013).

Medical education research has proposed a model of how CR develops, and this has subsequently gained widespread acceptance. This model proposes that it starts with a sound base of biomedical knowledge and combining this with early clinical exposure leads to knowledge that becomes encapsulated in memory. As clinical exposure progresses, illness scripts and exemplars are formed and stored in long-term memory, which are of vital importance to the CR process. This model is based on script theory first proposed more than three decades ago (Schmidt and Boshuizen 1993; Charlin, Tardif, and Boshuizen 2000; Charlin, Deschenes, and Fernandez 2021).

Essential to the development of these illness scripts is that the learning takes place within a meaningful context with ample constructive feedback – the master/apprentice model. This experience-feedback relationship enables the learner to connect individual practical experiences to underlying basic and fundamental knowledge (the so-called deep structure), and the learner is thus better able to store these experiences in memory and to amalgamate them into illness scripts. The possession of rich illness scripts is assumed to play a central role in the transfer of knowledge during problem solving.

Another contributing factor to the usability of experiences to script formation is that the experience takes place within a realistic context to optimise encoding specificity. The context in which CR occurs has rightfully gained increasing attention from medical education researchers over the past decade, and this is of importance to the teaching and assessment of CR in medical students. The relationship between contextual factors and CR draws on situated cognition theory, which says that context emerges from participant and setting interactions (Durning, et al. 2012b).

It also draws on cognitive load theory, which addresses the limits of working memory capacity; many of the contextual factors in clinical settings add to cognitive load in clinicians. Each of these two theories impacts directly on the other (Van Merrienboer and Sweller 2010).

The hallmarks that set LICs apart from more traditional medical educational models include the capacity of students to see more clinical cases (especially undifferentiated ones), the interleaved manner of learning that occurs during these clerkships (with its associated variability and unaggregated learning), the encoding specificity that is able to develop, and the retrieval of information from long-term memory that this model promotes. The relationships that LIC models promote allow for deeper interactions with preceptors, patients and peers, and this is a fundamental contributing factor in the development of good CR.

There is an implicit understanding in the LIC context that dealing with patients is an organic, complex process (much like CR) rather than a straightforward mechanistic one. LICs occur in a patient-centred context with continuity of place and of curriculum, and the ability to develop long-term, meaningful relationships with clinical supervisors and peers. They also have the added benefit of producing doctors who are more aligned to patient, societal and healthcare needs.

However, because LIC models of medical education are relatively new, less research has been conducted on students engaged in these programs and much is still unknown about how and why they have been so successful to date.

According to Greenhill and Poncelet (2013), this model is underpinned by two theoretical concepts: continuity and symbiosis, both of which serve to have a transformative effect on the thinking and attitude of student participants. Continuity and the integration of theoretical knowledge and evolving CR has a foundation in Mezirow's transformative learning theory (Kitchenham 2008). Continuity of placement has a mitigating effect on disorienting dilemmas with which students are often faced, which can be overwhelming from a cognitive load perspective. In the LIC model, students become legitimate peripheral participants in the treating teams with which they are placed rather than external bystanders and thus feel more supported.

A further underpinning theoretical concept around the learning that occurs during LICs is the social learning systems developed by Wenger, who framed learning as a social process which is the interplay between social competence and personal experience (Wenger 2000). This involves students becoming legitimate peripheral participants in the delivery of healthcare, participating in

multiple communities of practice, negotiating the boundaries between these, and using this to develop their own individual personal and social identities (Daly, et al. 2013b).

It could be argued that the TBR structures allow students to adapt better and more flexibly to new, unfamiliar work environments. This review, however, focussed on the development of CR and did not seek to address the issue of adaptation. It could also be argued that longitudinal learning environments have the potential to create difficulties for students who are not highly motivated and not self-directed learners, as well as the assessment bias that is possible when students are assessed by preceptors with whom they have strong relationships. Once again, this review focussed solely on the development of CR in LICs and did not attempt to address these issues.

Our understanding over the past decade of the development of CR has led to the understanding that more traditional forms of medical education are no longer fully aligned to societal expectations of the modern doctor. Modern medical education needs to produce graduates with the ability to re-invent themselves, to deal more flexibly with uncertainty, and to be life-long learners. I would argue that LICs are ontologically stronger to achieve this.

It is clear from this review that the unique characteristics and hallmarks of LICs should promote the development of more and stronger illness scripts and improved knowledge networks in medical students engaged in them, and that this, in turn, should lead to the improved development CR ability. However, there has to date been a lack of direct, robust evidence on how CR develops in students during LICs. This was seen as a major gap and the qualitative research study found in the following chapter was aimed at addressing this deficit.

CHAPTER 6:
A QUALITATIVE ANALYSIS OF THE FACTORS INFLUENCING THE DEVELOPMENT OF CLINICAL REASONING DURING LONGITUDINAL INTEGRATED CLERKSHIPS

"TELL ME AND I FORGET; TEACH ME AND I REMEMBER; INVOLVE ME AND I LEARN."
– BENJAMIN FRANKLIN (1705-1790)

"LISTEN TO OUR PATIENT, HE IS TELLING YOU THE DIAGNOSIS."
– SIR WILLIAM OSLER (1849-1919)

This chapter describes the qualitative approach used to answer the question of how longitudinal integrated clerkships (LICs) contribute to the development of clinical reasoning (CR) in medical students engaged in them. The themes and subthemes that were developed will be discussed, together with a discussion on how these various factors combine to contribute to the development of student CR.

As outlined in the hermeneutic literature review in Chapter 5, the concept of CR remains elusive and is difficult to define, teach and assess. As was concluded in Chapter 4, numerical measures of CR are, in the main, inadequate to quantify this multifaceted and complex cognitive process. I thus decided that the most appropriate next step in trying to determine how CR develops in students engaged in a LIC program would be to approach it from a qualitative perspective. A study such as this would provide better insight into how the interaction between students and supervisors in the context of regional, rural and remote learning environments leads to improvement of CR in medical students engaged in LICs. The results of such a study would have important implications for how to further optimise the design of LIC programs and possibly also inform the better design of assessment to capture CR.

The aim of this study was, therefore, to determine how the various unique program structures and other factors that come into play during a LIC interact with each other to foster and promote the development of CR of students participating in the program. Although the study was conducted in a single program only, that of the University of Wollongong (UOW), the aim was to understand the development of CR during LICs more broadly.

METHODOLOGY

Study design

For this study, I adopted an interview-based qualitative design to draw on the richness of the lived experiences of clinical preceptors and former students of the UOW LIC in the development of CR of students during the LIC. It largely followed the consolidated criteria for reporting qualitative research (COREQ) as described by Tong, Sainsbury, and Craig (2007.

Sampling and recruitment

Individual semi-structured interviews were conducted with 22 participants involved with the UOW LIC program, who were purposively selected due their current or former involvement with the program. Fifteen of the interviewees were clinical preceptors in the program, four were former students, and three were both former students and current clinical preceptors. This last group were asked to consider their responses from both student and preceptor perspectives. A deliberate decision was made not to interview current students, because CR is something that often develops imperceptibly, and I thus considered that current students would not have sufficient insight into the development of their CR to make a meaningful contribution to the study.

Data collection

Data collection took place between October 2021 and April 2022. All interviews were conducted by me (the PhD candidate) virtually through the Webex virtual conferencing platform, recorded, and transcribed *verbatim*. After de-identification, transcripts were imported into NVivo® for coding. Interviews lasted an average of 35.9 minutes, with the longest being 54.1 minutes and the shortest 21.0 minutes. Prior to each interview, an information sheet outlining the purpose and scope of the interviews, together with information about ethics approval, was sent to each participant. Research ethics approval was again discussed verbally with participants at the start of each interview.

A semi-structured interview guide was informed by literature in the field, by my theoretical framework, and the experience of me and my supervisory team. See Table 6.1 for an outline of sample questions for clinical preceptors and Table 6.2 (both below) for sample questions for former students. These two guides were combined for participants who were both former students and current clinical preceptors. Questions were modified depending on the individual participant's position and experience, and participants who were both former students and current clinical preceptors were asked to respond to questions from both perspectives. All

participants were allocated an alphanumeric code which enabled differentiation between clinical preceptors (CP), former students (FS), and those who were both former students and current clinical preceptors (CF).

Table 6.1: Interview question guide – clinical preceptors (CP)

Opening statement	The purpose of this research is to determine how the development of clinical reasoning occurs during longitudinal clinical placements such as the one that your students are engaged in during Phase 3 of their undergraduate training.
Questions	Can you please tell me what your view/understanding of clinical reasoning is? How long have you been involved in the University of Wollongong Phase 3 program? What were the factors that made you want to be a part of the University of Wollongong medical program? Was it the rural focus? Was it that fact that it had a mandated longitudinal clinical placement program for all medical students? Was it something else? Can you please tell me of you experience of the development of clinical reasoning in your students during their longitudinal placement in Phase 3? In your view, how does the continuity of place during Phase 3 positively or negatively contribute to this process? Does exposure of students to large numbers of undifferentiated patients help or hinder this process? How about students' ability to spend more time with patients during Phase 3? Does the fact that students learn multiple disciplines simultaneously during Phase 3 have any effect on the development of their clinical reasoning? In your view, does learning from patients in the clinical setting during Phase 3 make it easier for students to remember later when they saw another patient with a similar presentation? In your view, what impact does having students being part of a clinical team have on their learning and specifically on the development of their clinical reasoning? What impact, if any, does students been taken out of their comfort zone clinically have in terms of their ability to reflect and in terms of the development of their clinical reasoning? In your view, is the thinking of students challenged in terms of patient-centred care and social accountability during Phase 3, and if so, what impact did this have on the development of their clinical reasoning? Have you seen or become aware of any particular "eureka moments" at any stage of your students' medical training to date where things suddenly seem to have "gelled" in terms of their clinical reasoning abilities? If so, when did this happen and can you please describe it? What influence do you feel you have on the development of their clinical reasoning during Phase 3? Are there any other factors that influence the development of students' clinical reasoning during Phase 3 that we may not have already discussed?

Table 6.2: Interview question guide – former students (FS)

Opening statement	The purpose of this research is to determine how the development of clinical reasoning occurs during longitudinal clinical placements such as the one that you were engaged in during Phase 3 of your undergraduate training.
Questions	What were the factors that influenced you to apply to the University of Wollongong medical program? Was it the rural focus? Was it that fact that it had a mandated longitudinal clinical placement program for all medical students? Was it something else? How many years has it been since you completed your Phase 3 longitudinal clinical placement? Can you please tell me what your view/understanding of clinical reasoning is? Can you please tell me of you experience of the development of clinical reasoning during your longitudinal placement in Phase 3, and compare this to how your clinical reasoning developed during your hospital rotations during Phase 2 and during your training subsequent to Phase 3? How did the continuity of place during Phase 3 positively or negatively contribute to this process? Did exposure to large numbers of undifferentiated patients help or hinder this process? How about your ability to spend more time with patients during Phase 3? Did the fact that you learned multiple disciplines simultaneously during Phase 3 have any effect on the development of your clinical reasoning? Did learning from patients in the clinical setting during Phase 3 make it easier to remember later when you saw another patient with a similar presentation? What impact did being part of a clinical team have on your learning and specifically on the development of your clinical reasoning? What impact, if any, did being taken out of your comfort zone clinically have in terms of your ability to reflect and in terms of the development of your clinical reasoning? Was your thinking challenged in terms of patient-centred care and social accountability during Phase 3, and if so, what impact did this have on the development of your clinical reasoning? What influence did your clinical preceptors and mentors have on the development of your clinical reasoning during Phase 3? Have there been any particular “eureka moments” at any stage of your medical training to date where things suddenly “gelled” in terms of you clinical reasoning abilities? If so, when did this happen and can you please describe it? Are there any other factors which we may not have already discussed that influenced the development of your clinical reasoning during Phase 3?

Data analysis

All interviews were analysed inductively using a reflexive thematic analysis approach (Braun and Clarke 2019). The initial coding of all 22 transcripts and development of themes was done by me. Two experienced qualitative researchers then each reviewed 11 transcripts (half each) and

developed themes independently before the three of us met to discuss and come to consensus on the themes and subthemes. All agreed that data and meaning saturation had been reached in the 22 interviews and that no further interviews were required (Guest, Bunce, and Johnson 2006; Hennink, Kaiser, and Marconi 2017; Braun and Clarke 2021).

All three members of the team analysing the data were aware that their position as academics within the UOW program, as well as their professional and personal background, could influence their interpretation of the data. We thus engaged reflexively throughout the process to avoid this.

Ethical approval

This part of the research was approved by the Flinders University Human Research Ethics Committee (ID 4156) and endorsed by the University of Wollongong Human Research Ethics Committee (ID 2021/308).

RESULTS

Participant demographics

Participants were predominantly male, the majority had completed vocational (fellowship/ specialty) training, and the majority had more than 20 years of clinical experience. Demographic characteristics of the study participants are summarised in Table 6.3 below.

Table 6.3: Demographic characteristics of interview participants

Characteristic		n
Gender	Male	14
	Female	8
Professional status	Fellowed	19
	Non-fellowed	3
Years since graduation	<11 years	6
	11-20 years	2
	>20 years	14
Role in the UOW LIC	Clinical preceptor (CP)	15
	Former student (FS)	4
	Both former student and current clinical preceptor (CF)	3

Themes

Five key themes were derived from the data. These were:

1. Student effectivities
2. Relationships
3. Affordances
4. Outcomes (or effects)
5. Growth in clinical reasoning.

Each of these key themes was made up of multiple domains and sub-themes, many of which interacted and overlapped with each other in complex ways. These are depicted graphically in Figure 6.1 below.

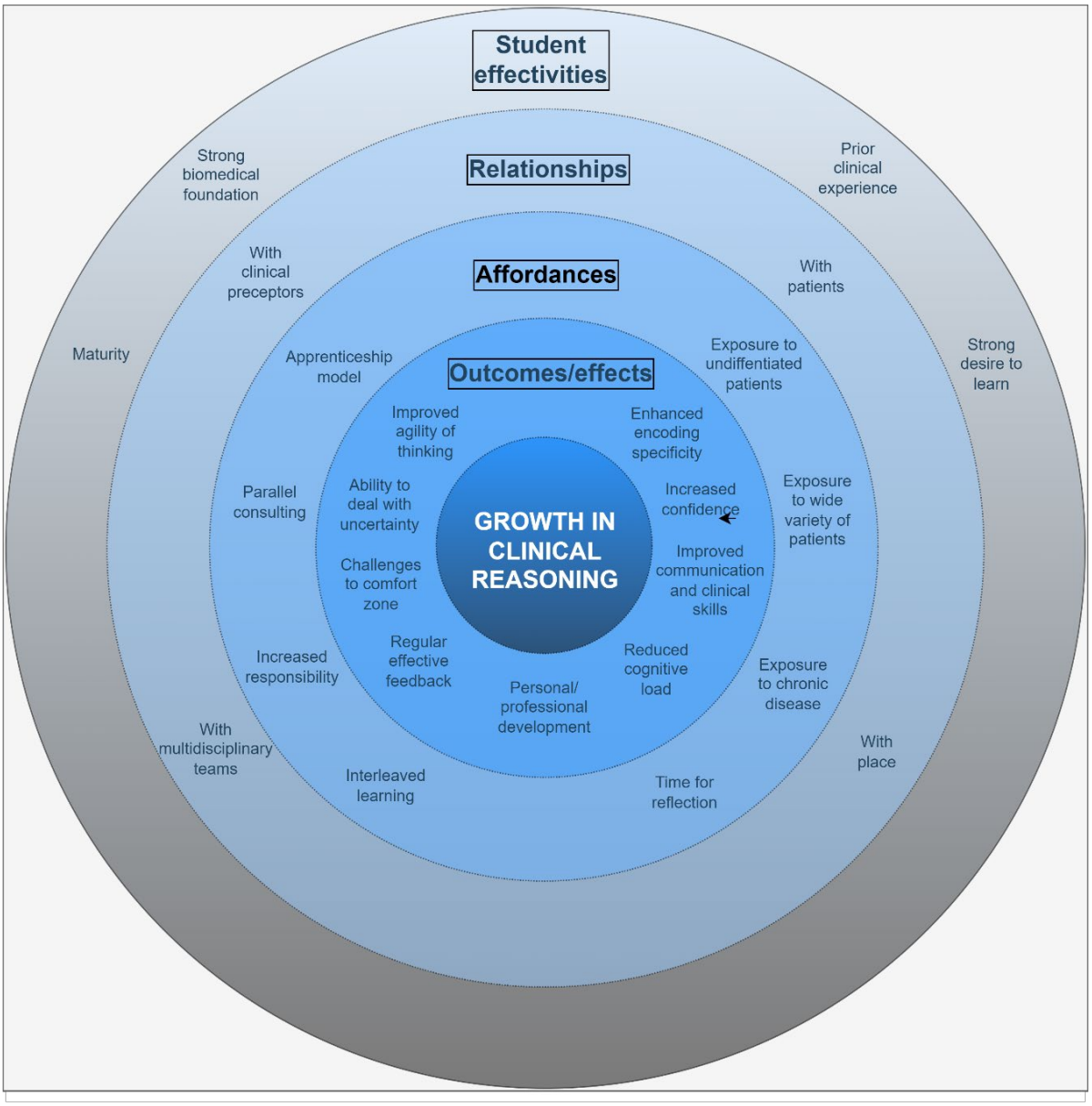

Figure 6.1: Graphical representation of key themes and subthemes

Key Theme 1: Student effectivities

Effectivities have been described by Watsjold, Ilgen, and Regehr (2022) as the actions an individual is able to perform in a specific context. They include the skills or abilities of the individual, but they also describe what an individual can do by applying their skills under appropriate circumstances and recognising what the situation affords. It can, thus, also include the attributes and attitudes of an individual.

There were five subthemes derived within this Key Theme contributing to success (or otherwise) in the development of student CR.

a) A strong biomedical foundation

Having a strong foundation in biomedical sciences is important for the development of CR because it gives a direction to the development of CR. It helps to create meaning from what the student experiences in the clinical environment and how they learn to cast those experiences into meaningful narratives.

> You've got to have enough of a scientific background behind you, and enough of a ***practical medical, clinical relationship of that science behind you to then know where the clinical reasoning is going***… which they do, they have very good scientific knowledge behind them. (CP5)

> One would be the underlying content knowledge – ***if you don't know the anatomy or physiology or pathology, the basic sciences, the clinical sciences, you're not going to get anywhere.*** (CP12)

b) Prior clinical experience

Having prior clinical experience helps the student to be able to perform clinical tasks in a more meaningful direction, and the development of CR can thus take place more rapidly through active involvement in the clinical process. This is enhanced when combined with having a strong biomedical foundation. For example, having a good foundation in clinical skills (as in taking a history, performing a physical examination, or communicating with patients) allows the student to engage in clinical activities and to learn actively in a more meaningful way, which in turn promotes the active development of their own CR.

> It does make a difference if they have had previous clinician-type experience – ***if they've done a bit of clinical reasoning before, and particularly people like the physios, because of their way of thinking, the way they are taught to think diagnostically and in management is not dissimilar to us as clinicians***… they've got all the medical knowledge now ***and they start to take off because this is a skill they've already used before***. (CP2)

c) A desire to learn

A desire or willingness to learn is important for the development of CR because it makes students want to understand clinical situations and, importantly, to understand them from various viewpoints, and consequently to develop a rich repertoire of narratives to explain and understand various clinical situations. Students who are able to achieve this can more agilely verbalise these clinical situations in a more meaningful way – this assists with patient handover and subsequent feedback, and thus with the development of their CR.

> I think to develop it *[clinical reasoning]* more, you need to have an ***inquisitive mind.*** I think ***you need to be able to question*** and, like, ***don't accept just any simple answer if it doesn't make any sense***. So you need to have an inquisitive mind, that sort of wanting to learn and know more and be inquisitive… You need to have the ***students willing to learn, be inquisitive, curious*** to sort of see various things. (CP1)

Additionally, student desire and enthusiasm have reciprocal effects. Supervisors who work with engaged students are more likely to want to be involved in partnering, nurturing, and helping the student to make meaning of their clinical experiences, and this has a direct effect on the development of CR in their students.

> The enthusiasm of the student often ***unconsciously raises the enthusiasm of the teacher***. (CP3)

> ***I enjoyed the appetite that that group of students had towards learning***. (CP6)

d) Student maturity

Learning medicine in general, and CR in particular, requires not only engagement and curiosity on the part of students, but prior life experiences and having a more balanced outlook on life provides benefits also. This can be expressed as student maturity.

> ***There is a maturity that goes with being a postgraduate entrant***, and I think that you've probably got to want to do it to come into it at that later stage. I think that being postgraduate gives you some… exposure to other stuff, that ***it does give you that life lived experience***, and hopefully ***a maturity*** to take into the program that you may not have had just because you did very, very well at school. (CP14)

> The UOW students I still very much enjoy teaching, and I think one of ***the pros is that they all seem very level-headed, which might be, again, a trade-off of a graduate medical school program***, or where you recruit your students from, or whether it is a prerequisite criterion. (CP13)

> The students were incredibly ***engaged and prepared and mature and maturing students***… the feedback that I get from hospital consultants over and over and over again, is that the UOW students are incredibly ***mature, hard workers, part of the team, and they always like to have them there.*** (CP10)

This maturity not only allows students to be better able to relate patient stories to their own experiences and to focus more on learning CR, but it is also valued by their clinical supervisors, and this helps to build supervisor/student relationships and partnerships.

e) Effectivities that may hinder

Some student effectivities can be counterproductive in the learning of CR, especially in a LIC environment. When students display maturity, have a strong biomedical background and possibly health professional experience in combination with maturity and curiosity, this is in alignment with what clinical supervisors value. But the flipside is that students without these effectivities could potentially be less afforded within a LIC context, as they may be less able to live up to expectations which clinical supervisors may have.

i) Students who are concrete or linear thinkers

Learning in the workplace, especially in a LIC, requires students to be able to 'connect the dots' in order to be able to understand how seemingly unconnected things make sense together. More lateral or associative thinkers thrive in such a context whereas concrete thinkers may suffer, despite having previously done well in a more structured learning environment.

> I just think that there's the odd person that gets into medicine that is a ***really concrete thinker, who hasn't gotten that next stage of Piaget's ability to deal with uncertainty*** who really struggles in general practice. (CP12)

ii) Students who are not good self-directed or self-regulated learners

During undergraduate medical training, a huge transition can take place from the relatively structured, bounded, and scaffolded pre-clinical part of the training to the relatively unstructured, almost infinite, and less scaffolded workplace during clinical training, especially those using a LIC structure. This requires the student to develop a considerable ability to self-direct and self-regulate learning, and students who find it difficult to do this could be at a disadvantage.

> One of the things about ***Phase 3 is it requires the students to be self-directed learners***, and the vast bulk of our students are, ***but some aren't***. The vast bulk of them will actually think: Oh, this is new, I've never seen a patient with sarcoid before, I'll go and look up what sarcoid is, and most of them will do that, but not all. (CP2)

iii) Students who experience non-academically related problems

There is also a potential for students to experience personal difficulties. These can be health issues, social issues, or issues related to just settling into an isolated, often remote setting. Any of these can impact negatively on the development of their CR.

> There might be ***reasons other than academic***, they may be ***social or health or other things going on***, those people that ***haven't had a good grounding can really struggle,*** because they're sort of ***behind the eight-ball when they begin Phase 3***. (CP12)

> And then, obviously, ***you can have the emotional/social well-being of the students***, if they're going through some difficult relationship issue, ***or they're a long way from home.*** (CP6)

Key Theme 2: Relationships

The significant relationships that develop during LICs are a key element in the development of CR in students. As described in the theoretical framework in Chapter 2, it is especially the clinical supervisor or supervisors who provide the link between the student and the clinical working environment where much of the learning takes place.

a) Relationships with individual clinical preceptors

The relationship between students and their clinical preceptors in a LIC setting, and by extension with their clinical learning environments, is the key to successful learning experiences. These relationships result in continuity of supervision, and they are a direct product of the length of the relationship. They have direct beneficial effects on student learning, and especially the learning of CR. The benefit occurs as a result of mutual trust that develops between clinical supervisor and student – the supervisor learns what the student is capable of, and this allows them to devolve more responsibility onto the student, while the student trusts that the feedback provided by the clinical supervisor is accurate, honest and well-intentioned.

> Over the course of a year, ***you've got time to develop that experience*** to not only learn from yourself, but your cohort that you're working with, and ***your preceptor***. Touching on you ***working with a group of preceptors for a much longer period of time, you pick up a lot of that intuition that develops from experience*** and discussing cases afterwards. (CF1)

> I think ***there is an efficiency*** there that's similar to the continuity of place that you can ***achieve with the same supervisors***. (CF3)

> I think a major shift was the ***individualised support from a longitudinal supervisor***. They ***get to know you and your strengths and weaknesses*** and can focus on those. (FS3)

Continuity of supervision allows for the development of deeper, more meaningful professional relationships, and it is the length of the time that the student is with the clinical preceptor that allows this depth to occur. It is both the length and the depth of these relationships that contribute to the development of CR in LIC students.

> I think the ***benefit of having that longer time***, a longitudinal supervision or relationship means that, from the perspective of both the learner and the supervisor… is that ***you get to see that progression, that change over time***, so you know where someone is at the start, you know where you want someone to be at the end. So, assuming that you've done it before, you can kind of have a little bit of signposting along the way and a ***give goal-directed supervision and feedback***. (FS4)

> I've got no doubt ***a longer attachment allows you to form relationships***, understand where people are coming from… You see how someone operates and you become respectful of their style and their skills, and ***you absorb information much more from someone who you know and respect***. (CP7)

> There's something in that ***depth of relationship that comes with the length of the relationship, and I think that affects your learning***. Having that opportunity to watch one clinician on multiple different

> occasions, I think, gives you a good sense of how their brain is operating and what their approach to a patient is. (CF2)

> There's ***a developing relationship*** between the preceptor and the other medical practitioners and the staff at the practice, and they develop a ***growing knowledge of and confidence in the student's personal and professional behaviours, their knowledge, their common sense, and their clinical reasoning***. And they're able to more appropriately, more accurately devolve responsibility to the student. (CP4)

The deeper relationships between preceptors and students enable more individualised and effective mentoring and nurturing in the growth and development of the students. Learning thus becomes more tailored and personalised in a safe learning environment, which has the effect of stimulating learning in students and this, in turn, has a direct beneficial effect on the learning of CR.

> ***We watch them grow, we watch them develop, we watch them stumble, we pick them up, we look after them very closely***… We know what's going on with each individual one, but that also means that we can tailor what we do to each individual student, and ***there's a lot of individual tailoring***… Some need a lot more, they need different encouragement, some need a kick up the butt, some need a slap on the wrist, some need lots of mollycoddling to start with, some need you just to walk beside. (CP5)

> It's quite a close relationship… you're not just seeing them present one case, it's seeing them present six cases a day over a year, and so ***you can get a richer a feel for what are their weaknesses and what are their strengths and what they need to work on***. (CP8)

> I think it's that continuity supervision that allows, almost like a personal trainer, ***you can adjust how you teach and how you allow that student to take on responsibility in an individual way***. (CP15)

> I think having a professional, I guess, unofficial or official mentor that sees you from also a personal and professional perspective and being able to ***provide that sort of graded autonomy to build your clinical reasoning, and to build your clinical decision-making processes***. (FS1)

The length and depth of these relationships allow students to become more comfortable with their situation and gives them the capacity to ask questions that they otherwise may have been reluctant to ask. This, in turn, has a beneficial effect on their confidence and thus ultimately on the development of their CR. It also enables the 'art' of medicine (which includes a wide range of issues like good communication, complexity, dealing with uncertainty, and multiple narratives) to be learned more effectively.

> I think it's ***the continuity with the preceptor*** and comfortable place of where the students doing Phase 3 that with that, you know, with that same person or people, I think that ***leads to better success***. (CP12)

> They *[the students]* are probably more inclined to ask or query things if they feel comfortable with the person rather than it being one or two ward rounds, where they feel that speaking up can be a bit more intimidating. ***They can more easily ask questions about what they should do and why they should do it***. (CP9)

> And it *[clinical reasoning]* is a very difficult thing to teach, but I think it's more something that you can teach by mentoring, and so when ***you have a long-term program that mentoring happens over time, and then you can distil the art of medicine much more effectively*** than when you only have short term interactions. (CP10)

The strong rapport that develops between clinical preceptors and students as a result of their longitudinal relationships leads to students feeling valued and respected, not only by their

preceptors but also by patients. This generates a sense of responsibility and greater commitment from students, inviting them to be more actively involved in the healthcare provision and, as a result, in their own learning.

> The second one I put down is ***building professional rapport***… I think I've gained to appreciate the importance of this indirect or direct rapport that you build, and I think a lot of medicine is this, especially from a more personal level, being able to gauge what your colleagues are like and ***place a level of trust in them***, whether you're a student, a colleague, a trainee, et cetera. (FS1)

> I think ***being valued*** is going to mean that you get more, you do feel more like as a student ***they will feel more like wanting to commit***, wanting to come up with a ***plan that they'll then receive a critique from their preceptor on and learn from***. (CP12)

The deep professional relationships that develop over time between clinical preceptors and their students during LICs contribute directly to a range of affordances and thus to learning outcomes. These include trust and entrustment, student independence and autonomy, repeated patient handover, effective feedback, and general advice and mentoring. These factors and how they contribute to the development of CR will be described in more detail in later themes.

The longitudinal nurturing relationships between students and clinical preceptors often leads to more than just the learning of medicine. It often also leads to general advice, guidance and support on life and career matters.

> So, it was nice, and they got to know us really well by the end of the twelve months, and they provided a ***very good life career advice and personal advice***. The feedback that [name of preceptor] provided was quite useful at the end… It wasn't just professional feedback was a ***good life advice*** as well that was quite tailored. (FS1)

> They wanted us to be competent and also enjoy rural practice. They wanted us to have a good time, which part of that, I think, was ***wanting us to feel happy and well supported*** in our position at the practice and in the hospital. (FS3)

There are, however, some potential downsides in the longitudinal relationships between students and clinical preceptors, and by extension clinical learning environments. One aspect of this is, when seen from a student perspective, having a clinical preceptor who is not really interested or engaged in the student learning process, or who is overly critical of the student.

> It becomes the luck of the draw, you know – if you have someone who is a fantastic educator, a role model who can inspire the learner, then this would be a fantastic opportunity, but if you have ***someone who is disinterested or does not fully appreciate the learning that's required*** in this student, this can be problematic. (CP13)

> So, I guess the worry that supervisors might have is: what if I get a dud *[student]* and then you stuck with them for the year? And I think students have that same concern: what if I get it dud supervisor, what will that look like? I think we're pretty lucky that we weed out the duds and we seem to only get good students up here, but I guess the concern is, ***if it's a longitudinal placement and the student and the supervisor aren't well matched, then then what happens?*** Do you have the flexibility to make modifications on the fly? (CP10)

It is also possible to get a clinical preceptor who is not just disinterested, but who may have personality clashes with a student or just does not get along well with them.

> Especially those I think that would be in some way traumatised by something that had happened and who felt all along that they really didn't like it, ***they didn't get on with their supervisor***. Unless you realise that you like them, or their supervisor was absent, or they felt overly criticised or all of those things. So, ***there's a potential danger in that relationship*** that we need to go in and look out for. (CP11)

> There'll always be ***potential friction in a longitudinal place, especially if you don't necessarily get along personally with your supervisor***. I was lucky enough that both of my supervisors and I got along very well. (FS4)

Because of having a smaller number of clinical preceptors within the LIC structure, it is possible for students to be exposed to a limited variability of CR and problem-solving approaches and thus get too narrow a view of CR and clinical problem solving.

> The continuity of supervision is a two-edged sword***. If you are the sole supervisor, the student only gets exposure to one way of approaching problems***. However, the positive side is that the supervisor learns the strengths and weaknesses of each of their individual students and knows how much autonomy to allow them, and also how each particular student learns best. (CP15)

It can be more difficult for clinical supervisors to give direct and honest feedback to students with whom they have developed a strong professional relationship.

> Sometimes you need to be a bit tough, and so if it's somebody that you don't know and unlikely to be dealing with again, it's sometimes easier to either, one I don't care and get out of my room, or two, be a bit a bit tough and a bit hard on them. Whereas, if it's somebody that you have known for a long time, on the one hand, you have a relationship with them and you need to be… you want to be honest with them. And so ***sometimes being tough is a bit harder***. However, being tough, if you've got a relationship with them, is better. You can say: Hey, come on, we need to have a bit of a talk about this, what's going on. And so, I think there's a two-edged sword here. (CP14)

Another potential risk is clinical preceptors having too much confidence in students' abilities too soon, which then places pressure on students to recognise this and ask for help.

> Sometimes they *[students]* are pushed, ***the supervisor may have more confidence in them than they should***, and that could put patient safety at risk. But I think it's important that the ***students have that self-confidence to put up their hand*** and say: I'm out of my depth and I need you to come in this, or: This patient is unwell, I need you to come and assist me. (CP10)

> I sometimes have felt that they're ***forced into learning a bit too quickly when they're a bit green behind the ears, and that's one of the dangers***, I think, in the longitudinal clerkship, that ***they may be out of their depth with a patient*** and not necessarily making a mistake, but perhaps it's a little bit like developing vicarious suffering from that patient. (CP11)

A further risk is students missing out on some aspects of learning if the preceptor had a special area of clinical interest.

> I know there are times when there are particular practitioners, ***preceptors who only have particular interests*** and they don't really have a lot of interest or knowledge in some other areas. So, the potential is therefore, in that situation, that ***the student might miss out on some major disciplines because their***

> ***clinical caseload is too narrow***. So, I think that's one of the dangers that's there if the clinical caseload is too narrow. (CP12)

Having internal administrative problems within a general practice that is hosting a LIC student is a potential risk, including such things as patient scheduling problems or financial stress. These issues could be compounded when the clinical preceptor is not in control of decision-making within the practice.

> There was a lot of stress within the practice from a financial point of view, and so with a lot of stress within the practice, I felt ***they couldn't particularly focus on helping me learn when they had a lot of stress going on in the background***. (FS2)

b) Relationships with multidisciplinary teams

There is a natural progression from students having good relationships with their clinical supervisors to having the capacity to develop good relationships with broader multidisciplinary teams (MDTs) in general practices as well as in other clinical settings. Students on longer clinical placements readily become included into these MDTs and this, in turn, enhances their learning in general and the development of their CR skills in particular by being exposed to a range of different approaches to clinical problem solving by doctors at different stages of training (vertical integration) and by other health professionals (horizontal integration).

> In our hub, being 12 months, they all pretty much become part of a team, and most of these practices are small boutique, like families, sort of thing, so ***they become part of that***. They take part in social activities and personal events and stuff. ***And that makes a big difference as well to the function of the student and their clinical teaching and reasoning*** eventually. (CP1)

> ***There are different members of the team who help students learn***… They see ***vertical learning as well***, they're seeing ***registrars at different levels, they're seeing junior doctors, senior doctors, they're seeing a range of people working on different stuff***… I think that means that ***they get to see different attributes of different team members***. (CP8)

> They *[students]* feel useful and part of the team, and then ***their reasoning and their knowledge increases as a result***… If they're confident in a team, I'm sure they learn more***, and they're more inclined to ask questions and if they feel comfortable with their preceptor, and if the preceptor does something they're not sure of, they may feel more comfortable to ask them, not in a challenging way, but just why that was that particular thing, which I'm sure would help, indirectly help, their clinical reasoning***. (CP9)

> Even as medical students, we got very involved with the sort of day in day out sort of clinical work at the hospital, as well as in the GP practice. I think a lot of it was ***feeling like you were part of the team and given some responsibility and encouraged to make decisions***. (FS2)

Being exposed to being part of and working in MDTs promotes the ability in students to learn when and how to ask for help, especially when faced with challenging clinical situations. This applies to not only during their LIC, but also beyond into the rest of their working lives.

> I think ***working as part of the team in developing those relationships allows that skill to develop on how to ask for help, where to ask for help, what's to the appropriate way to find out an answer***, and whether that's in your own practice, knowing how to ask a colleague or how to pick up the phone and call a specialist, call a colleague. I think ***developing those relationships is a big part of the job*** and essential skills. (CF1)

> Feeling that you are part of the team ***makes you more likely to ask for help more*** and less likely to be put off by, for example, approaching a specialist… And they *[students]* certainly are ***valuable parts of the team, especially in the second half of the Phase when they're more exp***erienced and they do a lot of work that's very valuable… Because they're so good at absorbing some of the workload, there isn't any doubt that they become valuable members. And ***when you are part of it and you're feeling like you're a good member, positive breeds positive.*** (CP7)

But even more so, being included in team structures allows students to build rapport with members of the MDTs, similar to what occurs in their relationships with clinical supervisors. As a consequence, they become valued, trusted and respected members of those teams. The entrustment that is generated leads to the giving of greater responsibility to students, which in turn leads to better engagement of students and thus ultimately to better learning, especially the learning of CR.

> So, the whole ***longitudinal nature of the program is what promotes that interaction*** between staff, between ***clinical staff, nursing staff, medical staff, but also with the clerical staff***, the front desk. (CP14)

> ***The student feels entrusted***, the ***nurse or doctor knows that the student is useful to them*** and, and being helpful, and the enthusiasm the student often unconsciously raises the enthusiasm of the teacher. (CP3)

> There's ***a developing relationship between the preceptor, and the other medical practitioners, and the staff at the practice***, and they ***develop a growing knowledge of and confidence in the student's personal and professional behaviours, their knowledge, their common sense, and their clinical reasoning. And they're able to more appropriately, more accurately devolve responsibility to the student***. (CP4)

Finally, the inclusion of students into MDTs also broadens the scope of what they learn by allowing interprofessional learning between LIC medical students and other allied health professionals to occur.

> The other thing that I think was good for our students was because we had a dietitian, and we had a psychologist, and we had an exercise physio, and the nurse, we would do some case conferencing about a patient that might have a complex problem. I would actually get the student to present the case… and they presented the various complex problems and then listen to the input from the other allied health practitioners. And that was a huge eye opener for a number of our students, because it put together not just the diagnosis is hypothyroidism or diabetes or whatever, but ***it's seeing that holistic approach, all the inputs and how they fit in and how you work with the management team***. I think that was very powerful, therefore I would encourage the students do it. (CP2)

c) Relationships with patients

The majority of patients are very willing to be engaged with students and contribute to their learning. Patients actually get enjoyment from being part of the learning process, and it also reflects well on clinical preceptors as the doctors who care for those patients.

But although this is nice in itself, there are also facets of this relationship that have a positive effect on the development of CR. The longitudinal nature of the LIC structure allows for a continuity of relationships between students and patients to develop with opportunities for students to form strong professional relationships with the patients who they see during their year-long LIC. This allows students to better understand the full complexity of a patient's illness in the full context of the patient as an individual, a member of a family, and a member of the community. This is likely to create more engagement with the patient and their issues and build richer and more diverse base of illness scripts and narratives in the memories of students which is so important for the development of CR.

> Whereas our students have this ***longitudinal time to develop relationships***, not only with their supervisor and the staff, but also ***many times with the patients***, because the patients come back in again, or ***even choose to see them***, and that's an interesting exercise which you wouldn't see in other forms of training. So, it's patients actually booking in deliberately to see the student ***because they have liked the care that that student has given them***. (CP11)

> You can ***build on a patient's story*** by having them come back and ***see the student multiple times***. (CP10)

> One of the strengths of the program is with the general practices, because they *[students]* ***can follow a patient on their journey for several months*** – see what inputs led to what results, could I have done this better, that treatment didn't work very well, the patient had a side effect from that. ***You only see that by longitudinal placement in general practice***, you won't see it in any other attachment, so that's a great advantage of Phase 3. (CP7)

The structure of the LIC program allows students to spend time with patients, frequently more time than patients' usual clinicians are able to spend with them. This has a beneficial effect on the development of CR in students by providing students with a richer experience. This results in richer and more patient-aligned narratives within students' memories and has a beneficial effect on their learning more generally.

> In general practice, you're in that room by yourself for half an hour, or in the emergency department ***you've got as long as you want with the patient before you go and talk to a doctor*** about the case… And this really gave me ***an opportunity to dig deeply into someone's history and reason things out before the preceptor came into the room, and think about how I would present the case***… The patients that stick in my memory from that time are people where we would have in depth conversations about the reason for them being there, or just their lives in general… I think ***that's an opportunity that's offered to students in a longitudinal placement with those longer appointments that benefits both patients and the student's own learning***. (CF2)

> If they see the patient and are ***spending time with them*** and have the availability of previous notes and are able to take an appropriate history and appropriate examination, then present that to their supervisor, I think all of those things are the process that we're talking about, that going through to being ***able to expand their clinical reasoning***. (CP14)

> Spending time with patients, helps the student get lots of skills that can't be necessarily taught in an extended manner – just ***relating to communicating well***, what to ask or what not to ask. And surely part of clinical reasoning is knowing the right question to ask, not asking everything in a potential respiratory history or whatever. ***Knowing when you haven't found what you're looking for*** and confirming or excluding all these, that are occurring and ***knowing when to enlarge a history or examination to exclude other possibilities***. All that comes with the chance to see that person without a doctor in a room, without just watching what else is happening, and having the time to do it. (CP3)

The best learning that students can have is by seeing real patients with real problems rather than trying to learn from textbooks, and this is especially true when it comes to the learning of CR. The more authentic clinical experiences that students have, the better the transfer of knowledge and thus memorisation, therefore resulting in better CR.

> I think learning from patients is a big thing. You're learning that those ***clinical presentations don't, often, present like the textbook***… And learning from patients, and the language that they may use, or how they might present, or knowing that sometimes their presenting problem may be just one issue that they're facing… You've got that real world experience, rather than just textbooks to know how particular cases can present or unusual presentations of common diseases. (CF1)

> That ***time spent with a patient***, see what they're saying, work out what's wrong with them and decide what to do. Our Phase 3 students get to do that hundreds of times, and the ones that, you know, do it more are the ones that are further ahead with the ***development of their clinical reasoning***. (CP4)

> It's Phase 3 where they're doing it themselves, first in a protected or a sheltered environment, but they're having to do it for themselves. In the end, ***we all learn best by doing***… actually ***getting them to engage with a patient, make a decision and present***. By the end of Phase 3, ***almost without realising that's what they're doing, it's just become part of their thinking***. (CP2)

The longitudinal exposure of students to patients and the relationships that develop from this is not only good for the learning of medicine in general and CR in particular, but it also exposes students to a more patient-centred approach, especially in primary care settings. This has the effect of providing to students a better understanding of the context of a patient's unique personal circumstances and consequently a better understanding of CR pertaining to that particular patient.

> I think that's an opportunity that's offered to students in a longitudinal placement. I had more of an awareness of the ***complexity of what might be going on in someone's life*** aside from, you know, the pathology of poorly controlled diabetes, that it's ***the reason is why the diabetes is poorly controlled***, not just that it is. (CF2)

> Actually, the students are learning to develop a professional relationship with their patient. They're picking up on how they can very ***best serve the patient for all of their needs***, rather than just one tiny little facet of it that might be superficially very simple to solve. (CP12)

> It's not enough just for students to rote learn medical conditions, they've actually got to problem solve along the way, from taking a history, doing examinations, through thinking through the management plan. And that ***takes into account the whole person, their community, and their environment***. (CP8)

> If it doesn't take the ***entire context of the patient and the community in which they live*** into context, which, I think, in clinical reasoning you have to do more of, then it may not be effective even if it's accurate. (CP10)

> ***Clinical reasoning comes from understanding in a holistic way***. I see holistic as meaning drawing in the psychosocial elements, looking at that patient is an individual, and ***all the factors that contribute to their illness***, and their ability to live with this illness, their ability to accept treatment, et cetera, so I see ***clinical reasoning as bringing all those threads in***… And it also brings you close to that patient and not only the intimacy of examination, but it's also the understanding, perhaps, of their pain or their distress or their personality, and you have to develop some kind of relationship with anybody you're touching in that way. (CP11)

However, just as there can be downsides to longitudinal student/clinical preceptor relationships, there are also some potential downsides to student/patient relationships. This is especially true if patients are short on time and in a hurry, or those who may be distressed in some way.

> When the patient ***doesn't want to be there and is impatiently waiting for the 'real appointment'***, it really comes down to, I guess, your ability to either convince them that they can get something from this: "Oh, while you're here, I see you haven't been to the doctor for a year, how are you going," have a chat. But ***if someone's particularly agitated and obviously just doesn't want to be there, then it's a waste of time*** trying to make them say things to you or have a conversation, engage with you if that's not what they want. (CF2)

d) Relationships with place

'Place', in this context, refers to both the clinical environments in which students are embedded and the non-clinical setting (i.e., the community) with which students interact during their LIC. In many cases, they are allocated to small rural towns. In our group of participants, approximately two-thirds of each cohort is allocated to one of nine rural settings of varying sizes within the state of New South Wales. The remaining one-third of each cohort is allocated to two non-rural settings – one is a large metropolitan setting, while the other a small town close to the Queensland border which is regarded as being non-rural.

Clinical environments have a direct role in the development of CR through the complex interactions between student, supervisor, patients, and health systems, while non-clinical settings have an indirect role through social integration and support of students during their year-long LIC. This is achieved through the commitment that students have to make to their LIC environment, as it calls for students to become fully immersed and engaged in both their clinical learning environment and their community.

> I think there is a big difference between six months and a year in terms of ***your psychological commitment*** to a situation and your ***ability to integrate into that environment***. ***You're not just a visitor when you're there for a year***. When you there for something that ends in months, the end is so visible that I think it's harder to let go and just be part of it. (CF2)

> Yeah, and it *[the LIC]* ***allows them to be embedded into the community*** in a much better way. (CF3)

As with continuity of relationships with clinical preceptors and patients, continuity of place adds a further dimension to the already complex interplay of relationships with clinical preceptors, MDTs and patients. The continuity generates familiarity and trust, which empowers the student to have the courage to explore the fuzzy boundaries and uncertainty with which they are faced. From a theoretical perspective, the complexity of these uncertainties is essential for the development of CR, and this would be much more difficult to generate in short term placements.

> ***I think place***, but probably more important, preceptor, but I do think place. I think ***becoming trusted and getting to know the preceptor*** that you have, or preceptors that you have, and *vice versa*, I think ***allows that growth in confidence of the student in their clinical reasoning***… particularly as that length of time during Phase 3 allows for them to ***settle into a sort of rhythm***. (CP12)

> With that ***longitudinal quality of place also becomes quality of people***. (CP5)

> You intentionally develop as a student; you ***develop knowledge of the local health system and the practitioners and health environments***. (CP3)

> That was a benefit to Phase 3, ***being in the one place to being able to work with the same group the whole time***. (FS4)

Being totally immersed in their clinical environment delivers huge advantages for students in terms of their learning, but especially the development of their CR, by allowing deeper involvement with practices, health systems, patients, and communities. This leads to greater entrustment of students, greater responsibility given to students, thereby drawing students more deeply into the community of practice and giving them a more authentic clinical experience.

> I had a very good experience where I could ***completely immerse myself in the day in day out*** sort of hospital environment… ***You don't quite settle into anywhere until you've been there for a year***. So, I feel like ***having the twelve months really allowed us to get involved*** with the community as a whole, the hospital, and the GP practice as a whole. (FS2)

> I think really the ***immersive nature of it is what contributes to the most***, because you're just *in situ*, you're in the space, ***you're embedded in a small team where you're getting to know people and learn from them in that mentoring way***. And then you're also ***applying that to undifferentiated patients*** as they walk in and out on a day-to-day basis. (FS4)

> One is immersive medicine. So, the fact that, a) you're in a single location, or b) you might rotate between another site for a few months as we did in [name of rural town], regardless, they're longer than two or three weeks or four-week blocks, so I found ***immersive medicine as one of the main benefits***. (FS1)

Making longitudinal connections with the local community also gives students a better understanding of the local context, through the shared knowledge that they have with patients. This mutual understanding creates trust that allows the student to have more freedom to explore fuzzy boundaries and uncertainty with the patients with whom they interact, and this, in turn, has a direct benefit on the development of their CR.

> I think by having that longitudinal placement where you are in one community working with one group of clinicians, part of understanding and an individual in the clinical environment is understanding their contexts, and you have that opportunity to ***understand the context of their small town, regional centre, or whatever it may be***, that has an impact on your assessment of them clinically… Having that long-term connection with clinicians and communities builds something for the future, whether it's confidence that you can thrive in that environment yourself, or whether it's connections that keep you in that place, you don't get that on a six-week or a twelve-week rotation. (CF2)

> By appreciating the ***role of communities themselves in their overall healthcare***, which I found quite useful in knowing, and there were different aspects such as access, health literacy, life priorities at that stage for that community. (FS1)

The length of the LIC is important in terms of students making a psychological commitment in terms of integrating into the community in which they are placed. This is an important driver in the development of CR, because the student is so much more engaged in the delivery of healthcare than if they were merely an observer of this process. They are forced to repeatedly engage with CR processes, even though the cognitive effort required may be difficult.

> I think there is a big difference between six months and a year in terms of your ***psychological commitment to a situation and your ability to integrate into that environment***. You're not just a visitor when you're there for a year. When you there for something that ends in months, the end is so visible that I think it's harder to let go and just be part of it. (CF2)

There are also potential downsides to placing students in communities for an extended period of time. One of these is sending a student to a community that they did not really want to be in.

> There are student factors, aren't there? You know, ***do you really want to be here***? (CP6)

Students sometimes feel that their peers in different geographic settings may be getting a better educational experience than they are.

> But I think that if they're not engaged in the place they've been allocated, then that's a big, big challenge, because they're looking over their shoulder. ***Someone else is getting something better in another hub***, and I'm not getting in, rather than concentrating on what they are getting. (CP6)

Key Theme 3: Affordances

Affordances are defined as being the qualities of a workplace that promote learning opportunities for the engaged participant (Latessa, et al. 2017; Billett 2001). The complex relationships that develop during LICs described above are key to giving rise to a range of affordances that facilitate

the learning processes of LIC students. These affordances develop as a direct result of the longitudinal nature of LICs, and many of them are unique to LICs and found only to a limited degree or not at all during traditional block rotations (TBRs).

a) Apprenticeship model of learning

Students become, in effect, apprenticed to their clinical preceptors during their year-long LIC, and this is beneficial for their learning. They learn by watching the clinical preceptors, discussing cases with them, and taking in the ways that they interact with patients. This includes the CR prowess of the clinical supervisors, but it goes beyond this – it also includes their clinical skills, their communication with patients, and their professionalism.

> And so, bringing back that sort of ***focus to the apprenticeship type of model*** that a lot of us were very familiar with and having that sort of as a refocus of the way that medical students learn. (CP5)

> You *[meaning students]* become part of a team, you see how things work on a practical sense in terms of ***the mentorship apprentice-type feeling or community of practice***… We're encouraging ***clinical reasoning by on the job learning*** then, and you'd have to be honest and say it's probably more relevant. (CP3)

> This is what I'm doing now with Mr Smith, this is what I'm thinking about, ***what are you thinking about while you're watching me?*** (CP6)

b) Parallel consulting

The parallel consulting process consists of the student seeing an undifferentiated patient initially alone, including taking a history, performing a relevant physical examination, and developing a provisional differential diagnosis and plan of management. The student then presents their findings to the clinical preceptor (with the patient present) and is then provided with immediate feedback from the preceptor (Tran et al. 2012; Allan and McAleer 2021). In the UOW program, this occurs in both general practices and in emergency departments and is a core component of the UOW LIC program. It is seen as an extremely valuable process in the development of CR in students (Campbell, et al. 2017). The reason that parallel works so well is that it forces students to be actively cognitively engaged with diagnostic and management processes, rather than simply being passive observers of these processes.

> This is ***the value of parallel consulting*** that we do in general practices and ED departments. Actually being in a position of being the only person with a patient, receiving all that information during the physical examination, making a diagnosis, et cetera. ***Actually having to do it is what develops it***. You can study bicycle riding all you like, but unless you actually get on the bike, you don't begin to learn. Or if you're learning to swim, you need help, you need to know that the water's not too deep and you need to know that the lifeguard's nearby, but it's actually doing the swimming that helps develop the skills. (CP4)

> The model is actually taking the history, examining, and then working out their plan of management, and ***it's really developing those diagnostic skills and independent reasoning***. They have to work independently. They do get to observe a little bit, but basically, ***they do their learning by doing and they're learning by thinking and developing their own skills***. (CP8)

> There were a few different ways that there was, kind of, tailored support during ***parallel consulting***, prompting me, asking me: What do you think is going on with the patient, what do you think we should do? Like, ***being very engaged with me as a student in my thought process after I'd seen the patient and providing opportunity for me to ask questions*** on about things that have come to mind, and teaching on ward rounds in the hospital. (FS3)

> The fact that they *[students]* have ***got to see the patients first*** and then present to you what they think should be done, what's wrong. So, ***we're actually pushing them into making clinical decisions***. We're not just sitting them in the corner of the room and saying, watch me do it. (CP2)

The parallel consulting process contributes to the development in students the ability to make clinical judgements. This, in turn, forces them to make diagnostic and therapeutic commitments in a safe, protected environment.

> The ***parallel consulting*** is a form of ***accelerating clinical judgment*** in students… It's the opportunity to parallel consult, being ***forced to commit***. (CP15)

> I think the priority in Phase 3 is to take them from the history and examination to ***starting to make decent differential diagnoses*** that are not ten long, but thinking what are the top three. Okay, so what am I going to do next? What are the possibilities? Do I need to investigate or not? What would be my management plan from here? (CP6)

c) Exposure to undifferentiated patients, a wide variety of patients, and patients with chronic disease

Undifferentiated patients are patients who present with a new problem, where the nature of the problem and diagnosis are as yet undetermined. In the Australian setting, this occurs predominantly in general practices and hospital emergency departments. This is in contrast to other healthcare settings like specialist clinics, hospital outpatient departments and hospital wards, where patients have largely already had a diagnosis made, or are well on the way to having had this done.

General practices and hospital emergency departments are also the settings where a wide variety of patient presentations occur. This is in contrast to other settings where variety is much narrower. Patients with chronic diseases are seen predominantly (although not exclusively) in general practice settings.

The parallel consulting model, in both general practices and hospital emergency departments, creates the capacity for students to see undifferentiated patients. This is a very important factor in LICs that contributes to the development of CR in its students, because it forces the students to

become cognitively and actively engaged in the process of working out *why* the patient is presenting and developing a differential diagnosis and a proposed management plan. This is followed by presenting (or handing over) the patient to the clinical preceptor and getting immediate feedback on their performance with that patient.

> But I feel like in terms of being a medical student, ***seeing undifferentiated patients was really helpful*** because through medical school you learn about this person presents with this, ***you think about your differentials and how would you look at those differentials and what the next steps are***. So, it's quite an easy thing to go through, it sort of follows the sort of stepwise thinking that you learn through medical school, and it is sort of putting that into practice. (FS2)

> I think that ***seeing undifferentiated patients is hugely important for them***. In real practice they get someone who presents with headaches or lethargy or dizziness and some of the multitude of possible explanations and they would have to work through that, and they may not know exactly what to do, but ***they can start the reasoning process and then follow up with their preceptor and learn that way***. (CP9)

> So, the emergency department and general practice is where you get it *[undifferentiated patients]*. People come in and ***they are undifferentiated***, and so ***that is the perfect training ground to help develop clinical reasoning skills***. (CF3)

> A lot of Phase 3 is seeing undifferentiated patients, both in the community placements and also in ED… ***Developing those skills from the undifferentiated patient happens, you learn from real-world experience***. (CF1)

> They get the ***opportunity to do that independent thinking first*** before the supervisor says: This is what it is. (CP2)

Being confronted with undifferentiated patients is a significant factor in the program of the students as they undergo the transition from a year of hospital specialty block rotations to year consisting of a LIC. This transition creates a whole new level of complexity for students to have to deal with initially. However, by having to actively generate ideas and narratives and thus become the initiators of the CR process rather than simply followers or observers, over time this has the beneficial effect of making their thinking more agile and flexible.

> When you're seeing an undifferentiated patient, you're having to deal with all of the aspects of case simultaneously, and also prioritise those which are most likely the cause harm now, harm in the future, which can be just watchful waiting and treated with a tincture of time. So, ***approaching it from that undifferentiated style of learning was a benefit*** as well because not only does ***it makes you think on your feet and process things differently and become a bit more agile as a clinician***, I think it also leads to better learning. (FS4)

> Suddenly they *[LIC students]* are in this situation where they've got nothing, they've got the triage information that someone presents with and they've got a patient in front of them, and that's it. Or in general practice, there's no triage information, there's just a name and a date of birth. So, ***you've gone from differentiated patients to undifferentiated patients***, from being constantly under the eye of either your team intern, resident, registrar, or the nurses on the ward, or the other patients on a ward to being in a room by yourself with a person who has a problem. (CF2)

> The ***undifferentiated nature is one of the most important parts of the model***… They've got to sift what is meaningful or not meaningful in what is often a quite complex patient… it becomes a skill with the student ***working out what's meaningful and what's not*** in a quite complex patient, sometimes. (CP8)

Spending an extended time in one geographic location with their time divided between a general practice and a hospital emergency department provides students with unique opportunities for them to encounter a wide variety of patient presentations, as opposed to students on TBRs who tend to see a very narrow subset of patients during each rotation. When combined with interleaved learning, this is very beneficial in the development of CR (see the section on interleaved learning below). Not only does this variety contribute to the development of CR by stimulating their cognitive reasoning, but it also contributes to the growth in confidence in students in their ability to sort out the relevant patient issues.

> So, you're trying to get them to ***see as many patients with as many variable presentations as possible***, so they can start to get used to history, examination, clinical presentation, ***what's most likely, you know, the clinical reasoning part of the thing***. (CP15)

> The variety of patients, the different settings of exposure to patient and because people presenting in general practice is a certain category of people. In ED they see much more acute stuff and trauma, so the ***variety of exposure is very important***. (CP1)

> The variety of what came through the door was actually what ***made it really exciting for him in the end, whereas that was what was terrifying him in the beginning***. So that change was that ability to manage those sorts of things. And there was a lot more stuff to it, but I think ***the variety stimulates their cognitive reasoning***, but also gives them a whole lot of different things to practice with their clinical reasoning, because some of that undifferentiated stuff is going to be really simple for them. (CP5)

The exposure of students to patients with chronic diseases also contributes to the development of CR by forcing students to think about not just solving the immediate clinical problem on hand, but also to consider the longer-term consequences of the particular chronic disease that the patient may have.

> Some of it is very simple medicine, particularly the medicine that gets directed to the students can be really simple, but then ***they also get the long-term chronic patients*** that can be quite complicated, and that's a ***whole other area of clinical reasoning that they have to learn***. (CP5)

However, there is a possibility that the time pressures on students that occur when seeing undifferentiated patients could have a negative impact on their depth of learning.

> The multiple undifferentiated cases, yes, it's good, but we have to ask ourselves, ***is there sufficient contact time with the client or the patient to allow a deep level of learning to occur?*** (CP13)

d) Interleaved learning

As discussed in the hermeneutic review (Chapter 5), interleaved learning is the process of students learning multiple concepts simultaneously. This has been shown by experimental psychology to facilitate the transfer of learning which is extremely important in recall (Taylor and Rohrer 2010; Rohrer 2012; Rohrer and Pashler 2010).

The interleaved learning that occurs during the UOW LIC is beneficial for several reasons. Because students spend much of their time during the LIC in generalist settings (where the interleaved learning largely occurs), having this approach equips them better for future practice. Interleaved learning has a direct benefit on the transfer of knowledge as espoused by Hruska, et al. (2016), Kulasegaram, et al. (2017) and others. In addition, it contributes to giving students a more patient-centred approach and encourages them to learn to think laterally and is arguably a better way to learn.

> Why do we start by teaching them to be specialists? It makes more sense to me to start the other way round… I think ***building medical students during Phase 3 as generalists and having a good, broad understanding, that's a better platform for them to go out***. (CP6)

> It *[interleaved learning]* is ***teaching a problem-oriented approach and a holistic approach***, rather than just breaking everything down into one system after another or one type of disease entity after another. I think that ***more integrated thinking helps students to think more holistically***, and also helps them to revise all of the different sorts of disciplines that might be there. (CP12)

> We are trying to ***teach the student about the person, the patient as a whole person***, and that is also part of the reasoning process – not only are they thinking about the history and examination for one body system, but they are weighing it against all the other body systems… ***Every person is a mix of all those clinical specialties***… So automatically seeing that as the natural and normal way to learn, rather than creating those silos. (CP8)

> So, the pros of it are that you look at these patients without going in with a preconceived notion of what their diagnosis is, ***it forces you to think outside the box*** essentially. (FS1)

> I found that it *[interleaved learning]* was actually ***more beneficial for my learning***, and I think ***I found myself progressing much faster*** and getting a lot better at taking an undifferentiated patient and coming up with a way to approach and investigate and diagnose and treat and things more quickly, because I was not siloed. (FS4)

In addition to all these advantages, interleaved learning in LICs is an important method of preventing students becoming 'immune' against a body of knowledge once they have been taught and tested on that specific body of knowledge – the so-called vaccination theory proposed by Postman and Weingartner (1969).

> The problem with the ***siloes of the knowledge is that they learn it and then it gets put away in a silo***, and then it's very hard to access when they are doing a new discipline… So, I think ***that cross-linking of knowledge is very critical***. (CP15)

While aspects of agility of thinking and problem solving, lateral thinking and the appreciation of a patient-centred perspective may be important, there is also the effect that interleaved learning allows for cross-connections between disciplines, disease entities or complaints can be forged in students' minds. This has a direct beneficial effect on the development of good CR, because when one learns CR in siloes (i.e., discrete specialties or disciplines), one tends to apply CR within these siloes. However, siloes are artificial constructs that have been created for the convenience of

health systems and organisations rather than patients. Patients, especially the elderly and those with complex health problems, do not always fit neatly into one discrete silo. Within a LIC, because patients are undifferentiated and student learning is interleaved, the quality of CR is arguably better because it is not constrained by these artificial siloes. Students see health problems more from the perspective of the patient, rather than from the perspective of the health system.

> You ***can't do medicine in silos and the clinical reasoning crosses over from discipline to discipline all the time***, and the more you learn about each discipline, the more you realise that it relates back to another one. It's so intertwined and so complicated – the human body is no silo. (CP5)
>
> When people have multiple medical problems, which lots of people do, the students can ***integrate that into their clinical reasoning because they haven't siloed the disciplines***. So, I think that ***builds on their clinical reasoning***. (CP10)
>
> I think that ***the development of the clinical reasoning is enhanced by not having things in compartments***, but by having things organised by symptoms and by doing things coincidentally… I think it's a much superior way of learning, because otherwise if you learn this stuff in the silos, you've got to take the information out of each silo before you can deal with the patient. (CP4)
>
> Having the ***overall general focus is the safest way to clinically reason because then you won't miss things***, whereas if you are sort of breaking things into individual sorts of systems or disciplines, other things will be left. (FS2)

There is, however, a possibility that some students could be overwhelmed by interleaved learning and that this could thus become a barrier to deep learning.

> I think it *[interleaved learning]* can be a double-edged sword. For some people, ***they can't tease the trees out from the forest, so to speak, and then it all becomes a giant blur***, and it doesn't allow that deep learning that I think is required when people advance as practitioners. (CP13)

e) Increased student responsibility and entrustment

The feeling of trust that develops between clinical preceptors and students as a result of their longitudinal relationships leads to greater entrustment of students by clinical preceptors, and this allows for growth in student learning and the development of CR. Trust is important because CR is a complex phenomenon, meaning that the outcome is not always predictable and therefore learning of CR requires exploring uncertainties and feeling comfortable with not knowing.

> I'm going back to the single word of trust, because ***if you don't trust the person who's teaching you or you're the teacher and you're not trusting the person you're teaching, you're not going to get anywhere*** with trying to develop their clinical reasoning… You're prepared to give the student more of their own head and to become more involved inpatient care as you trust what they're doing. (CP12)
>
> I think that the trust that develops between the supervisor and the student, and of course sometimes it doesn't, but the majority of times it does, and ***it's that trust which allows that student to grow***. (CP11)

> I liken my registrar experience to more how the medical students in UOW and Phase 3, is that we have this longitudinal program directly with the consultant, being pushed out of our comfort zone all the time and learned exponentially and ***gained people's trust and then learned more***. (CP10)

> They *[the clinical preceptors]* ***learned to trust you*** and they knew our how we worked and what we were competent at and what we weren't competent at. So, they got to know us very well. (FS2)

The capacity for students to be given more responsibility (under supervision) within the LIC is another aspect that is important for the development of CR. This occurs as a direct result of the deep professional relationships that develop and the entrustment that results from this, and it occurs both as a result of their relationship with clinical supervisors and patients. The capacity for increased student responsibility has a direct effect on enhancing the development of their CR.

> They *[students]* are that much further along in their learning process because less time is wasted checking something that's already known or already been observed once. You know they have the ability to reliably auscultate somebody's chest and report accurately the findings… And they *[clinical preceptors]* are ***able to more appropriately, more accurately, devolve responsibility to the student***. (CP4)

> I think ***with that trust comes a sense of responsibility*** and I think this comes back to the whole practice of immersive medicine and being able to build on these existing skills in a guarded environment and a protected environment. (FS1)

> It's actually members of the general public who expect them *[students]* to act like clinicians. And I think that acting like a clinician and that role modelling is a really critical part of the model as well. They're not acting a student – they are students, they still have to be supervised, but when they're there, they are ***starting to take on those roles of a health professional***. (CP8)

> I think that actually having the responsibility to care for patients, actually engaging in the consultation process from go to woe what ***really develops your clinical reasoning***. (CP4)

f) Time for reflection

Within a LIC, students are given sufficient time to reflect on the clinical cases that they see and also have the opportunity to discuss these cases with their clinical preceptor. Reflection is an important component of learning in complex situations. Complex situations are unpredictable to a certain extent, which means that it is not possible to predict precisely what will happen at a given point in time. However, reflection afterwards helps the learner to make meaning of what has happened during the consultation and why. That is thus an important part of building a CR 'toolkit'.

> The students who see plenty of patients but yet ***have a time to reflect are the students that develop those skills best***. So, I think there's an optimal number of parallel consulting patients to see and that's the number that allows you to have a little bit of time to reflect about what you've done, what you've seen, ***and time to talk to your preceptor***… There being initially repetitive guidance has meant that there is the opportunity to reflect and direct their learning, and then they had further opportunities with similar consultations. And by the end they are looking after the patient confidently and competently. (CP4)

Key Theme 4: Outcomes (effects)

The numerous affordances discussed in Key Theme 3 above that arise during the LIC were seen by participants to combine in various and complex ways to give rise to beneficial outcomes (or effects), especially when combined with positive student effectivities (Key Theme 1) and the relationships that develop (Key Theme 2). These have direct and indirect beneficial effects on the development of CR in LIC students, and how this works will be described under each of the sub-headings below.

a) Regular effective feedback

Patient handover from student to preceptor at the end of every clinical encounter that the student has with patients is an important process in the development of CR because it requires the student to constantly strive to develop a good narrative or reasoning to explain the clinical situation. As the LIC progresses, students become progressively more adept at this.

> I think that process of handover is a really critical part, of handing over to a preceptor and having to summarise what they've been through. (CP8)

> And then to use that ISBAR handover to start making recommendations. And I remember as a student, that's where my preceptor would really push me, especially as we got through to the halfway and latter stages of Phase 3 to say: well, what would you do now, what would you be your management? And then explaining why you would do that. (CF1)

> The fact that they *[the students]* have got to see the patients first, and then present to you what they think should be done, what's wrong. So, we're actually pushing them into making clinical decisions… I push them to do the thinking first, and then I push them to verbalise it to me, what's going on here and what are you going to do about it? And because we push them to do that, it forces them to develop that thinking… and the fact that you make them present the case to you, you're forcing them to verbalise that and structure it in their heads properly… And, you know, clinical reasoning is a practiced skill – the more you do it, the better you become at it. (CP2)

Flowing directly from the patient handover process is the meaningful feedback that is provided immediately by clinical preceptors to students – this is another essential part of the development of CR in students. This feedback can often be given in a tailored way specific to each student and their individual needs.

> I think the advantage of longitudinality is that you get more time with someone that you get to know, and it is that relationship and that trust, mutual trust that develops. And so, therefore, you're going to get better feedback, you're going to see incremental improvement in clinical reasoning that's measurable over that time, because it's a longer period. (CP12)

> From a longitudinal point of view, a longitudinal relationship with someone means that it's easy to give them realistic feedback and honest feedback. (CP14)

> So, having a supervisor/student relationship where you can have honest and blunt feedback is crucial, direct feedback… And I think, from my own time as a student, some of the best teaching I had was when I was given blunt feedback, we weren't dancing around. (CF3)

> By having to verbalise that out loud, they're put on the spot, and then ***their clinical reasoning grows because then they get immediate feedback***. (CP10)

> They could see what our strengths, they could see where our weaknesses were, and I think that was really valuable feedback. And also, like, even just the feedback in terms of, they got to know our personalities, and ***they could also give feedback with what sort of areas of medicine they felt would suit us from a personality perspective***, and I definitely think that that ***the longer-term placement provided more in-depth feedback from everyone***. (FS2)

Having longitudinal responsibility for a student means that their clinical supervisors become more invested in the success of that student – it is almost as though the preceptor feels directly responsible for the success of the student. This leads to better and higher quality feedback from preceptors than if they did not have this feeling of responsibility, which in turn promotes the development of CR.

> I think the attitude amongst doctors generally is, well if they're only here for a short time, I don't really care, they're not my responsibility. ***But, once it becomes: well, they are my student in my practice, I want to give them a good show. Ultimately, I want them to pass their exams and do well***. (CP6)

> I think in general ***the feedback is good because there's a mutual trust and respect so the supervisor takes it that their role is to train the student***, and they take that very seriously and, in general, it means that they will give feedback the student… They also learn to have to be independent and they learn to trust themselves and I think those things all contribute. (CP11)

b) Improved agility of thinking

As shown in the hermeneutic literature review (Chapter 5), agility and flexibility of thinking is a key component of good CR. The structure of LICs, with the relationships that develop and the affordances (especially the affordance of interleaved learning), are well placed to promote this in students by exposing students to undifferentiated patient, to a wide variety of patient presentations, to patients with complex and chronic problems, and by the interleaved nature of the learning.

> When you're seeing an undifferentiated patient, you're having to deal with all of the aspects of case simultaneously… So, approaching it from that undifferentiated style of learning was a benefit as well because not only does ***it makes you think on your feet and process things differently and become a bit more agile as a clinician***, I think it also leads to better learning. (FS4)

> You're not just in a paediatric mindset, you've got to be able to quickly change tack from dealing with a child, to dealing with a gynaecological issue, to dealing with someone with chest pain. And so, by the end of Phase 3, when you have had a lot more of ED and a lot more general practice***, you are far more adept at being able to dip in and out and be agile*** dipping into that foundational knowledge, and the clinical reasoning process then happens much more efficiently. (CF3)

> I think it ***makes them more agile, more flexible***. It's only human beings that love dividing problems into set things. (CP3)

> Having a varied exposure is great… I think ***it's important for them to be flexible*** and to flip from one thing to the other. (CP7)

c) Ability to deal with uncertainty

All clinicians need to develop the capacity to deal with uncertainty, but especially those who deal with undifferentiated patients. It is thus important for students to develop this ability, but it must be balanced against them becoming overly confident. The ability to deal with uncertainty can be personality dependent. Dealing with uncertainty is not just a goal in itself. As can be concluded from the hermeneutic literature review (Chapter 5), CR is a complex and iterative process. It is not an algorithm based on certainties and pure facts, but the ability to construct a narrative that is plausible and yet contains uncertainties. Students who produce algorithmic narratives only do not employ the full range of CR.

> We ***don't want somebody to be too comfortable in their uncertainty, because then they just become cowboys***. And then ***we don't want people who can't make a decision because they're totally uncomfortable with uncertainty***. Medicine and dealing with people is always uncertain. You've got to find that happy medium and that's what I see develops over the year… They don't always get it right, but ***they gradually become a bit more comfortable with being uncertain and knowing it has a safety net and it's okay***. And ***it's important to make a clinical decision which doesn't have to be set in concrete***, it can be rubbery, it can be reviewed, and you have to have the confidence to make those clinical judgments. That's what I see developing over those 40 weeks. (CP15)

> There's the odd person that gets into medicine who is a really concrete thinker, who hasn't gotten to that next stage of Piaget's ability to deal with uncertainty, who really struggles in general practice… They ***struggle with uncertainty and undifferentiated patients***, they're not sure where to go with it. So, I think it ***will come down to the actual makeup of the person***, their way of thinking, the more concrete thinking type people. (CP12)

d) Challenges to comfort zones

In order to develop the capacity to deal with uncertainty, it is sometimes necessary to be taken out of your comfort zone. Students engaged in LICs are frequently taken outside of their comfort zones, and this can be important for their learning in general and for the development of CR in particular. Of course, it is important to ensure that students feel safe and supported when the boundaries of their comfort zone are pushed. There is a fine line between being pushed too far and experiencing cognitive overload and being in a zone of proximal development, defined by Vygotsky as being the area of learning that learners can achieve with the help of more knowledgeable, experienced others (Harland 2003). In order to achieve this, a good supervisor-student relationship is key, and this needs time and trust to develop.

> I don't think ***you're going to learn anything if you remain in your comfort zone*** during learning anything. It's not only that it's going to be boring if you're not, but a lot of these students are also high achievers, so ***they want to be challenged***, they want to put themselves out there. They want to be right, sure, but ***they also want to be stimulated and challenged by what they're presented with***… I think clinical reasoning is why we end up with a more mature, more well-reasoning type of graduate, who has already been challenged. (CP12)

> I think students are often quite excited by it *[being taken outside of their comfort zone]*, quite challenged by it and sometimes upset by it, but hopefully have processes to deal with it***. I think they learn very fast by it; they learn a lot***. (CP8)

> There are things that you think about, things that you read about, but until you actually do it, there are so many other cognitive factors that come into play. So, yep, ***we were put out of our comfort zone***… There are definitely a few cases that we'll always remember, and they've ***definitely shaped us in the way we think about problems***. (FS1)

> I think they're taken out of their comfort zone all the time, and I think that ***as long as it's done in a supportive environment*** where they're not going to be yelled at and the patient is going to remain safe, that's a really important way to develop your clinical reasoning. (CP10)

It is at the start of the LIC in particular that students feel the most challenged in terms of their comfort zone. This is because their cognitive load is, in part, occupied with settling in and adjusting to a new environment. They are also faced with seeing undifferentiated patients on their own for the first time, and this can be a steep learning curve.

> I think a lot of them ***at the beginning of Phase 3 are naturally out of their comfort zone***, because they're in a practice, they're set up in their own room with their own computer with their own patients. It's like: Oh my God, what am I going to do? I have to pretend to be a real doctor. So, a lot of them are moved quite sideways out of their comfort zone. (CP5)

The level of discomfort felt by the student when their comfort zone is challenged is, to some extent, personality dependent. This means that although many students will thrive in environments like this, others will find it challenging and the development of their CR can thus be negatively affected.

> That *[the level of discomfort]* ***varies a lot, depending on the student and their personality***. ***Some students I have come across love it and thrive on these sorts of things***, and sometimes you think they're biting off more than they can chew. ***Others crack under the pressure and have a meltdown***. So, it depends on the students' personality, I think. But the majority do like to be challenged and that's how they learn. (CP1)

e) Reduced cognitive load

LICs have an important effect in reducing the cognitive load of students, especially when students face disorientating dilemmas or are being pushed outside their comfort zone. Students engaged in LICs have the advantage of having an initial settling-in period once only, and they are then able to focus all their cognitive efforts on their general learning, and in particular on the development of their CR.

> When you are in one place and you have that continuity, you get to know the people that come through, but ***you also have that cognitive load of change taken away***. (CP5)

> When the students are in just one ED and just one general practice for the whole year, basically they ***spend the first four to six weeks settling in, and they're learning for the rest of the year then***. (CP8)

> When the students are in just one ED and just one general practice for the whole year, they ***spend the first four to six weeks settling in, and basically, they're learning for the rest of the year***, then… But I think that continuity just allows that, and I really think with the other models, they don't get that development of reasoning because they're out of their comfort zone by being in new locations all the time. (CP8)

This is in stark contrast to the high cognitive load experienced by students on short-term clinical rotations each time they start a new rotation.

> One of the things about doing a ***short term-based rotation is that it takes three or four weeks to settle into the location***, knowing all the staff, knowing where all the equipment is, what the expectations are about your role. That takes up a lot of time and effort. (CP8)

> If a student is ***in a different location every four weeks, they've got an enormous cognitive load*** where they've got to learn new systems, they've got to learn new doorways, they've got to learn desk setups, just the really stupid things that take up cognitive space that is otherwise then redirected from their learning. (CP5)

> Each time you go to a new placement, and the more frequently you do that, the more ***time you waste getting oriented and getting to know the people and systems***, et cetera. So going to the one place, you do that once. (CP4)

This reduced cognitive load has not only the effect of improving students' capacity to learn, but it also helps to build their confidence (explored further in the next section).

> Reducing that stressful part of their cognitive load, I think is really important in getting them comfortable, because I think students learn, in a lot of ways ***they learn well when they're comfortable***… And that comfort level is ***when they feel that their cognitive load is less***. (CP5)

> Physically they're in a stable environment, they trust their environment, which means, then, their actual ***real clinical learning can progress from there***. So, I think it is that the stability around them which allows for development of their actual learning. (CP8)

f) Increased confidence

Growth in confidence in students over the twelve-month LIC is seen almost universally. It is something that some participants saw as developing suddenly, but others saw it as developing more gradually over the duration of the LIC. This is achieved through the continuity, entrustment and reduced cognitive load that the LIC environment provides, and it is, unsurprisingly, often in the later parts of the LIC when students start displaying the most confidence. Of significant importance, the growth in confidence in students has a direct beneficial effect on the development of their CR by having been able to become well acquainted with the people and systems in which they are embedded (i.e., being able to focus all of their cognitive efforts on learning rather than repeatedly settling into new learning environments) and becoming trusted members of the healthcare delivery teams (i.e., legitimate peripheral participants in those teams). By developing this confidence, students are more willing to be active participants in the CR

processes of patients, they feel as though they are useful to the team, and their cognitive processes are, as a consequence, taken to a whole new level.

> This is a huge change, ***all of a sudden you've got this leap of confidence***, this person is now able to actually get a good history, ask the right questions, all that sort of stuff… They don't seem to be moving very quickly to start with, but all of a sudden they take this sort of logarithmic leap that once they work it out and ***once they've become confident, they then start to think more like the way that interns think***. (CP5)

> One of the big things is a lot of the students will be very reluctant to come up with a diagnosis or management plan when they first start. They're very good at taking histories and examinations and performing procedures, but ***it's that confidence to actually say, I think this is what's going on***. By the end of Phase 3, that is the largest difference in students, ***they are very ready to say, this is what I think is going on***. (CF1)

> I think especially the last six months, when you've found your place in whatever site you're in, and you feel comfortable with the environment and basically, it's now just improving your skills. So, I think that's probably where ***the peak of our confidence comes, and at the end of Phase 3***, you kind of feel a bit better about your place in medicine. (FS1)

> They've certainly ***improved in confidence***, and ***they feel comfortable in the practice, and they feel useful and part of the team***, and then ***their reasoning and their knowledge increases as a result***. (CP9)

This growth in confidence in students comes as a direct result of the trust that develops between students, clinical preceptors, other members of the healthcare team, and patients. This is all a product of the deeper professional relationships that are able to flourish over time, and this has a directly positive effect on the development of CR in students.

> I think it is the autonomy, they're given a certain amount of autonomy to assess the patient. Patients see them first up, triage, history, examination, and they are encouraged to go as far as they feel safe to go, and then I encourage them to go a little bit further… ***If you give them the autonomy to go out there and bumble their way through, you're saying: make a commitment***, if it's wrong, we can always go back and fix it. (CP15)

> I can see looking back that I was allowed, I think autonomy is the wrong word as a student, but I was allowed more independence within the role of a medical student, as they grew to know what my skillset was, ***they grew to trust my judgement, my reasoning a bit more, and that that in turn allows you to develop a bit more of that reasoning***, because you've got to have a little bit more freedom to develop that knowledge and understanding, so you can actually start to think independently, rather than just parroting whatever you're told, and writing it down on a piece of paper or documenting it in a computer. (FS4)

> I think ***with that trust comes with a sense of responsibility***, and I think this comes back to the whole practice of immersive medicine and being able to build on these existing skills in a guarded environment and a protected environment. (FS1)

> I think becoming trusting and getting to know the preceptor that you have, or preceptors that you have, and vice versa, I think ***allows that growth in confidence of the student in their clinical reasoning***. (CP12)

The repeated exposure of students to undifferentiated patients leads to a growth in confidence over the twelve months of the LIC to deal with almost any problem with which they may be confronted. For the reasons outlined above, confidence is a key ingredient in the development of

CR and is important in this development in both undergraduate medical students and in the early years after graduating of working as junior doctors.

> I think that ***seeing undifferentiated patients is one of the crucial things***. One of the comments I loved most from one of my students was when he said to me that when he started off, he was terrified about what might come through the door with each patient, because he had no idea what to do. He said ***by the end of the 12 months, he didn't care what came through the door, because he knew he was going to be able to at least start the conversation***… So, I think it's a great place for undifferentiated clinical reasoning. (CP5)

> During your first three years of medicine post-graduation, the bulk of it is dealing with relatively undifferentiated patients, and most of the times when you get asked review a patient, it will be from an undifferentiated perspective anyway. So, ***if you get comfortable being able to see undifferentiated bread and butter conditions, it's probably by far the most useful skill you can get upon graduation***. (FS1)

g) Improved clinical and communication skills

There is a significant improvement in the clinical skills of students, and this contributes directly to the development of CR. This is achieved over the course if the LIC by practicing the art of really listening to patients' stories, taking focussed histories relevant to the particular presentation, and performing a physical examination relevant to the presentation. At the start of the LIC, many students have a scattergun, mechanistic approach to patients, but this is refined during the LIC and by the end they are much more focussed in dealing with patients' problems and what could be going on with each patient.

> They get to the point where they can function as a junior doctor, where they're not taking an hour to take a history and examine a patient. So, ***it is actually quite magical watching that develop over the year, where they can really target, go from taking a very broad, almost mechanical medical student history to quite a focused and well-communicated consult*** that's similar to a clinician, a qualified clinician… I think ***that part is of clinical reasoning*** as well, and even though they're often quite hands-on teaching, I think there's parts of that that are part of clinical reasoning. (CP8)

Closely linked to the development of clinical skills is a significant improvement in students' communication skills with patients, and this also has a direct beneficial effect on the development of their CR abilities by being able to effectively convey to patients what is going on in their thinking and why in relation to formulating diagnoses and management plans for their particular needs. The repeated practice that students are able to have in communicating with patients is therefore very valuable in this development process.

> It *[clinical reasoning]* ***relies on really skilled communication***; they do have to learn to communicate with undifferentiated members of the general public on whom they really are working out the diagnosis themselves. So, I think that means that ***their communication skills rapidly improve in a real-world setting*** because they have to. (CP8)

> But what I think is really important is the art of the conversation, and ***the art of the clinical conversation***. ***Part of that is clinical reasoning*** and the other part is negotiation and change management and how you drop bad news on somebody, how you negotiate with families, how you do

> all of that other stuff… That's not really about clinical reasoning, but ***how to ask the questions that lead to clinical reasoning***. (CP5)
>
> ***Clinical reasoning relies absolutely on communication skills***, good communication skills. It relies absolutely on appropriate and up to date clinical knowledge, and it relies absolutely on the confident and accurate elicitation of clinical signs. So, it's a combination of all of those processes. (CP4)
>
> And also spending time with patients, I know it's not so much reasoning, but it's getting lots of skills that can't be necessarily taught in an extended manner just ***relating to communicating well***, what to ask or what not to ask. And surely ***part of clinical reasoning is knowing the right question to ask***. (CP3)

h) Enhanced encoding specificity

As discussed in the hermeneutic literature review (Chapter 5), encoding specificity is the probability and efficiency of retrieving an item from memory being dependent on the similarity between the conditions of encoding and those of retrieval. This has been recognised in the literature as a significant rationale for community-based medical education, where substantial parts of LIC programs tend to occur. It is in these settings that much of the learning tends to take place, and where a diverse range of clinical problems is seen in real patients (Regehr and Norman 1996). This affordance is a significant factor in the development of CR in the LIC students.

> We all ***learn subconsciously from what we're seeing and experiencing*** and what worked well, or not, for certain patients. ***We always remember a patient with a certain thing*** that makes us a bit more knowledgeable about certain situations or presentations. (CP3)
>
> ***Clinical context makes it easier to remember and provides a relevancy to the knowledge***. Learning straight out of the textbook, there's no context, there's no relevance, and it's much harder to remember. (CP15)
>
> I think there's a huge improvement in the way you collect information ***by being in the same room as someone***, seeing little subtleties, seeing their physical presence, you know. (CP7)
>
> I've come to really trust my *gestalt*, that sort of instinct, and which is something ***you only get by experiencing it previously and having exposure to it***. And I guess, particularly with my experience in [name of LIC rural town], I was so fortunate to see so much, I think that gave me a really good basis to develop my clinical reasoning moving forward. (FS2)

i) Personal and professional development

There is considerable growth in personal and professional development of UOW LIC students, and this has a direct impact on the development of their CR. Through personal growth, CR does not stay confined to the biomedical aspects. but also includes professionalism and ethics. This enriches their reasoning and allows students to develop fuller 'stories' to understand their patient's issues and needs, and it leads to students being able to appreciate the importance of clinical ethical decision-making.

So, I think that's ***actually part of clinical reasoning***, and it's being able to express, at a high level, why they're making decisions on some of those issues. I think it's being able to verbalise ***why, in difficult ethical cases with the interaction with clinical care, you would act in certain ways***. And I think that's quite important as well; I think you do see that development. (CP8)

I think ***personal professional behaviours are also important for clinical reasoning***. The good care of a patient, which is the aim and result of the clinical reasoning process, is also dependant on the personal professional behaviours of the doctor. I mean, ***a necessary accompaniment of clinical reasoning is appropriate personal professional behaviours***; you don't get appropriate patient outcomes if that's not also practiced. (CP4)

Key Theme 5: Growth in clinical reasoning

When comparing the CR abilities of students between the start of their LIC and the end, there is little doubt that both clinical preceptors and former students perceive significant growth and development. This is not irrelevant, because from the perspective of education and learning as relativist, constructivist phenomena, participants being able to perceive growth and to verbalise how and when it takes place (rather than simply a global *gestalt*) can be seen as an indicator of actual learning. This was seen by clinical preceptors but was particularly seen by former students when reflecting back on their LIC experiences.

It *[clinical reasoning]* is definitely not just a little bit better, ***it's a lot better at the end for the majority of students***… Your average student improves really, really a lot through Phase 3, quite tangible improvement that occurs during Phase 3. (CP12)

You see it *[clinical reasoning]* ***develop and broaden***, so that ***their clinical reasoning scope is much broader*** because of the breadth of presentations that you see in general practice. So, the breadth of their clinical reasoning has been stretched and also their efficiency in generating differentials, in generating a provisional diagnosis and a management plan. They become more efficient at that, absolutely. (CF3)

And so, by the end of Phase 3, when you have had a lot more of ED and a lot more general practice, you are far more adept at being able to dip in and out and be agile dipping into that foundational knowledge, and ***the clinical reasoning process then happens much more efficiently***. (CF3)

And then ***as things progressed, it's almost like developing a rapid pattern recognition aspect of things***… I think it's just the accumulation of time and experience and exposure to undifferentiated stories and the need to gradually accumulate that experience with reasoning over time. (FS4)

It is interesting to note that the growth in CR appears to occur without students being conscious of it at the time. However, their clinical preceptors can see this growth and development, and over the course of the LIC year this is so significant that students are effectively functioning at intern level by the end of the LIC.

But the fact that I've got them for so long means that I can see them change and they can see me see them change, because we talk about that at the end. But ***they're often not aware of how much they've grown***. (CP5)

I find it's just a natural evolution, I can see from what the students are telling me, and ***they're probably not aware of their clinical reasoning developing***, but I can see already they're starting to think of a probable diagnosis and differentials and what they're going to do to confirm or deny that. (CF1)

I think most of the students develop their clinical reasoning significantly during Phase 3; ***they go from being intern unready to being intern ready***. (CP4)

Well, ***they're thinking like doctors when they leave***. They come in thinking like students, because they've been mostly learning out of books and from ward rounds, but when you start sitting them next to patients for full shift, and that's their job to do that. (CP7)

DISCUSSION

The key findings of this study are that students enter the LIC with effectivities (qualities) that lay the foundation for the development of strong relationships between the student and their clinical preceptors, the student and the patients they see, and the student and the place in which they learn and develop. These relationships, in turn, form the platform for an array of affordances which interact with one another in complex adaptive ways to promote a series of effects which have direct or indirect effects on the development of CR.

The relationships that develop during the LIC are complex and multi-faceted. The LIC model provides the mechanism for these relationships to grow, deepen and flourish, and it is these relationships that are seen as a key difference between this model and the traditional block rotation (TBR) model. Participants have clearly articulated the benefits of these relationships and have illustrated how and why these occur. But they have also highlighted some of the potential difficulties which can occur. The benefits, however, appear to far outweigh any potential difficulties.

The findings of this research align strongly with the views found in the hermeneutical literature review (Chapter 5) that LICs and CR have much in common: they are both complex adaptive processes that place the patient at the centre of students' thinking, rather than the disease with which the patient presents. While this ontological alignment may be interesting from a theoretical point of view, this study shows what such an alignment means in practical terms and how it is experienced by all stakeholders in the LIC learning context. Having patients at the centre of students' thinking has the positive effect of making them more sensitive to the needs of the patient and the community in which they live and work, and it thus has the capacity to produce medical graduates who are more attuned to the needs of both individual patient and of the wider community in which patients live and work.

The results of this research support not only the view that students engaged in a LIC learning context become more agile and flexible thinkers, but also how and why this is the case. Moreover, it shows that students develop a good capacity to deal with uncertainty. They grow in confidence, have improvements in their communication skills, their clinical skills, and their professionalism – all effects that contribute to the development of CR.

This study shows that there is no true dichotomy between longitudinal versus non-longitudinal, or integrated versus non-integrated. There is no magical length of time that makes a clerkship longitudinal. However, time is needed to forge partnerships, relationships, trust, and agency between students and others within the learning environment, and these are necessary for optimised learning. There is also the need to see undifferentiated patients, connect their 'medical' problems with their socio-economic context and life histories, and to understand care from an integrated perspective in order to be able to develop rich narratives. The richer the developed narrative, the easier the retrieval and the more agile its application in clinical settings. It is less about a particular length of time in a location and more about what time, location, relationships with people, and context allow for meaningful interactions to occur. It is the personalised spectrum of CR and other activities that are applied that provide richer learning experiences for students. In short, learning in a unafforded environment will not provide students with the richness of CR and problem-solving ability that students will get in an afforded environment.

Previous research has been undertaken to examine the factors that contribute to general student learning and academic outcomes during LICs (Shahi, et al. 2015; Latessa, et al. 2017; Latessa et al. 2015). However, there is no research to date that has specifically explored the factors influencing the development of CR during LICs. This research was aimed at filling that gap. The previously published research also used a more linear causal perspective on the mechanisms and outcomes, while this research used a complexity lens that better highlighted the nature and quality of interactions.

The general value of continuity of supervision, continuity of place, and continuity of patient care as an important characteristic of LICs as reported by others (Hirsh, et al. 2007; Latessa, et al. 2017) has, in this research, been shown to be an important affordance for the development of CR. The study by Latessa, et al. (2017 highlighted a range of affordances found in two LIC programs in the United States. However, this research found some affordances that their study did not find or report on. These include the affordance of parallel consulting under supervision in both primary

care settings and in emergency departments, which is closely tied to the affordances of seeing undifferentiated patients and patient handover to the clinical preceptor at the conclusion of the student seeing each patient with immediate feedback from the supervisor. This triad of affordances is seen as very important to the development of CR in LIC students. Other affordances found in this study but not the Latessa, et al. (2017 one, were the ability of students to spend time with patients, to see a wide variety of patients, and the capacity to learn directly from patients.

In a literature review of patient-centred care, Levesque, Hovey, and Bedos (2013 found that extending students' stays within a clinical clerkship site (i.e., in a LIC), which increases contact with a given cohort of patients as well as with clinical preceptors, has positive effects on their patient-centred attitudes. This is closely tied to the capacity for students to have time for meaningful reflection.

These studies, together with this study, demonstrate that there is a useful amount of understanding of which factors of longitudinal and integrated placements lead to the development of high-quality CR. This understanding is not only relevant to support the value of LICs as educational context, that they are at least as good as, but likely better than, TBRs for the development of CR. It also provides important information to clerkship designers, clinical supervisors and to students as to how to design and engage with LICs to optimise the learning of CR. In addition, it provides insights into the development of better assessment for CR and provides more concrete avenues for further research.

A limitation of this study is that it was conducted in a single program in Australia. However, because LIC programs globally have many features and characteristics in common, the findings should be generalisable to many other programs. Another limitation is that some of the interview questions were not framed neutrally and, in some instances, the positive option was placed before the negative one – this could have introduced some bias and cued responses on the part of participants. A further caveat is that this research applied a complexity lens to the phenomenon of the development of CR in LICs but had to report this study and its findings in a linear way. This way of reporting may not have done justice to the many complex interactions I sought to describe and may give the impression of redundancy in some instances.

CHAPTER 7:
DISCUSSION AND CONCLUSIONS

"A PHYSICIAN IS OBLIGATED TO CONSIDER MORE THAN A DISEASED ORGAN, MORE EVEN THAN THE WHOLE MAN – HE MUST VIEW THE MAN IN HIS WORLD."

– DR HARVEY CUSHING (1869-1939)

In this concluding chapter, I will discuss the key findings of this research and how they have addressed the research questions. I will also review the implications of the research for medical education, outline its limitations, and make suggestions for further research.

The theoretical approach that I used for this research was a combination of theories relevant to the setting and to the research questions. Cognitive load theory (CLT) and development of expertise theory were used to best understand the perspective of the student, communities of practice theory for the learning environment, and legitimate peripheral participation theory and situated learning theory for the clinical supervisor, who is the key player linking the students to the learning environment. Underpinning this entire construct and supporting the way in which the perspectives with the theoretical lenses can be meaningfully combined was complexity theory. Complexity theory also provided a useful lens on the intricate systems of healthcare delivery, the nuanced processes of clinical reasoning (CR), and the multifaceted interactions between students, supervisors and learning environments of longitudinal integrated clerkships (LICs). It is especially useful when it is focussed on the interactions of the various stakeholders and factors in these systems rather than just approaching stakeholders and factors as static components of the system. This provides a better understanding of the limited predictability of what occurs within the fuzzy boundaries between the various players in these systems. Complexity theory is also a useful lens to recognise the complexity of CR, the complexity of LICs, and that there are strong synergies between these two constructs.

The initial research questions, which were framed from a positivist perspective, were an attempt to confirm that the development of CR in students engaged in LICs is superior to that of students in the traditional block rotation (TBR) model of medical education. An initial quantitative study on the semantic and syntactic content of clinical log entries was undertaken, followed by a quantitative, best-case analysis performed to explore whether any indication for differential development of CR quality could be found in routine assessment data. However, neither of these studies was able to substantiate such effects.

It thus became clear that this question was not only difficult or even impossible to answer from a logical positivist perspective, it was also not the most relevant one. It is a question that would have assumed that education, assessment, LICS and CR all should be perceived from a linear causal perspective – one cause with one predictable outcome – and would have ignored the complex nature of it all and the contextualised nature of the effects of education. In retrospect, it is not surprising that this proved to be an unsatisfactory approach, and a change of direction in the research approach was needed.

Consequently, I shifted my focus to addressing questions about how and why students engaged in LICs acquired good CR, i.e., exploring what the factors are within LICs that promote the acquisition of good CR. This change in direction called for an approach from a constructivist perspective, and this proved to be better placed to explore the complex and contextually dependent topic of CR. The final primary research question that finally evolved was:

> *What are the various unique program structures and other factors that come into play during LICs that interact with each other to foster and promote the development of CR of students participating in the program?*

The initial step after this direction change was to revisit the literature utilising a hermeneutic approach to determine what is already known on the relationship between the development of CR and LICs (see Chapter 5). This clearly revealed that CR is a complex, multifaceted, cognitive process. It also showed that student engagement with preceptors and patients, and their approach to learning in LICs is organic and complex, and that LICs thus have strong synergies with CR. The hermeneutic literature review showed that the unique structure of LICs allows learners to see undifferentiated patients, have exposure to interleaved learning (with its associated variability and unaggregated learning), allows for more encoding variability (reducing the effect of encoding specificity), and that these factors combine to promote retrieval of information from long-term memory. This, then, leads to the assumption that the development of CR should be better in LICs than in TBRs, and that theoretically LICs should promote better development of CR. This literature review also confirmed the finding of the earlier scoping review that to date there is a lack of direct, robust evidence on how CR develops in students engaged in LICs. This was seen as a major gap and this research was aimed at addressing this deficit.

The next step in this process was a qualitative study interviewing clinical preceptors and former students in the University of Wollongong (UOW) LIC, i.e., people with lived experience of the UOW

LIC. This confirmed the view that CR and LICs have much in common, and it showed that immersing students with appropriate characteristics in settings with the many unique affordances that LICs provide gives rise to strong effects that combine in complex adaptive ways to have a direct impact on the development of good CR. The triad of parallel consulting under supervision, seeing undifferentiated patients, and the handover of the patients to clinical preceptors at the conclusion of each patient interaction, on a background of the development of deep, meaningful relationships with clinical preceptors, is seen to be especially important in the development of CR in UOW LIC medical students. It has the additional benefits of improving patient-centred attitudes, having improved clinical skills, and improved communication skills in students, all of which contribute to the improvement of CR in these students.

Each chapter of this thesis has had its own discussion and meaning making of the findings. However, when considering the findings across the chapters, there are also some important conclusions of key messages that can be derived at a higher level. These are discussed in the following section.

KEY FINDINGS

The key findings of this research are summarised in Table 7.1 below.

Table 7.1: Summary of key findings

Key Finding 1:	My initial assumption that longitudinal integrated clerkships automatically lead to better clinical reasoning was too simplistic; it is the affordances that are provided and mediated by longitudinal integrated clerkships, which inherently have organistic, complex adaptive structures, that this provides in terms of the deep relationships between student, clinical preceptor and the learning context that lead to the development of clinical reasoning in students.
Key Finding 2:	The existing published quantitative evidence supporting the view that longitudinal integrated clerkships have a beneficial effect on the development of clinical reasoning is weak.
Key Finding 3:	Quantitatively measuring the development of clinical reasoning using realist/logical positivist approaches is inherently problematic.
Key Finding 4:	Clinical reasoning is a complex adaptive construct.
Key Finding 5:	Clinical reasoning is an elusive concept to define, teach and assess.
Key Finding 6:	There are strong ontological parallels between clinical reasoning and longitudinal integrated clerkships.
Key Finding 7:	The settings in which clinical reasoning is best learned is one that mirrors the complex nature of clinical reasoning.

Key Finding 8:	Traditional approaches to medical education are no longer fully aligned with the societal needs and expectations of the modern doctor.

<u>Key Finding 1:</u> My initial assumption that longitudinal integrated clerkships automatically lead to better clinical reasoning was too simplistic; it is the affordances that are provided and mediated by longitudinal integrated clerkships, which inherently have organistic, complex adaptive structures, that this provides in terms of the deep relationships between student, clinical preceptor and the learning context that lead to the development of clinical reasoning in students.

The continuity that LICs provide affords the ability for students to develop deep and meaningful relationships with members of the healthcare teams in which they are embedded, but especially with their clinical preceptors; this allows trust between student and clinical preceptor to develop, which in turn gives rise to more meaningful feedback. Furthermore, the inherently complex structures of LICs entail learning by students of multiple concepts simultaneously over a longer period of time, compared with learning fewer concepts serially as in TBRs (see Chapters 5 and 6). This means that students engaged in LICs need to be self-motivated, self-directed and be able to adapt to the learning environment in order to thrive, and this can create difficulties for students who do not possess these qualities. However, the advantages far outweigh any disadvantages that may arise.

<u>Key Finding 2:</u> The existing published quantitative evidence supporting the view that longitudinal integrated clerkships have a beneficial effect on the development of clinical reasoning is weak

An initial scoping literature review (Chapter 3) examining the relationships between LICs and the development of CR found that the existing evidence supporting the positive impact that LICs have on the development of CR is weak. This evidence was based largely on author opinions and perceptions, student self-reports, clinical preceptor reports and/or opinions, or a combination of these. No studies were found that examined how or why CR develops in LICs or how much it develops. The hermeneutic review (Chapter 5) confirmed this finding. Both reviews thus revealed a significant gap in the literature, with a lack of robust evidence of how this pedagogical approach to medical education works in terms of the development of sound CR.

Key Finding 3: Quantitatively measuring the development of clinical reasoning using realist/logical positivist approaches is inherently problematic

The initial research approach was to adopt a quantitative one in an attempt to objectively measure the development of CR in medical students engaged in the UOW LIC. Two different quantitative approaches were used, and both showed that this is highly likely to be not possible (see Chapter 4). The conclusion that was reached after both approaches is that studying the development of CR within LIC programs from a realist ontological perspective and a positivist epistemological perspective is fraught with difficulty. This is most likely because this approach lends itself more to studying elements in a system rather than their interactions, it looks at predictability, and studies topics that have clear boundaries. CR being a domain-specific, multifaceted, complex, idiosyncratic, non-algorithmic, interactional phenomenon which is undertaken iteratively in the heads of clinicians and students is thus not the result of elements in a system but of the interactions between those elements. Therefore, it does not lend itself to one-off, quantitative approaches, and these are inherently inappropriate to demonstrate how LICs support the development of CR through supervisor/student/clinical context educational interactions. The absence of any positive findings in quantitative studies is not a consequence of the specific methodological considerations of these studies but is rather due to a fundamental ontological mismatch between such study designs and the nature of CR as a complex, interactive phenomenon.

Key Finding 4: Clinical reasoning is a complex adaptive construct

CR is seen as the cognitive process during which the clinician selects the best narrative for the particular clinical problem with which he or she is faced, in other words it is the generative aspect of the here and now and with whom. It is a complex, multifaceted, context-dependant, adaptive cognitive process that takes place in the minds of clinicians and medical students, and it is largely hidden from view. It is, therefore, not a straightforward, linear process that is measurable. The *results* of the CR manifesting as clinical decision-making can be seen and measured, but the *process* itself is hidden. This was a key finding that pervaded almost every aspect of this research (see Chapters 3, 4, 5 and 6).

Key Finding 5: Clinical reasoning is an elusive concept to define, teach and assess

As shown in the hermeneutic review of the literature (Chapter 5), research into CR over the past few decades has showed that it is far more complex than originally thought (Durning, et al.

2013b). Being an idiosyncratic, multifaceted, highly complex construct, further compounded by the fact that it is 'hidden' due to it taking place in clinicians' thinking, and despite significant research into this area over the past two decades, it has remained difficult to define (Pelaccia, et al. 2011; Pelaccia, et al. 2017; Morris and Campbell 2015). There are several definitions which vary widely and do not converge (Durning, et al. 2013a; Daniel, et al. 2019; Young, et al. 2020; Kononowicz, et al. 2020; Torre, et al. 2021). It is so nebulous and misunderstood that it has been described as a 'black box' (Sandhu and Carpenter 2006).

The complex nature of CR also means that it is difficult to teach, measure and assess, and the conclusion that I have come to is that it is better learned by students under expert guidance than explicitly taught to them. However, this requires a rich contextual setting for students to be immersed in with sufficient time and contact with real patients, with its complexity calling for expert guidance by experienced clinical preceptors, preferably over a longer period of time.

<u>Key Finding 6:</u> There are strong ontological parallels between clinical reasoning and longitudinal integrated clerkships

As described in Key Finding 3, CR is a complex, multifaceted, context-dependent, adaptive cognitive process. Similarly, as described in Key Finding 5, LICs are complex adaptive structures in which students need to be motivated in order to thrive. There are thus strong ontological parallels between CR processes and LIC structures, and this could, in part, explain why LIC students develop good CR. It also helps to best understand why any linear causal comparative study or direct observational comparisons between LICs and TBRs with quantitative outcomes cannot succeed, because of the mismatch between the ontological assumption behind such a study approach and the ontological nature of both LICs and CR.

<u>Key Finding 7:</u> The settings in which clinical reasoning is best learned is one that mirrors the complex nature of clinical reasoning

Good CR is not achieved by knowing one single best narrative, but rather by having a series of narratives – as a sort of agile toolkit – from which to choose the one best narrative serving the situation in the here-and-now (see Chapters 5 and 6), regardless of whether this narrative is an internal mental one or is used to communicate with others. It is the complex interactions between the student, the learning environment and the supervisor, and the meaningful relationships that develop out of these interactions that is so important to the process of acquiring good CR. They are moderated by a range of student factors, learning environment factors and supervisor factors.

Student factors include motivation, maturity, curiosity, initiative, a general desire to learn, as well as interactions with their peers. Learning environment factors include continuity of place and patients, ability to conduct parallel consultations, variety of patient presentations, undifferentiated patient presentations, inclusion into healthcare teams, and the ability to spend time with patients. Supervisor factors include personality, continuity, the capacity to listen to patient handover by students, and the ability to give meaningful feedback to his or her students.

<u>Key Finding 8:</u> Traditional approaches to medical education are no longer fully aligned with the societal needs and expectations of the modern doctor

The traditional structure of organising medical students' clinical education around a series of rotations in hospital departments and/or clinical specialties reflects the needs of the department or specialty rather than that of students or patients (Medalie, Mettee, and Stevens 1997) (see Chapters 5 and 6). Students have transient contact with both medical teams and patients, and patients have shortened stays and fragmented contact with the health care system (Bell, et al. 2008). Students in these settings, particularly in large teaching hospitals, are becoming increasingly marginalised as care has become more specialised with shorter patient stays, and this has a negative effect on their learning experiences (Whitcomb 2005). There is a distinct lack of continuity, with a focus of learning about the disease rather than about the patient (Irby 2007). This model does not adequately prepare students to meet the complex healthcare needs of a chronically ill and ageing society (Teherani, et al. 2009; MDANZ 2021).

This research provides a contrasting view. It has confirmed the view that LICs have the potential to better prepare graduates for practice, and the unique hands-on learning that this model provides gives greater insights into patient cultural and contextual factors which ultimately leads to the provision of better individual and population health care, provided it is done correctly and with sufficient stakeholder engagement (Daly, et al. 2013a). The deeper, more meaningful relationships that develop between students and clinical preceptors, patients and communities are factors that all have a beneficial effect on student placements and learning (Worley, et al. 2006; Stolper, et al. 2021).

GENERAL DISCUSSION

As suggested by the hermeneutic literature review (Chapter 5) and confirmed by the qualitative study (Chapter 6), a key ingredient for the success of LICs in the development of CR is the capacity

of LICs for strong relationships to develop, and it is the length of the relationships that allows the depth of these relationships to flourish. The most important relationships are between students and clinical preceptors; it is the clinical preceptors who are the essential link between students and their clinical learning environments. Through clinical supervisors, students get access to healthcare delivery teams (which are frequently multidisciplinary) and, in effect, become legitimate peripheral participants in and members of these teams. These strong relationships allow trust and entrustment to develop, and students become integral, active and agentic parts of the delivery of healthcare to patients rather being simply passive observers of this process.

The qualitative study (Chapter 6) clearly demonstrated that there are also opportunities for other relationships to develop. Students in LICs develop relationships with patients by seeing them over time, and this allows them to observe first-hand the contextual, social and economic effects of healthcare interventions. This longitudinal exposure also gives them good access to patients with chronic and complex health problems. Immersion of students in smaller communities gives them a good understanding of the unique issues around the delivery of healthcare to those communities, and thus an understanding of the context in which people in those communities live and work. This is important in the development in students of a more holistic approach to the delivery of healthcare.

There are multiple learning affordances that arise from these relationships. These include an apprenticeship-type model of learning, opportunities for parallel consulting, exposure to undifferentiated patients, exposure to a wide variety of clinical presentations, interleaved learning, increased levels of responsibility, and time for reflection.

These relationships, together with the learning affordances that arise, have multiple effects or outcomes. Students get regular and meaningful feedback from their clinical preceptors, which is vital to the development of CR. They become more agile and flexible thinkers, and they develop a sound capacity to deal with uncertainty. Their comfort zones are challenged, their boundaries stretched, and they experience lower extraneous cognitive load which allows them to focus on learning. They grow in confidence, their communication and clinical skills improve and develop, and they are exposed to enhanced encoding specificity. Their professional identities develop in a direction that is best placed for them to understand the context in which their patients live and work, and this enables them to deliver care that is tailored to the needs of individuals and communities, rather than diseases. All these aspects require students to use discovery, trial and

error, and exploring fuzzy boundaries on a continual basis. This is why trust, relationships, but also ample opportunities for this discovery, trial and error, and exploration are needed. From the perspective of the theoretical frameworks, including cognitive load theory, communities of practice theory and legitimate participation theory, the connection between the affordances of the learning context in LICs and the complex interactive nature of CR is obvious.

These factors combine in complex, adaptive, and non-linear ways to produce students, who by the end of the LIC, are competent clinical reasoners. This results in enhanced clinical decision-making and thus ultimately in better outcomes for patients.

IMPLICATIONS FOR MEDICAL EDUCATION AND FURTHER RESEARCH

A major priority of undergraduate medical education programs, irrespective of which pedagogical approach or model of education is used, is not just to produce junior doctors with a broad and sound base of knowledge and skills who are work-ready for internship, but also to produce doctors who have been given a sound preparation for meeting the complex healthcare needs of the members of the communities in which they work. Traditional approaches have typically provided students with contact with a larger number of specialist (often sub-specialist) clinicians, but relatively little contact with generalist clinicians. This gives them a narrower, more technical, disease-focussed view on how healthcare is delivered. A key feature of LIC models is the departure from student contact with a large number of specialists with a narrow content focus to a model where a smaller number of generalists provide training across a broader range of content (McLaughlin, et al. 2011).

Societal changes and changed patient expectations form another argument for changes to medical education. Medical care has evolved progressively over the past two decades from an inpatient hospital setting to a community one, and the training of medical students has followed (Ogrinc, Mutha, and Irby 2002). Thus, although the development of CR may be important for any healthcare related context, the development of agile, whole-patient narratives that include the patient's context in how a patient's care is managed, is even more important in a more generalist context. This connects the importance of the development of CR with other relevant outcomes of LIC programs.

A first that comes to mind is the type of professional identity that students develop during these programs. Emerging evidence shows that students in LIC programs emerge with some differences,

such as increases in empathy, sensitivity to healthcare inequities, and an ethic of caring (Huang and Malinow 2010; Konkin and Suddards 2012). A further intended outcome is for students to become more patient focussed instead of being disease focussed, as outlined above (Gaufberg, et al. 2014; Walters and Brooks 2016).

There is also a growing body of evidence that graduates who are exposed to LIC models during their undergraduate training, especially in rural settings, are more likely to make career choices to work in settings of workforce need (Roberts, et al. 2012; Playford, Ng, and Burkitt 2016; Weston, et al. 2018). Additionally, there is evidence to show that exposure to primary care during undergraduate training has a beneficial effect in making career choices in primary care, especially in the context of LICs (Amin, et al. 2018).

A further workforce benefit that has been proposed is that by providing medical education in areas of need, the youth living in these areas actually witness first-hand the training of young doctors, and this gives them the previously unrealised perception that there could be local educational opportunities for them (Figueiredo, et al. 2019; O'Sullivan and Chater 2019).

The LIC model was initially developed for medical student teaching in generalist rural settings. However, it has since been adapted for other settings such as urban areas and secondary and even tertiary hospital speciality localities (Heddle et al. 2014; Mahoney, Campbell, and Garner 2011). This shows that the benefits of LICs from an educational point of view are transferrable to contexts other than the remote and rural ones. This research on the development of CR as a consequence of the educational characteristics of LICs adds to this value and mounts an additional strong argument for the transfer of LIC-type education to more urban contexts.

There are several important implications that have emerged from this research for those considering the implementation of a new LIC program or for those reviewing an existing LIC program. It has showed how important relationships are for the success of student learning within LICs. Supervisors (or potential supervisors) need to be made aware of their vital role and should be brought in as partners in the medical school educational process (Pront, Gillham, and Schuwirth 2016). They need to be given information on how to guide students on the cognitive aspects of meaning-making from patient encounters as well as how to guide them through disorientating dilemmas, thus imparting wisdom on how to deal with uncertainty. Their role as mentors to and nurturers of students cannot be underestimated, and their development is thus paramount.

LICs, which have a strong work-based learning structure, and CR are both complex adaptive phenomena, and neither thus lend themselves to a standardised approach. Because of this, the best approach is one of bespoke and tailored supervision that adapts itself to the local situation and the needs of the individual student. Supervisors need specific guidance on this aspect.

Similarly, because of the complex adaptive nature of both LICs and CR, fairness in student learning and assessment should be tailored around equity rather than standardisation and equality, and supervisors also need guidance on this (Valentine et al. 2022; Valentine, et al. 2023). It means in practice that affordances provided to students by the LIC program are similar but not necessarily standardised or identical.

Given the complex adaptive nature of CR and thus the difficulty in defining, learning and assessing it, this raises the issue of how CR could better be assessed and measured. It is clear that linear causal views of CR, which are dependent on the assumption that it can be measured quantitatively, are completely unsatisfactory. The conclusion that must be drawn is that being a complex adaptive structure, the development of CR during LICs comes as a result of the interaction between student, clinical supervisor and clinical setting (the context), which is supported by the other affordances that LICs provide. It thus cannot be tested or measured with simple closed questions. Measuring CR in these circumstances should include the following characteristics:

- Instead of focussing on a single correct answer, assessing CR should focus on the student's ability to generate multiple plausible answers
- The recognition that fuzzy boundaries (the boundaries between acceptable and unacceptable problem-solving solutions and narratives) are possible and important
- The ability of the student to be able to recognise then a chosen narrative or problem-solving solution is not working and having the agility of thinking to change tack
- The ability of the student to be able to explain a particular problem from multiple perspectives, i.e. agility of narratives
- The ability of the student to understand the deep structure of a particular problem and to meaningfully link surface features with that deep structure
- The ability of the student to deal with uncertainty and with contextual variations.

Students may get anxious if learning and assessment opportunities are not standardised, so they also need specific guidance around this and reassurance that because learning experiences may

not be identical, this does not mean that one is inferior to the other. Supervisors also need to be made aware that this could be a concern on the part of students. Students should also be encouraged by preceptors and local staff to proactively seek out learning opportunities rather than expecting them to simply be provided to them.

LIMITATIONS OF THIS RESEARCH

Because this research was conducted on a single LIC only, its findings may be limited. By this I do not mean limited in generalisability as explained in the Introduction (Chapter 1), but there could be more factors or interactions within LICs that may not have been sufficiently clear in the context of this study. These factors could be more prominent in other societal or cultural contexts. However, because the underlying principles of LICs are similar worldwide, especially Type C (comprehensive) LICs according the typology classification of Worley, et al. (2016, the findings would most likely be generalisable more broadly.

It is important to keep in mind that this research has showed that the value of LICs regarding the development of CR is highly dependent on the interaction between the learner, their clinical supervisor/s, the patients who they see, and the healthcare context. How these interactions take place specifically is very much dependent on healthcare organisation, and societal and cultural norms. For example, sections of societies with a larger power differential and that are more hierarchical will require a different way for students to interact with their clinical supervisors and patients than settings with a lower power differential and which are less hierarchical.

This study has been performed from the perspective of certain theoretical frameworks, especially a complexity perspective. In medical education research, the purpose of theoretical frameworks and perspectives is to illuminate or magnify certain aspects of a phenomenon. This, inevitably, comes at the expense of other aspects. The most important thing that I have learned from this research is that CR is complex and multifaceted. It is important, therefore, to realise that in choosing certain theoretical frameworks and perspectives we automatically chose not to use others. It is thus possible that there are other ways in which LICs could further foster the development of CR. It is also possible that certain negative aspects of LICs regarding the development of CR have been under-examined in this study.

The two small quantitative studies in this thesis (Chapter 4) led to the conclusion that studying CR is best not approached from a quantitative, post-positivist perspective and I have used this as an

argument in favour of looking at CR as a complex interactive phenomenon. However, when studies producing negative findings conclude the absence of an effect, there will always be a concern that it is difficult to distinguish between the absence of an effect or the lack of sensitivity of the study to determine such an effect. In this case, I was forced to conclude that there was an absence of an effect in real data with a best-case approach. However, this does not mean that in other contexts, indications for a quantitative, post-positive approach to CR may not be found.

DIRECTIONS FOR FURTHER RESEARCH

There are several aspects on the development of CR during LICs which were beyond the scope of this study, and which could be studied further. These include (but are by no means limited to):

- A study to explore the link between the development of CR and the development of professionalism in medical students during LICs;
- A study looking at the relationship between CR and clinical decision-making, assuming that the former can be approached from a complexity perspective and the latter from a more linear dynamic perspective;
- Studies into the nature of the development of the learning relationships in the context of LICs, and the specific roles or role definitions of clinical supervisors;
- Studies into the nature of staff development for clinical supervisors to optimise the way in which they can take advantage of relationships with their students to promote the development of CR;
- A study to examine how the foundation in CR gained during LICs equips graduates for their junior doctor years and beyond.

FINAL CONCLUSIONS

This research fills an identified gap in the published literature on how and why LICs and the affordances that they provide contribute to the development of sound CR in medical students who are engaged in them. It found that LICs inherently have organistic, complex adaptive structure, and this has strong ontological parallels with the complex adaptive constructs of CR, and this could explain, at least in part, why LIC students develop good CR. However, LICs do more than promote the development of good CR – they also have the benefit of better preparing students to meet the

healthcare needs of contemporary society in all geographic settings, but especially those in settings of workforce need.

All these findings were derived and concluded from the information provided by the participants in the qualitative study. This understanding, garnered from those with first-hand knowledge and lived experience of the UOW LIC program (see Chapter 6), makes perfect sense when aligned with the understandings from the hermeneutic literature review (Chapter 5) and even the 'failed' quantitative studies (Chapter 4). When generalised to other LIC programs that subscribe to the same principles, the conclusion that can be drawn is that there is little doubt that the LIC programs are very successful in promoting the development of CR in students – a fundamental ability for all doctors to be able to practice medicine safely and effectively meet the needs of their patients.

BIBLIOGRAPHY

Ajjawi, Rola, and Joy Higgs. 2008. "Learning to Reason: A Journey of Professional Socialisation." *Advances in Health Sciences Education* 13, no. 2 (May): 133-150. https://dx.doi.org/10.1007/s10459-006-9032-4.

Al-Ababneh, MM. 2020. "Linking Ontology, Epistemology and Research Methodology." *Science & Philosophy* 8, no. 1: 75-91.

Alanazi, Ahmed. 2016. "A Critical Review of Constructuvist Theory and the Emergence of Constructionism." *American Research Journal of Humanities and Social Sciences* 2.

Allan, Rachel, and Sean McAleer. 2021. "Parallel Consulting Method: Student and Tutor Evaluation in General Practice." *Education for Primary Care* 32, no. 5 (Sep 3): 308-310. https://dx.doi.org/10.1080/14739879.2021.1908174.

Amin, Maslah, Shiv Chande, Sophie Park, Joe Rosenthal, and Melvyn Jones. 2018. "Do Primary Care Placements Influence Career Choice: What Is the Evidence?" *Education for Primary Care* 29, no. 2 (2018): 64-67. https://dx.doi.org/10.1080/14739879.2018.1427003.

Anakin, Megan, Madelyne Jouart, Julie Timmermans, and Ralph Pinnock. 2020. "Student Experiences of Learning Clinical Reasoning." *Clinical Teacher* 17, no. 1 (Feb): 52-57. https://dx.doi.org/10.1111/tct.13014.

APA. 2020. *American Psychological Association Dictionary of Psychology*.

Ark, T. K., L. R. Brooks, and K. W. Eva. 2006. "Giving Learners the Best of Both Worlds: Do Clinical Teachers Need to Guard against Teaching Pattern Recognition to Novices?" *Academic Medicine* 81, no. 4 (Apr): 405-409. https://dx.doi.org/10.1097/00001888-200604000-00017.

Ark, Tavinder K., Lee R. Brooks, and Kevin W. Eva. 2007. "The Benefits of Flexibility: The Pedagogical Value of Instructions to Adopt Multifaceted Diagnostic Reasoning Strategies." *Medical Education* 41, no. 3 (Mar): 281-287. https://dx.doi.org/10.1111/j.1365-2929.2007.02688.x.

Arksey, Hilary, and Lisa O'Malley. 2005. "Scoping Studies: Towards a Methodological Framework." *International Journal of Social Research Methodology* 8, no. 1 (Feb 2005): 19-32. https://dx.doi.org/10.1080/1364557032000119616.

Artemeva, Natasha, Christen Rachul, Bridget O'Brien, and Lara Varpio. 2017. "Situated Learning in Medical Education." *Academic Medicine* 92, no. 1 (Jan): 134-134. https://dx.doi.org/10.1097/acm.0000000000001495.

Arvanitis, Alexios, and Antonis Karampatzos. 2011. "Negotiation and Aristotle's Rhetoric: Truth over Interests?" *Philosophical Psychology* 24, no. 6 (2011): 845-860. https://dx.doi.org/10.1080/09515089.2011.569910.

Asgarova, Sevinj, Mark MacKenzie, and Joanna Bates. 2017. "Learning from Patients: Why Continuity Matters." *Academic Medicine* 92, no. 11 (Nov): S55-S60. https://dx.doi.org/10.1097/acm.0000000000001911.

Audetat, Marie-Claude, Suzanne Laurin, Valerie Dory, Bernard Charlin, and Mathieu R. Nendaz. 2017. "Diagnosis and Management of Clinical Reasoning Difficulties: Part I. Clinical Reasoning Supervision and Educational Diagnosis." *Medical Teacher* 39, no. 8 (2017): 792-796. https://dx.doi.org/10.1080/0142159x.2017.1331033.

Audetat, Marie-Claude, Stuart Lubarsky, Jean-Guy Blais, and Bernard Charlin. 2013. "Clinical Reasoning: Where Do We Stand on Identifying and Remediating Difficulties?" *Creative Education* 4, no. 6A: 42-48. https://dx.doi.org/10.4236/ce.2013.46A008.

Aukes, Leo C., Jelle Geertsma, Janke Cohen-Schotanus, Rein P. Zwierstra, and Joris P. J. Slaets. 2008. "The Effect of Enhanced Experiential Learning on the Personal Reflection of Undergraduate Medical Students." *Medical education online* 13 (2008 Nov): 15-15. https://dx.doi.org/10.3885/meo.2008.Res00279.

Azer, S. A., A. P. S. Guerrero, and A. Walsh. 2013. "Enhancing Learning Approaches: Practical Tips for Students and Teachers." *Medical Teacher* 35, no. 6: 433-443. https://dx.doi.org/10.3109/0142159x.2013.775413.

Baig, Lubna A., Claudio Violato, and Rodney A. Crutcher. 2009. "Assessing Clinical Communication Skills in Physicians: Are the Skills Context Specific or Generalizable." *BMC Medical Education* 9 (May 15). https://dx.doi.org/10.1186/1472-6920-9-22.

Balmer, Dorene F., Boyd F. Richards, and Lara Varpio. 2015. "How Students Experience and Navigate Transitions in Undergraduate Medical Education: An Application of Bourdieu's Theoretical Model." *Advances in Health Sciences Education* 20, no. 4 (Oct): 1073-1085. https://dx.doi.org/10.1007/s10459-015-9588-y.

Balslev, T., A. B. Rasmussen, T. Skajaa, J. P. Nielsen, A. Muijtjens, W. De Grave, and J. Van Merrienboer. 2015. "Combining Bimodal Presentation Schemes and Buzz Groups Improves Clinical Reasoning and Learning at Morning Report." *Medical Teacher* 37, no. 8: 759-766. https://dx.doi.org/10.3109/0142159x.2014.986445.

Banh, Kenny, Rene Ramirez, and Christina Thabit. 2014. "Effectiveness of Emergency Medicine in Longitudinal Integrated Clerkships." *Medical Education Online* 19 (2014). https://dx.doi.org/10.3402/meo.v19.25429.

Bansal, A., D. Singh, J. Thompson, A. Kumra, and B. Jackson. 2020. "Developing Medical Students' Broad Clinical Diagnostic Reasoning through Gp-Facilitated Teaching in Hospital Placements." *Advances in Medical Education and Practice* 11: 379-388. https://dx.doi.org/10.2147/amep.S243538.

Bartlett, Maggie, Eliot Lloyd Rees, and Robert K. McKinley. 2017. "'Knowledge Leech' to 'Part of the Team': Students' Learning in Rural Communities of Practice." *Education for Primary Care* 29, no. 1: 5-10. https://dx.doi.org/10.1080/14739879.2017.1362664.

Bell, Sigall K., Edward Krupat, Sara B. Fazio, David H. Roberts, and Richard M. Schwartzstein. 2008. "Longitudinal Pedagogy: A Successful Response to the Fragmentation of the Third-Year Medical Student Clerkship Experience." *Academic Medicine* 83, no. 5: 467-475. https://dx.doi.org/10.1097/ACM.0b013e31816bdad5.

Bergman, Esther, Jeantine de Feijter, Janneke Frambach, Merijn Godefrooij, Irene Slootweg, Renee Stalmeijer, and Jonne van der Zwet. 2012. "Am Last Page: A Guide to Research Paradigms Relevant to Medical Education." *Academic Medicine* 87, no. 4 (2012-Apr): 545-545. https://dx.doi.org/10.1097/ACM.0b013e31824fbc8a.

Billett, Stephen. 2001. "Learning through Work: Workplace Affordances and Individual Engagement." *Journal of Workplace Learning* 13, no. 5: 209-214.

Bing-You, Robert, Victoria Hayes, Tamara Palka, Marybeth Ford, and Robert Trowbridge. 2018. "The Art (and Artifice) of Seeking Feedback: Clerkship Students' Approaches to Asking for Feedback." *Academic Medicine* 93, no. 8 (Aug): 1218-1226. https://dx.doi.org/10.1097/acm.0000000000002256.

Bleakley, Alan, Richard Farrow, David Gould, and Robert Marshall. 2003. "Making Sense of Clinical Reasoning: Judgement and the Evidence of the Senses." *Medical Education* 37, no. 6: 544-552.

Bleiker, J., S. Morgan-Trimmer, K. Knapp, and S. Hopkins. 2019. "Navigating the Maze: Qualitative Research Methodologies and Their Philosophical Foundations." *Radiography* 25 (Oct): S4-S8. https://dx.doi.org/10.1016/j.radi.2019.06.008.

Boell, Sebastian K., and Dubravka Cecez-Kecmanovic. 2010. "Literature Reviews and the Hermeneutic Circle." *Australian Academic & Research Libraries* 41, no. 2 (Jun): 129-144. https://dx.doi.org/10.1080/00048623.2010.10721450.

---. 2014. "A Hermeneutic Approach for Conducting Literature Reviews and Literature Searches." *Communications of the Association for Information Systems* 34: 257-286.

Bonney, A., G. Albert, J. N. Hudson, and P. Knight-Billington. 2014. "Factors Affecting Medical Students' Sense of Belonging in a Longitudinal Integrated Clerkship." *Australian Family Physician* 43, no. 1-2 (Jan-Feb): 53-57. <Go to ISI>://WOS:000343947600014.

Bordage, G. 1994. "Elaborated Knowledge: A Key to Successful Diagnostic Thinking." *Academic Medicine* 69, no. 11 (Nov): 883-885. https://dx.doi.org/10.1097/00001888-199411000-00004.

Bordage, G., K. J. Connell, R. W. Chang, M. R. Gecht, and J. M. Sinacore. 1997. "Assessing the Semantic Content of Clinical Case Presentations: Studies of Reliability and Concurrent Validity." *Academic Medicine* 72, no. 10 (Oct): S37-S39. https://dx.doi.org/10.1097/00001888-199710001-00013.

Bordage, G., and M. Lemieux. 1991. "Semantic Structures and Diagnostic Thinking of Experts and Novices." *Academic Medicine* 66, no. 9 (Sep): S70-S72. https://dx.doi.org/10.1097/00001888-199109000-00045.

Bordage, Georges. 2007. "Moving the Field Forward: Going Beyond Quantitative-Qualitative." *Academic Medicine* 82, no. 10 (Oct): S126-S128. https://dx.doi.org/10.1097/ACM.0b013e31813e661d.

Boshuizen, H. P. A., and H. G. Schmidt. 1992. "On the Role of Biomedical Knowledge in Clinical Reasoning by Experts, Intermediates and Novices." *Cognitive Science* 16, no. 2 (Apr-Jun): 153-184. https://dx.doi.org/10.1207/s15516709cog1602_1.

Bowen, Judith L. 2006. "Educational Strategies to Promote Clinical Diagnostic Reasoning." *New England Journal of Medicine* 355, no. 21 (Nov 23): 2217-2225.

Boyle, James G., Matthew R. Walters, Susan Jamieson, and Steven J. Durning. 2020. "Clinical Reasoning in the Wild: Premature Closure During the Covid-19 Pandemic." *Diagnosis* 7, no. 3 (Sep): 177-179. https://dx.doi.org/10.1515/dx-2020-0061.

Braude, Hillel D. 2012. "Conciliating Cognition and Consciousness: The Perceptual Foundations of Clinical Reasoning." *Journal of Evaluation in Clinical Practice* 18, no. 5 (Oct): 945-950. https://dx.doi.org/10.1111/j.1365-2753.2012.01898.x.

Braun, Virginia, and Victoria Clarke. 2019. "Reflecting on Reflexive Thematic Analysis." *Qualitative Research in Sport Exercise and Health* 11, no. 4 (2019): 589-597. https://dx.doi.org/10.1080/2159676x.2019.1628806.

---. 2021. "To Saturate or Not to Saturate? Questioning Data Saturation as a Useful Concept for Thematic Analysis and Sample-Size Rationales." *Qualitative Research in Sport Exercise and Health* 13, no. 2 (Mar 4): 201-216. https://dx.doi.org/10.1080/2159676x.2019.1704846.

Brown, Megan E. L., Paul Whybrow, Gavin Kirwan, and Gabrielle M. Finn. 2021. "Professional Identity Formation within Longitudinal Integrated Clerkships: A Scoping Review." *Medical Education* 55, no. 8 (Aug): 912-924. https://dx.doi.org/10.1111/medu.14461.

Bunniss, Suzanne, and Diane R. Kelly. 2010. "Research Paradigms in Medical Education Research." *Medical Education* 44, no. 4 (Apr): 358-366. https://dx.doi.org/10.1111/j.1365-2923.2009.03611.x.

Calder, Lisa A., Alan J. Forster, Ian G. Stiell, Laura K. Carr, Jamie C. Brehaut, Jeffrey J. Perry, Christian Vaillancourt, and Patrick Croskerry. 2012. "Experiential and Rational Decision Making: A Survey to Determine How Emergency Physicians Make Clinical Decisions." *Emergency Medicine Journal* 29, no. 10 (Oct): 811-816. https://dx.doi.org/10.1136/emermed-2011-200468.

Campbell, David G., Matthew R. McGrail, Belinda O'Sullivan, and Deborah J. Russell. 2019. "Outcomes of a 1-Year Longitudinal Integrated Medical Clerkship in Small Rural Victorian Communities." *Rural and Remote Health* 19, no. 2. https://dx.doi.org/10.22605/rrh4987.

Campbell, David, Lucie Walters, Ian Couper, and Jane Greacen. 2017. "What Are They Thinking? Facilitating Clinical Reasoning through Longitudinal Patient Exposure in Rural Practice." *Rural and Remote Health* 17, no. 4. https://dx.doi.org/10.22605/RRH4162.

Capaldi, Vincent F., Steven J. Durning, Louis N. Pangaro, and Rosalie Ber. 2015. "The Clinical Integrative Puzzle for Teaching and Assessing Clinical Reasoning: Preliminary Feasibility, Reliability, and Validity Evidence." *Military Medicine* 180, no. 4 (April): 54-60. https://dx.doi.org/10.7205/milmed-d-14-00564.

Chamberland, M., S. Mamede, C. St-Onge, J. Setrakian, and H. G. Schmidt. 2015. "Does Medical Students' Diagnostic Performance Improve by Observing Examples of Self-Explanation Provided by Peers or Experts?" *Advances in Health Sciences Education* 20, no. 4 (Oct): 981-993. https://dx.doi.org/10.1007/s10459-014-9576-7.

Chamberland, Martine, Silvia Mamede, Linda Bergeron, and Lara Varpio. 2021. "A Layered Analysis of Self-Explanation and Structured Reflection to Support Clinical Reasoning in Medical Students." *Perspectives on Medical Education* 10, no. 3 (Jun): 171-179. https://dx.doi.org/10.1007/s40037-020-00603-2.

Chang, Hyung-Joo, June Kang, Byung-Joo Ham, and Young-Mee Lee. 2016. "A Functional Neuroimaging Study of the Clinical Reasoning of Medical Students." *Advances in Health Sciences Education* 21, no. 5 (Dec): 969-982. https://dx.doi.org/10.1007/s10459-016-9685-6.

Chang, R. W., G. Bordage, and K. J. Connell. 1998. "The Importance of Early Problem Representation During Case Presentations." *Academic Medicine* 73, no. 10 (Oct): S109-S111. https://dx.doi.org/10.1097/00001888-199810000-00062.

Charlin, B. D., J. Tardif, and H. P. A. Boshuizen. 2000. "Scripts and Medical Diagnostic Knowledge: Theory and Applications for Clinical Reasoning Instruction and Research." *Academic Medicine* 75, no. 2 (Feb): 182-190. https://dx.doi.org/10.1097/00001888-200002000-00020.

Charlin, Bernard, Henny P. A. Boshuizen, Eugene J. Custers, and Paul J. Feltovich. 2007. "Scripts and Clinical Reasoning." *Medical Education* 41, no. 12 (Dec): 1178-1184. https://dx.doi.org/10.1111/j.1365-2923.2007.02924.x.

Charlin, Bernard, Marie-France Deschenes, and Nicolas Fernandez. 2021. "Learning by Concordance (Lbc) to Develop Professional Reasoning Skills: Amee Guide No. 141." *Medical Teacher* 43, no. 6 (Jun 3): 614-621. https://dx.doi.org/10.1080/0142159x.2021.1900554.

Charlin, Bernard, Stuart Lubarsky, Bernard Millette, Francoise Crevier, Marie-Claude Audetat, Anne Charbonneau, Nathalie Caire Fon, Lea Hoff, and Christian Bourdy. 2012. "Clinical Reasoning Processes: Unravelling Complexity through Graphical Representation." *Medical Education* 46, no. 5 (May): 454-463. https://dx.doi.org/10.1111/j.1365-2923.2012.04242.x.

Chiu, YiChing Jean, and John Cowan. 2012. "Helping Eastern Students to Master Western Critical Thinking." *Asia Pacific Education Review* 13, no. 1 (Mar): 103-111. https://dx.doi.org/10.1007/s12564-011-9189-2.

Christakis, D. A., and C. Feudtner. 1997. "The Ethical Consequences of Transient Social Relationships in Medical Training." *JAMA-Journal of the American Medical Association* 278, no. 9 (Sep 3): 739-743. https://dx.doi.org/10.1001/jama.278.9.739.

Christie, Michael, Michael Carey, Ann Robertson, and Peter Grainger. 2015. "Putting Transformative Learning Theory into Practice." *Australian Journal of Adult Learning* 55, no. 1 (Apr): 9-30.

Clardy, P. F., and R. M. Schwartzstein. 2015. "Considering Cognition: Current Challenges and Future Directions in Pulmonary and Critical Care Fellowship Training." *Annals of the American Thoracic Society* 12, no. 4: 474-479.

Cleary, Timothy J., Alexis Battista, Abigail Konopasky, Divya Ramani, Steven J. Durning, and Anthony R. Artino, Jr. 2020. "Effects of Live and Video Simulation on Clinical Reasoning Performance and Reflection." *Advances in Simulation* 5, no. 17. https://dx.doi.org/10.1186/s41077-020-00133-1.

Cleland, Jennifer, Laura J. Gates, Gordon D. Waiter, Vincent B. Ho, Lambert Schuwirth, and Steven Durning. 2021. "Even a Little Sleepiness Influences Neural Activation and Clinical Reasoning in Novices." *Health Science Reports* 4, no. 4 (Dec). https://dx.doi.org/10.1002/hsr2.406.

Collins, Allan, John Seely Brown, and Ann Holum. 1991. "Cognitive Apprenticeship: Making Thinking Visible." *American Educator* 15, no. 3.

Connor, Denise M., Steven J. Durning, and Joseph J. Rencic. 2020. "Clinical Reasoning as a Core Competency." *Academic Medicine* 95, no. 8 (Aug): 1166-1171. https://dx.doi.org/10.1097/acm.0000000000003027.

Connors, G. R., and J. M. Siner. 2015. "Clinical Reasoning and Risk in the Intensive Care Unit." *Clinics in Chest Medicine* 36, no. 3 (Sep): 449-459. https://dx.doi.org/10.1016/j.ccm.2015.05.016.

Cook, David A., Jonathan Sherbino, and Steven J. Durning. 2018. "Management Reasoning: Beyond the Diagnosis." *JAMA-Journal of the American Medical Association* 319, no. 22 (Jun 12): 2267-2268. https://dx.doi.org/10.1001/jama.2018.4385.

Cooper, Nicola, Maggie Bartlett, Simon Gay, Anna Hammond, Mark Lillicrap, Joanna Matthan, Mini Singh, and U. K. Clinical Reasoning In Med Edu. 2021. "Consensus Statement on the Content of Clinical Reasoning Curricula in Undergraduate Medical Education." *Medical Teacher* 43, no. 2 (Feb 1): 152-159. https://dx.doi.org/10.1080/0142159x.2020.1842343.

Couper, I., P. S. Worley, and R. Strasser. 2011. "Rural Longitudinal Integrated Clerkships: Lessons from Two Programs on Different Continents." *Rural and Remote Health* 11, no. 1 (Jan-Mar). <Go to ISI>://WOS:000296910400003.

Crebbin, W., S. W. Beasley, and D. A. Watters. 2013. "Clinical Decision Making: How Surgeons Do It." *ANZ Journal of Surgery* 83, no. 6: 422-428.

Cristancho, Sayra, Emily Field, and Lorelei Lingard. 2019. "What Is the State of Complexity Science in Medical Education Research?" *Medical Education* 53, no. 1 (Jan): 95-104. https://dx.doi.org/10.1111/medu.13651.

Croskerry, Pat. 2009a. "Clinical Cognition and Diagnostic Error: Applications of a Dual Process Model of Reasoning." *Advances in Health Sciences Education* 14 (Sep): 27-35. https://dx.doi.org/10.1007/s10459-009-9182-2.

---. 2009b. "A Universal Model of Diagnostic Reasoning." *Academic Medicine* 84, no. 8 (Aug): 1022-1028. https://dx.doi.org/10.1097/ACM.0b013e3181ace703.

Croskerry, Pat, and Geoff Norman. 2008. "Overconfidence in Clinical Decision Making." *American Journal of Medicine* 121, no. 5 (May): 24-29. https://dx.doi.org/10.1016/j.amjmed.2008.02.001.

Croskerry, Pat, David A. Petrie, James B. Reilly, and Gordon Tait. 2014. "Deciding About Fast and Slow Decisions." *Academic Medicine* 89, no. 2 (Feb): 197-200. https://dx.doi.org/10.1097/acm.0000000000000121.

Crotty, M. 2020. *The Foundations of Social Research* London and New York: Routledge. 1998.

Cruess, Richard L., Sylvia R. Cruess, and Yvonne Steinert. 2018. "Medicine as a Community of Practice: Implications for Medical Education." *Academic Medicine* 93, no. 2 (Feb): 185-191. https://dx.doi.org/10.1097/acm.0000000000001826.

Daly, Michele, David Perkins, Koshila Kumar, Chris Roberts, and Malcolm Moore. 2013a. "What Factors in Rural and Remote Extended Clinical Placements May Contribute to Preparedness for Practice from the Perspective of Students and Clinicians?" *Medical Teacher* 35, no. 11 (2013): 900-907. https://dx.doi.org/10.3109/0142159x.2013.820274.

Daly, Michele, Chris Roberts, Koshila Kumar, and David Perkins. 2013b. "Longitudinal Integrated Rural Placements: A Social Learning Systems Perspective." *Medical Education* 47, no. 4 (Apr): 352-361. https://dx.doi.org/10.1111/medu.12097.

Daniel, Michelle, Joseph Rencic, Steven J. Durning, Eric Holmboe, Sally A. Santen, Valerie Lang, Temple Ratcliffe, David Gordon, Brian Heist, Stuart Lubarsky, Carlos A. Estrada, Tiffany Ballard, Anthony R. Artino Jr, Ana Sergio Da Silva, Timothy Cleary, Jennifer Stojan, and Larry D. Gruppen. 2019. "Clinical Reasoning Assessment Methods: A Scoping Review and Practical Guidance." *Academic Medicine* 94, no. 6 (Jun): 902-912. https://dx.doi.org/10.1097/acm.0000000000002618.

Debue, Nicolas, and Cecile van de Leemput. 2014. "What Does Germane Load Mean? An Empirical Contribution to the Cognitive Load Theory." *Frontiers in Psychology* 5: 1-12. https://dx.doi.org/10.3389/psyg.2014.01099.

Delavari, Somayeh, Alireza Monajemi, Hamid Reza Baradan, Phyo Kyaw Myint, Minoo Yaghmaei, and Seyed Kamran Soltani Arabshahi. 2020. "How to Develop Clinical Reasoning in Medical Students and Interns Based on Illness Script Theory: An Experimental Study." *Medical journal of the Islamic Republic of Iran* 34, no. 9 (20 Feb). https://dx.doi.org/10.34171/mjiri.34.9.

Dong, Hongmei, Jonathan Lio, Renslow Sherer, and Ivy Jiang. 2021. "Some Learning Theories for Medical Educators." *Medical Science Educator* 31, no. 3 (Jun): 1157-1172. https://dx.doi.org/10.1007/s40670-021-01270-6.

Dong, T., S. J. Durning, A. R. Artino, C. van der Vleuten, E. Holmboe, R. Lipner, and L. Schuwirth. 2015. "Dual Process Theory and Intermediate Effect: Are Faculty and Residents' Performance on Multiple-Choice, Licensing Exam Questions Different?" *Military Medicine* 180, no. 4 (Apr): 92-96. https://dx.doi.org/10.7205/milmed-d-14-00555.

Ducos, G., C. Lejus, F. Sztark, N. Nathan, O. Fourcade, I. Tack, K. Asehnoune, M. Kurrek, B. Charlin, and V. Minville. 2015. "The Script Concordance Test in Anesthesiology: Validation of a New Tool for Assessing Clinical Reasoning." *Anaesthesia, Critical Care & Pain Medicine* 34, no. 1: 11-15.

Durning, S., A. R. Artino, Jr., L. Pangaro, C. P. van der Vleuten, and L. Schuwirth. 2011. "Context and Clinical Reasoning: Understanding the Perspective of the Expert's Voice." *Medical Education* 45, no. 9: 927-938.

Durning, S. J., A. Artino, J. Boulet, J. La Rochelle, C. Van der Vleuten, B. Arze, and L. Schuwirth. 2012a. "The Feasibility, Reliability, and Validity of a Post-Encounter Form for Evaluating Clinical Reasoning." *Medical Teacher* 34, no. 1: 30-37. https://dx.doi.org/10.3109/0142159x.2011.590557.

Durning, S. J., A. R. Artino, J. R. Boulet, K. Dorrance, C. van der Vleuten, and L. Schuwirth. 2012b. "The Impact of Selected Contextual Factors on Experts' Clinical Reasoning Performance (Does Context Impact Clinical Reasoning Performance in Experts?)." *Advances in Health Sciences Education* 17, no. 1: 65-79.

Durning, S. J., A. R. Artino, Jr., L. Schuwirth, and C. van der Vleuten. 2013a. "Clarifying Assumptions to Enhance Our Understanding and Assessment of Clinical Reasoning." *Academic Medicine* 88, no. 4: 442-448. https://dx.doi.org/10.1097/ACM.0b013e3182851b5b.

Durning, S. J., M. Costanzo, A. R. Artino, Jr., C. van der Vleuten, T. J. Beckman, E. Holmboe, M. J. Roy, and L. Schuwirth. 2014. "Using Functional Magnetic Resonance Imaging to Improve How We Understand, Teach, and Assess Clinical Reasoning." *Journal of Continuing Education in the Health Professions* 34, no. 1: 76-82.

Durning, S. J., M. E. Costanzo, A. R. Artino, J. Graner, C. van der Vleuten, T. J. Beckman, C. M. Wittich, M. J. Roy, E. S. Holmboe, and L. Schuwirth. 2015a. "Neural Basis of Nonanalytical Reasoning Expertise During Clinical Evaluation." *Brain and Behavior* 5, no. 3: e00309.

Durning, S. J., W. Kelly, M. E. Costanzo, A. R. Artino, C. van der Vleuten, T. J. Beckman, M. J. Roy, E. S. Holmboe, C. M. Wittich, and L. Schuwirth. 2015b. "Relationship of Neuroimaging to Typical Sleep Times During a Clinical Reasoning Task: A Pilot Study." *Military Medicine* 180, no. 4 (Apr): 129-135. https://dx.doi.org/10.7205/milmed-d-14-00572.

Durning, S. J., T. Ratcliffe, A. R. Artino, Jr., C. van der Vleuten, T. J. Beckman, E. Holmboe, R. S. Lipner, and L. Schuwirth. 2013b. "How Is Clinical Reasoning Developed, Maintained, and Objectively Assessed? Views from Expert Internists and Internal Medicine Interns." *Journal of Continuing Education in the Health Professions* 33, no. 4 (Fall): 215-223. https://dx.doi.org/10.1002/chp.21188.

Durning, Steven J., Michelle E. Costanzo, Thomas J. Beckman, Anthony R. Artino, Jr., Michael J. Roy, Cees van der Vleuten, Eric S. Holmboe, Rebecca S. Lipner, and Lambert Schuwirth. 2016. "Functional Neuroimaging Correlates of Thinking Flexibility and Knowledge Structure in Memory: Exploring the Relationships between Clinical Reasoning and Diagnostic Thinking." *Medical Teacher* 38, no. 6 (Jun): 570-577. https://dx.doi.org/10.3109/0142159x.2015.1047755.

Durning, Steven J., Robert L. Trowbridge, and Lambert Schuwirth. 2020. "Clinical Reasoning and Diagnostic Error: A Call to Merge Two Worlds to Improve Patient Care." *Academic Medicine* 95, no. 8 (Aug): 1159-1161. https://dx.doi.org/10.1097/acm.0000000000003041.

Dwyer, Christopher P., Michael J. Hogan, Owen M. Harney, and John O'Reilly. 2014. "Using Interactive Management to Facilitate a Student-Centred Conceptualisation of Critical Thinking: A Case Study." *Educational Technology Research and Development* 62, no. 6 (Dec): 687-709. https://dx.doi.org/10.1007/s11423-014-9360-7.

Efklides, Anastasia. 2014. "How Does Metacognition Contribute to the Regulation of Learning? An Integrative Approach." *Psychological Topics* 23, no. 1: 1-30.

Eley, D. S., R. Synnott, P. G. Baker, and A. B. Chater. 2012. "A Decade of Australian Rural Clinical School Graduates - Where Are They and Why?" *Rural and Remote Health* 12, no. 1 (Jan-Mar).

Ellaway, Rachel H. 2016. "Ideology and Health Professional Education Scholarship." *Advances in Health Sciences Education* 21, no. 3 (Aug): 501-503. https://dx.doi.org/10.1007/s10459-016-9684-7.

---. 2017. "Moral Agency and the Medical Education Researcher." *Medical Education* 51, no. 1 (Jan): 3-5. https://dx.doi.org/10.1111/medu.12924.

---. 2020. "Postmodernism and Medical Education." *Academic Medicine* 95, no. 6 (Jun): 856-859. https://dx.doi.org/10.1097/acm.0000000000003136.

Ellaway, Rachel H., Lisa Graves, and Beth-Ann Cummings. 2016. "Dimensions of Integration, Continuity and Longitudinality in Clinical Clerkships." *Medical Education* 50, no. 9 (Sep): 912-921. https://dx.doi.org/10.1111/medu.13038.

Ellaway, Rachel H., Amalia Kehoe, and Jan Illing. 2020. "Critical Realism and Realist Enquiry in Medical Education." *Academic Medicine* 95, no. 7: 984-988. https://dx.doi.org/10.1097/ACM.0000000000003232.

Elstein, A. S., L. S. Shulman, and S. A. Sprafka. 1978. *Medical Problem Solving: An Analysis of Clinical Reasoning*. Cambridge, MA.: Harvard University Press.

Epstein, R. M. 2013. "Whole Mind and Shared Mind in Clinical Decision-Making." *Patient Education and Counseling* 90, no. 2 (Feb): 200-206. https://dx.doi.org/10.1016/j.pec.2012.06.035.

Ericsson, K. Anders. 2007. "An Expert-Performance Perspective of Research on Medical Expertise: The Study of Clinical Performance." *Medical Education* 41, no. 12 (Dec): 1124-1130. https://dx.doi.org/10.1111/j.1365-2923.2007.02946.x.

Eva, K. W. 2003. "On the Generality of Specificity." *Medical Education* 37, no. 7 (Jul): 587-588. https://dx.doi.org/10.1046/j.1365-2923.2003.01563.x.

Eva, K. W., J. P. W. Cunnington, H. I. Reiter, D. R. Keane, and G. R. Norman. 2004. "How Can I Know What I Don't Know? Poor Self Assessment in a Well-Defined Domain." *Advances in Health Sciences Education* 9, no. 3 (2004): 211-224. https://dx.doi.org/10.1023/B:AHSE.0000038209.65714.d4.

Eva, K. W., T. J. Wood, J. Riddle, C. Touchie, and G. Bordage. 2010. "How Clinical Features Are Presented Matters to Weaker Diagnosticians." *Medical Education* 44, no. 8 (Aug): 775-785. https://dx.doi.org/10.1111/j.1365-2923.2010.03705.x.

Eva, Kevin W. 2005. "What Every Teacher Needs to Know About Clinical Reasoning." *Medical Education* 39, no. 1: 98-106.

Facione, N. C., and P. A. Facione. 2008. "Critical Thinking and Clinical Judgement." In *Critical Thinking and Clinical Reasoning in the Health Sciences*. Millbrae, California: Insight Assessment/The California Academic Press.

Facione, P. A. 2000. "The Disposition Towards Critical Thinking: Its Character, Measurement, and Relationship to Critical Thinking Skill." *Informal Logic* 20, no. 1: 61-84.

Facione, P. A., and N. C. Facione. 2013. "Critical Thinking for Life: Valuing, Measuring, and Training Critical Thinking in All Its Forms." *Inquiry Critical Thinking Across the Disciplines* 28, no. 1: 5-25. https://dx.doi.org/10.5840/Inquiryct20132812.

Fenwick, Tara, and Graham R. Nimmo. 2015. "Making Visible What Matters: Sociomaterial Approaches for Research and Practice in Healthcare Education." In *Researching Medical Education*, edited by Jennifer Cleland and Steven J. Durning. West Sussex, United Kingdon: Wiley Blackwell.

Figueiredo, Alexandre Medeiros, Danette Waller McKinley, Kenio Costa Lima, and George Dantas Azeyedo. 2019. "Medical School Expansion Policies: Educational Access and Physician Distribution." *Medical Education* 53, no. 11 (Nov): 1121-1131. https://dx.doi.org/10.1111/medu.13941.

Flavell, John H. 1979. "Metacognition and Cognitive Monitoring: A New Area of Cognitive-Developmental Inquiry." *American Psychologist* 34, no. 10: 906-911.

Franz, Timothy. 2018. "Hawthorne Effect." In *The Sage Encyclopedia of Educational Research, Measurement, and Evaluation*, edited by Bruce B. Frey, 767-769: SAGE Publications.

Fuller, Lara, Mary Lawson, and Jessica Beattie. 2021. "The Impact of Clerkship Model and Clinical Setting on Medical Student's Participation in the Clinical Workplace: A Comparison of Rural Lic and Rural Block Rotation Experience." *Medical Teacher* 43, no. 3 (Mar 4): 307-313. https://dx.doi.org/10.1080/0142159x.2020.1839032.

Gammon, Copelan, and Marc H. Bornstein. 2018. "John Henry Effect." In *The Sage Encyclopedia of Educational Research, Measurement, and Evaluation*, edited by Bruce B. Frey, 909-912: SAGE Publications.

Gaufberg, Elizabeth, David Hirsh, Edward Krupat, Barbara Ogur, Stephen Pelletier, Deborah Reiff, and David Bor. 2014. "Into the Future: Patient-Centredness Endures in Longitudinal Integrated Clerkship Graduates." *Medical Education* 48, no. 6 (Jun): 572-582. https://dx.doi.org/10.1111/medu.12413.

Gee, Waverley, Megan Anakin, and Ralph Pinnock. 2017. "Using Theory to Interpret How Senior Clinicians Define, Learn, and Teach Clinical Reasoning." *MedEdPublish*. https://dx.doi.org/10.15694/mep.2017.000182.

Ghafouri, H. B., F. Shokraneh, H. Saidi, and A. Jokar. 2012. "How Do Iranian Emergency Doctors Decide? Clinical Decision Making Processes in Practice." *Emergency Medicine Journal* 29, no. 5: 394-398.

Gibbs, T., S. Durning, and C. Van der Vleuten. 2011. "Theories in Medical Education: Towards Creating a Union between Educational Practice and Research Traditions." *Medical Teacher* 33, no. 3: 183-187. https://dx.doi.org/10.3109/0142159x.2011.551680.

Girotti, Jorge A., Gary L. Loy, Joanna L. Michel, and Vida A. Henderson. 2015. "The Urban Medicine Program: Developing Physician-Leaders to Serve Underserved Urban Communities." *Academic Medicine* 90, no. 12 (Dec): 1658-1666. https://dx.doi.org/10.1097/acm.0000000000000970.

Graham, Blair, Hadir Elbeltagi, Pam Nelmes, Annie Jenkin, and Jason E. Smith. 2019. "What Difference Can a Year Make? Findings from a Survey Exploring Student, Alumni and Supervisor Experiences of an Intercalated Degree in Emergency Care." *BMC Medical Education* 19, no. 1: 188-188. https://dx.doi.org/10.1186/s12909-019-1579-x.

Greenhalgh, Trisha, Christine A'Court, and Sara Shaw. 2017. "Understanding Heart Failure: Explaining Telehealth - a Hermeneutic Systematic Review." *BMC Cardiovascular Disorders* 17 (Jun 14). https://dx.doi.org/10.1186/s12872-017-0594-2.

Greenhill, Jenenne, Janet Noreen Richards, Sarah Mahoney, Narelle Campbell, and Lucie Walters. 2018. "Transformative Learning in Medical Education: Context Matters, a South Australian Longitudinal Study." *Journal of Transformative Education* 16, no. 1 (Jan): 58-75. https://dx.doi.org/10.1177/1541344617715710.

Greenhill, Jennene, and Ann N. Poncelet. 2013. "Transformative Learning through Longitudinal Integrated Clerkships." *Medical Education* 47, no. 4 (Apr): 336-339. https://dx.doi.org/10.1111/medu.12139.

Greenhill, Jennene, and Lucie Walters. 2014. "Longitudinal Integrated Clerkships." *Academic Medicine* 89, no. 3 (2014-Mar): 526. https://dx.doi.org/10.1097/acm.0000000000000160.

Gruppen, Larry D. 2017. "Clinical Reasoning: Defining It, Teaching It, Assessing It, Studying It." *The Western Journal of Emergency Medicine* 18, no. 1 (2017-Jan): 4-7. https://dx.doi.org/10.5811/westjem.2016.11.33191.

Guerrasio, J., and E. M. Aagaard. 2014. "Methods and Outcomes for the Remediation of Clinical Reasoning." *Journal of General Internal Medicine* 29, no. 12 (Dec): 1607-1614. https://dx.doi.org/10.1007/s11606-014-2955-1.

Guest, Greg, Arwen Bunce, and Laura Johnson. 2006. "How Many Interviews Are Enough? An Experiment with Data Saturation and Variability." *Field Methods* 18, no. 1 (Feb): 59-82. https://dx.doi.org/10.1177/1525822x05279903.

Gupta, Mona, and Ross Upshur. 2012. "Critical Thinking in Clinical Medicine: What Is It?" *Journal of Evaluation in Clinical Practice* 18, no. 5 (Oct): 938-944. https://dx.doi.org/10.1111/j.1365-2753.2012.01897.x.

Hale, Andrew J., Daniel N. Ricotta, Jason Freed, C. Christopher Smith, and Grace C. Huang. 2019. "Adapting Maslow's Hierarchy of Needs as a Framework for Resident Wellness." *Teaching and Learning in Medicine* 31, no. 1 (Jan 1): 109-118. https://dx.doi.org/10.1080/10401334.2018.1456928.

Hamwey, Meghan, Louise Allen, Margaret Hay, and Lara Varpio. 2019. "Bronfenbrenner's Bioecological Model of Human Development: Applications for Health Professions Education." *Academic Medicine* 94, no. 10 (Oct): 1621-1621. https://dx.doi.org/10.1097/acm.0000000000002822.

Han, H., N. K. Roberts, and R. Korte. 2015. "Learning in the Real Place: Medical Students' Learning and Socialization in Clerkships at One Medical School." *Academic Medicine* 90, no. 2: 231-239. https://dx.doi.org/10.1097/ACM.0000000000000544.

Hansen, Lori, and Edward Simanton. 2009. "Comparison of Third-Year Student Performance in a Twelve-Month Longitudinal Ambulatory Program with Performance in Traditional Clerkship Curriculum." *South Dakota Medicine: The Journal of the South Dakota State Medical Association* 62, no. 8 (Aug): 315-317.

Harland, Tony. 2003. "Vygotsky's Zone of Proximal Development and Problem-Based Learning: Linking a Theoretical Concept with Practice through Action Research." *Teaching in Higher Education* 8, no. 2: 263-272. https://dx.doi.org/10.1080/1356251030000052483.

Hatala, R. M., L. R. Brooks, and G. R. Norman. 2003. "Practice Makes Perfect: The Critical Role of Mixed Practice in the Acquisition of Ecg Interpretation Skills." *Advances in Health Sciences Education* 8, no. 1: 17-26. https://dx.doi.org/10.1023/a:1022687404380.

Hathcoat, JD, C Meixner, and MC Nicholas. 2019. "Ontology and Epistemology." In *Handbook of Research Methods in Health Social Sciences*, edited by P Liamputtong. Singapore: Springer Nature.

Hauer, K. E., L. Mazotti, B. O'Brien, P. A. Hemmer, and L. Tong. 2011. "Faculty Verbal Evaluations Reveal Strategies Used to Promote Medical Student Performance." *Medical Education Online* 16. https://dx.doi.org/10.3402/meo.v16i0.6354.

Hauer, Karen E., David Hirsh, Iris Ma, Lori Hansen, Barbara Ogur, Ann N. Poncelet, Erik K. Alexander, and Bridget C. O'Brien. 2012a. "The Role of Role: Learning in Longitudinal Integrated and Traditional Block Clerkships." *Medical Education* 46, no. 7 (Jul): 698-710. https://dx.doi.org/10.1111/j.1365-2923.2012.04285.x.

Hauer, Karen E., Bridget C. O'Brien, Lori A. Hansen, David Hirsh, Iris H. Ma, Barbara Ogur, Ann N. Poncelet, Erik K. Alexander, and Arianne Teherani. 2012b. "More Is Better: Students Describe Successful and Unsuccessful Experiences with Teachers Differently in Brief and Longitudinal Relationships." *Academic Medicine* 87, no. 10 (Oct): 1389-1396. https://dx.doi.org/10.1097/ACM.0b013e31826743c3.

Hauer, Karen E., Olle ten Cate, Christy Boscardin, David M. Irby, William Iobst, and Patricia S. O'Sullivan. 2014. "Understanding Trust as an Essential Element of Trainee Supervision and Learning in the Workplace." *Advances in Health Sciences Education* 19, no. 3 (Aug): 435-456. https://dx.doi.org/10.1007/s10459-013-9474-4.

Hay, Colin. 2016. "Good in a Crisis: The Ontological Institutionalism of Social Constructivism." *New Political Economy* 21, no. 6 (Dec): 520-535. https://dx.doi.org/10.1080/13563467.2016.1158800.

Heddle, William, Gayle Roberton, Sarah Mahoney, Lucie Walters, Sarah Strasser, and Paul Worley. 2014. "Challenges in Transformation of the 'Traditional Block Rotation' Medical Student Clinical Education into a Longitudinal Integrated Clerkship Model." *Education for Health* 27, no. 2 (2014): 138-142. https://dx.doi.org/10.4103/1357-6283.143744.

Hemmer, P. A., T. Dong, S. J. Durning, and L. N. Pangaro. 2015. "Novel Examination for Evaluating Medical Student Clinical Reasoning: Reliability and Association with Patients Seen." *Military Medicine* 180, no. 4 (Apr): 79-87. https://dx.doi.org/10.7205/milmed-d-14-00576.

Hennink, Monique M., Bonnie N. Kaiser, and Vincent C. Marconi. 2017. "'Continuity' as an Organizing Principle for Clinical Education Reform." *Qualitative Health Research* 27, no. 4 (Mar): 591-608. https://dx.doi.org/10.1177/1049732316665344.

Hirsh, D. A., B. Ogur, G. E. Thibault, and M. Cox. 2007. "'Continuity' as an Organizing Principle for Clinical Education Reform." *New England Journal of Medicine* 356, no. 8 (Feb 22): 858-866.

Hirsh, David, Lucie Walters, and Ann N. Poncelet. 2012. "Better Learning, Better Doctors, Better Delivery System: Possibilities from a Case Study of Longitudinal Integrated Clerkships." *Medical Teacher* 34, no. 7 (2012): 548-554. https://dx.doi.org/10.3109/0142159x.2012.696745.

Hobus, P. P. M., H. G. Schmidt, H. P. A. Boshuizen, and V. L. Patel. 1987. "Contextual Factors in the Activation of First Diagnostic Hypotheses: Expert-Novice Differences." *Medical Education* 21, no. 6 (Nov): 471-476. https://dx.doi.org/10.1111/j.1365-2923.1987.tb01405.x.

Hruska, Pam, Kent G. Hecker, Sylvain Coderre, Kevin McLaughlin, Filomeno Cortese, Christopher Doig, Tanya Beran, Bruce Wright, and Olav Krigolson. 2016. "Hemispheric Activation Differences in Novice and Expert Clinicians During Clinical Decision Making." *Advances in Health Sciences Education* 21, no. 5 (Dec): 921-933. https://dx.doi.org/10.1007/s10459-015-9648-3.

Hrynchak, Patricia, Susan Glover Takahashi, and Marla Nayer. 2014. "Key-Feature Questions for Assessment of Clinical Reasoning: A Literature Review." *Medical Education* 48, no. 9 (Sep): 870-883. https://dx.doi.org/10.1111/medu.12509.

Huang, William Y., and Ana Malinow. 2010. "Curriculum and Evaluation Results of a Third-Year Medical Student Longitudinal Pathway on Underserved Care." *Teaching & Learning in Medicine* 22, no. 2 (Apr): 123-130.

Ilgen, J. S., K. W. Eva, and G. Regehr. 2016. "What's in a Label? Is Diagnosis the Start of the End of Clinical Reasoning?" *Journal of General Internal Medicine* 31, no. 4: 435-437. https://dx.doi.org/10.1007/s11606-016-3592-7.

Illeris, Knud. 2018. "An Overview of the History of Learning Theory." *European Journal of Education* 53, no. 1 (Mar): 86-101. https://dx.doi.org/10.1111/ejed.12265.

Illing, J. 2010. "Thinking About Research: Frameworks, Ethics and Scholarship." In *Understanding Medical Education: Evidence, Theory and Practice*, edited by T. Stanwick. West Sussex, U. K.: Wiley-Blackwell.

Irby, D. M. 1990. "Shifting Paradigms of Research in Medical Education." *Academic Medicine* 65, no. 10 (Oct): 622-623. https://dx.doi.org/10.1097/00001888-199010000-00002.

Irby, David M. 2007. "Educational Continuity in Clinical Clerkships." *New England Journal of Medicine* 356, no. 8 (Feb 22): 856-857. https://dx.doi.org/10.1056/NEJMe068275.

Islam, R., C. R. Weir, M. Jones, G. Del Fiol, and M. H. Samore. 2015. "Understanding Complex Clinical Reasoning in Infectious Diseases for Improving Clinical Decision Support Design." *BMC Medical Informatics and Decision Making* 15 (Nov). https://dx.doi.org/10.1186/s12911-015-0221-z.

Jabareen, Y. 2009. "Building a Conceptural Framework: Philosophy,Definitions, and Procedure." *International Journal of Qualitative Methods* 8, no. 49-62.

Jackson, Simon A., and Sabina Kleitman. 2014. "Individual Differences in Decision-Making and Confidence: Capturing Decision Tendencies in a Fictitious Medical Test." *Metacognition and Learning* 9, no. 1 (Apr): 25-49. https://dx.doi.org/10.1007/s11409-013-9110-y.

Jost, Meike, Peter Brustle, Marianne Giesler, Michel Rijntjes, and Jochen Brich. 2017. "Effects of Additional Team-Based Learning on Students' Clinical Reasoning Skills: A Pilot Study." *BMC Research Notes* 10, no. 1 (2017 Jul). https://dx.doi.org/10.1186/s13104-017-2614-9.

Kahneman, D., and A. Tversky. 1982. "Variants of Uncertainty." *Cognition* 11, no. 2 (1982): 143-157. https://dx.doi.org/10.1016/0010-0277(82)90023-3.

Kelekar, Arati, and Nelia Afonso. 2020. "Evaluation of the Effect of a New Clinical Reasoning Curriculum in a Pre-Clerkship Clinical Skills Course." *Perspectives on Medical Education* 9, no. 2 (Apr): 123-127. https://dx.doi.org/10.1007/s40037-020-00566-4.

Kelly, Len, Lucie Walters, and David Rosenthal. 2014. "Community-Based Medical Education: Is Success a Result of Meaningful Personal Learning Experiences?" *Education for Health* 27, no. 1 (Apr): 47-50. https://dx.doi.org/10.4103/1357-6283.134311.

Kelly, Moira. 2010. "The Role of Theory in Qualitative Health Research." *Family Practice* 27, no. 3 (Jun): 285-290. https://dx.doi.org/10.1093/fampra/cmp077.

Khin-Htun, Swe, and Anisa Kushairi. 2019. "Twelve Tips for Developing Clinical Reasoning Skills in the Pre-Clinical and Clinical Stages of Medical School." *Medical Teacher* 41, no. 9 (Sep 2): 1007-1011. https://dx.doi.org/10.1080/0142159x.2018.1502418.

Kiesewetter, J., R. Ebersbach, A. Gorlitz, M. Holzer, M. R. Fischer, and R. Schmidmaier. 2013. "Cognitive Problem Solving Patterns of Medical Students Correlate with Success in Diagnostic Case Solutions." *Plos One* 8, no. 8 (Aug). https://dx.doi.org/10.1371/journal.pone.0071486.

Kitchenham, Andrew. 2008. "The Evolution of John Mezirow's Transformative Learning Theory." *Journal of Transformative Education* 6, no. 2 (Apr): 104-123. https://dx.doi.org/10.1177/1541344608322678.

Koens, F., K. V. Mann, Ejfm Custers, and O. T. J. Ten Cate. 2005. "Analysing the Concept of Context in Medical Education." *Medical Education* 39, no. 12 (Dec): 1243-1249. https://dx.doi.org/10.1111/j.1365-2929.2005.02338.x.

Konkin, Jill, and Carol Suddards. 2012. "Creating Stories to Live By: Caring and Professional Identity Formation in a Longitudinal Integrated Clerkship." *Advances in Health Sciences Education* 17, no. 4 (Oct): 585-596. https://dx.doi.org/10.1007/s10459-011-9335-y.

Kononowicz, Andrzej A., Inga Hege, Samuel Edelbring, Monika Sobocan, Soeren Huwendiek, and Steven J. Durning. 2020. "The Need for Longitudinal Clinical Reasoning Teaching and Assessment: Results of an International Survey." *Medical Teacher* 42, no. 4 (Apr 2): 457-462. https://dx.doi.org/10.1080/0142159x.2019.1708293.

Konopasky, Abigail, Anthony R. Artino, Alexis Battista, Megan Ohmer, Paul A. Hemmer, Dario Torre, Divya Ramani, Jeroen van Merrienboer, Pim W. Teunissen, Elexis McBee, Temple Ratcliffe, and Steven J. Durning. 2020a. "Understanding Context Specificity: The Effect of Contextual Factors on Clinical Reasoning." *Diagnosis* 7, no. 3 (Sep): 257-264. https://dx.doi.org/10.1515/dx-2020-0016.

Konopasky, Abigail, Steven J. Durning, Anthony R. Artino, Divya Ramani, and Alexis Battista. 2020b. "The Linguistic Effects of Context Specificity: Exploring Affect, Cognitive Processing, and Agency in Physicians' Think-Aloud Reflections." *Diagnosis* 7, no. 3 (Sep): 273-280. https://dx.doi.org/10.1515/dx-2019-0103.

Konopasky, Abigail, Steven J. Durning, Alexis Battista, Anthony R. Artino, Jr., Divya Ramani, Zachary A. Haynes, Catherine Woodard, and Dario Torre. 2020c. "Challenges in Mitigating Context Specificity in Clinical Reasoning: A Report and Reflection." *Diagnosis* 7, no. 3 (Sep): 291-297. https://dx.doi.org/10.1515/dx-2020-0018.

Konopasky, Abigail, Divya Ramani, Megan Ohmer, Alexis Battista, Anthony R. Artino, Elexis McBee, Temple Ratcliffe, and Steven J. Durning. 2020d. "It Totally Possibly Could Be: How a Group of Military Physicians Reflect on Their Clinical Reasoning in the Presence of Contextual Factors." *Military Medicine* 185 (Jan-Feb): 575-582. https://dx.doi.org/10.1093/milmed/usz250.

Koufidis, Charilaos, Katri Manninen, Juha Nieminen, Martin Wohlin, and Charlotte Silen. 2021. "Unravelling the Polyphony in Clinical Reasoning Research in Medical Education." *Journal of Evaluation in Clinical Practice* 27, no. 2 (Apr): 438-450. https://dx.doi.org/10.1111/jep.13432.

Krupat, E., S. Pelletier, E. K. Alexander, D. Hirsh, B. Ogur, R. Schwartzstein, Edward Krupat, Stephen Pelletier, Erik K. Alexander, David Hirsh, Barbara Ogur, and Richard Schwartzstein. 2009. "Can Changes in the Principal Clinical Year Prevent the Erosion of Students' Patient-Centered Beliefs?" *Academic Medicine* 84, no. 5 (May): 582-586.

Kulasegaram, Kulamakan M., Zarah Chaudhary, Nicole Woods, Kelly Dore, Alan Neville, and Geoffrey Norman. 2017. "Contexts, Concepts and Cognition: Principles for the Transfer of Basic Science Knowledge." *Medical Education* 51, no. 2 (Feb): 184-195. https://dx.doi.org/10.1111/medu.13145.

Laksov, K. B., C. McGrath, and A. Josephson. 2014. "Let's Talk About Integration: A Study of Students' Understandings of Integration." *Advances in Health Sciences Education* 19, no. 5 (Dec): 709-720. https://dx.doi.org/10.1007/s10459-014-9499-3.

LaRochelle, Jeffrey S., Ting Dong, and Steven J. Durning. 2015. "Preclerkship Assessment of Clinical Skills and Clinical Reasoning: The Longitudinal Impact on Student Performance." *Military Medicine* 180, no. 4 (Apr): 43-46. https://dx.doi.org/10.7205/milmed-d-14-00566.

Latessa, Robyn A., Robert A. Swendiman, Anna Beth Parlier, Shelley L. Galvin, and David A. Hirsh. 2017. "Graduates' Perceptions of Learning Affordances in Longitudinal Integrated Clerkships: A Dual-Institution, Mixed-Methods Study." *Academic Medicine* 92, no. 9 (Sep): 1313-1319. https://dx.doi.org/10.1097/acm.0000000000001621.

Latessa, Robyn, Norma Beaty, Kenneth Royal, Gaye Colvin, Donald E. Pathman, and Jeffery Heck. 2015. "Academic Outcomes of a Community-Based Longitudinal Integrated Clerkships Program." *Medical Teacher* 37, no. 9 (2015): 862-867. https://dx.doi.org/10.3109/0142159x.2015.1009020.

Lave, Jean, and Etienne Wenger. 1991. *Situated Learning: Legitimate Peripheral Participation*. Cambridge: Cambridge University Press.

Lemieux, M., and G. Bordage. 1992. "Propostional Versus Structural Semantic Analyses of Medical Diagnostic Thinking." *Cognitive Science* 16, no. 2 (Apr-Jun): 185-204. https://dx.doi.org/10.1016/0364-0213(92)90023-n.

Leppink, Jimmie, and Angelique van den Heuvel. 2015. "The Evolution of Cognitive Load Theory and Its Application to Medical Education." *Perspectives on Medical Education* 4, no. 3 (Jun): 119-127. https://dx.doi.org/10.1007/s40037-015-0192-x.

Levesque, Martine C., Richard Bruce Hovey, and Christophe Bedos. 2013. "Advancing Patient-Centered Care through Transformative Educational Leadership: A Critical Review of Health Care Professional Preparation for Patient-Centered Care." *Journal of Healthcare Leadership* 5 (2013): 35-46. https://dx.doi.org/10.2147/jhl.S30889.

Levine, D. 2014. "The Importance of Clinical Reasoning in the Training of All Medical Practitioners." *Journal of the Royal Society of Medicine* 107, no. 5 (May): 178-178. https://dx.doi.org/10.1177/0141076814532581.

Loughlin, M., R. Bluhm, S. Buetow, R. E. G. Upshur, M. J. Goldenberg, K. Borgerson, V. Entwistle, and E. Kingma. 2012. "Reason and Value: Making Reasoning Fit for Practice." *Journal of Evaluation in Clinical Practice* 18, no. 5 (Oct): 929-937. https://dx.doi.org/10.1111/j.1365-2753.2012.01896.x.

MacLeod, Anna, Rachel H. Ellaway, Elise Paradis, Yoon Soo Park, Meredith Young, and Lara Varpio. 2020. "Being Edgy in Health Professions Education: Concluding the Philosophy of Science Series." *Academic Medicine* 95, no. 7 (Jul): 995-998. https://dx.doi.org/10.1097/acm.0000000000003250.

Mahoney, S, S Campbell, and S Garner. 2011. "Community Engagement in an Urban Community Based Medical Education Program: A Case Study." *Australasian Journal of University-Community Engagement* (Spring): 80-94.

Mamede, S., H. G. Schmidt, and J. C. Penaforte. 2008. "Effects of Reflective Practice on the Accuracy of Medical Diagnoses." *Medical Education* 42, no. 5 (May): 468-475. https://dx.doi.org/10.1111/j.1365-2923.2008.03030.x.

Mamede, Silvia. 2020. "What Does Research on Clinical Reasoning Have to Say to Clinical Teachers?" *Scientia Medica* 30, no. 1 (Jun 19). https://dx.doi.org/10.15448/1980-6108.2020.1.37350.

Mamede, Silvia, Henk G. Schmidt, Remy M. J. P. Rikers, Eugene J. F. M. Custers, Ted A. W. Splinter, and Jan L. C. M. van Saase. 2010. "Conscious Thought Beats Deliberation without Attention in Diagnostic Decision-Making: At Least When You Are an Expert." *Psychological Research-Psychologische Forschung* 74, no. 6 (Nov): 586-592. https://dx.doi.org/10.1007/s00426-010-0281-8.

Mamede, Silvia, Henk G. Schmidt, Remy M. J. P. Rikers, Julio C. Penaforte, and Joao M. Coelho-Filho. 2007. "Breaking Down Automaticity: Case Ambiguity and the Shift to Reflective Approaches in Clinical Reasoning." *Medical Education* 41, no. 12: 1185-1192.

Mamede, Silvia, Tamara van Gog, Alexandre S. Moura, Rosa M. D. de Faria, Jose M. Peixoto, Remy M. J. P. Rikers, and Henk G. Schmidt. 2012. "Reflection as a Strategy to Foster Medical Students' Acquisition of Diagnostic Competence." *Medical Education* 46, no. 5 (May): 464-472. https://dx.doi.org/10.1111/j.1365-2923.2012.04217.x.

Mamede, Silvia, Tamara van Gog, Alexandre Moura Sampaio, Rosa Malena Delbone de Faria, Jose Peixoto Maria, and Henk G. Schmidt. 2014a. "How Can Students' Diagnostic Competence Benefit Most from Practice with Clinical Cases? The Effects of Structured Reflection on Future Diagnosis of the Same and Novel Diseases." *Academic Medicine* 89, no. 1 (Jan): 121-127. https://dx.doi.org/10.1097/acm.0000000000000076.

Mamede, Silvia, Tamara van Gog, Kees van den Berge, Jan L. C. M. van Saase, and Henk G. Schmidt. 2014b. "Why Do Doctors Make Mistakes? A Study of the Role of Salient Distracting Clinical Features." *Academic Medicine* 89, no. 1 (Jan): 114-120. https://dx.doi.org/10.1097/acm.0000000000000077.

Mann, Karen V. 2011. "Theoretical Perspectives in Medical Education: Past Experience and Future Possibilities." *Medical Education* 45, no. 1 (Jan): 60-68. https://dx.doi.org/10.1111/j.1365-2923.2010.03757.x.

Marcum, J. A. 2012. "An Integrated Model of Clinical Reasoning: Dual-Process Theory of Cognition and Metacognition." *Journal of Evaluation in Clinical Practice* 18, no. 5 (Oct): 954-961. https://dx.doi.org/10.1111/j.1365-2753.2012.01900.x.

Maslow, AH. 1943. "A Theory of Human Motivation." *Psychological Review* 50, no. 4: 370-396. https://dx.doi.org/https://doi.org/10.1037/h0054346.

Mayer, Richard E. 2010. "Applying the Science of Learning to Medical Education." *Medical Education* 44, no. 6 (Jun): 543-549. https://dx.doi.org/10.1111/j.1365-2923.2010.03624.x.

McBee, Elexis, Temple Ratcliffe, Katherine Picho, Anthony R. Artino, Jr., Lambert Schuwirth, William Kelly, Jennifer Masel, Cees van der Vleuten, and Steven J. Durning. 2015. "Consequences of Contextual Factors on Clinical Reasoning in Resident Physicians." *Advances in Health Sciences Education* 20, no. 5 (Dec): 1225-1236. https://dx.doi.org/10.1007/s10459-015-9597-x.

McGaghie, William C. 2010. "Medical Education Research as Tranlational Science." *Science Translational Medicine* 2, no. 19. https://dx.doi.org/10.1126/scitranslmed.3000679.

McKeachie, Wilbert J. 1980. "Implications of Cognitive Psychology for College Teaching." *New Directions for Teaching & Learning* 2: 85-93.

McLaughlin, Kevin, Joanna Bates, Jill Konkin, Wayne Woloschuk, Carol A. Suddards, and Glenn Regehr. 2011. "A Comparison of Performance Evaluations of Students on Longitudinal Integrated Clerkships and Rotation-Based Clerkships." *Academic Medicine* 86, no. 10 Suppl (Oct): S25-S29.

McMillan, W 2015. "Theory in Healthcare Education Research: The Importance of Worldview." In *Researching Medical Education*, edited by JA Cleland and SJ Durning. West Sussex, United Kingdom: Wiley Blackwell.

Medical Deans Australia and New Zealand, 2021. *Discussion Paper: Training Tomorrow's Doctors - All Pulling in the Right Direction.* by MDANZ.

Medalie, J. H., T. M. Mettee, and D. P. Stevens. 1997. "An Integrated Clerkship Program for Medical Students." *Academic Medicine* 72, no. 4 (Apr): 250-251.

Merriam, Sharan B. 2001. "Andragogy and Self-Directed Learning: Pillars of Adult Learning Theory." *New Directions for Adult and Continuing Education* 89: 3-13.

Mezirow, J. 1994. "Understanding Transformation Theory." *Adult Education Quarterly* 44, no. 4 (Summer): 222-232. https://dx.doi.org/10.1177/074171369404400403.

Monteiro, S. M., and G. Norman. 2013. "Diagnostic Reasoning: Where We've Been, Where We're Going." *Teaching & Learning in Medicine* 25 Suppl 1: S26-S32.

Moon, Katie, and Deborah Blackman. 2014. "A Guide to Understanding Social Science Research for Natural Scientists." *Conservation Biology* 28, no. 5 (Oct): 1167-1177. https://dx.doi.org/10.1111/cobi.12326.

Morris, A., and D. E. Campbell. 2015. "The Script Concordance Test for Clinical Reasoning in Paediatric Medicine: Medical Student Performance and Expert Panel Reliability." *Focus on Health Professional Education - A Multidisciplinary Journal* 16, no. 2: 4-12. https://dx.doi.org/10.11157/fohpe.v16i2.65.

Norman, Geoff. 2011. "Chaos, Complexity and Complicatedness: Lessons from Rocket Science." *Medical Education* 45, no. 6 (Jun): 549-559. https://dx.doi.org/10.1111/j.1365-2923.2011.03945.x.

Norman, Geoff, Meredith Young, and Lee Brooks. 2007. "Non-Analytical Models of Clinical Reasoning: The Role of Experience." *Medical Education* 41, no. 12: 1140-1145.

Norman, Geoffrey. 2005. "Research in Clinical Reasoning: Past History and Current Trends." *Medical Education* 39, no. 4: 418-427.

---. 2006. "Building on Experience - the Development of Clinical Reasoning." *New England Journal of Medicine* 355, no. 21: 2251-2252.

Norman, Geoffrey R., and Kevin W. Eva. 2010. "Diagnostic Error and Clinical Reasoning." *Medical Education* 44, no. 1: 94-100.

Norman, Geoffrey R., Sandra D. Monteiro, Jonathan Sherbino, Jonathan S. Ilgen, Henk G. Schmidt, and Silvia Mamede. 2017. "The Causes of Errors in Clinical Reasoning: Cognitive Biases, Knowledge Deficits, and Dual Process Thinking." *Academic Medicine* 92, no. 1 (Jan): 23-30. https://dx.doi.org/10.1097/acm.0000000000001421.

Norman, Geoffrey, Jonathan Sherbino, Kelly Dore, Tim Wood, Meredith Young, Wolfgang Gaissmaier, Sharyn Kreuger, and Sandra Monteiro. 2014. "The Etiology of Diagnostic Errors: A Controlled Trial of System 1 Versus System 2 Reasoning." *Academic Medicine* 89, no. 2 (Feb): 277-284. https://dx.doi.org/10.1097/acm.0000000000000105.

Norris, Thomas E., Douglas C. Schaad, Dawn DeWitt, Barbara Ogur, Daniel Hunt, and the Consortium of Longitudinal Integrated Clerkships. 2009. "Longitudinal Integrated Clerkships for Medical Students: An Innovation Adopted by Medical Schools in Australia, Canada, South Africa, and the United States." *Academic Medicine* 84, no. 7 (Jul): 902-907. https://dx.doi.org/10.1097/ACM.0b013e3181a85776.

Nunn, Robin J. 2007. "Complexity Theory Applied to Itself." *Emergence-Complexity & Organization* 9, no. 1-2 (2007).

O'Doherty, Jane, Sarah Hyde, Raymond O'Connor, Megan E. L. Brown, Peter Hayes, Vikram Niranjan, Aidan Culhane, Pat O'Dwyer, Patrick O'Donnell, Liam Glynn, and Andrew O'Regan. 2022. "Development and Sustainment of Professional Relationships within Longitudinal Integrated Clerkships in General Practice (Lics): A Narrative Review." *Irish Journal of Medical Science* 191, no. 1 (Feb): 447-459. https://dx.doi.org/10.1007/s11845-021-02525-2.

O'Donoghue, Sinead, Deidre McGrath, and Walter Cullen. 2015. "How Do Longitudinal Clerkships in General Practice/Primary Care Impact on Student Experience and Career Intention? A Cross-Sectional Study of Student Experience." *Education For Primary Care* 26, no. 3: 166-175. https://dx.doi.org/10.1080/14739879.2015.11494336.

O'Riordan, Margaret, Andre Dahinden, Zekeriya Akturk, Jose Miguel Bueno Ortiz, Nezih Dagdeviren, Glyn Elwyn, Adrian Micallef, Mikko Murtonen, Marianne Samuelson, Per Struk, Danny Tayar, and Janecke Thesen. 2011. "Dealing with Uncertainty in General Practice: An Essential Skill for the General Practitioner." *Quality in Primary Care* 19, no. 3 (2011): 175-181.

O'Sullivan, Belinda G., and Bruce Chater. 2019. "Medical School Expansion to Areas of Need Improves Physician Distribution." *Medical Education* 53, no. 11 (Nov): 1072-1073. https://dx.doi.org/10.1111/medu.13957.

O'Sullivan, E. D., and S. J. Schofield. 2018. "Cognitive Bias in Clinical Medicine." *Journal of the Royal College of Physicians of Edinburgh* 48, no. 3 (Sep): 225-232. https://dx.doi.org/10.4997/jrcpe.2018.306.

Ogden, Kathryn, Sue Kilpatrick, and Shandell Elmer. 2023. "Examining the Nexus between Medical Education and Complexity: A Systematic Review to Inform Practice and Research." *Bmc Medical Education* 23, no. 1 (Jul 5). https://dx.doi.org/10.1186/s12909-023-04471-2.

Ogrinc, G., S. Mutha, and D. M. Irby. 2002. "Evidence for Longitudinal Ambulatory Care Rotations: A Review of the Literature." *Academic Medicine* 77, no. 7 (Jul): 688-693. https://dx.doi.org/10.1097/00001888-200207000-00008.

Ogur, Barbara, David Hirsh, Edward Krupat, and David Bor. 2007. "The Harvard Medical School-Cambridge Integrated Clerkship: An Innovative Model of Clinical Education." *Academic Medicine* 82, no. 4 (Apr): 397-404. https://dx.doi.org/10.1097/ACM.0b013e31803338f0.

Olson, Andrew P. J., Steven J. Durning, Carolina Fernandez Branson, Brian Sick, Kathleen P. Lane, and Joseph J. Rencic. 2020. "Teamwork in Clinical Reasoning - Cooperative or Parallel Play?" *Diagnosis* 7, no. 3 (Sep): 307-312. https://dx.doi.org/10.1515/dx-2020-0020.

Papa, Frank J., and Feiming Li. 2015. "Evidence of the Preferential Use of Disease Prototypes over Case Exemplars among Early Year One Medical Students Prior to and Following Diagnostic Training." *Diagnosis* 2, no. 4 (Dec): 217-225. https://dx.doi.org/10.1515/dx-2015-0024.

Papp, K. K., G. C. Huang, L. M. Lauzon Clabo, D. Delva, M. Fischer, L. Konopasek, R. M. Schwartzstein, and M. Gusic. 2014. "Milestones of Critical Thinking: A Developmental Model for Medicine and Nursing." *Academic Medicine* 89, no. 5: 715-720.

Parboosingh, John T. 2002. "Physician Communities of Practice: Where Learning and Practice Are Inseparable." *Journal of Continuing Education in the Health Professions* 22, no. 4 (2002): 230-236. https://dx.doi.org/10.1002/chp.1340220407.

Parsons, Andrew S., Thilan P. Wijesekera, and Joseph J. Rencic. 2020. "The Management Script: A Practical Tool for Teaching Management Reasoning." *Academic Medicine* 95, no. 8 (Aug): 1179-1185. https://dx.doi.org/10.1097/acm.0000000000003465.

Pelaccia, Thierry, Laurie H. Plotnick, Marie-Claude Audetat, Mathieu Nendaz, Stuart Lubarsky, Nazi Torabi, Aliki Thomas, Meredith Young, and Valerie Dory. 2020. "A Scoping Review of Physicians' Clinical Reasoning in Emergency Departments." *Annals of Emergency Medicine* 75, no. 2 (Feb): 206-217. https://dx.doi.org/10.1016/j.annemergmed.2019.06.023.

Pelaccia, Thierry, Jacques Tardif, Emmanuel Triby, and Bernard Charlin. 2011. "An Analysis of Clinical Reasoning through a Recent and Comprehensive Approach: The Dual-Process Theory." *Medical Education Online* 16.

---. 2017. "A Novel Approach to Study Medical Decision Making in the Clinical Setting: The "Own-Point-of-View" Perspective." *Academic Emergency Medicine* 24, no. 7 (Jul): 785-795. https://dx.doi.org/10.1111/acem.13209.

Perkins, D. N., and G. Salomon. 1989. "Are Cognitive Skills Context-Bound?" *Educational Researcher* 18, no. 1 (Jan-Feb 1989): 16-25.

Pinnock, Ralph, Megan Anakin, Julie Lawrence, Helen Chignell, and Tim Wilkinson. 2019. "Identifying Developmental Features in Students' Clinical Reasoning to Inform Teaching." *Medical Teacher* 41, no. 3 (Mar 4): 297-302. https://dx.doi.org/10.1080/0142159x.2018.1463433.

Pinnock, Ralph, Tracy-Lee Fisher, and Jane Astley. 2016. "Think Aloud to Learn and Assess Clinical Reasoning." *Medical Education* 50, no. 5 (May): 585-586. https://dx.doi.org/10.1111/medu.13006.

Pinnock, Ralph, and Paul Welch. 2014. "Learning Clinical Reasoning." *Journal of Paediatrics and Child Health* 50, no. 4 (Apr): 253-257. https://dx.doi.org/10.1111/jpc.12455.

Plackett, Ruth, Angelos P. Kassianos, Maria Kambouri, Natasha Kay, Sophie Mylan, Jenny Hopwood, Patricia Schartau, Shani Gray, Jessica Timmis, Sarah Bennett, Chris Valerio, Veena Rodrigues, Emily Player, Willie Hamilton, Rosalind Raine, Stephen Duffy, and Jessica Sheringham. 2020. "Online Patient Simulation Training to Improve Clinical Reasoning: A Feasibility Randomised Controlled Trial." *BMC Medical Education* 20, no. 1 (Jul 31). https://dx.doi.org/10.1186/s12909-020-02168-4.

Playford, Denese E., Wen Qi Ng, and Tessa Burkitt. 2016. "Creation of a Mobile Rural Workforce Following Undergraduate Longitudinal Rural Immersion." *Medical Teacher* 38, no. 5 (May): 498-503. https://dx.doi.org/10.3109/0142159x.2015.1060304.

Playford, Denese E., Asha Nicholson, Geoffrey J. Riley, and Ian B. Puddey. 2015. "Longitudinal Rural Clerkships: Increased Likelihood of More Remote Rural Medical Practice Following Graduation." *BMC Medical Education* 15 (Mar 21). https://dx.doi.org/10.1186/s12909-015-0332-3.

Poncelet, Ann, Seth Bokser, Brook Calton, Karen E. Hauer, Heidi Kirsch, Tracey Jones, Cindy J. Lai, Lindsay Mazotti, William Shore, Arianne Teherani, Lowell Tong, Maria Wamsley, and Patricia Robertson. 2011. "Development of a Longitudinal Integrated Clerkship at an Academic Medical Center." *Medical Education Online* 16.

Poncelet, Ann N., and J. Nicky Hudson. 2015. "Student Continuity with Patients: A System Delivery Innovation to Benefit Patient Care and Learning (Continuity Patient Benefit)." *Healthcare* 3, no. 3 (Sep): 607-618. https://dx.doi.org/10.3390/healthcare3030607.

Posel, N., J. B. McGee, and D. M. Fleiszer. 2015. "Twelve Tips to Support the Development of Clinical Reasoning Skills Using Virtual Patient Cases." *Medical Teacher* 37, no. 9: 813-818. https://dx.doi.org/10.3109/0142159x.2014.993951.

Postman, N., and C. Weingartner. 1969. *Teaching as a Subversive Activity*. New York: Dell Publishing Co.

Prentice, Shaun, Jill Benson, Emily Kirkpatrick, and Lambert Schuwirth. 2020. "Workplace-Based Assessments in Postgraduate Medical Education: A Hermeneutic Review." *Medical Education* 54, no. 11 (Nov): 981-992. https://dx.doi.org/10.1111/medu.14221.

Pront, Leeanne, and David Gillham. 2017. "Supervisor Expertise to Optimise Learner : Preceptor Ratios." *Medical Education* 51, no. 2 (Feb): 128-129. https://dx.doi.org/10.1111/medu.13237.

Pront, Leeanne, David Gillham, and Lambert W. T. Schuwirth. 2016. "Competencies to Enable Learning-Focused Clinical Supervision: A Thematic Analysis of the Literature." *Medical Education* 50, no. 4 (Apr): 485-495. https://dx.doi.org/10.1111/medu.12854.

Rahayu, G.R., and S. McAleer. 2011. "Clinical Reasoning Inventory: An Alternative Method to Measure Clinical Reasoning Skills." *Focus on Health Professional Education - A Multidisciplinary Journal* 12, no. 3: 17-29.

Ramani, Divya, Michael Soh, Jerusalem Merkebu, Steven J. Durning, Alexis Battista, Elexis McBee, Temple Ratcliffe, and Abigail Konopasky. 2020. "Examining the Patterns of Uncertainty across Clinical Reasoning Tasks: Effects of Contextual Factors on the Clinical Reasoning Process." *Diagnosis* 7, no. 3 (Sep): 299-305. https://dx.doi.org/10.1515/dx-2020-0019.

Raupach, Tobias, Jil C. Andresen, Katharina Meyer, Lisa Strobel, Michael Koziolek, Wolfram Jung, Jamie Brown, and Sven Anders. 2016. "Test-Enhanced Learning of Clinical Reasoning: A Crossover Randomised Trial." *Medical Education* 50, no. 7 (Jul): 711-720. https://dx.doi.org/10.1111/medu.13069.

Rees, Charlotte E., Paul E. S. Crampton, and Lynn V. Monrouxe. 2020. "Re-Visioning Academic Medicine through a Constructionist Lens." *Academic Medicine* 95, no. 6 (Jun): 846-850. https://dx.doi.org/10.1097/acm.0000000000003109.

Reeves, Scott, Mathieu Albert, Ayelet Kuper, and Brian David Hodges. 2008. "Qualitative Research - Why Use Theories in Qualitative Research?" *British Medical Journal* 337, no. 7670 (Sep 13): 631-634. https://dx.doi.org/10.1136/bmj.a949.

Regehr, G., and G. R. Norman. 1996. "Issues in Cognitive Psychology: Implications for Professional Education." *Academic Medicine* 71, no. 9: 988-1001.

Rencic, Joseph, Lambert W. T. Schuwirth, Larry D. Gruppen, and Steven J. Durning. 2020a. "Clinical Reasoning Performance Assessment: Using Situated Cognition Theory as a Conceptual Framework." *Diagnosis* 7, no. 3 (Sep): 241-249. https://dx.doi.org/10.1515/dx-2019-0051.

---. 2020b. "A Situated Cognition Model for Clinical Reasoning Performance Assessment: A Narrative Review." *Diagnosis* 7, no. 3 (Sep): 227-240. https://dx.doi.org/10.1515/dx-2019-0106.

Ribeiro, Ligia Maria Cayres, Silvia Mamede, Eliza Maria de Brito, Alexandre Sampaio Moura, Rosa Malena Delbone de Faria, and Henk G. Schmidt. 2021. "Exploring Mechanisms Underlying Learning from Deliberate Reflection: An Experimental Study." *Medical Education* 55, no. 3 (Mar): 404-412. https://dx.doi.org/10.1111/medu.14410.

Richardson, V. 2003. "Constructivist Pedagogy." *Teachers College Record* 105, no. 9 (Dec): 1623-1640. https://dx.doi.org/10.1046/j.1467-9620.2003.00303.x.

Richmond, Anna, Nicola Cooper, Simon Gay, William Atiomo, and Rakesh Patel. 2020. "The Student Is Key: A Realist Review of Educational Interventions to Develop Analytical and Non-Analytical Clinical Reasoning Ability." *Medical Education* 54, no. 8 (Aug): 709-719. https://dx.doi.org/10.1111/medu.14137.

Roberts, Chris, Michele Daly, Fabian Held, and David Lyle. 2017. "Social Learning in a Longitudinal Integrated Clinical Placement." *Advances In Health Sciences Education: Theory And Practice* 22, no. 4: 1011-1029. https://dx.doi.org/10.1007/s10459-016-9740-3.

Roberts, Chris, Michele Daly, Koshila Kumar, David Perkins, Deborah Richards, and David Garne. 2012. "A Longitudinal Integrated Placement and Medical Students' Intentions to Practise Rurally." *Medical Education* 46, no. 2: 179-191. https://dx.doi.org/10.1111/j.1365-2923.2011.04102.x.

Rohrer, Doug. 2012. "Interleaving Helps Students Distinguish among Similar Concepts." *Educational Psychology Review* 24, no. 3 (Sep): 355-367. https://dx.doi.org/10.1007/s10648-012-9201-3.

Rohrer, Doug, and Harold Pashler. 2010. "Recent Research on Human Learning Challenges Conventional Instructional Strategies." *Educational Researcher* 39, no. 5 (Jun-Jul): 406-412. https://dx.doi.org/10.3102/0013189x10374770.

Ross, David, Kim Loeffler, Shirley Schipper, Ben Vandermeer, and G. Michael Allan. 2013. "Do Scores on Three Commonly Used Measures of Critical Thinking Correlate with Academic Success of Health Professions Trainees? A Systematic Review and Meta-Analysis." *Academic Medicine* 88, no. 5 (May): 724-734. https://dx.doi.org/10.1097/ACM.0b013e31828b0823.

Round, A. P. 1999. "Teaching Clinical Reasoning - a Preliminary Controlled Study." *Medical Education* 33, no. 7: 480-483.

Sandars, John. 2009. "The Use of Reflection in Medical Education: Amee Guide No. 44." *Medical Teacher* 31, no. 8: 685-695. https://dx.doi.org/10.1080/01421590903050374.

Sandhu, Harpartap, and Christopher Carpenter. 2006. "Clinical Decisionmaking: Opening the Black Box of Cognitive Reasoning." *Annals of Emergency Medicine* 48, no. 6 (Dec): 713-719. https://dx.doi.org/10.1016/j.annemergmed.2006.03.011.

Sawatsky, Adam P., John T. Ratelle, Sara L. Bonnes, Jason S. Egginton, and Thomas J. Beckman. 2017. "A Model of Self-Directed Learning in Internal Medicine Residency: A Qualitative Study Using Grounded Theory." *BMC Medical Education* 17 (Feb 2). https://dx.doi.org/10.1186/s12909-017-0869-4.

Schmidt, H. G., and S. Mamede. 2015. "How to Improve the Teaching of Clinical Reasoning: A Narrative Review and a Proposal." *Medical Education* 49, no. 10 (Oct): 961-973. https://dx.doi.org/10.1111/medu.12775.

Schmidt, H. G., G. R. Norman, and H. P. A. Boshuizen. 1990. "A Cognitive Perspective on Medical Expertise: Theory and Implications." *Academic Medicine* 65, no. 10 (Oct): 611-621. https://dx.doi.org/10.1097/00001888-199010000-00001.

Schmidt, Henk G., and Henny P. A. Boshuizen. 1993. "On Acquiring Expertise in Medicine." *Educational Psychology Review* 5, no. 3 (Sep): 205-221. https://dx.doi.org/10.1007/bf01323044.

Schmidt, Henk G., and Remy M. J. P. Rikers. 2007. "How Expertise Develops in Medicine: Knowledge Encapsulation and Illness Script Formation." *Medical Education* 41, no. 12 (Dec): 1133-1139. https://dx.doi.org/10.1111/j.1365-2923.2007.02915.x.

Schuwirth, L. W. T., C. P. M. Van der Vleuten, and H. H. L. M. Donkers. 1996. "A Closer Look at Cueing Effects in Multiple-Choice Questions." *Medical Education* 30, no. 1 (Jan): 44-49. https://dx.doi.org/10.1111/j.1365-2923.1996.tb00716.x.

Schuwirth, Lambert. 2002. "Can Clinical Reasoning Be Taught or Can It Only Be Learned?" *Medical Education* 36, no. 8: 695-696.

---. 2009. "Is Assessment of Clinical Reasoning Still the Holy Grail?" *Medical Education* 43, no. 4: 298-300.

Schuwirth, Lambert W. T., Steven J. Durning, and Svetlana M. King. 2020. "Assessment of Clinical Reasoning: Three Evolutions of Thought." *Diagnosis* 7, no. 3 (Sep): 191-196. https://dx.doi.org/10.1515/dx-2019-0096.

Scotland, James. 2012. "Exploring the Philosophical Underpinnings of Research: Relating Ontology and Epistemology to the Methodology and Methods of the Scientific, Interpretive, and Critical Research Paradigms." *English Language Teaching* 5, no. 9: 9-16. https://dx.doi.org/10.5539/elt.v5n9p9.

Seidel, Bastian M., Steven Campbell, and Erica Bell. 2015. "Evidence in Clinical Reasoning: A Computational Linguistics Analysis of 789,712 Medical Case Summaries 1983-2012." *BMC Medical Informatics and Decision Making* 15 (Mar 21). https://dx.doi.org/10.1186/s12911-015-0136-8.

Shahi, Rashmi, Lucie Walters, Helena Ward, Richard J. Woodman, and David Prideaux. 2015. "Clinical Participation of Medical Students in Three Contemporary Training Models." *Medical Education* 49, no. 12 (Dec): 1219-1228. https://dx.doi.org/10.1111/medu.12815.

Sherbino, J., K. Kulasegaram, E. Howey, and G. Norman. 2014. "Ineffectiveness of Cognitive Forcing Strategies to Reduce Biases in Diagnostic Reasoning: A Controlled Trial." *Canadian Journal of Emergency Medicine* 16, no. 1 (Jan): 34-40. https://dx.doi.org/10.2310/8000.2013.130860.

Sherbino, Jonathan, Steven Yip, Kelly L. Dore, Eric Siu, and Geoffrey R. Norman. 2011. "The Effectiveness of Cognitive Forcing Strategies to Decrease Diagnostic Error: An Exploratory Study." *Teaching and Learning in Medicine* 23, no. 1 (2011): 78-84. https://dx.doi.org/10.1080/10401334.2011.536897.

Sim, J. H., Y. F. Abdul Aziz, A. Mansor, A. Vijayananthan, C. C. Foong, and J. Vadivelu. 2015. "Students' Performance in the Different Clinical Skills Assessed in Osce: What Does It Reveal?" *Medical Education Online* 20, no. 26185. https://dx.doi.org/10.3402/meo.v20.26185.

Smythe, Elizabeth, and Deborah Spence. 2012. "Re-Viewing Literature in Hermeneutic Research." *International Journal of Qualitative Methods* 11, no. 1: 12-25. https://dx.doi.org/10.1177/160940691201100102.

Snow, Sarah C., Jennifer Gong, and Jennifer E. Adams. 2017. "Faculty Experience and Engagement in a Longitudinal Integrated Clerkship." *Medical Teacher* 39, no. 5: 527-534. https://dx.doi.org/10.1080/0142159X.2017.1297528.

Soh, Michael, Abigail Konopasky, Steven J. Durning, Divya Ramani, Elexis McBee, Temple Ratcliffe, and Jerusalem Merkebu. 2020. "Sequence Matters: Patterns in Task-Based Clinical Reasoning." *Diagnosis* 7, no. 3 (Sep): 281-289. https://dx.doi.org/10.1515/dx-2019-0095.

Stevens, Carl D., LuAnn Wilkerson, and Sebastian Uijtdehaage. 2014. "Longitudinal Continuity Experiences Can Repair Disconnects in the Core Clerkships for Medical Students." *Academic Medicine* 89, no. 2 (Feb): 205-207. https://dx.doi.org/10.1097/acm.0000000000000108.

Stieger, Stefan, Andrea Praschinger, Kurt Kletter, and Franz Kainberger. 2011. "Diagnostic Grand Rounds: A New Teaching Concept to Train Diagnostic Reasoning." *European Journal of Radiology* 78, no. 3 (Jun): 349-352. https://dx.doi.org/10.1016/j.ejrad.2009.05.015.

Stolper, Erik, Paul Van Royen, Edmund Jack, Jeroen Uleman, and Marcel Olde Rikkert. 2021. "Embracing Complexity with Systems Thinking in General Practitioners' Clinical Reasoning Helps Handling Uncertainty." *Journal of Evaluation in Clinical Practice* 27, no. 5 (Oct): 1175-1181. https://dx.doi.org/10.1111/jep.13549.

Swanson, David B., John J. Norcini, and Louis J. Grosso. 1987. "Assessment of Clinical Competence: Written and Computer-Based Simulations." *Assessment and Evaluation in Higher Education* 12, no. 3: 220-246. https://dx.doi.org/10.1080/0260293870120307.

Sweller, J. 1988. "Cognitive Load During Problem-Solving: Effects on Learning." *Cognitive Science* 12, no. 2 (Apr-Jun): 257-285. https://dx.doi.org/10.1016/0364-0213(88)90023-7.

Sweller, J., J. J. G. van Merrienboer, and Fgwc Paas. 1998. "Cognitive Architecture and Instructional Design." *Educational Psychology Review* 10, no. 3 (Sep): 251-296. https://dx.doi.org/10.1023/a:1022193728205.

Sweller, John, Jeroen J. G. van Merrienboer, and Fred Paas. 2019. "Cognitive Architecture and Instructional Design: 20 Years Later." *Educational Psychology Review* 31, no. 2 (Jun): 261-292. https://dx.doi.org/10.1007/s10648-019-09465-5.

Tanner, Kimberly D. 2012. "Promoting Student Metacognition." *CBE-Life Sciences Education* 11, no. 2 (Jun): 113-120. https://dx.doi.org/10.1187/cbe.12-03-0033.

Tavakol, M, and AA Zeinaloo. 2004. "Medical Research Paradigms: Positivistic Inquiry Paradigm Versus Naturalistic Inquiry Paradigm." *Journal of Medical Education* 5, no. 2: 75-80.

Taylor, David C. M., and Hossam Hamdy. 2013. "Adult Learning Theories: Implications for Learning and Teaching in Medical Education: Amee Guide No. 83." *Medical Teacher* 35, no. 11 (2013): E1561-E1572. https://dx.doi.org/10.3109/0142159x.2013.828153.

Taylor, Kelli, and Doug Rohrer. 2010. "The Effects of Interleaved Practice." *Applied Cognitive Psychology* 24, no. 6 (Sep): 837-848. https://dx.doi.org/10.1002/acp.1598.

Teherani, Arianne, David M. Irby, and Helen Loeser. 2013. "Outcomes of Different Clerkship Models: Longitudinal Integrated, Hybrid, and Block." *Academic Medicine* 88, no. 1 (Jan): 35-43. https://dx.doi.org/10.1097/ACM.0b013e318276ca9b.

Teherani, Arianne, Bridget C. O'Brien, Dylan E. Masters, Ann N. Poncelet, Patricia A. Robertson, and Karen E. Hauer. 2009. "Burden, Responsibility, and Reward: Preceptor Experiences with the Continuity of Teaching in a Longitudinal Integrated Clerkship." *Academic Medicine* 84, no. 10 Suppl (Oct): S50-S53.

Thomas, Aliki, Stuart Lubarsky, Lara Varpio, Steven J. Durning, and Meredith E. Young. 2020. "Scoping Reviews in Health Professions Education: Challenges, Considerations and Lessons Learned About Epistemology and Methodology." *Advances in Health Sciences Education* 25, no. 4 (Oct): 989-1002. https://dx.doi.org/10.1007/s10459-019-09932-2.

Tong, Allison, Peter Sainsbury, and Jonathan Craig. 2007. "Consolidated Criteria for Reporting Qualitative Research (Coreq): A 32-Item Checklist for Interviews and Focus Groups." *International Journal for Quality in Health Care* 19, no. 6 (Dec): 349-357. https://dx.doi.org/10.1093/intqhc/mzm042.

Torre, Dario M., Paul A. Hemmer, Steven J. Durning, Ting Dong, Kimberly Swygert, Deanna Schreiber-Gregory, William F. Kelly, and Louis N. Pangaro. 2021. "Gathering Validity Evidence on an Internal Medicine Clerkship Multistep Exam to Assess Medical Student Analytic Ability." *Teaching and Learning in Medicine* 33, no. 1 (Jan 1): 28-35. https://dx.doi.org/10.1080/10401334.2020.1749635.

Tran, Peter Duy, Jerome Martin Laurence, Kathryn M. Weston, and Peter L. McLennan. 2012. "The Effect of Parallel Consulting on the Quality of Consultations in Regional General Practice." *Education for Primary Care* 23, no. 3 (2012): 153-157. https://dx.doi.org/10.1080/14739879.2012.11494098.

Uy, Raymonde Charles, Raymond Francis Sarmiento, Alex Gavino, and Paul Fontelo. 2014. "Confidence and Information Access in Clinical Decision-Making: An Examination of the Cognitive Processes That Affect the Information-Seeking Behavior of Physicians." *AMIA Annual Symposium proceedings 2014*: 1134-1140.

Uygur, Jane, Ellen Stuart, Muireann De Paor, Emma Wallace, Seamus Duffy, Marie O'Shea, Susan Smith, and Teresa Pawlikowska. 2019. "A Best Evidence in Medical Education Systematic Review to Determine the Most Effective Teaching Methods That Develop Reflection in Medical Students: Beme Guide No. 51." *Medical Teacher* 41, no. 1 (Jan 2): 3-16. https://dx.doi.org/10.1080/0142159x.2018.1505037.

Valentine, N., S. J. Durning, E. M. Shanahan, C. van der Vleuten, and L. Schuwirth. 2022. "The Pursuit of Fairness in Assessment: Looking Beyond the Objective." *Medical Teacher* 44, no. 4 (Apr): 353-359. https://dx.doi.org/10.1080/0142159x.2022.2031943.

Valentine, Nyoli, Steven J. Durning, Ernst Michael Shanahan, and Lambert Schuwirth. 2023. "Fairness in Assessment: Identifying a Complex Adaptive System." *Perspectives on Medical Education* 12, no. 1 (2023): 315-326. https://dx.doi.org/10.5334/pme.993.

Valentine, Nyoli, Steven Durning, Ernst Michael Shanahan, and Lambert Schuwirth. 2021. "Fairness in Human Judgement in Assessment: A Hermeneutic Literature Review and Conceptual Framework." *Advances in Health Sciences Education* 26, no. 2 (May): 713-738. https://dx.doi.org/10.1007/s10459-020-10002-1.

van Baalen, Sophie, and Mieke Boon. 2015. "An Epistemological Shift: From Evidence-Based Medicine to Epistemological Responsibility." *Journal of Evaluation in Clinical Practice* 21, no. 3 (Jun): 433-439. https://dx.doi.org/10.1111/jep.12282.

Van der Vleuten, C. P., and D. I. Newble. 1995. "How Can We Test Clinical Reasoning?" *Lancet* 345, no. 8956: 1032-1034.

Van Merrienboer, Jeroen J. G., and John Sweller. 2010. "Cognitive Load Theory in Health Professional Education: Design Principles and Strategies." *Medical Education* 44, no. 1 (Jan): 85-93. https://dx.doi.org/10.1111/j.1365-2923.2009.03498.x.

Van Schalkwyk, S. C., J. Bezuidenhout, H. H. Conradie, T. Fish, N. J. Kok, B. H. Van Heerden, and M. R. De Villiers. 2014. "'Going Rural': Driving Change through a Rural Medical Education Innovation." *Rural and Remote Health* 14, no. 2 (Apr-Jun).

Van Schalkwyk, Susan, Elize Archer, Mariette Volschenk, and Julia Blitz. 2020. "Teaching Clinical Reasoning: A New Playbook." *Clinical Teacher* 17, no. 5 (Oct): 541-543. https://dx.doi.org/10.1111/tct.13231.

Varpio, Lara, and Mathieu Albert. 2013. "Am Last Page: How Pierre Bourdieu's Theory and Concepts Can Apply to Medical Education." *Academic Medicine* 88, no. 8 (2013-Aug): 1189-1189. https://dx.doi.org/10.1097/ACM.0b013e31829d5815.

Varpio, Lara, and Rachel H. Ellaway. 2021. "Shaping Our Worldviews: A Conversation About and of Theory." *Advances in Health Sciences Education* 26, no. 1 (Mar): 339-345. https://dx.doi.org/10.1007/s10459-021-10033-2.

Varpio, Lara, and Anna MacLeod. 2020. "Philosophy of Science Series: Harnessing the Multidisciplinary Edge Effect by Exploring Paradigms, Ontologies, Epistemologies, Axiologies, and Methodologies." *Academic Medicine* 95, no. 5 (May): 686-689. https://dx.doi.org/10.1097/acm.0000000000003142.

Varpio, Lara, Bridget O'Brien, Charlotte E. Rees, Lynn Monrouxe, Rola Ajjawi, and Elise Paradis. 2021. "The Applicability of Generalisability and Bias to Health Professions Education's Research." *Medical Education* 55, no. 2 (Feb): 167-173. https://dx.doi.org/10.1111/medu.14348.

Varpio, Lara, Elise Paradis, Sebastian Uijtdehaage, and Meredith Young. 2020. "The Distinctions between Theory, Theoretical Framework, and Conceptual Framework." *Academic Medicine* 95, no. 7 (Jul): 989-994. https://dx.doi.org/10.1097/acm.0000000000003075.

Walters, L., J. Greenhill, J. Richards, H. Ward, N. Campbell, J. Ash, and L.W.T. Schuwirth. 2012. "Outcomes of Longitudinal Integrated Clinical Placements for Students, Clinicians and Society." *Medical Education* 46 (October 2012): 1028-1041. https://dx.doi.org/10.1111.

Walters, Lucie, and Kathleen Brooks. 2016. "Integration, Continuity and Longitudinality: The 'What' That Makes Patient-Centred Learning in Clinical Clerkships." *Medical Education* 50, no. 9 (Sep): 889-891. https://dx.doi.org/10.1111/medu.13118.

Wamsley, Maria A., Nadine Dubowitz, Puja Kohli, Molly Cooke, and Bridget C. O'Brien. 2009. "Continuity in a Longitudinal out-Patient Attachment for Year 3 Medical Students." *Medical Education* 43, no. 9 (Sep): 895-906.

Watsjold, B. K., J. S. Ilgen, and G. Regehr. 2022. "An Ecological Account of Clinical Reasoning." *Academic Medicine* 97, no. 11S (Nov): S80-S86. https://dx.doi.org/10.1097/acm.0000000000004899.

Weaver, K., and J. K. Olson. 2006. "Understanding Paradigms Used for Nursing Research." *Journal of Advanced Nursing* 53, no. 4 (Feb): 459-469. https://dx.doi.org/10.1111/j.1365-2648.2006.03740.x.

Wells, L. A. 2015. "Clinical Thinking in Psychiatry." *Journal of Evaluation in Clinical Practice* 21, no. 3 (Jun): 514-517. https://dx.doi.org/10.1111/jep.12324.

Wenger, E. 2000. "Communities of Practice and Social Learning Systems." *Organization* 7, no. 2 (May): 225-246. https://dx.doi.org/10.1177/135050840072002.

Weston, K. M., D. L. Garne, J. A. Bushnell, and J. N. Hudson. 2018. "The Big City by-Pass: Origin Is Important in Medical Students' Preference for Future Practice in Regional Cities and Large Towns." *Focus on Health Professional Education - A Multidisciplinary Journal* 19, no. 1 (2018): 12-24.

Weston, W. W., J. B. Brown, and M. A. Stewart. 1989. "Patient-Centered Interviewing. 1. Understanding Patients Experiences." *Canadian Family Physician* 35 (Jan): 147-151.

Whitcomb, M. E. 2005. "Redesigning Clinical Education: A Major Challenge for Academic Health Centers." *Academic Medicine* 80, no. 7 (Jul): 615-616. https://dx.doi.org/10.1097/00001888-200507000-00001.

Wilcox, G., and M. Schroeder. 2015. "What Comes before Report Writing? Attending to Clinical Reasoning and Thinking Errors in School Psychology." *Journal of Psychoeducational Assessment* 33, no. 7 (Oct): 652-661. https://dx.doi.org/10.1177/0734282914562212.

Williams, Reed G., Debra L. Klamen, and Rebecca M. Hoffman. 2008. "Medical Student Acquisition of Clinical Working Knowledge." *Teaching and Learning in Medicine* 20, no. 1 (Jan-Mar): 5-10. https://dx.doi.org/10.1080/10401330701542552.

Williams, Reed G., Debra L. Klamen, Christopher B. White, Emil Petrusa, Ruth-Marie E. Fincher, Carol F. Whitfield, John H. Shatzer, Teresita McCarty, and Bonnie M. Miller. 2011. "Tracking Development of Clinical Reasoning Ability across Five Medical Schools Using a Progress Test." *Academic Medicine* 86, no. 9: 1148-1154.

Woods, N. N., and M. Mylopoulos. 2015. "On Clinical Reasoning Research and Applications: Redefining Expertise." *Medical Education* 49, no. 5 (May): 543-543. https://dx.doi.org/10.1111/medu.12643.

Worley, P., A. Esterman, and D. Prideaux. 2004. "Cohort Study of Examination Performance of Undergraduate Medical Students Learning in Community Settings." *British Medical Journal* 328, no. 7433 (Jan 24): 207-209. https://dx.doi.org/10.1136/bmj.328.7433.207.

Worley, P., D. Prideaux, R. Strasser, A. Magarey, and R. March. 2006. "Empirical Evidence for Symbiotic Medical Education: A Comparative Analysis of Community and Tertiary-Based Programmes." *Medical Education* 40, no. 2 (Feb): 109-116. https://dx.doi.org/10.1111/j.1365-2929.2005.02366.x.

Worley, P., C. Silagy, D. Prideaux, D. Newble, and A. Jones. 2000. "The Parallel Rural Community Curriculum: An Integrated Clinical Curriculum Based in Rural General Practice." *Medical Education* 34, no. 7 (Jul): 558-65.

Worley, Paul, Ian Couper, Roger Strasser, Lisa Graves, Beth-Ann Cummings, Richard Woodman, Pamela Stagg, David Hirsh, and Longitudinal Integrated Consortium. 2016. "A Typology of Longitudinal Integrated Clerkships." *Medical Education* 50, no. 9 (Sep): 922-932. https://dx.doi.org/10.1111/medu.13084.

Wu, B., M. Wang, J. M. Johnson, and T. A. Grotzer. 2014. "Improving the Learning of Clinical Reasoning through Computer-Based Cognitive Representation." *Medical Education Online* 19, no. 25940.

Wu, Bian, Minhong Wang, Tina A. Grotzer, Jun Liu, and Janice M. Johnson. 2016. "Visualizing Complex Processes Using a Cognitive-Mapping Tool to Support the Learning of Clinical Reasoning." *BMC Medical Education* 16 (Aug 22). https://dx.doi.org/10.1186/s12909-016-0734-x.

Yardley, Sarah, Pim W. Teunissen, and Tim Dornan. 2012a. "Experiential Learning: Amee Guide No. 63." *Medical Teacher* 34, no. 2: E102-E115. https://dx.doi.org/10.3109/0142159x.2012.650741.

---. 2012b. "Experiential Learning: Transforming Theory into Practice." *Medical Teacher* 34, no. 2: 161-164. https://dx.doi.org/10.3109/0142159x.2012.643264.

Young, John Q., Jeroen Van Merrienboer, Steve Durning, and Olle Ten Cate. 2014. "Cognitive Load Theory: Implications for Medical Education: Amee Guide No. 86." *Medical Teacher* 36, no. 5 (May): 371-384. https://dx.doi.org/10.3109/0142159x.2014.889290.

Young, Meredith, Valerie Dory, Stuart Lubarsky, and Aliki Thomas. 2018a. "How Different Theories of Clinical Reasoning Influence Teaching and Assessment." *Academic Medicine* 93, no. 9 (Sep): 1415. https://dx.doi.org/10.1097/acm.0000000000002303.

Young, Meredith, and Anna Ryan. 2020. "Postpositivism in Health Professions Education Scholarship." *Academic Medicine* 95, no. 5 (May): 695-699. https://dx.doi.org/10.1097/acm.0000000000003089.

Young, Meredith, Aliki Thomas, David Gordon, Larry Gruppen, Stuart Lubarsky, Joseph Rencic, Tiffany Ballard, Eric Holmboe, Ana Da Silva, Temple Ratcliffe, Lambert Schuwirth, and Steven J. Durning. 2019. "The Terminology of Clinical Reasoning in Health Professions Education: Implications and Considerations." *Medical Teacher* 41, no. 11 (Nov 2): 1277-1284. https://dx.doi.org/10.1080/0142159x.2019.1635686.

Young, Meredith, Aliki Thomas, Stuart Lubarsky, Tiffany Ballard, David Gordon, Larry D. Gruppen, Eric Holmboe, Temple Ratcliffe, Joseph Rencic, Lambert Schuwirth, and Steven J. Durning. 2018b. "Drawing Boundaries: The Difficulty in Defining Clinical Reasoning." *Academic Medicine* 93, no. 7 (Jul): 990-995. https://dx.doi.org/10.1097/acm.0000000000002142.

Young, Meredith, Aliki Thomas, Stuart Lubarsky, David Gordon, Larry Gruppen, Joseph Rencic, Tiffany Ballard, Eric Holmboe, Ana Da Silva, Temple Ratcliffe, Lambert Schuwirth, Valerie Dory, and Steven Durning. 2020. "Mapping Clinical Reasoning Literature across the Health Professions: A Scoping Review." *BMC Medical Education* 20, no. 1 (Apr 7). https://dx.doi.org/10.1186/s12909-020-02012-9.

Young, R. A., and A. Collin. 2004. "Constructivism and Social Constructionism in the Career Field." *Journal of Vocational Behavior* 64, no. 3 (Jun): 373-388. https://dx.doi.org/10.1016/j.jvb.2003.12.005.

Yudkowsky, R., Y. S. Park, A. Hyderi, and G. Bordage. 2015. "Characteristics and Implications of Diagnostic Justification Scores Based on the New Patient Note Format of the Usmle Step 2 Cs Exam." *Academic Medicine* 90, no. 11 Suppl: S56-S62.

Zaidi, Zareen, and Douglas Larsen. 2018. "Paradigms, Axiology, and Praxeology in Medical Education Research." *Academic Medicine* 93: S1-S7. https://dx.doi.org/10.1097/acm.0000000000002384.

Zheng, Juan, Shan Li, and Susanne P. Lajoie. 2020. "The Role of Achievement Goals and Self-Regulated Learning Behaviors in Clinical Reasoning." *Technology Knowledge and Learning* 25, no. 3 (Sep): 541-556. https://dx.doi.org/10.1007/s10758-019-09420-x.

Zink, T., B. Center, D. Finstad, J. G. Boulger, L. A. Repesh, R. Westra, R. Christensen, and K. D. Brooks. 2010. "Efforts to Graduate More Primary Care Physicians and Physicians Who Will Practice in Rural Areas: Examining Outcomes from the University of Minnesota–Duluth and the Rural Physician Associate Program." *Academic Medicine* 85, no. 4: 599-604.

Zink, Therese, Gwen W. Halaas, Deborah Finstad, and Kathleen D. Brooks. 2008. "The Rural Physician Associate Program: The Value of Immersion Learning for Third-Year Medical Students." *Journal of Rural Health* 24, no. 4: 353-359.