The development of design principles to guide the development of clinical reasoning in physiotherapy education

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Keywords

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Abstract

Clinical reasoning is enigmatic; however, students need to learn how to do it, educators need to be able to develop it, and experts need to explain how they do it. Health professions educators have described clinical reasoning as a skill required for health professionals. Clinical reasoning has been used synonymously with terms such as clinical judgement, critical thinking and clinical decision-making. Broadly speaking, clinical reasoning refers to the thought and decision-making processes associated with clinical practice and particularly choosing a course of action for a patient. Possible strategies for developing clinical reasoning and the use of certain learning tasks in the development of clinical reasoning in undergraduate health professions students have been highlighted. However, there are still areas of research to consider. The need for further research includes comparing clinical reasoning processes between physiotherapists with differing levels of experience, in order to provide an overall perspective on the development of clinical reasoning in students and in the curriculum. Furthermore, although clinical reasoning has been well studied, a continual reassessment of teaching methods is necessary to remain relevant. This provided the impetus for the current study. The aim of this thesis was to develop design principles that could guide the development of clinical reasoning in undergraduate physiotherapy students. The objectives to reach this aim were 1) to explore and describe the views of students, experts and lecturers on their understanding and process of clinical reasoning; 2) to explore and describe the learning tasks used by lecturers to develop clinical reasoning in their students; 3) to explore how theory influences the teaching strategies used for developing clinical reasoning in undergraduate health professions students; 4) to design a set of draft principles that could guide the development of clinical reasoning in undergraduate physiotherapy students; 5) to refine the draft design principles for clinical reasoning development, and 6) to recommend a final set of design principles that could guide the

development of clinical reasoning. The overall methodological framework used to conduct the study was design-based research. The use of design-based research in this study extended across four phases. Phase 1 was the identification and analysis of problems by researchers and practitioners. This phase makes use of both literature and stakeholder exploration. The researcher employed a qualitative approach and conducted interviews with students, experts and lecturers to gain insight into their understanding and process of clinical reasoning as well as the teaching strategies used by lecturers to enhance clinical reasoning. The outcome of this phase showed that the students, experts and lecturers understood clinical reasoning as a cognitive and mental process and that the clinical reasoning process included multiple components. The stakeholders also noted that there were internal and external factors that contributed to the development of clinical reasoning. Some of the internal factors highlighted were patient-centredness, and embracing uncertainty and vulnerability. The lecturers confirmed a variety of strategies such as case studies, scaffolding, questioning, reflection and feedback, which they used to develop clinical reasoning in their undergraduate physiotherapy students. As part of this phase, a scoping review was also conducted assessing the theoretical foundations which underpin the strategies to improve clinical reasoning. The scoping review demonstrated the importance of basing teaching strategies on theory. For this scoping review, constructivism was the overarching theory that underpinned the teaching strategies used in the included articles. Phase 2 was the development of prototypical solutions informed by theories, existing design principles, and technological innovations. The researcher conducted a document analysis using the findings from the scoping review and the interviews to refine solutions in practice and develop a set of draft design principles. Phase 3 involved iterative cycles of testing and refinement of solutions in practice. During this third phase, the draft design principles that were developed in the second phase were incorporated into a Delphi study which was sent to an expert panel of educators in the field of health professions education for their input on the draft design principles. The input from the panel was incorporated by the researcher and used to refine the draft design principles in order to produce a final set of principles for the development of clinical reasoning in undergraduate physiotherapy students. Phase 4 was the reflection phase to produce design principles and enhance solution implementation in practice. During this phase the final version of the designed principles is presented. The principles highlight that clinical reasoning development is not only dependent on the teaching environment or strategies used to enhance clinical reasoning; it also depends on the person who is attempting to develop the skill. Therefore, educators need to be aware of their own limitations and model that awareness to their students in order to develop a skill as complex as clinical reasoning.

Definition of terms

Clinical educator: A health professional paid by the university, who primarily engages in teaching and learning (on the clinical platform), maintains some clinical practice, and has variable degrees of involvement in research (Kumar et al., 2011).

Clinical placement: The placement of students in a clinical setting which provides them with opportunities to be confronted with patient problems and thus learn how to practise their clinical reasoning skills in a real-life context (Wijbenga et al., 2019).

Clinical reasoning: “Clinical reasoning (or practice decision-making) is a context-dependent way of thinking and decision-making in professional practice to guide practice actions. It involves the construction of narratives to make sense of the multiple factors and interests pertaining to the current reasoning task. It occurs within a set of problem spaces informed by the practitioner’s unique frames of reference, workplace context and practice models, as well as by the patient’s or client’s contexts. It utilises core dimensions of practice knowledge, reasoning and metacognition and draws on these capacities in others. Decision-making within clinical reasoning occurs at micro, macro and meta levels and may be individually or collaboratively conducted. It involves metaskills of critical conversations, knowledge generation, practice model authenticity and reflexivity” (Higgs et al., 2008, p. 4). For the purpose of this thesis clinical reasoning will embrace all the cognitive processes that are included in reasoning. Throughout the thesis various aspects of these cognitive processes may be referred to.

Clinical decision-making: “Clinical decision making is a continuous and evolving process in which data are gathered, interpreted, and evaluated in order to apply evidence to formulate a decision" (Tiffen et al., 2014, p. 400). Note: In this thesis clinical decision-making refers to the output of clinical reasoning.

Clinical judgement: The process of observation, reflection and analysis of data to reach a conclusion (van Graan et al., 2016). Note: In this thesis clinical judgement refers to the balance of all the data gathering activities in order to come up with a diagnosis and management plan for a patient.

Design-based research (DBR): A paradigm for the study of learning in context through the systematic design and study of instructional strategies and tools (The Design-Based Research Collective, 2003).

Diagnostic clinical reasoning processes: The part of procedural reasoning that deals with evaluation and identification of patient problems (Rogers & Holm, 1991).

Dual process theory: A theory thought to have two different routes to persuasion in making decisions. The first route is known as the central route and this takes place when a person is thinking carefully about a situation, elaborating on the information they are given, and creating an argument, now known as System 2 thinking, slow thinking. This route occurs when individuals are motivated. The second route is known as the peripheral route and this takes place when a person is not thinking carefully about a situation and uses shortcuts to make judgements, now known as System 1 thinking or intuitive thinking. This route occurs when an individual's motivation or ability are low (Petty & Cacioppo, 1986).

Educators: "Individuals who teach in academic and clinical settings, as well as those involved in educational planning, administration and/or research" (Thomas et al., 2019, p. 1013).

Health Professions Education (HPE): "HPE inculcates the profession-specific knowledge and skills, as well as generic competencies and attributes required to effect the scopes of practice of the different health professionals as mandated and regulated by the professional councils" (Academy of Science of South Africa, 2018). Note: In this thesis "medical education" is included under the more general HPE definition.

Heuristics: "Simple, efficient shortcuts applied in judgment and decision-making when people face overly complex tasks, have limited time or cognitive ability, or deal with incomplete information in the world" (Haselton et al., 2009, p. 738).

Hypothetico-deductive reasoning: A method in which clinicians pay attention to initial cues (information) from or about the patient. From these cues, cautious hypotheses are generated. After the hypothesis generation, there is an ongoing analysis of patient information in which further data are collected and interpreted. Continued hypothesis creation and evaluation take place as examination and management are continued and the various hypotheses are confirmed or negated (Edwards et al., 2004).

Illness scripts: "Hypothesised general knowledge structures that consist of three components: enabling conditions, a fault, and consequences. Enabling conditions are contextual and patient background factors that influence the probability that someone gets a disease. Examples of enabling conditions are age, sex, medical history, current medication, risk behaviour, hereditary factors, occupation, and living environment. These enabling conditions may contribute to the fault, the latter being the pathophysiological malfunctioning that constitutes the biomedical core of a disease. This fault may give rise to certain consequences: complaints, signs, and symptoms" (Feltovich and Barrows, 1984, cited by Custers et al., 1998, p. 369).

Learning theory: An explanation for why something has happened or how it happens. It aims to assist educators to understand both how knowledge is created and how people learn (Harasim, 2017).

Narrative clinical reasoning processes: Narrative reasoning would describe the patient's story. The story or narrative is the context for understanding the exact nature of the patient's problem (Neistadt, 1996).

Pattern recognition: A process in which the clinician identifies certain features of a case, and this recognition leads to the use of other relevant information. Pattern recognition is in the clinician's stored knowledge network (Edwards et al., 2004).

Uncertainty types: The first type results from incomplete mastery of available knowledge. No one can have all the skills and all knowledge regarding medicine at their command. The second depends on limitations in current medical knowledge. There is a myriad of questions that all health professionals no matter how well trained may struggle to answer. A third type of uncertainty derives from the first two. This consists of difficulty in distinguishing between personal ignorance or incompetence and the limitations of present medical knowledge (Merton et al., 1957).

Vulnerability: "Uncertainty, risk, and emotional exposure" (Brown, 2012, p. 29). Note: In this thesis *vulnerability* is defined as the acceptance of uncertainty.

Declaration

I declare that this work entitled *The development of design principles to guide the development of clinical reasoning in physiotherapy education* is my own work. It has not been submitted for any degree or examination in any other university, and that all the sources I have used or quoted have been indicated and acknowledged by complete references.

Name: Danelle Hess   Date: November 2021

Witness: Associate Professor Michael Rowe

Signed: Date: November 2021

Dedication

For my Dad, who I miss so much.

For my daughters, Jorja, Rylee and Ava. You are the reasons I work and attempt to make a greater contribution to the world we live in every day. I don't always get it right but I will keep on trying for you.

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Finally, thank you to my Creator. With whom all things are possible.

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Chapter 1: Background and literature review

1.1 Introduction to the chapter

In this introductory chapter the background and literature review are combined to provide a context for the study which culminates in the rationale and problem statement. The background and literature review introduce the definition of clinical reasoning and its synonyms, the process of decision-making (and thinking), some strategies for developing clinical reasoning and how clinical reasoning might be developed in students. These are presented along with the main and subsidiary research questions, and the aim and objectives of the study. The chapter concludes with the significance of the study and an outline of each of the chapters.

1.2 Background

The theoretical foundation of clinical reasoning has been researched ever since 1971 (Round, 2001). This research has stemmed from various perspectives such as psychology, clinical psychology, clinical practice and clinical education (Round, 2001). Therefore, the study of clinical reasoning has spanned many decades. Clinical reasoning is associated with thought processes and decision-making which are integral to clinical practice (Audétat et al., 2013). After health professions students have spent time learning theory, it is customary to engage them in clinical practice (also referred to as clinical clerkships in medical education) which exposes students to the real-life patient context (Rudaz et al., 2013). In the study by Rudaz et al. (2013) clinical reasoning is identified as a vital clinical competency in both the diagnostic and decision-making process, and in patient management. Producing a management plan for a patient and making a clinical diagnosis is fundamental to healthcare; for this reason, developing clinical reasoning is of critical importance (Durning et al., 2013).

1.2.1 Clinical judgement, decision-making, problem-solving and reasoning

Health professions education includes the development of both theoretical knowledge and practical skills in undergraduate health professions students and therefore aims to graduate professionals who are capable across areas of knowledge, attitudes and skills (Academy of Science of South Africa, 2018; Thibault, 2020). Skills such as understanding human anatomy and physiology, the pathogenesis of disease, communication and diagnostic and therapeutic decision-making are the predominant focus of health professions education (Thibault, 2020). Healthcare providers make clinical decisions based on the patient's objective and subjective presentation, via clinical reasoning (the thought process), which is known as clinical judgement. According to Kienle and Kiene (2011, p. 58), "Clinical judgment is developed through practice, experience, knowledge and continuous critical analysis. It extends into all medical areas namely diagnosis, therapy, communication and decision-making." One of the important roles of health professions educators, specifically clinical educators, is to provide the links between theory and practice (Voges & Frantz, 2019). In this way, they contribute to developing clinical judgement and more specifically the clinical reasoning processes among students (Delany & Golding, 2014).

Clinical reasoning as a term has been and still is used interchangeably with a variety of synonyms such as clinical decision-making, clinical problem-solving, clinical judgement and clinical rationale (Case et al., 2000). The idea of clinical reasoning is often demonstrated and put into use differently depending on the context (Young et al., 2020). Therefore, clinical reasoning has many different descriptions. It has been described as the total thinking and decision-making processes associated with clinical practice, a vital skill central to the practice of professional autonomy which enables practitioners to take the best judged action in a specific context (Higgs et al., 2008). It has also been defined as the establishment of the diagnosis and the process of decision-making with regard to a plan of action for the patient (Hastie, 2001). Clinical reasoning is the integration of the health practitioner's (biomedical and clinical) knowledge and initial patient information to establish a case representation of the problem (Gruppen, 2017). Although the decision-making process within clinical reasoning is prominent, it is not only the view of the practitioner but includes the input of the patient as well (Higgs et al., 2008). Clinical reasoning stands out as a situated, practice-based form of reasoning that necessitates a scientific and technological research-based knowledge foundation about general cases (Benner et al., 2008). It requires a practical ability to distinguish the importance of the evidence behind general, scientific and technical knowledge and how it applies to a particular patient (Benner et al., 2008). Consequently, while clinical reasoning is a complex and ambiguous process (Durning et al., 2011) it is a process that remains imperative for health professionals.

Clinical decision-making refers to the procedure of selecting a course of action (Hastie, 2001) and can be considered a part and a consequence of clinical reasoning and problem-solving in clinical reasoning (Noll et al., 2001; Smith et al., 2008). This could be interpreted as accurate decision-making being dependent on the ability to reason in the clinical context. According to Groves et al. (2003), expert clinical reasoning requires the identification and interpretation of relevant clinical information and synthesis for diagnostic accuracy. Norman (2005) also highlights that reasoning ability has a key influence on the accuracy of the decisions reached. In order for healthcare professionals to provide competent and effective patient management, clinical decision-making is necessary (Noll et al., 2001).

Clinical decision-making, however, can be problematic owing to human limitation, as human reasoning is susceptible to predictable error (Redelmeier et al., 2001). When health practitioners make errors, they are most often errors of reasoning or decision quality (failure to elicit, synthesise, decide, or act on clinical information) (Scott, 2009). Errors are likely to result from a lack of clinical reasoning and an interaction between knowledge deficits and processing problems (Norman & Eva, 2010). Diagnostic errors also occur as a result of the clinician not listening to the patient’s story or believing that the patient's presentation is too complex (Scott, 2009). These errors then appear in the patient management and occur as a result of the clinician thinking a specific treatment would work because it worked for a similar patient in the past (Scott, 2009). Redelmeier et al. (2001) place the reasons for the tendency to make mistakes in three categories: intellectual factors, the lack of checking for errors, and environmental factors. As examples, Redelmeier et al. (2001) suggest that overconfidence is an example of intellectual factors, reluctance to change one's initial opinion is an example of lack of checking errors, and lack of awareness of limits of judgement is an example of environmental factors. Quality decision-making is an essential component of clinical practice and can assist in fewer errors being made during patient interaction (Smith et al., 2008), leading to fewer concerns around patient safety.

In their 1998 study, Rimoldi and Raimondo recommended that clinical problem-solving is improved with increased clinical experience. Similarly, Vyas et al. (2011) suggest using more hands-on clinical opportunities to develop problem-solving. In order to make safe and satisfactory treatment decisions for patients, clinicians require both general and specific problem-solving strategies (Kiesewetter et al., 2016). However, according to Elstein and Schwarz (2002) clinical problem-solving is dependent on how difficult the case is, and the clinician's knowledge of the content and of strategies to address the problem. Kiesewetter et al. (2016) summarise and confirm some of the thoughts of Elstein and Schwarz (2002) by highlighting that clinical problem-solving is influenced by conceptual knowledge (basic knowledge relevant to a discipline to solve problems), strategic knowledge (how to execute something), conditional knowledge (understanding the basic elements and how they fit into a bigger system) and finally metacognitive knowledge (knowledge about one's own knowledge: awareness of what one knows and does not know). The authors conclude that when health professions educators consider strategies for promoting clinical reasoning, it is important not only to focus on the specific knowledge categories but, more importantly, to focus on the sequence of stimulating or activating these knowledge categories. Accordingly, clinical judgement, clinical reasoning and clinical decision-making are key aspects of managing patients. However, clinical judgement and error contribute to the complexity of clinical reasoning in clinical practice. The complexity of clinical reasoning furthermore arises from the involvement of hypothesis formation and testing to confirm or disprove the hypothesis (Noll et al., 2001) and the fact that human reasoning sometimes depends on fast intuitive processing and heuristics owing to the nature of thinking and memory (Norman et al., 2017).

1.2.2 The process of thinking and decision-making

Clinical practice is secured in and framed by the decisions that clinicians make (Muoni, 2012). Furthermore, the clinician has a responsibility to provide safe, high quality patient care which is dependent on an ability to reason, think, and judge (Tay et al., 2016). Durning et al. (2013) believe that clinical reasoning involves both the mental processes and the behaviour exhibited in terms of diagnostic decisions. The link between the clinician's knowledge and clinical practice is therefore dependent on the ability of the clinician to solve clinical problems through clinical reasoning (Linsen et al., 2018). Multiple segments of data from diverse contexts are involved in making an accurate diagnosis and because this is a cognitive process which is often innate to the clinician, it is sometimes difficult to describe how or why the clinician came to a particular conclusion (Rylander & Guerrasio, 2016). Norman (2000) questions whether clinical reasoning is understandable by appreciating the integration of symptoms and diseases (more external) or whether it is understandable only by examining mental processes in detail (more internal).

When examining mental processes, thinking can be classified into two types. Kahneman (2011) explains that the brain has two characteristics; one is fast thinking (System 1) and the other is slow thinking (System 2). System 1 operates automatically and intuitively (pattern recognition) whereas System 2 operates slowly, deliberating, solving problems and reasoning (deductive reasoning) (Kahneman, 2011). Norman et al. (2017) and Tay et al. (2016) have followed this interpretation in their work, but use the terms Type 1 and Type 2 to describe these characteristics of the brain. When clinical problems are straight-forward and time is against the clinician, Type 1 takes effect (Pelaccia et al., 2011; Tay et al., 2016). Therefore, the choice to use either the intuitive or the analytical system is dependent on the situation the clinician is presented with (Pelaccia et al., 2011). Errors originate either from heuristics employed in Type 1 and not corrected by Type 2, or from both processes (Norman et al., 2017). A possible example of this type of heuristic error is presented by Ely et al. (2011) as the tendency to perceptually fixate on obvious features of the patient's presentation too early in the diagnostic process (fast thinking) and then subsequently failing to adjust the first impression in light of the development of information. According to Ely et al. (2011) this heuristic is known as anchoring. Heuristics are “simple, efficient shortcuts applied in judgment and decision-making when people face overly complex tasks, have limited time or cognitive ability, or deal with incomplete information in the world” (Haselton et al., 2009, p. 738). Heuristics are essentially associated with decision-making, problem-solving, guidelines, mental shortcuts and cognitive strategies (Muoni, 2012).

Students can accumulate clinical cases in order to develop a mental database early on, which could result in a firm foundation on which to allow non-analytic processes to contribute to decision-making (Eva, 2005). Exposure to many different types of clinical cases will allow the development of health professions students’ intuition through the building of patterns in their long-term memory (Pelaccia et al., 2011). These are also known as illness scripts. These illness scripts can, however, only develop in students’ memory while they frequently apply previously acquired knowledge of the underlying causes of diseases to understand patients’ problems (Linsen et al., 2018). Students depend mostly on an analytical way of reasoning by attempting to apply their theoretical (biomedical) knowledge, gained in the early years of their education, and gradually move on to using clinical knowledge to solve clinical problems (Linsen et al., 2018). Consequently, choosing whether to use Type 1 or 2 thinking in a given clinical situation depends on the complexity of the circumstances in relation to the individual’s capabilities, past experiences, and self-confidence (Tay et al., 2016).

There has traditionally been a focus on utilising the analytical pathway in teaching clinical reasoning; however, it seems that there is a non-analytical base of clinical reasoning present (Eva, 2005; Linsen et al., 2018). Eva (2005) found that both forms of processing are not mutually exclusive, that both contribute to the final decisions reached in all cases (for both novices and experts), and that ultimately the ideal form of clinical reasoning should perhaps consist of both analytic and non-analytic processes. This is supported by Ark et al. (2006) suggesting that educators should not guard against the use of non-analytic reasoning strategies. Therefore, the ideal form of clinical reasoning should perhaps consist of both analytic and non-analytic processes.

1.2.3 Possible strategies for developing clinical reasoning skills

Many different approaches to developing clinical reasoning exist and the choice of approach seems to be more dependent on the educator's taste rather than what is needed in a specific situation (Schmidt & Mamede, 2015).

Problem-based learning (PBL) is a very explicit approach to medical education which is supported by an array of instruments developed to facilitate a particular teaching and learning process (Barrows & Tamblyn, 1980). It has been advocated as a strategy to promote clinical problem-solving in authentic learning situations Yew and Goh (2016) although the evidence in support of its effectiveness is unclear. Khanyile and Mfidi (2005) report that PBL did not improve clinical reasoning in nursing students and that the gap between theory and practice still remained. However, Scaffa and Wooster (2004) found that PBL significantly improved clinical reasoning in final year occupational therapy students. One reason for PBL not enhancing clinical reasoning might be that the numbers of cases presented in the curricula are often limited (Schmidt & Mamede, 2015). However, the PBL strategy can be successful because it encourages students to work together and enhances their self-directed learning (Aldarmahi, 2016).

In dentistry, various strategies have been used to enhance clinical reasoning among their students. Postma and White (2015) found that the use of a case-based approach within the 4C/ID-model is useful and McMillan (2010) found that conceptual learning can facilitate the development of clinical reasoning. The 4C/ID is a four-component instructional design model that prescribes instruction for learning in a complex environment and focuses on incorporating requisite skills and creating a learning environment (van Merriënboer et al., 2002). Consequently, the 4C/ID-model has been used by Verheyden et al. (2011) to support physiotherapy students in complex learning by constructing learning and learning processes based on realistic and complete handling requirements during assessment of how physiotherapy competencies alongside theories could be developed in an educational physiotherapy programme. When students use concept maps to represent their understanding of the basic sciences in the pre-clinical context it contributes to the development of conceptual frameworks that can be transferred to the clinical context (McMillan, 2010). Conceptual learning is the gathering and application of new knowledge that helps to make connections between two previously disparate ideas (Maclellan, 2005). These concept maps are predominantly a classroom activity and can be used to illustrate relationships between biomedical concepts and clinical concepts. Concept maps used in the classroom environment add value by establishing the students' level of understanding of concepts before exposing them to clinical practice and can decrease knowledge gaps (Joseph et al., 2017).

Another widely used strategy to promote clinical reasoning is reflection. According to Donaghy and Morss (2000), decision-making and confidence in clinical decision-making can be facilitated by applying a reflective practice framework. Reflection is looking back on an experience, which indicates either an awareness of an event or experience which includes the awareness of an action associated with the experience (Mezirow, 1998). Delany and Watkin (2009) demonstrated that a shift in the curriculum that included both time and support to expose students to the skills of reflection as a component of professional clinical learning was necessary. Accordingly, reflection proved to be a worthwhile component of early clinical education. Metacognition is also known as reflective self-awareness and is part of reflection. It aims to bridge knowledge and cognition and may involve reflecting on and critiquing data collection processes and results, while considering various strategies of reasoning (Higgs et al., 2008). Metacognition refers to the "kinds of processes involved, and the self-knowledge gained, in thinking about, and in controlling, one's own thinking" Proust (2010, p. 989) and has been identified as an important part of clinical reasoning (Tan et al., 2010). Exposing students to more clinical cases increases the importance of metacognitive knowledge and decreases the application of conceptual and strategic knowledge (Kiesewetter et al., 2016). Therefore, when medical educators design interventions to foster clinical reasoning, it is vital to rather focus on the use of the right sequences of knowledge at the right time, including the application of metacognition (Kiesewetter et al., 2016).

A review by Eva (2005) recommends that real-world examples (provided by educators) would help students build a mental database of cases, and that clinicians should share novel cases with students, as working through textbook cases where the answer is known does not always enable the student to determine whether or not they would be able to recognise the case if it were to show up in clinical practice. Eva (2005) concludes that just because a student has provided an accurate diagnosis and management plan, an assumption that students understand the physiological mechanisms and underlying processes should not be made.

More recently Guerrero (2019) mentions steps to guide clinical reasoning in nursing students. The steps in the process of clinical reasoning involve skills such as observation, collecting information, processing the information, deciding on a plan, activating the plan, evaluating and reflecting on the plan. The author indicates that clinical reasoning happens on a daily basis and is accompanied by clinical decision-making and clinical judgement (Guerrero, 2019).

1.2.4 Developing clinical reasoning in students

A number of different approaches and views regarding the development of clinical reasoning in the undergraduate curriculum exist. Support for the development of clinical reasoning in both the classroom and the clinical domain is available.

Van Wyngaarden et al. (2019) recently illustrated that nurse educators have a responsibility to facilitate the development of clinical reasoning skills in the classroom environment. However, earlier work by May et al. (2010) questioned the effectiveness of classroom teaching strategies such as problem-solving and case studies and their related classroom activities in assisting in the development of clinical reasoning. May et al. (2010) further doubted the existence of educational methods that could sharpen clinical reasoning skills at the undergraduate level. Cruz et al. (2012a) suggest that the emphasis placed on theoretical knowledge and technical skills in the physiotherapy curriculum may result in a narrow focus on patient symptoms, impairment, and functional problems in clinical practice. Gilliland and Wainwright (2017) assessed clinical reasoning development in physiotherapy students in the United States, and the students demonstrated a particularly impairment-based focus in clinical practice. The authors conclude that these findings could be problematic for the holistic management of the patient (Gilliland & Wainwright, 2017). The study by

Cruz et al. (2012a) also demonstrates minimal integration of patients' problems with their needs, lifestyles and environments. A contribution to the literature by Furze et al. (2015a) indicates that the learning setting was too focused on certainty or student formulation of the correct answer, and less on student engagement in the thoughtful critical analysis of their own thinking and the learning process. This could be why van Wyngaarden et al. (2019) recently demonstrated that student nurses still needed assistance with applying theoretical knowledge to specific clinical circumstances.

Rencic et al. (2017) point out that clinical instruction commences during the pre-clinical years, focusing on the patient interview, the physical examination and pathology. However, the authors find that these aforementioned courses do not explicitly address the clinical reasoning process in a structured manner and that clinical reasoning abilities are better promoted through the patient interaction and exposure to a more experienced role model during the clinical placement (Rencic et al., 2017). The experience during clinical practice provides the opportunity for theory to merge into practice and for students to learn to assimilate the knowledge and skills of the profession (Ernstzen et al., 2009). This is explained by the situated cognition learning theory, which claims that thinking transpires from individuals acting in harmony with their environment (Holmboe & Durning, 2014). It has been widely reported that the development of clinical reasoning was facilitated by the clinical educator in clinical practice (Bowen, 2006; Delany & Golding, 2014; Wijbenga et al., 2019). Schmidt and Mamede (2015) agree that the acquisition of the capacity to reason clinically has usually been left to clinical rotations because it is where the students see real patients for the first time and need to apply their wide-ranging theoretical knowledge. In their study, Delany and Golding (2014) demonstrated that when clinical educators made thinking visible to Australian physiotherapy students, the clinical reasoning process was facilitated and made accessible to the students. Bowen's study of 2006 presented multiple strategies for clinical educators. These included reasoning aloud for students to hear what the thinking process was for a particular case or patient, modelling behaviour to students (for example, modelling the history-taking), providing the student with cognitive feedback, and encouraging students to review both final and hypothesised patient diagnoses. Furthermore, Bowen (2006) suggests that the clinical educator diagnoses both the patient and the student's ability when engaging in bedside teaching, whereas Delany and Golding (2014, p. 2) propose a specific skill to "make thinking visible" to the student to facilitate clinical reasoning in clinical practice. The challenge facing clinical educators is perhaps even greater because not only must clinical educators be capable of performing all the tasks listed above, but they must also find a way to convey their knowledge and reasoning strategies to novice diagnosticians to nurture each student's own development of expertise (Eva, 2005).

Students complete various modules in their undergraduate education and are expected to apply concepts from those modules in their clinical practice. However, it must be noted that the classroom and clinical settings are very different from each other, offering completely separated learning environments.

The classroom embodies controlled learning conditions where activities are usually planned and structured, while the clinical environment is unplanned and requires flexibility (Ernstzen et al., 2014). Therefore, it seems that a careful balance of both the classroom and the clinical activities could be considered when attempting to develop clinical reasoning.

1.2.5 The need for further research

Smart and Doody (2006) suggest that further research should seek to describe, compare and contrast the clinical reasoning process by physiotherapists with varying levels of experience to possibly provide an overall perspective of clinical reasoning. Smith et al. (2008) emphasise a need for a more comprehensive range of intricate clinical reasoning and decision-making skills for both students and new graduates. Furthermore, Smith et al. (2008) propose a collection of dynamic reasoning processes rather than a single process of making a fixed choice among a limited number of alternatives involved in clinical decision-making in physiotherapy. Increasingly, clinical decision-making has been understood as requiring more complex reasoning than incorporated by hypothetico-deductive reasoning or pattern recognition; therefore, it is pertinent to the physiotherapy profession to thoroughly understand the nature of clinical decision-making as the complexity of the process calls for deeper investigation to more fully understand its nature (Smith et al., 2008).

Cruz et al. (2012b) state that strategies to enhance the development of clinical reasoning are warranted as areas of research because clinical reasoning is an essential aspect of clinical competence, and abilities such as critical thinking (which go beyond technical profession-specific skills) are needed. Durning et al. (2013) suggest that new perspectives on clinical reasoning are necessary for the advancement of the field. Furze et al. (2015a) highlight the minimal development of the clinical reasoning process in physiotherapy students; they propose guidelines be produced for the development of the student clinical reasoning process and strategies to facilitate the learning process in both the classroom and clinical sections of the curriculum. This is recommended as educators are responsible for establishing strong clinical reasoning skills to meet the demands of clinical practice in order to prepare competent, effective physiotherapists (Furze et al., 2015a). Similarly, Schmidt and Mamede (2015) report that research related to teaching clinical reasoning is limited and that a clinical reasoning curriculum as part of undergraduate training would be welcomed. Owing to the difficulty associated with preparing students for clinical practice, creating guidelines for the development of clinical reasoning might facilitate consistent educational outcomes for new physiotherapy graduates (Christensen et al., 2017). The findings from the study by Christensen et al. (2017) demonstrate a lack of information related to the learning of clinical reasoning in physiotherapy education; participating physiotherapy education programmes all agreed that clinical reasoning was an important component of a curriculum, but there were differences in the ways in which clinical reasoning was taught. Therefore, Christensen et al. (2017) conclude that research is needed to assist in improving the focus and quality of clinical reasoning instruction. Rencic et al. (2017) further observe that standards and objectives regarding the teaching of clinical reasoning could be used to guide curricular design efforts. Finally, most recently, Sole et al. (2019) emphasise that continual reassessment and revision of teaching methods are needed to maintain an updated perspective on clinical reasoning development.

The literature therefore highlights the need for an updated understanding of the processes of clinical reasoning, the uncertainty regarding the teaching methods related to clinical reasoning, and the necessity of continued research to remain relevant. These conclusions demonstrate a need to assess what reasoning strategies are being used by educators, in order to establish teaching methods to support the development of clinical reasoning. Consequently, the present study aims to develop design principles that could guide the development of clinical reasoning in undergraduate physiotherapy students.

1.3 Problem statement

According to the South African Society of Physiotherapy, physiotherapists are first line practitioners and must be able to make well-informed decisions about patient care and the complexities that come with patient care. As previously highlighted, clinical reasoning is a cognitive process that is used to make informed decisions about patient management and these decisions affect the outcomes of patient care. However, literature suggests that clinical reasoning develops over time and is consequently lacking in newly qualified and student physiotherapy populations. Clinical reasoning in the undergraduate student population and its development in physiotherapy undergraduate programmes is not well understood, particularly from the student's perspective. It is therefore essential that physiotherapy students are adequately introduced to the difficulties that surround reasoning and decision-making as they will become first line practitioners. This thesis therefore attempts to create a guideline for developing clinical reasoning in undergraduate physiotherapy students.

1.4 Research question

What design principles could guide the development of clinical reasoning in undergraduate physiotherapy students?

1.4.1 Secondary research questions

1. What is the understanding and process of clinical reasoning in physiotherapy students, experts in the field of physiotherapy and lecturers teaching physiotherapy?
2. What are lecturers' beliefs regarding the strategies used to develop clinical reasoning in undergraduate physiotherapy students?
3. How does theory influence the teaching strategies used for developing clinical reasoning in undergraduate health professions students?
4. What are the draft design principles for the development of clinical reasoning in undergraduate physiotherapy students?
5. How are the draft design principles refined?

6. What is the final set of design principles that could guide the development of clinical reasoning in undergraduate physiotherapy students?

1.5 Research aim

The research aim of the study is to develop design principles that could guide the development of clinical reasoning in undergraduate physiotherapy students.

1.6 Objectives

The following are the objectives of this study:

1. to explore and describe the views of students, experts and lecturers on their understanding and the process of clinical reasoning;
2. to explore and describe the learning tasks used by lecturers to develop clinical reasoning in their students;
3. to explore how theory influences the teaching strategies used for developing clinical reasoning in undergraduate health professions students;
4. to design a set of draft principles that could guide the development of clinical reasoning in undergraduate physiotherapy students;
5. to refine the draft design principles for clinical reasoning development; and
6. to recommend a final set of design principles that could guide the development of clinical reasoning.

1.7 Significance of the study

Developing clinical reasoning is challenging for health professions educators. This could be a consequence of the natural invisible nature of the clinical reasoning process, its complexity, and the vast number of definitions for clinical reasoning. Sound clinical reasoning could translate into good clinical decision-making that will ultimately benefit patients because it would lead to acceptable outcomes for the patients. Building capacity in others is the core responsibility of an educator. For this reason, assisting the profession to create guidelines for developing clinical reasoning will perhaps benefit health professions as well as future physiotherapy students who will eventually become first line practitioners. For researchers and educators, this research might result in tools to assist both undergraduate students in developing their thinking and problem-solving abilities, and other health professions educators as they continue the quest to develop clinical reasoning in undergraduate health professions students.

1.8 Conclusion

Chapter 1 provides an overview of clinical reasoning and the synonyms frequently used when describing clinical reasoning. It also outlines a review of the decision-making process, strategies that have been described in the literature to develop clinical reasoning, literature related to the development of clinical reasoning, and attempts to highlight the gap in which the current study is situated. The problem statement, research question, aim, objectives, and significance of the study are also presented. Chapter 2 will offer an in-depth explanation of the methods used to conduct the study.

1.9 Summary of chapters

Chapter 1

This introductory chapter is combined with the literature review to provide an overview of the topic. The chapter discusses the various synonyms for clinical reasoning that have been used throughout the literature. Concepts such as thinking and decision-making are expanded. A review of publications related to the development of clinical reasoning and the teaching strategies; such as problem-based learning, case-based approaches using the 4C/ID model, concept maps and reflection, is also included. The chapter concludes with presenting the need for the current study, the problem statement, significance of the study, study aim and the objectives of the study.

Chapter 2

Chapter 2 provides a background for and detailed explanations of the methodological framework, design-based research (DBR), for the study. The chapter describes the structure of the study, separated into phases. The four phases are Phase 1: problem identification (which consists of two stages), Phase 2: development of the solution, Phase 3: cycles of testing and Phase 4: reflection to produce design principles. Each of the study’s four phases has its own data collection methods. The chapter describes and provides clarification regarding the choices made to collect the data, and discusses the data collection and analysis during the four phases of the study. In addition, the population and sampling methods, research setting and ethical considerations are reported on. Trustworthiness and reflexivity are also discussed in this chapter.

Chapter 3

The thesis does not have a designated results chapter. Instead, the results of the study are presented in chapters 3 to 7. Chapter 3 highlights the results of the first stage of Phase1, problem identification, and is based on the interviews conducted with the students, experts and lecturers regarding their understanding and process of clinical reasoning. The chapter has an introduction and literature review, a brief summary of the methods used, the results, a discussion of the results and a conclusion. The results demonstrate the themes, sub themes, and supporting quotes for the understanding and process of clinical reasoning in the stakeholders.

Chapter 4

This chapter continues to report on problem identification of the data collection process, but in this case, the results discussed in the chapter are the strategies used by the lecturers to enhance clinical reasoning in the students. This chapter also consists of an introduction and literature review, a brief reference to the methodology, the results, a discussion of the results and a conclusion to the chapter. The results in this chapter are also presented by using the themes, sub themes and supporting quotes to highlight the strategies to develop clinical reasoning used by lecturers.

Chapter 5

The results presented in this chapter still report on the first phase of the study, problem identification, now in its secondary stage. Chapter 5 presents the results of a scoping review which was conducted to explore how theory influences the teaching strategies used for developing clinical reasoning. Similar to the previous chapters, there is an introduction and literature review, and a shortened version of the methodology. The results are presented narratively, summarised in a table, and discussed to bring the chapter to a close.

Chapter 6

The draft design principles and consequently the second phase of the study, the development of the solution, are presented in this chapter. This data was collected via a document analysis, which culminated in the production of a set of draft design principles for the development of clinical reasoning. The chapter also includes an introduction and literature review, a brief explanation of the methodology followed, the draft design principles and a discussion of the findings.

Chapter 7

Chapter 7 reports on the third phase of the study, namely cycles of testing and refinement of the solution. This chapter therefore displays the results of the Delphi study conducted on an expert panel, a group of health professions educators, to test and refine the draft design principles. The chapter encompasses an introduction and literature review, a brief explanation of the methods, the results of the Delphi study and a discussion of the findings. The final set of design principles are then presented in this chapter.

Chapter 8

This is the final chapter in the thesis and presents the conclusion of the study, any limitations that the researcher encountered and recommendations for future research. The researcher highlights the main findings of each of the individual studies and how they relate to one another.

Chapter 2: Methodology

2.1 Introduction

The previous chapter provided the background, aims and objectives of the current study as well as a review of the literature. This chapter provides an overview of the study methods used to develop the principles that may guide the development of clinical reasoning in physiotherapy students. The study was conducted in four phases, each of which is explained below.

2.2 Research setting

The study was conducted in the Physiotherapy Department of the University of the Western Cape (UWC) in Cape Town, South Africa. The university is located in Bellville, Cape Town, South Africa. The UWC Physiotherapy Department is one of nine departments and schools within the Faculty of Community and Health Sciences. The Physiotherapy Department was established in 1983 and has a proud history of community engagement and professional development of physiotherapists from all over the African continent.

2.3 Methodological framework

Design-based research (DBR) was the overarching methodological framework (Kennedy-Clark, 2013) chosen for this study. According to Herrington et al. (2007), DBR in itself is not a methodology, but a research framework. DBR is therefore seen as a series of approaches, rather than a single approach, with the aim of producing new theories, artefacts, or practices that account for and potentially impact learning and teaching in naturalistic settings (Barab & Squire, 2004). This overarching framework makes use of different methods and has the power to generate knowledge that directly applies to educational practice (The Design-Based Research Collective, 2003) as the focus is largely on the design and testing of an educationally significant intervention (Anderson & Shattuck, 2012).

DBR allows for collaboration between practitioners and researchers which could generate the development of knowledge that can be used in practice and to inform future practice (Wang & Hannafin, 2005). Similarly, Anderson and Shattuck (2012) note that because DBR is situated in a real educational context, it provides a "sense" of validity to the research and allows the researcher to attempt the effective use of the results to assess, inform, and improve practice in at least one context. It also allows for the integration between practice and theory (Anderson, 2005). DBR raises important questions for research that is applied to practice (The Design-Based Research Collective, 2003) and possesses features such as the production of an end result, the fact that it occurs in naturalistic contexts and is iterative in nature (Barab & Squire, 2004). Additionally, DBR acknowledges the disarray of real-world practice, and involves flexible design revision, multiple dependent variables, and capturing social interaction (Barab & Squire, 2004). Finally, DBR endeavours to create and advance a set of theoretical constructs that transcend the environmental specifications of the contexts in which they were generated, selected, or refined. This focus on advancing theory well-founded in a naturalistic setting is what distinguishes DBR from laboratory experiments or evaluation research (Barab & Squire 2004).

DBR as a methodological framework also presents challenges. The framework has been criticised for being deficient in a clear definition, approaches and theoretical foundations (Kelly, 2004). Anderson (2005) notes that DBR is not short-term or clear-cut and seems to have endless possibilities with limited guidelines for researchers. The ability to characterise the intricacy, delicateness, disarray and eventual strength of the design in a way that is valuable to others is a challenging component of doing educational research on DBR interventions (Barab & Squire, 2004). It seems this methodological framework is more suited to small-scale systems or for sustaining improvements in educational systems when the research project is completed (Anderson & Shattuck, 2012). It also appears to make a difference at the level of small-scale interventions and in the lives of individual teachers and schools; therefore, its ability to bring about large-scale and far-reaching systems has been questioned (Anderson & Shattuck, 2012). The researcher conducted the present study at one institution. For that reason, even though there were many stakeholders involved, the research was manageable and the framework allowed for the use of many small investigations. The literature also mentions difficulties arising from the complexity of real-world situations and their resistance to experimental control, the requirement to combine large amounts of data from the results of qualitative analysis, and making comparisons across designs (Collins et al., 2004). Although this was challenging, it was managed by reporting on the results of each individual study separately. Education problems can be complex, so it is important that usable knowledge is generated from DBR about educational practice (The Design-Based Research Collective, 2003). In the present study, this was achieved by the research culminating in a set of design principles. It is important to note that ensuring knowledge claims are used appropriately has also been reported as a challenge (The Design-Based Research Collective, 2003).

This framework is therefore not dependent on a specific methodology as it can make use of both qualitative and quantitative methods as appropriate within any of the four phases (Anderson, 2005). DBR aspires to change and refine educational practice (Anderson, 2005) by incorporating the development of solutions to practical problems in learning environments with the identification of reusable design principles (Herrington et al, 2007). The researcher set out to acquire the process and understanding of clinical reasoning from the students, experts and lecturers, after which she reviewed the literature to explore and describe the solutions currently being implemented, before producing design principles. This research was driven by a desire for impact and to improve what was being done. The researcher chose this design in order to determine design principles that could guide the development of clinical reasoning in undergraduate physiotherapy students.

Furthermore, this framework leaves room for and encourages multiple iterations through all four of the phases resulting in the intervention's continuous evolution and development (Anderson, 2005). This project used the phases as described by Reeves (2006) in Herrington et al. (2007). It is described as the refinement of problems (Phase 1), solutions (Phase 2), methods (Phase 3) and design principles (Phase 4). The framework according to Reeves (2006) in Herrington et al (2007), as presented in Figure 2.1 below.

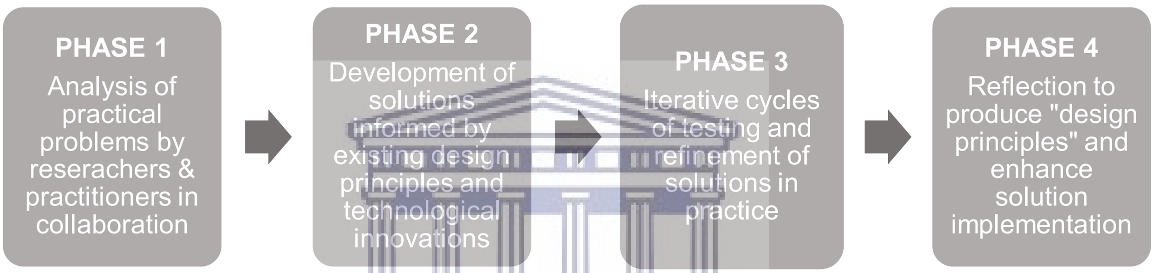

Figure 2.1: Design-based research (Reeves, 2006 in Herrington et al., 2007)

Table 2.1 (below) summarises the study phase, the objectives, the data collection method and the samples for Phases 1 to 4. Briefly, Phase 1 was the Identification and analysis of problems by researchers and practitioners. During this phase the researcher interviewed the students, experts and lecturers with regard to their process of clinical reasoning and also asked the lecturers how they taught clinical reasoning in the classroom. The interviews were used to acquire an in-depth understanding of how the participants identified clinical reasoning and what their thought processes were in guiding others. A scoping review was also conducted looking at the theoretical foundations which underpin the strategies to improve clinical reasoning. Understanding the strategies facilitated the researcher in thinking through what the principles would be for developing clinical reasoning among students. Therefore, Phase 1 consisted of two stages.

Phase 2 was the development of prototypical solutions informed by theories, existing design principles, and technological innovations. In this study, the researcher conducted a document analysis of the findings from the scoping review as well as the interview data from the students, experts and lecturers. Convergence was created by combining the findings of both data sets. A narrative summary of the scoping review, the studies included in the scoping review and the transcribed interviews, was used to refine solutions in practice and develop a draft set of design principles.

Phase 3 involved iterative cycles of testing and refinement of solutions in practice. For this thesis the draft design principles that were developed in Phase 2 were incorporated into a Delphi study which were sent to expert health professions educators for their input in the draft design principles.

Phase 4 was the reflection to produce design principles and enhance solution implementation in practice. Following the Delphi study, the researcher considered the recommendations and input from the expert panel in order to produce the final set of the design principles. This final phase consequently produced the final set of design principles to develop clinical reasoning in undergraduate physiotherapy students.

Table 2.1: Study phases, objectives and data collection

Study phase	Objective	Data collection method	Sample
Phase 1: Problem identification	1. To explore and describe the views of students, experts and lecturers on their understanding and the process of clinical reasoning.	Interviews	18 Physiotherapy students (3rd and 4th year students); 8 experts as identified by the South African Society of Physiotherapy; 10 lecturers employed at UWC Physiotherapy Department.
	2. To explore and describe the learning tasks used by lecturers to develop clinical reasoning in their students.	Interviews	10 lecturers employed at UWC Physiotherapy Department.
	3. To explore how theory influences the teaching strategies used for developing clinical reasoning in undergraduate health professions students.	Scoping review	Literature regarding the use of theory that informs teaching strategies to develop clinical reasoning.
Phase 2: Development of the solution	4.To design a set of draft principles that could guide the development of clinical reasoning in undergraduate physiotherapy students.	Document analysis	Using the analysis of the findings of the scoping review literature and Interview transcripts.
Phase 3: Cycles of testing and refinement of solution	5. To refine the draft design principles for clinical reasoning development.	Delphi study	Experts in health professions education.
Phase 4: Final set of design principles	6. To recommend a final set of design principles that could guide the development of clinical reasoning	Final report	

2.3.1 Phase 1: Problem identification

The first phase of DBR consists of exploration which makes use of a literature review, theoretical extrapolation, and expert and participant input to inform the design of the intervention. Therefore, data collection in this phase focused on literature reviews, expert interviews and evaluation of interventions in comparable educational contexts (Anderson 2005). This phase is therefore rooted in the necessary research steps of problem identification, literature survey, and problem definition (Bannan-Ritland, 2003). Herrington et al. (2007, p. 4092) define this phase as the “analysis of practical problems by researchers and practitioners in collaboration”. According to Herrington et al. (2007), this phase includes a literature review and consultation with researchers and practitioners as the DBR framework places high value on the input of practitioners working in the problem area. DBR addresses complex problems in real contexts in collaboration with practitioners (Reeves et al., 2005). Since theories cannot account for the variety of variables in a learning situation, exploration is needed to fill the gaps. The problem identification phase of the study allows the researcher to explore the research problem through empirical methods and secondary sources, and combines that knowledge into a form that can be used later in the research process.

To inform the design intervention the researcher conducted a scoping review and explored input from various stakeholders. The first phase of the study therefore included two stages. During Stage 1, in-depth interviews were conducted to gain an understanding of clinical reasoning as well as the process of reasoning that was followed as described by physiotherapy students, expert physiotherapists and physiotherapy lecturers. In addition, the lecturers were asked to describe the teaching strategies used to develop clinical reasoning. During Stage 2, a scoping review was conducted to explore the theory that informs teaching strategies aimed at developing clinical reasoning in undergraduate health professions students.

2.3.1.1 Stage 1: In-depth interviews (qualitative)

Qualitative research presents a rounded approach that involves discovery (Williams, 2007) and according to Smith et al. (2008), qualitative research methods are most suitable to investigate a complex human activity such as decision-making since it occurs in the real and consequence-laden environment of clinical practice. Qualitative research consists of a set of interpretive practices that make the world visible – which could be seen as the study of things in their natural settings, attempting to make sense of, or understand, phenomena in terms of the meanings people bring to them (Denzin & Lincoln, 2011). According to Creswell and Poth (2016), this type of approach is often chosen because the research problem requires exploration, and a detailed understanding of the issues is necessary. Qualitative methods can therefore be used to answer questions about practice, meaning and perspective, most often from the participant's viewpoint (Hammarberg et al., 2016). Chigbu (2019) further states that medical education research questions are often well-suited to a qualitative research approach as there is a focus on how things work.

The qualitative approach helps to understand the meaning of the accounts given by the participants regarding their experiences because it focuses on the behaviour taking place (Maxwell, 2009). According to Malterud (2001), because this approach provides a wide-ranging understanding of what actually takes place clinically, it allows for the description of the participant's realities. The researcher therefore set out to understand the process and beliefs of clinical reasoning of the participants of this study; a qualitative research approach had the potential to allow for the participant's stories to be conveyed. Furthermore, this research approach allows for the findings to be presented in the form of a narrative or storyline (Chigbu, 2019). The researcher attempted to gain the participants' perspectives and insight into their experiences with regard to the process of and beliefs concerning clinical reasoning.

Qualitative researchers typically gather multiple forms of data, such as interviews, observations, and documents (Creswell & Poth, 2016). This phase of the study used a qualitative cross-sectional exploratory design which utilised in-depth interviews to find the answers to the questions posed by the researcher. Cross-sectional designs are employed by researchers at one point in time to describe and provide a snapshot of a population of interest (Cummings, 2018). Furthermore, cross-sectional designs allow the researcher to collect qualitative data about individual opinions or beliefs, and they provide the opportunity to make comparisons between two or more groups (Creswell, 2002). This design therefore enabled the researcher to have a holistic understanding of what clinical reasoning meant to all the stakeholders and allowed for comparison between the groups of participants. In-depth interviews can be used to bring meaning to complex social issues that are pertinent to healthcare settings and can produce abundant and detailed information about the experiences of the participants (DiCicco-Bloom & Crabtree, 2006). It also allows for a more personal and intimate meeting that permits open, direct, verbal questions which could draw out detailed narratives and stories from the participant (DiCicco-Bloom & Crabtree, 2006). In addition, in-depth interviews are often used by healthcare researchers to collaborate with interviewees in the development of new ideas relating to perceptions and experiences regarding healthcare delivery (DiCicco-Bloom & Crabtree, 2006). Some of the advantages of conducting in-depth interviews are that they provide comprehensive information, and they offer an opportunity to create an atmosphere to collect information in which participants may feel more comfortable having a conversation with the interviewer (Boyce & Neale, 2006). Another advantage is the fact that detailed descriptions of and participant quotes from the interviews are made available (Maxwell, 2009).

2.3.1.1.1 Population and sampling

The groups of individuals who were of interest for this stage of Phase 1 of the study and made up the study population, were physiotherapy students, experts and lecturers. The physiotherapy students and lecturers studied and worked at the physiotherapy department where the researcher is employed. The experts were physiotherapists who had demonstrated expertise in various areas of physiotherapy. The study sample included 18 undergraduate 3rd and 4th year students registered for the 2017 year of study, a group of eight experts in various clinical fields of physiotherapy, and ten lecturers employed in the UWC

Physiotherapy Department. Two types of sampling methods were used in this aspect of the study.

a) Purposive sampling

Purposive sampling was used to identify the student and expert samples. A purposive sample is a type of non-probability sample that aims to be representative of the population (Lavrakas, 2008). Purposive sampling is widely used in qualitative research for the identification and selection of information-rich cases for the most effective use of limited resources (Patton, 2014). It involves identifying and selecting individuals who are especially knowledgeable about, or experienced with, the phenomenon of interest (Creswell & Clark, 2017). The researcher needed to identify physiotherapy students and experts who could provide adequate knowledge on the area of interest, clinical reasoning.

The researcher initially set out to use the students' academic performance to recruit a diverse student population and made multiple attempts to recruit students who were representative of the cohort, including emails sent to students individually and personal requests in contact classes. Students from diverse academic, cultural, economic, and social backgrounds were sought to participate in the study. In order to recruit the students, the researcher assessed the students’ academic performance across the physiotherapy programme and invited all 3rd and 4th year students who were registered for the 2017 academic year to participate in the study. The students who volunteered to participate in the study made up a certain subset of students, all female and among the top performing students in the class. Ultimately, 18 students participated in the interviews.

For the purpose of this study, the researcher defined an expert as a person who has widespread knowledge and skill in a particular area of physiotherapy (Case et al., 2000). The following description was also considered: a person who has "an enormous background of experience, has an intuitive grasp of the situation and zeroes in on the accurate region of the problem without inefficient deliberation of a large range of unfruitful possible problem solutions" (Benner, 1982, p. 405). The following inclusion criteria were used; experience within a particular area of physiotherapy by treating patients daily and sharing that expertise on continuous professional development courses or clinical lectures. The physiotherapy experts were identified with the assistance of the president of the South African Society of Physiotherapy (whose term was from March 2015 to September 2017). The president had adequate knowledge of which physiotherapists were considered experts across the various areas of physiotherapy. A group of 22 experts were identified from various fields of physiotherapy and invitations were sent to all of them. After multiple attempts were made to contact all identified experts via WhatsApp and email, a total of eight participants agreed to participate in the study.

b) Convenience sampling

Convenience sampling was used for the lecturer population. Convenience sampling is a type of non-probability sampling in which the population is sampled because they are convenient sources of data for researchers (Lavrakas, 2008). Convenience sampling is often thought of as “accidental” sampling, because participants are selected in relation to where the researcher is collecting the data (Etikan et al., 2016). Therefore, all the lecturers (n = 10) working at the UWC Physiotherapy Department during the time the study was conducted were invited to participate in the study. All ten lecturers who were invited participated in the study.

2.3.1.1.2 Data collection

Data collection methods for Stage 1 of the first phase of the study included one-on-one in-depth interviews that were conducted in English. In-depth interviews are useful when detailed information about thoughts and behaviours are necessary (Boyce & Neale, 2006). The researcher sought out detailed information on the clinical reasoning process and the understanding of clinical reasoning from the experts, students and lecturers. The teaching strategies utilised by lecturers were also explored. The researcher conducted the interviews for the students and the experts which took about 45 to 60 minutes per participant.

All participants were invited via email and a consent form (Appendix A1-3) and information sheet (Appendix B1-3) were attached to the invitation. The process of data collection varied. All the student interviews were conducted face-to-face at a time and place that was convenient for the student; these interviews mostly took place on the university campus and in the physiotherapy department. The questions (see Appendix C1) used in the interview were informed by literature related to decision-making and clinical reasoning in the physiotherapy student (Kahneman, 2011; Langridge et al., 2016; Widerström et al., 2019; Wijbenga et al., 2019). Eight experts agreed to participate in the study and all interviews were conducted using Zoom video conferencing software as many of the experts were based in different parts of the country. Participants could decide whether they wanted to have their cameras on or off and they all consented to the interview being recorded. The questions (see Appendix C2) that were posed to the experts were informed by literature related to novice and expert reasoning and the progress of clinical reasoning with regard to experience (Benner et al., 2008; Case et al., 2000; Gilliland, 2014; May et al., 2010; Noll et al., 2001). The lecturer interviews were conducted by a research assistant as the researcher was a colleague of the lecturer participants and did not want the data collection to be influenced by any judgements or biases. However, the researcher did have to conduct two interviews with staff members who were not in the department at the time of initial data collection. Those interviews were conducted at a place and time that was convenient for the lecturers and were all face-to-face interviews. All interviews lasted between 30 and 60 minutes. Field notes were taken during the interviews conducted by the researcher in order to follow up on any new ideas and make sure she understood what the participants were saying. The interview questions (see Appendix C3) for the lecturers were formulated using literature concerning educators and the development of clinical reasoning in physiotherapy (Delany & Golding, 2014; Furze et al., 2015a).

2.3.1.1.3 Data analysis

Thematic analysis was used to analyse the interview data as it allows for comprehensive, rich explanations of the data (Maxwell, 2009). This type of analysis is “a method for identifying, analysing and reporting patterns (themes) within data” (Braun & Clarke, 2006, p. 79). The analysis encompasses the search for and identification of common threads that extend across an interview or set of interviews (DeSantis and Ugarriza, 2000) and provides a purely qualitative and comprehensive account of the data (Braun & Clarke, 2006). According to Braun and Clarke (2006) thematic analysis could be seen as a method that underpins qualitative analysis as it is flexible and provides fundamental skills that will be useful for conducting many other forms of qualitative analysis. The researcher followed the Braun and Clarke (2006) six-phase guide to conduct the thematic analysis. The various groups were interviewed separately. The lecturers were interviewed first, followed by the students and finally the experts. Each group’s interviews were recorded and then transcribed verbatim by an independent transcriber. Accordingly, each group's set of transcripts and each participant's transcript within the group were analysed separately.

During the first phase the researcher immersed herself in the data by listening to the interviews and reading the transcripts a few times to search for meanings and patterns. The researcher made notes for coding during this phase. The second phase began and included producing codes from the data. The coding was done line by line on an electronic version of the transcripts in Microsoft Word. The data was coded by making comments associated with the texts being analysed and texts were highlighted to identify segments of data. The researcher then attached codes to the segments of data. This process of matching the code with quotes brought meaning to each particular code. The researcher ensured that all participant responses were coded. The third phase began with a list of codes produced across the data set and focused on sorting the codes into potential themes. The researcher first examined the codes for any duplicates or repeated codes and the duplicates were then merged before being developed into themes. During the fourth phase, the themes were reviewed. Initially, the researcher collated the coded participant responses by reading all the collated extracts for each theme to determine if they formed a coherent pattern. Themes that seemed repetitive were merged and sub themes were created. Once this was completed, the researcher had a good understanding of the different themes and sub themes and how they could be integrated to represent the data and provide an overall picture. During the fifth phase, the themes were defined and named. The sixth and final phase included writing a narrative representation of the results (Braun & Clarke, 2006).

Once the narrative report was written, three interview transcripts as well as the researcher’s interpretation were sent to a representative of each group of participants to ensure that the researcher had captured the essence of what the respondents shared in the interview. This was part of the process to ensure trustworthiness.

2.3.1.1.4 Trustworthiness

Credibility is one of the constructs used to judge the trustworthiness of interpretive research (Shenton, 2004). Cope (2014) suggests that the researcher reports the study by demonstrating engagement, methods of observation, and audit trails. Audit trails record the course of development of the finalised analysis (Carcary, 2009). Credibility can be further strengthened by the researcher describing their experiences as a researcher and confirming the research findings with the participants (Cope, 2014). This confirmation of research findings is referred to as member checking (Thomas, 2017). According to Thomas (2017), the traditional meanings for member checks refer to interview participants being sent a transcript of their own interview, a copy of emerging findings, and a draft copy of the research report. The participants then review, comment, and/or correct what was sent to them (Thomas, 2017). Shenton (2004) agrees that member checks relate to the accuracy of the data by participants being asked to read transcripts of dialogues in which they have participated. To attempt to ensure credibility, the researcher discussed the coded data with the study supervisors, and ensured member checking by distributing the transcripts and their interpretations to selected participants to ensure that the true essence of their beliefs, processes and understanding was captured. Furthermore, the methodology chapter outlines the process of data collection and analysis of the data.

When the results of a qualitative study are meaningful for persons not directly involved in the study and can be associated with their personal experiences, **transferability** has been improved (Cope, 2014). Bitsch (2005) states that transferability allows for establishing the extent to which research findings can be applied in other contexts or with other individuals; the researcher enhances transferability through thick description and purposeful sampling. Thick description involves the researcher thoroughly explaining the research processes including the data collection process, context of the study and the presentation of the final report (Anney, 2014). Thick description therefore assists other researchers to reproduce the study with comparable conditions in other settings (Anney, 2014). Purposive sampling intends to produce a sample that will answer the research questions (Teddlie & Yu, 2007). However, according to Shenton (2004), considering that the findings of a qualitative study are specific to a particular environment and specific individuals, it is not always possible to demonstrate that the study findings and conclusions are applicable to different populations. Cope (2014) suggests that researchers provide adequate information on the participants and the research context to enable others to assess the research findings as transferable (Cope, 2014). Ultimately, the results of a qualitative study must be appreciated within the context of the institution it relates to and the location where the data collection was carried out (Shenton, 2004). The researcher attempted to improve transferability by endeavouring to provide sufficient contextual information regarding the study, the context in which it took place, the participants and how it unfolded. This is outlined in the methodology and results chapters of the thesis.

Dependability is accomplished through a process of auditing (Tobin & Begley, 2004). Practically, dependability can be illustrated through an audit trail (Tobin & Begley, 2004). Providing a thorough and extensive report of the research process and methodological decisions ensure the dependability of research findings (Bitsch, 2005). Central to the audit trail is reflexivity, in which the researcher documents a self-critical account of the research process, including the researcher's internal and external dialogue (Tobin & Begley 2004). Dependability was enhanced by providing a detailed report of the study depicted in the methodology chapter as well as the inclusion of reflexivity.

Confirmability deals with the matter of the researcher's bias and prejudices (Bitsch, 2005). Confirmability, also known as objectivity, is therefore concerned with establishing that the research findings, data and interpretations are not figments of the researcher's imagination, but are clearly obtained from the data (Tobin & Begley 2004). Confirmability can be demonstrated by outlining conclusions and interpretations of data unfolding, and by providing examples, such as quotes, from the participants of the study to confirm the data and emerging themes (Cope, 2014). The study findings, data and interpretations of the data are meant to be rooted in contexts unrelated to the researcher so that findings are not tainted by personal values, reasons, or political persuasions (Bitsch, 2005). The researcher attempted to ensure confirmability by representing the codes, themes and corresponding quotes that answered the research questions of the study.

2.3.1.2 Stage 2: Scoping review

A scoping review was also conducted as part of Phase 1. Scoping reviews are used to determine the scope or coverage of a body of literature on a particular topic and provide a clear indication of the volume of literature and studies available as well as an overview of the topic's focus (Munn et al., 2018). A scoping review was considered because it allows for the examination of the extent, range and nature of research activity which results in mapping fields of study where it is difficult to visualise the range of studies that might be available (Arksey & O'Malley, 2005). The researchers wanted to explore the breadth of knowledge related to the theory that underpins teaching strategies which the nature of scoping reviews allow for (Thomas et al., 2020). Iteration is large part of how scoping reviews are conducted especially considering that an emerging area of work was reviewed and this approach provided the researchers with an opportunity to construct meaning to the area of research that was considered (Thomas et al., 2020). The aim of this review was to explore how theory influences the teaching strategies used for developing clinical reasoning in undergraduate health professions students. The review aimed to provide evidence to inform practice and not to answer a specific clinical question (Munn et al, 2018). Since the study was aimed at the identification of certain concepts in studies and the mapping, reporting and discussion of these concepts, a scoping review was an appropriate choice (Munn et al., 2018). Furthermore, health professions education often occurs in heterogeneous settings due to the diverse groups of students in assorted traditional and clinical educational settings, scoping reviews address this wide range of skills and competencies

(Thomas et al., 2017). It also a method well suited to answer a definite subsection of research questions relevant to health professions education (Thomas et al., 2017). Peters et al. (2015) agree that a scoping review is appropriate when the body of literature is heterogeneous in nature and not agreeable with a systematic review. Scoping reviews are seen as a valid review approach and an effective method in conditions where systematic reviews are not able to meet the objectives or requirements of knowledge users (Munn et al., 2018).

The process of conducting a scoping review is similar to that of a systematic review (Peters et al., 2015). The scoping review also predefines the objectives and methods and details the proposed plans (Peters et al., 2015). However, the research question for the scoping review may address a broad topic and therefore various research designs can be considered for inclusion in the review (Arksey & O'Malley, 2005). The goal of the scoping review is not to produce a critically appraised and synthesised result, but rather to provide an overview (Munn et al., 2018). Nevertheless, rigorous and clear methods in the conduct of the scoping review should remain in order to guarantee that the results are trustworthy (Munn et al., 2018).

2.3.1.2.1 Methods

a) Population intervention comparison outcome (PICO)

The PICO framework was used to formulate the review question (Pollock & Berge, 2018). The PICO framework is explained as *P* for patient or population, *I* for intervention or indicator, *C* for comparison or control and *O* for outcome, which refers to a clinical outcome, result, or to the response that is expected to be found in the sources of scientific material (Leonardo, 2018). Review questions are consequently formulated in terms of the problem/population, intervention, comparison, and outcome (Huang et al., 2006). The PICO for the review is outlined below in Table 2.2. The population of the included articles for the review was all health professions education students. This includes all undergraduate students who are studying towards a health professions degree. Health professions refers to medicine, dentistry, nursing, pharmacy and the allied health professions. The main intervention of the articles that were considered was the theory that underpins the teaching strategy used to develop clinical reasoning in the undergraduate health professions student. Theory refers to learning theory or educational theory. The outcome of interest for this review was a change in the clinical reasoning ability when theory was used to support the teaching strategy.

Table 2.2: PICO for the review

P	Population or participants	**Health professions education students**
I	Intervention	**Theories that underpin teaching strategies used by educators to inform the development of clinical reasoning**
C	Comparisons (optional)	**No comparisons will be made**
O	Outcome	**A change in clinical reasoning when theory underpinned the strategies used by the educators**

a) Research question for the review

1. How does theory influence the teaching strategies used for developing clinical reasoning in undergraduate health professions students?

b) Secondary research questions for the review

1. What theories are used to inform strategies that develop clinical reasoning in undergraduate health professions students?
2. What strategies are used to develop clinical reasoning in undergraduate health professions students?
3. How are the theories used to inform the highlighted teaching strategies?

c) Objectives of the review

The following were the objectives of this review:

1. to identify the theories that inform the teaching strategies for the development of clinical reasoning in undergraduate health professions students;

2. to identify the teaching strategies used to develop clinical reasoning in undergraduate health professions students; and
3. to explore how the theories were used to inform the highlighted teaching strategies.

d) Search strategy (identification)

Once the research question was formulated, the inclusion and exclusion criteria were determined. The period considered for the search strategy (identification process) was January 1994 to December 2019. The aim of the review was to explore the influence of theory to inform the teaching strategies used for developing clinical reasoning in undergraduate health professions students. Because educational research and research on clinical reasoning dates back decades, the decision was made to extend the search as far back as 25 years. All full-text, peer-reviewed articles published in English were considered. All studies that included health professions education in undergraduate students (such as medicine, nursing, physiotherapy, occupational therapy, dentistry, pharmacy, speech therapy, dietetics and emergency medicine) were considered for the review. The specific study designs included randomised controlled trials, cohort studies, case-controlled studies, cross-sectional studies and studies that describe reasoning strategies that were used to develop clinical reasoning. Traditionally, scoping reviews are not limited to primary research (Thomas et al., 2020). However, the researchers decision to critically appraise the studies for academic rigour meant that the chosen study types needed to align with the critical appraisal tools. Studies that were conducted on postgraduate students and any duplicates were excluded.

Databases that were available from the UWC library were used to conduct the search. The databases included were Pubmed (MEDLINE), Directory of Open Access Journals (DOAJ), SCOPUS, Ovid, Academic Search Complete, Biomed Central, CINAHL, ERIC, Health Source, Nursing Academic Edition (Ebsochost) and Medline (Ebsohost). An initial set of search strings (Appendix D) was devised based on the research question, the population, the intervention and the outcome. The search strings included various combinations of keywords. This was piloted on the first database, Pubmed (MEDLINE), and then simplified based on the number of hits received for each search string. The final search strings were used across all of the databases and are presented in Table 2.3 below. The titles were recorded in an Excel spreadsheet and the number of hits for each search string documented.

Table 2.3: Search strings

Final search strings
clinical reasoning clinical reasoning AND educators clinical reasoning AND educators AND health professional students clinical reasoning AND educators AND health professional students AND development clinical reasoning AND learning theory AND students clinical reasoning AND learning theory AND health professional students clinical reasoning AND development clinical reasoning AND development AND health professional students clinical reasoning AND development AND learning theory clinical reasoning AND development AND learning theory AND health professional students clinical reasoning AND development AND medical students clinical reasoning AND development AND medical students AND learning theory critical thinking AND development AND health professional students critical thinking AND development AND learning theory critical thinking AND development AND nursing students**

e) Screening process

The first step of the screening process was reading the titles. Once titles were read, the abstracts (n = 371) of the retrieved titles were screened. Once the abstracts were screened the full texts (n = 61) of the studies whose abstracts seemed to fit the inclusion criteria were read. The full text review was completed by two reviewers (the researcher and a postgraduate student with whom the review was conducted). For articles where consensus was not reached, one of the thesis supervisors was asked to review. After the full text of the articles was reviewed, various articles (n = 55) were excluded and the critical appraisal of the included articles could commence. On closer inspection of the excluded articles, having read the full texts, it was confirmed that they either did not meet the inclusion criteria, or did not include any theory or include an explanation of the theory was used. A detailed table regarding the excluded articles is shown in Appendix E. The inclusion criteria were applied at both levels of identification and screening.

f) Critical appraisal (eligibility)

The methodological quality appraisal of the full text articles (n = 6) was conducted using a standardised critical appraisal instrument from the Joanna Briggs Institute Qualitative Assessment (JBI) tools. JBI's critical appraisal tools assist in evaluating the trustworthiness, relevance and results of published papers. The JBI tools[1] were selected because they offer checklists specific to a variety of study designs. A range of study designs was part of the inclusion criteria for this review. Each critical appraisal tool contains an overview of the JBI and a checklist, followed by an extensive explanation of each question in the checklist (Buccheri & Sharifi, 2017). The full text articles were appraised by the researcher and a postgraduate student registered on the project, each of whom reviewed the articles and appraised them independently. The appraisal was then discussed and where consensus was not reached, one of the thesis supervisors was consulted. Feehan et al. (2011) notes that a major limitation of scoping reviews are because they do not require methodological appraisal of the included studies. Churchill et al. (2011) states that in order to make strong recommendations for practice, quality assessment is necessary. The methodological appraisal that was conducted was not used to exclude any articles but was undertaken in order to make statements about the rigour of the

[1] The JBI tools have 13 critical appraisal tools available; they can be viewed here https://jbi.global/critical-appraisal-tools.

included studies. The methodological quality of the identified articles may affect the recommendation of the teaching strategies.

2.3.1.2.2 Data extraction

A self-developed data extraction form (Appendix F) was adapted from one originally adapted by Hoque et al. (2017) in order to answer the research question and address the objectives of the current review. Table 2.4 below summarises the type of data that was collected.

Table 2.4: Outline of self-developed data extraction form

Methods	Aim of the article Study design Data analysis Tool to collect data
Population and setting	Methods of recruitment Number of participants/sample size Detailed description of the population Age of participants Country/nationality
Eligibility – PICO (**P**opulation – health prof students; **I**ntervention – theory that underpins teaching strategy to improve clinical reasoning; **O**utcome – improvement in clinical reasoning)	Health professions students' discipline Theory that underpins teaching strategy to improve clinical reasoning How theory was used by educators Teaching strategy used Measurement of the outcomes Results of the study/outcome – improvement of clinical reasoning
Other	Rigour of the article (appraisal) Key conclusions made by study authors

The self-developed data extraction form was piloted by the researcher and the postgraduate student and reviewed by one of the thesis supervisors. The form was piloted with six studies that were not included in the critical appraisal because they had been excluded as part of the screening process.

2.3.1.2.3 Data analysis

A narrative synthesis was undertaken by the researcher. According to Popay et al. (2006), a crucial part of the review is the synthesis, since it is the process that merges the findings from the set of included studies in order to draw conclusions based on the body of evidence. A narrative synthesis aims to synthesise the findings from included studies by the use of words and text to summarise and explain the findings of the synthesis (Popay et al 2006). The researcher used both tables and text to showcase the findings of the study. The results described the most common theory underpinning teaching strategy, the teaching strategies themselves, and how the theory was used. The methodological appraisal and results of the included studies were also compared to assess any association between methodological features and results (a change in clinical reasoning). The results may also aid in a guide which could be utilised by educators when developing clinical reasoning abilities among health professions students.

2.3.2 Phase 2: Development of the solution

Herrington et al. (2007, p. 4093) describe Phase 2 as the “development of solutions informed by existing design principles and technological innovations”. During Phase 2 the suggested solution to the emphasised educational problem is developed from consideration of relevant literature and consultation with practitioners, which results in the principles derived from these sources (Herrington et al., 2007). Consequently, this phase allows for the development of draft design principles (Herrington et al., 2007). Phase 2 consisted of initial intervention design (Bannan-Ritland, 2003) in the current study; the intervention is the draft design principles. Data collection in this second phase aimed to document decisions and processes (Anderson, 2005). Design-based research allows for the integration of the development of solutions and practical problems in learning environments with the identification of reusable design principles (Herrington et al., 2007).

For the current study, the data collected from the interviews and the scoping review underwent further analysis to ultimately develop the draft design principles. Based on the findings of the scoping review and the interview data, a qualitative document analysis was conducted guided by specific questions to describe and explain the emerging principles. According to Altheide and Schneider (2013), qualitative document analysis is a research method for rigorously and systematically analysing the content of written documents. The approach is usually used in political science research to facilitate impartial and consistent analysis of written policies but has been used for education research to help extract the guiding principles. Altheide and Schneider (2013) describe a process of qualitative document analysis which has five stages and 12 steps (see Figure 2.2).

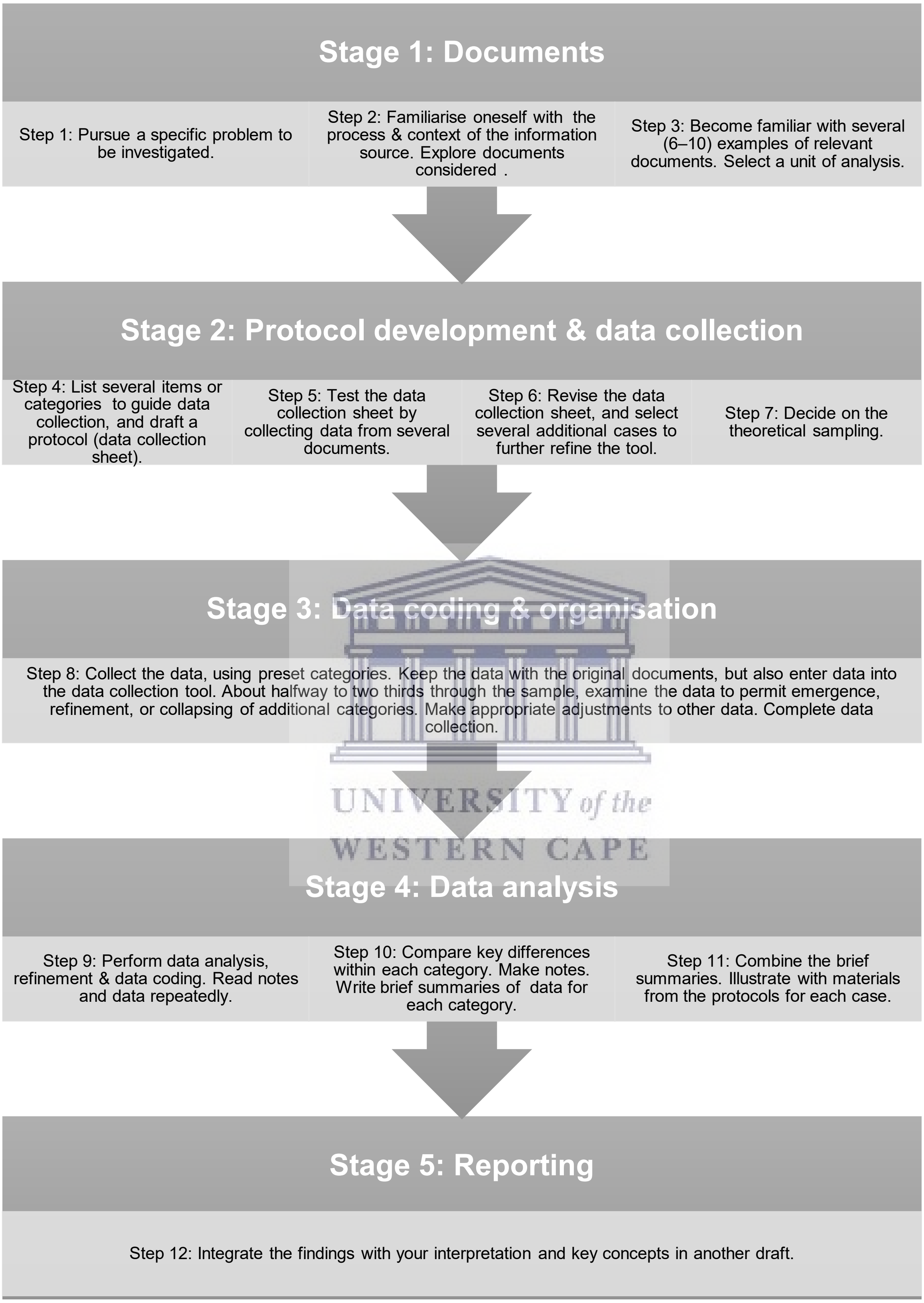

Figure 2.2: Qualitative document analysis process (Altheide & Schneider, 2013)

2.3.2.1 Study design

Document analysis was the study design used to collate the interview data and the scoping review to develop the draft design principles. Document analysis is a systematic approach for assessing both printed and electronic documents (Bowen, 2009). Documents that may be used for systematic evaluation as part of a study take a variety of forms and previous studies can be used as sources of data for document analysis (Bowen, 2009). In this case, the sources of data are the report containing the results of the interviews that were conducted with the students, experts and lecturers, the results of the scoping review and the six studies included in the scoping review. The reasoning behind the use of document analysis is its role in data triangulation (Bowen, 2009). Furthermore, Bowen (2009) states that documents can present a range of purposes as part of the research process and that the documents have the following five specific functions: documents provide background and context, additional questions to be asked, supplementary data, a means of tracking change and development, and verification of findings from other data sources. As the documents can provide supplementary research data, the insight and interpretations derived from the documents can be valuable additions to a knowledge base (Bowen, 2009). The researcher therefore used the themes from the interviews and results from the scoping review to develop the draft design principles. According to Labuschagne (2003), document analysis produces data in the form of excerpts, quotes, or entire passages; these are then arranged into codes and then overall themes via content analysis. Therefore, it is seen as a process of evaluating documents in such a way that empirical knowledge is produced and understanding is developed (Bowen, 2009).

Traditionally, document analysis uses an assortment of documents. These include advertisements, agendas, attendance registers, minutes of meetings, manuals, background papers, books and brochures, diaries and journal, event programmes and newspapers (Bowen, 2009). For the purpose of the present study the process of qualitative document analysis (Altheide & Schneider, 2013) was followed. Altheide and Schneider (2013) state that the research problem assists to inform the appropriate unit of analysis, or which parts of relevant documents will be investigated. The overall aim of the current study was to develop design principles that could guide the development of clinical reasoning in undergraduate physiotherapy students. Therefore, the documents to guide the development of the aforementioned principles are the reports containing the results of the interviews and the scoping review and the six studies that were included in the scoping review. Briefly, Altheide and Schneider (2013) describe the qualitative document analysis as finding the appropriate documents, collecting the data from the documents, organising the data and finally analysing the data. The five stages are documents, protocol development and data collection, data coding and organisation, data analysis, and report. The process of qualitative document analysis is dependent on the researcher's interaction and involvement with the chosen documents (Altheide & Schneider, 2013).

2.3.2.2 Data collection

Altheide and Schneider (2013) deconstruct the five stages into twelve steps. These twelve steps will be described as part of the data collection and analysis process followed by the researcher. During Stage 1 of the document analysis the researcher used the problem that was investigated to identify the documents that will be used as part of the document analysis. This stage consisted of three steps. In the first step, the researcher pursued a specific problem to be investigated. For this thesis it was the need to understand the clinical reasoning processes between physiotherapists with differing levels of experience, a lack of information regarding the development of clinical reasoning in students and in the curriculum, and a reassessment of teaching methods in order to remain relevant. During the second step, the researcher addressed the information sources, which were transcripts of the interviews, the articles included in the scoping review, and the results of the scoping review. These documents then formed the basis for the document analysis and became what Altheide and Schneider (2013) refer to as units of analysis. The units of analysis were the final report of the interview data (exploring the understanding and process of clinical reasoning in students, experts and lecturers and exploring the teaching strategies used by lecturers to improve clinical reasoning), the final report on the scoping review that was conducted, and the six studies that were included in the scoping review. Theoretical sampling was used for the selection of the documents. Altheide and Schneider (2013) explain that theoretical sampling is vital for examining the documents for themes and the selection of the documents are dependent on the researcher's interest.

Therefore, the production of a set of draft design principles was based on the collection of data which was linked to the problem.

The second stage of the document analysis included developing a data collection tool, which Altheide and Schneider (2013) refer to as a protocol, to collect the data. The data collection tool for the qualitative analysis must contain categories that are related to characteristics of social action including providing information about time, place, and manner of activity. For the purpose of this document analysis, the manner of activity was taken into consideration in conjunction with questions to guide the data collection tool and ultimately the data collection. Altheide and Schneider (2013) encourage one to pose more specific questions for the data collection tool. The categories for the data collection tool originated from the literature review, which highlights the need for the study and simultaneously the research problem. The researcher then listed several categories to guide the data collection and draft a data collection tool (Appendix G). It included an understanding of clinical reasoning among various stakeholders (students, experts, lecturers), the process of clinical reasoning, how clinical reasoning is best supported and what improves clinical reasoning. The data collection sheet was piloted on all the interview transcripts and the studies from the scoping review (Carbogim et al., 2019; Torre et al., 2019; Costello et al., 2017; Rush et al., 2010; Kuiper et al., 2009; Kautz et al., 2005). The data collection tool was also discussed with one of the thesis supervisors. The researcher then revised the data collection tool and added a section from the student's perspective and included a section for additional information. The categories were captured on the data collection tool which was then used to extract data from each document. Midway through extracting the data, the researcher examined the data to search for commonalities and further refined the data. No further adjustments were necessary and the data collection was completed.

2.3.2.3 Data analysis

During Stage 4 of the document analysis the data analysis took place and the data which had been collected using the data collection tool was analysed. Once the data was collected and recorded on the data collection tool, the researcher coded and organised the data. All similar answers or categories that appeared across the nine documents were then grouped together and compared and coded. The data was read repeatedly and the researcher compared each category across all the documents. All common categories were highlighted; themes were produced based on what was common and any differences were noted. The categories were then compared and the researcher made notes and summaries for each category. All similar summaries were then combined. A draft set of principles was produced integrating the findings and interpreting the concepts that were highlighted. The researcher used the raw data to support the interpretation and the development of the principle. The draft principles are presented in Chapter 6 of the thesis.

2.3.3 Phase 3: Cycles of testing and refinement of solution

According to Herrington et al. (2007, p. 4094) the third phase is known as "iterative cycles of testing and refinement of solutions in practice". Once an intervention has been designed, the next phase of DBR encompasses the implementation and evaluation of the proposed solution in practice (Herrington et al., 2007). In the third phase of DBR a variety of qualitative and quantitative measures can be used to assess the multiple impacts of the intervention in the original context for which it was designed in order to collect more data related to the meaning of the intervention in the lives of the participants (Anderson, 2005). For this study, the third phase took the form of a Delphi study to test the design principles among a group of health professions educators for refinement.

2.3.3.1 Study design

A Delphi study is a method for gathering opinions on a particular subject for which there is a high level of uncertainty and little is known (de Villiers et al., 2005). This data collection method presents a range of applications and uses for researchers who aim to gather information from experts in a particular area (Hsu & Sandford, 2007). The Delphi technique is a creative and efficient method of facilitating health sciences education research (de Villiers, et al., 2005). In addition, De Villiers et al. (2005) describe different types of Delphi studies. The conventional Delphi is the typical forum for the prioritisation of facts and incorporates a questionnaire that is sent out to a group of experts, with a second questionnaire based on the outcome of the first and then succeeding questionnaires refine the facts, gauging their accuracy or support from the participants. This process takes place over a series of what are termed “rounds” (de Villiers et al., 2005). Repeated rounds of this process are carried out until consensus has been reached. Therefore, the Delphi technique is a multistage approach, with each stage progressing from the results of the previous one (McKenna, 1994).

A modified Delphi design (Avella, 2016) is also available. In this case, the expert panel is not asked to generate answers to the first round of questions. The researcher collects the initial answers to the research questions through different research methods and presents them to the panel to begin the consensus-seeking process (Avella, 2016). Hill and Fowles (1975) termed this an alternative approach. A disadvantage to using the Delphi technique is the panel's failure to return the first questionnaire, and the subsequent smaller numbers of respondents who return questionnaires at each iteration (Hill & Fowles, 1975). For the current study a scoping review and the exploration through interviews provided the researcher with data from which a set of draft design principles were produced. Thereafter, a preselected set of statements (the draft design principles) were sent to an expert panel in the first round for agreement.

2.3.3.2 Population and sampling

The expert panel for this Delphi survey consisted of health professions educators, with an interest in curriculum development and teaching and learning from various disciplines. According to the Academy of Science of South Africa (2018), some of the core competencies for health professions educators are evidence-based knowledge, applying research in practice, lifelong learning and the use of appropriate educational approaches (including problem-based learning, case studies, discussions and group work and experiential learning). Because health professions educators who publish in the area of clinical reasoning – or the scholarship of teaching and learning – have either published or demonstrated interest in the use of various educational approaches, these were the individuals who were approached to act as experts for the Delphi study. Purposive and snowball sampling techniques were used where the supervisors recommended possible participants based on their expertise. Snowballing samples emerge through a process of reference from one person to the next (Streeton et al., 2004). The sample is then composed of a number of referrals within a group of people who are familiar with one another (Streeton et al., 2004). The inclusion criteria for the participants were that they had to have a Master's degree, and be actively contributing to health professions education, curriculum development and/or clinical reasoning in the form of scholarship. They also had to have more than five years' experience in health professions education. According to de Villiers et al. (2005), a panel usually consists of 15 to 30 participants from the same discipline or at least five from different professional groupings. The panel was made up of 28 health professions education experts in the area of health professions education, curriculum development and/or clinical reasoning. The health professions educators were from the following backgrounds: health professions education (n = 6), medicine (n = 2), physiotherapy (n = 12), pharmacy (n = 1), nursing (n = 3), dentistry (n = 1) and occupational therapy (n = 3).

2.3.3.3 Data collection

The expert panel was invited (see Appendix H) via email and a consent form (see Appendix I) and information sheet (see Appendix J) was included. The Delphi process traditionally begins with an open-ended questionnaire (Hsu & Sandford, 2007). But for this thesis, a modified Delphi was used and the draft principles based on the findings from the document analysis were sent to the participants in the first round. The Delphi survey was sent via Google forms and shared with the participants via their email addresses. The survey consisted of four sections, namely an introductory section, the principles, a section to complete demographics, and a section to upload the consent form if the participant had not already done so. The section on the principles included a background to the principle explaining how the researcher developed the principle, the principle with a 4-point Likert scale (strongly agree, agree, disagree and strongly disagree) and an opportunity for the participant to add any further comments they thought were applicable to the design principle. Regular reminders (four in all) were sent out to the participants to complete the online survey. Agreement on the principles was set at 70% and only one round was conducted as consensus was reached after the first round.

2.3.3.4 Data analysis

The data analysis of the Delphi process can include both qualitative and quantitative data (Hsu & Sandford, 2007). According to Hsu and Sandford (2007) consensus is reached if 70% or more of the participants are in agreement. The agreement was set at 70% for this study, where design principles had an agreement of 70% or more consensus was reached. The agreement for each statement was above 70%, therefore a second round for further consensus was not necessary. The percentage agreement was calculated for each response to capture the agreement rate for each principle. Agreement was divided into non-consensus and consensus categories (Yassin et al., 2021). The consensus category included the responses related to "strongly agree" and "agree" and the non-consensus category included the responses related to "strongly disagree" and "disagree". For consensus to be reached, collective ratings need to reach 70% (Hsu & Sandford, 2007). Descriptive statistics were used to determine the mean and the median of the data. The use of the median score based on the 4-point Likert scale is recommended (Hill & Fowles, 1975). If 70% of the Delphi panellists rate 3 or higher on the 4-point Likert scale and the median is 3.25 or higher, then the panel is in agreement (Green, 1982). The Statistical Package for the Social Sciences (version 27) was used to analyse the frequencies, means and medians for the quantitative data from the Likert scale. The qualitative feedback regarding the principles received in round 1 was analysed, and the principle was revised to include the participants' feedback. In terms of the additions that were made to the principle, these were incorporated into the principle. All additions and comments related to each principle were grouped together. The researcher then checked for any common ideas and sought to group similar ideas to form themes. These themes were then incorporated into the principles where it was appropriate. One of the research supervisors was consulted as part of this process.

2.3.4 Phase 4: Reflection to the produced design principles

The final phase, Phase 4, is called “reflection to produce design ‘principles’ and enhance solution implementation” (Herrington et al., 2007, p. 4094). According to Herrington et al. (2007), DBR suggests outputs in the form of both knowledge and products. In DBR, the product of design is viewed as design artefacts which can range from software packages to professional development programs (Herrington et al., 2007). The knowledge output from DBR, which sets it apart from other research approaches, takes the form of design principles (van den Akker et al., 1999). As explained by van den Akker (1999) design principles are evidence-based heuristics that can inform future development and implementation decisions. The output for the current study was design principles. Phase 4 is often seen as the typical “dissemination” phase of educational research in which publication or presentation of findings is sometimes seen as a closure event (Bannan-Ritland, 2003). According to Kennedy-Clark (2013), the purpose of this final phase is to surmise how the findings of the study meet the aim and objectives, as well as generate recommendations for future work. Following the Delphi study, the design principles were finalised and presented. The final set of design principles is the answer to the study’s research question, which was: What design principles could guide the development of clinical reasoning in undergraduate physiotherapy students?

2.4 Ethics considerations

Ethics clearance was sought from the Humanities and Social Sciences Research and Ethics Committee (HSSREC) of the UWC, ethics clearance number HS17/5/18 (see Appendix K). Permission to conduct the study was sought from the Registrar of the UWC and the Head of the Physiotherapy Department. The study was conducted according to ethical practices pertaining to the study of human subjects. Participation in the study was voluntary and the participants had the right to withdraw at any time. At all phases of the study an information sheet was provided to participants to give them a clear understanding of the project and what it entailed. All participants signed a consent form at the various stages of the study. The information gathered was kept anonymous by using coding and/or pseudonyms. The Delphi study was kept confidential and participants did not discuss their answers. The participants' real names were not used, to ensure anonymity. Confidentiality was ensured throughout the project. The data was stored on two cloud servers Dropbox and Google drive. Both of these cloud servers are linked to the researcher’s personal accounts, for which only the researcher has the password. All other data in hard copy format was stored in a locked cupboard, to which only the researcher had access. The data will be disposed of after a five-year period. The results of the study will be disseminated to the UWC Physiotherapy Department and recommendations will be made.

2.5 Reflexivity

Reflexivity is an activity that provides researchers with the opportunity to openly examine how their research agenda, assumptions, personal beliefs and emotions enter into their research (Hsiung, 2008). It is concerned with developing transparency in decision-making in the research process at a personal, methodological, and ethical level (Engward & Davis, 2015). Since researchers bring their own viewpoints and sets of beliefs to the research study, they ultimately inform how the study is conducted and documented (Creswell & Poth, 2016). The researchers' own background and individual, cultural and historical experiences therefore influence the interpretation of the data (Creswell & Poth, 2016).

In the current study, the researcher's teaching philosophy stems from the inclination to help others and be of service. A great satisfaction of practising as a physiotherapist has been seeing patients improve and reach their full potential. Now as a lecturer and teacher, the researcher's role is to facilitate learning and engagement so that students can reach their full potential and subsequently positively assist their patients. It is also important to disclose that the researcher is employed as a lecturer in the UWC Physiotherapy Department, which was the overall setting for the research study. This means that the researcher lectures the students and is a colleague of the lecturers who participated in the study. When the student participants were asked which tasks assisted them in developing their clinical reasoning, some stated that tasks given to them by the researcher were particularly helpful. This could have been their answer because the researcher was the one asking them the question. Mauthner and Doucet (2003) state that situating oneself socially and emotionally in relation to the participants is a critical aspect of reflexivity.

The researcher has hoped to maintain the integrity of the findings of the study by using literature to inform the questions she asked the stakeholders in their interviews, having a research assistant conduct the majority of the lecturer interviews, sharing the interview transcripts with one of the supervisors and discussing the themes with the research supervisors. The researcher also sent her interpretations of the data collected from the stakeholders to a few stakeholders, to make sure she had interpreted what they had shared as accurately as possible. The scoping review was conducted with a master's student to limit bias, and whenever consensus was not reached between the researcher and the master's student, one of the supervisors acted as a third reviewer.

According to Darawsheh (2014), reflexivity in itself has been questioned as there is a lack of agreement regarding its meaning, how and when it can be employed as a rigorous strategy in qualitative research studies, and how it can be utilised in qualitative research to promote credible findings. However, Engward and Davis (2015) argue that the process of reflexivity identifies and recognises the limitations of the research in relation to specific processes, data collection and analysis. This is necessary as part of the research process because the study results are used to promote the construction of new knowledge.

2.6 Conclusion

This chapter aimed to comprehensively describe the methodological framework used by the researcher in order to conduct the present study. The study was conducted in four phases and the specific study designs used in each phase are described in detail.

During Phase 1, the problem was identified through interviews and a scoping review. During the second phase, a document analysis was conducted using the outputs from the interviews and the scoping review in order to design a set of draft design principles. During the third phase, the draft design principles were distributed via a Delphi study to refine the draft principles. Once the Delphi process was completed the final set of design principles were produced (Phase 4).

The thesis does not contain a formal results chapter. The results of each of the smaller studies (that were conducted as part of the DBR framework) follow in the upcoming chapters.

Chapter 3: Exploring the understanding and process of developing clinical reasoning: Views of students, experts and lecturers

3.1 Introduction to the chapter

This chapter explores the understanding of clinical reasoning from student, expert and lecturer perspectives, and analyses the process of clinical reasoning in students and experts. Included in this chapter is an introduction and literature review, a brief summary of the methodology which was used, and a presentation and discussion of the results.

3.2 Introduction and literature review

Physiotherapists are first line practitioners; therefore, the development of their clinical reasoning is particularly important. The ever-changing and dynamic healthcare landscape means that physiotherapists are increasingly being held accountable for producing clinically significant improvements in their patients' functional outcomes (Christensen et al., 2017). The development of clinical reasoning skills in students has been a critical aspect of professional physiotherapy education programmes (Gilliland, 2014) and nursing education as well (Gonzalez, 2018).

Noll et al. (2001) state that the development of advanced clinical reasoning skills is reliant on experience. A clinician's ability to deliver safe, high quality care can be dependent upon their ability to reason, think, and judge – all of which can be limited by lack of experience (Benner et al., 2008). Furthermore, the inexperienced clinician (or student) lacks time, confidence and adequate support to effectively combine the roles of clinician, educator and role model (Faure et al., 2002). The skills required in clinical reasoning involve the use of knowledge and experience to identify patient problems and to direct clinical judgements and actions that result in positive outcomes for the patient (Benner et al. 2008). This leads to the question of how educators can effectively provide undergraduate students with adequate "experience" to develop their clinical reasoning ability.

Previous studies have reported on expert reasoning versus novice reasoning. Clinical reasoning strategies of experts have demonstrated an interplay of different reasoning processes with the different reasoning tasks. The participants in a study by Edwards et al. (2004) demonstrated the use of a range of clinical reasoning skills representing the diversity of their thinking. Case et al. (2000) evaluated the differences in clinical reasoning processes in expert and novice cardiorespiratory physiotherapists. The authors found that the more experienced physiotherapists expressed themselves more concisely, were more holistic and demonstrated more logical and organised processes than their novice counterparts. The novice physiotherapists in Case et al. (2000) were less clear in their responses, less organised and less logical. In a study by Noll et al. (2001), the goal was to describe the clinical reasoning process of experienced McKenzie physiotherapists. The McKenzie method is an assessment tool used to diagnose spinal conditions and has been cited in the literature frequently as a classification system for the lumbar spine (Noll et al., 2001). This method of physiotherapy management is based on the principles of self-treatment, direction of preference and progression of force (McKenzie & May, 1981). The findings of the study by Noll et al. (2001) suggested that physiotherapists either followed what the authors term “forward reasoning” – which is the process of hypothesis formation based on the physiotherapist’s organisation of knowledge and subjective information from patients seen in the past – or else “backward reasoning”, which is hypothesis formation from an exhaustive collection of interview and physical assessment data.

Doody and McAteer (2002) investigated the clinical reasoning of physiotherapists working in the musculoskeletal outpatient area as they assessed and treated a patient. The findings of this study demonstrated that experts generated their hypotheses during the interview, which differed from the novices, who also showed some errors in their reasoning process. After developing a hypothesis, the novices could not always evaluate the cues or the hypothesis and therefore ended up guessing what treatments should be carried out for the patient they were seeing (Doody & McAteer, 2002). Mitchell and Unsworth (2005) aimed to examine the differences in the clinical reasoning of novice and expert community health occupational therapists. They found that the experts used a blend of reasoning and fewer remote instances of procedural reasoning than the novices. Smart and Doody (2007) assessed reasoning in evaluating pain, and demonstrated that experts classified pain into categories which were grounded in models of pain (highlighting the importance of the knowledge base). Reasoning within these categories appeared to be beneficial in helping participants understand and account for clinical presentations of pain. Such reasoning was also found to sway prognostic decision-making as well as the planning of physical assessments (Smart & Doody, 2007). May et al. (2010) looked at experts' reasoning processes when they assessed and managed patients with shoulder pain. They found that experts made use of diagnostic and narrative clinical reasoning processes (mostly diagnostic) and largely made use of hypothetico-deductive and pattern recognition approaches. Horler et al. (2020) explored musculoskeletal physiotherapists' clinical reasoning for using education for the treatment of people with chronic low back pain. The findings showed that the participants made use of narrative, hypothetico-deductive and pattern recognition reasoning in order to educate their patients. These findings demonstrate that experts have more sophisticated reasoning processes than do novices or those with less experience. The research clearly illustrates a course of progression from novice to expert.

Gilliland (2014) describes an evolving process from physiotherapy student to novice practitioner and finally, to expert clinician. However, according to Babyar et al. (2003) the student's perspective with regard to developing clinical reasoning should also be examined. Christensen et al. (2017) have found that the understanding of the nature and development of clinical reasoning is still relatively under-researched. According to Richards et al. (2020), understanding foundational considerations in cognitive processing can allow educators to effectively teach clinical reasoning skills. Furthermore, investigating students could allow educators to better inform their clinical reasoning and assessment practices (McBee et al., 2018). It follows then, that interpreting multiple perspectives of stakeholders could assist in understanding what needs to be focused on to develop clinical reasoning in undergraduate students. Therefore, the objective for this part of the study was to explore and describe the understanding and the process of clinical reasoning in students, experts and lecturers.

3.3 Methodology

3.3.1 Research design

The research design for this aspect of the study was a cross-sectional exploratory design using in-depth interviews to collect qualitative data.

3.3.2 Population and sampling

The population included key stakeholders involved in physiotherapy education namely lecturers, students and expert clinicians. The study sample included all the lecturers (n = 10) who worked in the physiotherapy department at the

University of the Western Cape at the time of the study, 8 experts and 18 students who agreed to participate in the study. Purposive sampling was used to obtain the expert and student sample, while convenience sampling was applied to select the lecturers.

3.3.3. Data collection and analysis

In-depth interviews using both face-to-face methods and online Zoom interviews were used to collect the data. All interviews were recorded and then transcribed. The thematic analysis of Braun and Clarke (2006) was used to analyse the transcripts and their six-phase analysis process was followed. The data analysis resulted in a variety of codes which were merged to highlight themes and sub themes presented in this chapter.

3.4 Results

3.4.1 Demographic data of the study participants

The total sample for this aspect of the study was 36 (18 students, 10 lecturers and 8 experts). Most of the students had a BSc Physiotherapy degree with the exception of two participants, one of whom had a diploma in Dance and the other had completed Therapeutic Massage and Reflexology courses as well as a postgraduate certification in Education. The mean age of the student participants was 22.8 years. Four students had repeated a year in their degree and all the participants were female. The mean age across the eight expert participants was 43.5 years and the mean years of clinical experience across the group was 21.5 years. The majority of respondents on the expert panel were female (87.5%), with 100% of the participants having a postgraduate qualification, of whom 50% held a master's degree. In addition, 75% were involved with teaching (either at a university or on continuous professional development courses) and all participants expressed a contribution to community engagement (such as contributing to the profession via continuous professional development courses and professional bodies). The lecturers who mentioned an interest in teaching and learning, physiotherapy or clinical education were 30% of the total population and the mean age of the lecturers was 39.3 years. The majority of the lecturers were female (60%).

3.4.2 Interview data

The aim was to explore and describe the understanding and process of clinical reasoning[2]. The themes were based on the questions asked to achieve this objective. The three themes are:

1. Defining clinical reasoning
2. The process of clinical reasoning
3. What needs to be considered for clinical reasoning and clinical decision-making?

[2] The understanding and process of clinical reasoning described in this chapter is based on the data collected by interviewing this particular group and is therefore interpreted based on their responses.

3.4.2.1 Theme 1: Defining clinical reasoning

All participants shared what they understood by the phrase *clinical reasoning*. The sub themes under this theme were that clinical reasoning is a mental activity, clinical reasoning is based on a foundation, it is related to the patient and it is important.

Table 3.1: Defining clinical reasoning

Sub theme	Student codes	Expert codes	Lecturer codes
Clinical reasoning is a mental activity	Sensemaking Process	Sensemaking Decision-making	Sensemaking Decision-making Problem-solving Systematic
Clinical reasoning is based on a foundation	Knowledge (theory) Integration of theory and practice	Data collection Data informs choice	Data collection Knowledge and data
Clinical reasoning is related to the patient	Patient-centred Patient management	*	*
Clinical reasoning is important	Important Difficult	Essential Ever-changing	*

* Participants did not have codes for sub themes

3.4.2.1.1 Clinical reasoning is a mental activity

The participants believed that clinical reasoning was a mental activity or process. “Sensemaking” was a common code for all the participants and “decision-making” was common for the experts and the students. The students thought that clinical reasoning was being able to make sense of the information they were presented with and how it all links together. For the lecturers and experts, it was related to making sense of the data. The following quoted extracts give meaning to the code “sensemaking”.

"… but also an ability to like you said reason clinically and reason out based out on this person so you need to look at the individual person and using the knowledge and the tools that you have and apply it in an appropriate way." (Student 3)

"… you try to interpret or make sense of whatever you are given whether it's a patient's presentation, whether it's just outside of physio related things, but just like trying to making an understanding of the information that you received or what you found out …" (Student 11)

"It is the way … I think it is the way that you get to the answer of a problem that a patient presents with … so it's how you look at how the patient presents and then you make a whole lot of different links." (Student 18)

"… understanding and interpreting what you're seeing on assessment …" (Expert 5)

"… in order for us to move from just being a technical applicator of just doing things, to actually applying with insight and knowledge, one needs to go through a reasoning process." (Expert 8)

"… then at the end of it, collating all that information, or connecting the dots, linking things from what the patient said to what I done and what I found to …" (Lecturer 1)

"So now as a student, they have to be able to weigh up the conflicting evidence that they find in the literature, plus the conflicting feedback that they get from clinicians, supervisors and lecturers, they've got to take all of that information plus what they get from the patients, and they've got to somehow, they've got to come up with a decision that is going to be good for the patient." (Lecturer 6)

The experts and the lecturers thought of clinical reasoning as a "decision-making" process. They noted that clinical reasoning was ultimately about making a decision for a patient based on the variables they were presented with.

"… make a decision based on that even though it does not follow the recipe and the handle that's clinical reasoning for me." (Expert 3)

"… to then determine what it is that they need to physically test …" (Lecturer 1)

"That's what clinical reasoning is. I want to do this because of this." (Lecturer 6)

The students also thought that clinical reasoning was about "processing" the information they have or receive, in order to come up with the best treatment for the patient.

"… the thinking that goes on in your brain before you actually see a patient." (Student 2)

"I make like little notes in my brain …" (Student 6)

"… so the thought behind before actually doing something critically." (Student 9)

"… that you are in to be able to basically talk your way through your thought process or what you are doing and how to approach the next step …" (Student 16)

The lecturers thought that clinical reasoning was essentially about "problem-solving". They thought that it was a process that led to solving a problem for a patient.

"Clinical reasoning for me is a way of thinking that tries to address a problem in a clinical context." (Lecturer 6)

Furthermore, the lecturers highlighted that clinical reasoning was "systematic" and that there was a specific process to follow in order to assist the patient.

"So, I've got to go through the steps." (Lecturer 1)

"I think it is a process of logical reasoning and elimination" (Lecturer 10)

3.4.2.1.2 Clinical reasoning is based on a foundation

The students and lecturers saw the foundation for clinical reasoning as being "knowledge" related to content. Having adequate knowledge was highlighted as a prerequisite to be able to clinically reason. The lecturers and experts mentioned the collection of (patient) data as the foundation required for clinical reasoning. An additional code for the students was 'integration of theory and practice' and for the experts was that 'data informs choice'. All of these aspects are based on what the participants believed was necessary for an adequate foundation for clinical reasoning. The following quotes, from the students and lecturers, emphasises 'knowledge'.

> *"…because knowledge forms the basis of clinical reasoning…" (Student 1)*
>
> *"Okay so for me I think it is the use of your knowledge…" (Student 2)*
>
> *"…so how we use knowledge that we gain either from class or from doing our own research…" (Student 4)*

Both the students and the lecturers highlighted the importance of theoretical knowledge in order to work effectively in the clinical setting.

> *"Clinical reasoning also allows you to apply the theoretical literacy that we covered from first year to fourth year like your anatomy and things like that…" (Student 10)*

“So, from what I can understand clinical reasoning is being able to take all the knowledge that you have learnt so far and apply it to your patient.” (Student 15)

“Clinical reasoning is when you’re there now in the practical arena, in the environment, in the clinical environment, and you actually have a patient with a set of problems or a condition or diagnosis, and you use then your theoretical background…” (Lecturer 5)

The experts and the lecturers shared that ‘data collection’ was part of the foundation. ‘Data collection’ refers to collecting data from the patient, the patient folder or other stakeholders involved with the patient's care.

“…listen to someone to take the objective and subjective symptoms and signs…” (Expert 3)

“I am looking for the patterns, so if they flex is it painful no, but the extend so they are closing the joint back pain if they rotate to that side if they laterally flex to that side…” (Expert 5)

In this way, using data provided by the patient and anatomy knowledge enables one to start making links.

> *"So, it is integrating findings from different sources, from what you see and from what you know and from what the patient tells you and trying to form a coherent picture." (Lecturer 10)*

> *"… and to collect, let's say information from a patient. Whether they're reading the folder, whether they're talking to the patient or talking to the family …" (Lecturer 1)*

> *"So, variables would be everything that might actually influence your decision-making. So, it would be from as small as the signs and symptoms, to specific anatomical markers to patient social context, to the room that you're sitting in, the patient's emotional state …" (Lecturer 6)*

The students thought that clinical reasoning was the ability to "integrate" their theory and practical knowledge.

> *"What I understand as clinical reasoning it is your ability to take your theoretical knowledge, your practical knowledge and apply to a specific situation …" (Student 16)*

> *"So, my understanding of clinical reasoning is you are putting … you take your theoretical knowledge and you are applying it practically …" (Student 6)*

"From what I understand it would be like the area where our knowledge and our practice combines." (Student 4)

For the experts, "data informs choice" was interpreted as the experts using data to make a choice, and this was part of what clinical reasoning meant to them. This refers to the fact that the data collected from the patient informs their physical assessment choices and data collected from the physical assessment informs their treatment choices or management plans.

"… then I will test the hypothesis with various movements or special tests as appropriate and come up with a final hypothesis from what was positive …" (Expert 2)

"… your interview for me gives me almost more clues in my physical exam …" (Expert 4)

3.4.2.1.3 Clinical reasoning is related to the patient

The codes for this sub theme are "patient-centred" and "patient management". This was unique to the students who reported that they thought clinical reasoning was dependent on the patient, and therefore had to be patient-centred.

"… and the patient is half of the clinical reasoning you can't … not take them into account." (Student 1)

"Definitely because if I was the patient I would want to know as much as possible before making a decision so I feel like giving them that opportunity it allows them to benefit their own personal growth." (Student 4)

"… this is about the patient …" (Student 5)

"… and how it would benefit the patient." (Student 8)

"I try to follow it all the time but if I see like a patient wants to walk but they just had a CVA and they can't even sit then I will try to explain to the patient you know what … we will try to get to walking one day but let's first work on the smaller components like balance and … I try to make them understand or make it a bigger goal but then like set like smaller goals with the patient." (Student 12)

The students also thought that clinical reasoning was about patient management.

"… and then you use those signs and symptoms to diagnose the patient and then plan the treatment." (Student 7)

"Yes, it's what makes up physio and your treatment and everything it stems from your clinical reasoning because you won't be effective in treating your patient even if you don't touch your patient, and you just refer the patient or something, it stems from your clinical reasoning." (Student 10)

"… so that you can best treat and assess them that is basically what I understand is clinical reasoning." (Student 11)

"What I understand is that say you are having a patient and being able to think of any possible reasons how to treat them …" (Student 13)

"… and being able to use that to focus your assessment and treatment of your patient …" (Student 15)

"… and by understanding all of that then using the most appropriate treatment to then whatever is wrong with the patient." (Student 17)

"… which gets you to your answer of how you want to treat the patient." (Student 18)

3.4.2.1.4 Clinical reasoning is important

This idea was shared by the students and the experts, who stated that clinical reasoning was important and essential to their practice as a physiotherapist.

The extracts from the students and experts below give meaning to the codes "important" and "essential".

"Yes, because your whole job requires clinical reasoning." (Student 6)

"Yes, clinical reasoning is really needed." (Student 7)

"Like clinical reasoning is such a big thing …" (Student 11)

"I think clinical reasoning is where you can use information that you have learnt …" (Student 17)

"So, I think clinical reasoning is fundamental to being able to practise as a physio whether you are a novice or an expert." (Expert 1)

Even though the students thought that clinical reasoning was very "important", they also reported that they thought it was "difficult".

"… with experience especially in ICU as well because you get patients there that has a lot of stuff happening in their bodies …" (Student 2)

"… but that's sometimes difficult." (Student 6)

"It's quite difficult." (Student 9)

"… but it isn't … so it has become easier but it isn't an easy thing …" (Student 11)

The experts commented that clinical reasoning is "ever-changing". This suggests that developing the clinical reasoning skill is a continuous activity and that they are always learning and developing the skill themselves.

"… it's an ongoing process …" (Expert 5)

3.4.2.1.5 Summary (Theme 1: Defining clinical reasoning)

According to these participants, clinical reasoning is a cognitive mental activity that requires a basic foundation (of knowledge and patient data) to inform decision-making and is influenced by the person making the decision and the person providing the information (usually the patient).

3.4.2.2 Theme 2: The clinical reasoning process

When the students were asked about their process of clinical reasoning, they provided much more detail than the experts in their answers. For example, referring to data collection, students mentioned each component of the clinical reasoning process in which the data then informs their choice of physical assessment technique, whereas the experts referred to data collection using a clinical reasoning form, which would include the use of patient data to inform choice of physical assessment. The only sub theme that was common to both students and experts was “following a structure”. An additional sub theme for the experts was “making use of feedback” as part of their reasoning process. Sub themes for the students were “mental process” and “having an approach”.

Table 3.2: The clinical reasoning process

Sub theme	Student codes	Expert codes
Following a structure	Data collection Data informs choice Patient evaluation Problem list Physical (objective) assessment Precautions and contraindications	Data collection (using clinical reasoning form or evaluation form) Models of clinical reasoning
Making use of feedback	*	Patient feedback Outcome measures
Mental process	Interpretation	*
Having a strategy	Complete assessment Shortened assessment	*

* Participants did not have codes for sub themes

3.4.2.2.1 Following a structure

Most student participants used or followed a structure when going through the clinical reasoning process. The codes for this sub theme are “data collection”, “data informs choice”, “patient evaluation form”, “problem lists”, “physical (objective) assessment” and “precautions and contraindications”.

The codes related to the sub theme “following a structure”, along with their interpretations and supporting quoted extracts, are presented below. Most students stated that their clinical reasoning process commenced with “data collection”. This meant interviewing the patient, and gathering information from the nurses and doctors, or from the folder.

> *“So obviously when you first interact just the general getting an idea of what the problem is whether it is from a folder if it’s in a hospital situation …” (Student 11)*

"If I don't understand something in the folder I either speak to a clinician if available or a doctor." (Student 13)

"So, taking a file and looking through the file …" (Student 15)

"So, for me it starts literally from subjective …" (Student 1)

"Firstly, I would say how the injury occurred and so it doesn't matter across all fields how the injury occurred plays an important role of like how we would get them back to function as well as their base line prior to the injury." (Student 4)

"I have taught myself to listen to the patient so it is the subjective part of it …" (Student 8)

"A good basis would be your subjective information firstly because you need it specific to that patient so not necessarily just the interview but also what is in the medical folder to understand the history of the patient and what they presenting like now." (Student 16)

The students stated that the "data informs choice" as part of their clinical reasoning process. This is interpreted as the interview data collected informs their physical assessment choice and the physical assessment results informs their treatment choices.

"… and that [data from patient] then leading into your objective …" (Student 1)

"… and then you would have a look at what treatment techniques are appropriate for this person." (Student 3)

"The decisions would be something like whether they are able to do exercises to enhance their performance or whether they should come see physiotherapists more regularly because it's a manual problem or a biomechanical problem that they necessary can't fix, but something like an external force needs fixing then just education in general so whether the patient understands what you think and what they should gain I guess from the session." (Student 4)

"… and then from the assessment combined with like their goal to try and find a suitable management plan for that patient." (Student 5)

"… and then based on those results would formulate your treatment." (Student 10)

"And then I do assessments according to how the patient presents …" (Student 13)

"… and then for you to make an educated decision as to where to go next …" (Student 16)

The students preferred having a "patient evaluation form" to follow when going through their clinical reasoning process. This patient evaluation form would include prompts such as "data collection", "problem list" and a space to record information from the patient which might assist them in their clinical reasoning process.

> *"… so, I like thinking of clinical reasoning as a patient evaluation if you look at the setup the actual setup of that." (Student 1)*
>
> *"… so, you can use that similar order to help you find what is wrong with the patient you are seeing currently." (Student 5)*
>
> *"… there is an order of … I remember you sent a document this specific like observations and then palpation and everything." (Student 11)*

Some students used the "problem list" specifically to assist them during their clinical reasoning process. The problem list the students refer to asks the students to record the patient's activity in terms of the impairment (the patient's complaint, for example, pain) and the missing component (what the patient cannot do in terms of activity due to the pain).

> *"… but where it all ties together for me is our problem list where identify functional problems missing component underlying reason." (Student 1)*
>
> *"… then if it is then I am going to look at the missing components, underlying reasons [which make up the problem list] …" (Student 2)*
>
> *"I would use my problem list …" (Student 10)*

Some students highlighted the “physical assessment” as a major part of their clinical reasoning process.

> *“… and then I would go and see ankle range of motion is our patient going to be fine, hip range of motion as well, so kind of from a top bottom so like hip, knee or knee hip, ankle …” (Student 2)*

> *“… and then based on that you can see and also their level of function at the moment …” (Student 3)*

The students considered “precautions and contraindications” in their clinical reasoning process. They noted the condition and patient condition and applied appropriate precautions as part of their clinical reasoning process.

> *“… then going into the precautions and the contra indications as well because that is also going to affect the why of the treatment, but you also have to know what the patient has their diagnosis.” (Student 2)*

> *“… and then I would ask myself why wouldn’t you want to do this to the patient or that to the patient because of this and because of the presentation …” (Student 14)*

> *“… so, we need to check the high blood pressure before we treat her …” (Student 15)*

The experts referred to “data collection” using a specific clinical reasoning form or evaluation form, and to the use of “models of clinical reasoning” for their process of reasoning. The “clinical reasoning form” noting details such as interview data collected from the patient, then prompts for choice of physical assessment to be based on the collected data. It could assist the clinician to capture the thought processes with regard to decision-making for the patient. The components of the clinical reasoning form or evaluation form will be similar to what the students mentioned as part of their clinical reasoning process.

> *“… to fill in the lengthy form of a thorough interview and then have a clinical reasoning section where you break down the kind of things that you need to think about with the patient and make it applicable the answer applicable to that patient.” (Expert 4)*

> *“I think I use a little bit of it all [models], ja, but that’s only come with experience though …” (Expert 6)*

3.4.2.2.2 Making use of feedback

The experts highlighted the use of “patient feedback” and the use of “outcome measures” as part of their process of clinical reasoning. Accordingly, they used both subjective and objective feedback as part of their reasoning process.

> *“This is why I’m using the example because it makes it quite explicit how the patient gave information and shared with them why I thought, or what I thought was wrong, and why I’m going to do a particular treatment and that I value their feedback …” (Expert 1)*

"So, we use outcome measures so we use like the CPAX in ICU and the DEMI's in the ward …" (Expert 5)

"Well obviously if you can reproduce these symptoms and know that you have found the source of the problem then you can work on your manual therapy stuff from there …" (Expert 7)

3.4.2.2.3 Mental process

Students indicated that they needed to "interpret" what was happening with their patient as part of their clinical reasoning process.

"… that is where I will try and figure out what is wrong with the patient…" (Student 7)

"…so, when I start planning I know that as they are speaking I know this is the condition that we might be presenting with…" (Student 8)

"I would think about anatomy and what is happening and biomechanics and all of that." (Student 10)

"Now I have to always be thinking of if it is going to work what is the next step …" (Student 16)

3.4.2.2.4 Having a strategy

The students mentioned an additional sub theme, “having a strategy”, related to how they work in different situations (high pressure situations versus no pressure situations) and how this affected their process of clinical reasoning.

The students reported on the strategies they used when they went through their clinical reasoning process. The codes for this sub theme are “shortened assessment” and “complete assessment”.

Some students suggested that they sometimes shortened their patient assessment. This seems to have been their response in a high-pressure situation or when they had too many patients to see.

> *“… one patient might present similarly to another then you might think okay let me manage the patient just saying that I did that previous patient you don’t look at individual people so much.” (Student 3)*

> *“I do especially when … with OA especially because a lot of them present the same, a lot of them are a bit older so you would then try to do what worked for the other person …” (Student 14)*

Nonetheless, students who shortened their assessments were aware that it may not always be the best thing for their patients and that a complete or comprehensive assessment was necessary.

“I don’t know. It might leave the opening for you to miss something, [even though] it saves everyone time.” (Student 15)

Some students indicated that they felt the need to conduct a “complete assessment” with patients as part of their clinical reasoning process.

“So, you would first start by assessing the patient so you wouldn’t start with any preconceived ideas you can think based on the patients that you have seen previously how this one might present but you would go by assessment, (Student 3)

“If this patient needs my attention now I am going to assess the things I need to assess …” (Student 11)

“… and then your evaluation of the patient …” (Student 14)

“Because I have had experiences where you go through things slowly because you want to do it properly because I mean if you get it right now it is going to help in the future …” (Student 17)

3.4.2.2.5 Summary (Theme 2: The clinical reasoning process)

The clinical reasoning process seems to be very specific for the students, as they mentioned specific components of their process. The patient (taking into consideration precautions and contraindications) and interpretation is also part of their process. The experts do not mention specific components of their clinical reasoning process but seem to approach it more holistically. In addition, the experts use both subjective and objective patient feedback as part of their clinical reasoning process.

3.4.2.3 Theme 3: What needs to be considered for clinical reasoning and clinical decision-making?

There were several factors that participants believed would help them with regard to the development of their clinical reasoning. This theme was further divided into the sub themes "internal factors" (all participants), "external factors" (all participants) and "factors related to the university experience" (students).

Table 3.3: What needs to be considered for clinical reasoning and clinical decision-making?

Sub theme	Student codes	Expert codes	Lecturer codes
Internal factors	Vulnerability Knowledge Patient-centredness Self-reflective Lifelong learning Self-directed Adaptability	Vulnerability Patient-centredness Reflection Lifelong learning Motivation Curiosity Uncertainty	Vulnerability Knowledge Motivation
External factors	Time Experience Relationships	Time Experience Discussion Collaboration Safe space (working environment) Mentorship	Time Experience Mentorship Feedback
Factors related to university experience	Clinical practice Mini-CEX Case studies (Paper patients) Paper patient assignments Guidance and facilitation	*	*

* Participants did not have codes for sub themes

The “internal factor” common to students, experts and lecturers was “vulnerability”. The code “knowledge” was shared by the students and lecturers, while the students and experts shared the codes “patient-centredness”, “reflection” and “lifelong learning”. “Motivation” was a common code for the experts and lecturers. Furthermore, the codes “self-directed”, “self-research” and “adaptability” were offered by the students. Additional codes for the experts were “curiosity” and “uncertainty”.

In terms of the “external factors”, “time” and “experience” are codes that were common for all participants. The code “mentorship” appeared for both experts and lecturers. Further codes are “relationships” (found in the students), “discussions”, “safe space” (working environment) and “collaboration” (experts) and “feedback” (lecturers). A third sub theme highlighted only by students was “factors related to university”.

3.4.2.3.1 Internal factors

A code that was common to all participants for this sub theme was “vulnerability”. Students reported their need to allow themselves to be vulnerable when they did not know or understand a particular concept. They needed to ask when they did not know something.

> *“And the thing is especially in clinical practice you can’t be shy you need to just go with it get on with it, you need to get out of your shell and go and ask if you don’t know something …” (Student 6)*

“And I am pretty sure that any graduate would go out into comm serve and for the first half of the year they will still be asking questions like to the senior clinicians like okay is this right …” (Student 16)

“You look at your peers and you ask them for help.” (Student 18)

The experts considered it important to show vulnerability and to ask when unsure, since this influenced their growth as an expert in their field.

“… phone one of my friends and ask them okay I’ve got this what do you think?” (Expert 3)

“… please explain to me why you did this or why don’t you want to do that please I need to learn, can you come show me on this x-ray where you see this because I can’t see it.” (Expert 5)

“Like you can always ask for clinical advice, even now at our stage.” (Expert 7)

The lecturers also highlighted the importance of asking for assistance when unsure. They acknowledged that if doing so is difficult for people who have been qualified as a health professional for years, it would be even more difficult for undergraduate students.

“You must be able to discuss, you must be able to accept criticism and you must be able to give criticism. But it’s difficult, I mean it’s difficult

even for us qualified who have been qualified for years. Now you can imagine a student, and some of the doctors do make you feel like this." (Lecturer 2)

The students and lecturers believed that having sufficient "knowledge" was vital for clinical reasoning. This knowledge was related to content knowledge and a theoretical foundation.

"You need the basic knowledge in order to figure things out." (Lecturer 1)

"… as a student it's not always easy to reason clinically if you don't have the baseline knowledge …" (Student 3)

"Definitely knowledge I would obviously start there because you obviously need to understand the condition or the problem in order to effectively like identify what the problem is and then treat …" (Student 11)

"If you've got a good understanding of your theory that is vital…" (Student 14)

"… honestly knowledge is the only thing that can actually really prepare you for clinical reasoning." (Student 15)

The students and experts explained that they assumed the need to put their patient first, no matter what they were doing. Accordingly, they had the code "patient-centredness" in common because they believed it contributed to the development of their reasoning.

> *"... just tell your patient, be honest with your patient if you don't know or something tell them, but sometimes that makes them a bit apprehensive, but it is … you can back that up and it will make them feel a bit better." (Student 6)*
>
> *"Yes, like let her [the patient] take a break because I was thinking I have to finish and then I realised she's exhausted and then I just stopped and let her relax …" (Student 10)*
>
> *"Patients have a right to make their own decisions regarding their care so I think when you are trying to determine what the outcome for the patient should be or where you want them to go you have to look at what the patient was like before, you have to look at what the patient's disease process or illness or whatever is now and then you have to look at the patient expectations." (Expert 5)*
>
> *"So, you need to find what is important now and that is very often a fairly fast decision and it is frequently based on what does the person want as well, not necessarily want but what do they need for immediate help …" (Expert 8)*

The students reported that they valued "reflection" and saw the relevance and importance of reflection in their own practice and development. Similarly, the experts thought that it was important to be able to reflect on their practice and that it improved their ability to clinically reason.

> *"… if there is an incident with the patient that not necessarily goes well but my response to it was well, then it is sort of… it benefits the patient for future because then at least by that situation I was able to learn and breathe and focus and then now I know what to do when it does happen again." (Student 4)*

> *"I will think about the day and I ask myself if I could have done it better. I could have still done the same thing that I wanted to do, but how could I have improved so why wouldn't I have done this or why was I adamant on doing that and then look at the result." (Student 14)*

> *"Sometimes I do think that looking back on a way you did something can help and I often find that reflecting on a situation where you learnt something is very helpful because it helps you to change your behaviour in the future." (Student 15)*

.

> *"I do go, 'Okay, why is patient [A] not getting better, why did they not finish their treatment?' … so, I do sit and think that." (Expert 3)*

> *"As I am doing my assessment I will reason through it. As I go along my head. And it is generally after they leave because admin is a pain. So, you often end up doing notes after work then you kind of reflect back." (Expert 7)*

“But I think if you are not contemplating your sort of quick decision thinking, you can veer away from being accurate …” (Expert 8)

The code “lifelong learning” was common to students and experts. The students shared an understanding that, because the medical landscape was constantly changing, they would need to embrace lifelong learning. The experts communicated that being lifelong learners was important in the development of their clinical reasoning skills. They also reported participation in postgraduate courses as part of their lifelong learning.

“But I think we do know that there are like once we are done now for next year and for the future there are things that we need to do and there are ways like developing yourself and so on.” (Student 11)

“Because I think like things change so I will never know everything but as long as I know like the basics of something I will be able to research more about the thing or ask someone who is more experienced or even ask someone who is less experienced that might have newer knowledge or so.” (Student 12)

“… it’s something that I think I am going to be learning for the rest of my life, for the rest of my time as a physio and I think that is good.” (Student 15)

“… and go to courses things like that there is always a lot of things that you can do, a lot of ways you can get experience just also being in certain settings opens your eyes or teaches you a lot of things.” (Student 16)

"I think it definitely can but I would say you would need to actively read up about conditions, you would have to build your theoretical knowledge somehow …" (Expert 2)

"That's it … I think maybe you are also appreciating or realising that you are never an expert … I mean I never feel like I know enough …" (Expert 4)

The experts continued their lifelong learning by participating in postgraduate courses. While continuous professional development is a requirement for health professionals, the experts also expressed a desire to improve their practice by participating in postgraduate courses which ultimately improved their clinical reasoning.

"And then coming back from the UK I did the OMT course I had been qualified about ten years before I did the OMT course …" (Expert 4)

"… but the course taught me by the things I did instinctively was correct …" (Expert 5)

"I was first introduced to clinical reasoning when I did the OMT course, which was pretty scary in that, that was six years after I qualified …" (Expert 6)

"… it is certainly something that was highlighted hugely for me when I did a Gifford and Butler course when that was 97, which was when I saw the necessity of it. And although it was there, it was maybe not

accentuated as much, whereas now I focus very much on the person's expectations and needs." (Expert 8)

The experts highlighted the fact that they were very "motivated" to continually know more and the lecturers noted the importance of being motivated as a factor that contributed to the development of clinical reasoning.

> *"… is sort of the daily commitment to being better …" (Expert 6)*
>
> *"You do not need to have somebody standing over you saying you need so many points. but it is because I am a professional and I need to keep feeding myself." (Expert 8)*
>
> *"A clinician, an expert clinician never thinks I need to be mediocre. I need to make sure that I'm just average. And expert clinician is always saying, 'How do I make sure I'm better tomorrow?' That's what matters." (Lecturer 6)*

The students expressed the thought that it was important that they were "self-directed" and managed their own learning experience and took responsibility for conducting their own research, especially when they did not know something.

> *"But, I also feel that at some point in time it has to come from you and there is only so much that you can be taught so I think it has to be initiated …" (Student 1)*

"… then to do your own research will only benefit you more and then develop some more understanding …" (Student 4)

"… you as an individual you need to take the time to go and maybe just go and maybe read." (Student 6)

The students found that they were having to do a considerable amount of research themselves to fill in the knowledge gaps that they sometimes experienced.

"… because going into a hospital and I have never heard of say now for instance a bronchopleural fistula before that I actually have to go and google what it is because I don't actually know …" (Student 2)

"Yes. I still try and find even though I struggle finding information specifically like in orthopaedics or something like that where I find information is limited, but that might just be my research skills." (Student 4)

"… and kind of read up on stuff at home of new conditions that I have learnt, or quickly like google on my phone how does this person present …" (Student 13)

"If I can't get through with it then I just start researching." (Student 17)

In addition, the students thought that they needed to be “adaptable” in their patient management approach because circumstances are constantly changing. Adaptability would assist them in the development of clinical reasoning.

> *“Someone might present in an atypical way so you think you should be managing and you’ve got the theory behind you that says this is the protocol that you do with this person, but they are not presenting how you expect them to and so your management will then change …” (Student 7)*

> *“… and if it doesn’t work how do we … maybe backtrack or always how do you … so you always have like a drawing board sort of thing that is how I approach it.” (Student 16)*

The experts stated that because they were naturally inquisitive or “curious”, they were able to develop their clinical reasoning abilities.

> *“… if you see something that’s off or doesn’t make sense to sort of stand and go hmm why would that be … why would this [blood] gas be bad?” (Expert 5)*

> *“I am very interested in people, so I’m more interested in people than the injury actually, so I would say that I maybe veer … I’m probably more inclined towards that because it’s a personal interest of mine …” (Expert 6)*

"And the thing is all of us are the inquiring type and we just want to develop and we want to do stuff and it is sometimes hard to work with somebody like that. So, no not everybody is like that." (Expert 7)

The experts also conveyed that being comfortable with "uncertainty" was an important factor in developing confidence in the ability to clinically reason.

"And to be a reflective practitioner, you say to yourself I don't know everything and I am here to learn." (Expert 1)

"I am not afraid to say I don't know." (Expert 3)

"And to know that it's okay to not know for a while …" (Expert 6)

3.4.2.3.2 Summary (Internal factors)

Various factors that the participants felt assisted them with the development of clinical reasoning were highlighted. "Vulnerability", referring to being open to asking when one does not know something, came up for students, experts and lecturers as an important "internal factor" for the development of clinical reasoning. "Knowledge" was important for students and lecturers, perhaps because they are located in a particular academic space and students have to pass their degree. "Patient-centredness" was noted by students and experts because they are constantly in contact with the patient.

3.4.2.3.3 External factors

The students, experts and lecturers emphasised that “time” had an impact on their development. The students expressed the view that they could see a change in their thinking from the time they began seeing patients (in their second year) to the time of the interview (at the end of their third or fourth year). The experts found that having had time in their field ultimately assisted their clinical reasoning development while lecturers observed the change in their students over time. The following quoted extracts from participants offer support for these interpretations.

> *“I think from second year to now my clinical reasoning has gotten better and I can see it on my marks as well and I think it definitely just comes with experience to just know the why behind everything …” (Student 2)*

> *“It has become easier like now versus me last year second block let’s say, it definitely develops over time …” (Student 11)*

> *“… because compared to third to fourth year I was much more confident; I felt like I know what I was doing; I could back myself up. I could actually tell myself what was my end goal and how could I get there because of how the patient came in.” (Student 14)*

> *“… and then obviously your clinical experience within a geographical area will also help but that grows over time.” (Expert 2)*

> *“I mean I’m now fifteen years qualified, and I would say it’s only been in the last four years that I’ve felt competent, that’s a long time to feel*

unsure … but that's like call it ten years for me to feel like I was … I've earned my stripes; do you know what I mean?" (Expert 6)

"It gets easier as you go year by year, because then they know what that entails." (Lecturer 5)

The students, experts and lecturers confirmed that gaining more "experience" in the clinical setting was beneficial to them and played a role in their clinical reasoning development. This experience is related to clinical exposure and being exposed to more patients.

"The more patients you see, the more … you kind of think about it the diagnosis you think about how they present …" (Student 2)

"… but as you start building your clinical experience you actually start doing those things and you start going into their lives more and see how your treatment can help them function." (Student 3)

"I think your clinical reasoning the more you see like I said the clinical reasoning also plays a role in what you would experience … your experience will also help you improve clinical reasoning because if you have experienced that for example you saw a patient with a back pain problem you are going to want to figure out what is wrong and then if you see that patient another patient with the same problem, your clinical reasoning is going to be better because you have already experienced it so with experience as you go along." (Student 6)

"I also think with regards to clinical reasoning maybe it's just my own experience but it's certainly been a bit of a process or a journey …" (Expert 4)

"… because of the time that I have spent in the field is that the more experienced you become, the easier it is for you to connect the dots …" (Expert 1)

"I think it's just something that as you get more qualified and have more experience your learning starts to make sense …" (Expert 4)

"So, I think most of that is gained when you start entering the work environment." (Lecturer 7)

"Relationships" is a code that arose for the students, who stated that when they had a good rapport or relationship with the colleagues, clinicians, supervisors, lecturers or patients, their learning and development was better.

"… if you think your teacher will or lecturer or supervisor understands you then it makes the process of understanding the topic and just getting the general gist of things easier." (Student 1)

"I think the first year I would have definitely been scared, but now throughout, building relationships it gets easier it is not as intimidating." (Student 4)

"With the patient a good relationship because I think that is where it starts being able to understand the patient and once you start understanding the patient and having a good relationship with them it does influence your treatment a lot …" (Student 8)

The experts commented that "discussion" helped them in developing their clinical reasoning expertise. This referred to talking to colleagues about patients or concepts they were struggling with.

"… but at the same time having kind of having regular meetings one on one with the supervisor discussing difficult patients …" (Expert 4)

"… then we sort of talked through the process and we did multiple disciplinary team discussion …" (Expert 5)

"And you could really sit down and discuss difficult cases with people." (Expert 7)

The code "collaboration" emerged for the experts. They communicated that working with others (not necessarily physiotherapists) also assisted them in developing better reasoning skills.

"Working with different people. We travelled a lot with to expos and stuff with a sports group so I would work with people from different universities it sounds strange, but all of us are taught differently that sort of mix of we were taught it this way and that is how we are

comfortable, but they do it in a totally different way that helps …" (Expert 3)

"… and I also think it is important to have contact with people outside your profession but to have a similar field." (Expert 8)

The experts believed that one's "working environment" had a significant influence on their development; it needed to be an environment that created a "safe space" for learning and growth.

"So, it's always good to work with or have I'm thinking of now our practice have employees that are constantly asking questions that you can feed back and problem-solve with … is much easier to work with and I think much more beneficial for patients and for their learning and growing" (Expert 4)

"… but also, being in a workplace that promotes that type of thing [mentoring] …" (Expert 5)

"Ja, so that was great because you get [to work with] people who really you know they field well." (Expert 7)

A code that was common to experts and lecturers was "mentorship". Both the experts and the lecturers mentioned that mentorship assisted them in their development.

"… and then I want to talk about specific individuals along my clinical journey as a clinician. That I worked with individuals that were knowledgeable they were supportive and nurturing and they encouraged me to do certain things" (Expert 1)

"So, I feel you need guidance and it is not something you can necessarily develop only on your own because then you have tunnel vision. You do not get different opinions and different techniques and so on." (Expert 7)

"I think there are a couple of things. I had a really good mentor … you need to have some people who are experienced that you can refer to, to discuss things with, to run things by." (Expert 8)

"…I have a lot of mentors there, a lot of facilitators, so I could go to speak to any of them, and they're very well-equipped, they're really experienced…" (Lecturer 4)

The lecturers highlighted "feedback" as an important contributor to clinical reasoning development.

"No, I'm saying that if I'm a practicing clinician, I get feedback from my patients. Is this better than this? Do you feel today more than you did yesterday? All of that impacts my clinical reasoning." (Lecturer 6)

3.4.2.3.4 Summary (External factors)

The students, experts and lecturers agreed that external factors such as time and experience were vital for the development of clinical reasoning. The experts and lecturers also noted that feedback and mentoring from others played a role in the development of clinical reasoning.

3.4.2.3.5 Factors related to university

The students reported that there were certain factors regarding their university experience that assisted them in the clinical reasoning development. The codes for this sub theme are "clinical practice", "mini-CEX", "case studies", "paper patient assignments" and "facilitation and guidance".

The students communicated that "clinical practice", clinical supervision during clinical practice and practical exposure had helped them with their clinical reasoning. This related to the fact that they could experience what they learnt in the class in the real-life context.

> *"I think the experience definitely helps a lot more to get clinical reasoning in your clinical practice rather than what we are told in class …" (Student 2)*

> *"… then when you are in like the blocks and you are there actually experiencing it it's like a mixture." (Student 5)*

> *"… but it is something that I had to learn over time through supervision and just interacting with my supervisor for them to explain to me what I*

should be doing and the angle that I should be going into in terms of treating my patients." (Student 8)

"… but you definitely learn a lot of it or most of it at a block." (Student 17)

The "mini-CEX" is the mini-clinical evaluation exercise and involves observing the student during a clinical encounter (Modi et al., 2015). In this setting the mini-CEX is used as a structured feedback exercise in clinical practice when clinical supervisors see the students struggling with a specific activity. The students thought this activity was useful in assisting them with developing their clinical reasoning skills.

"In the third year I see it very strongly in our structured feedback sessions. In every single structured feedback." (Student 1)

"… the mini CEXs that you get during blocks they obviously there to identify a weakness that you have or something like … let's not call it a weakness something that you are struggling with that you could use more if you had more information about it, you would perhaps understand it better and I think those were really, really helpful." (Student 11)

"… what I do think is important is the mini CEXs that we do those really, really helped me, so I did it whether or not it was issued to me by my supervisor when I found something I didn't understand …" (Student 16)

The “case studies” and “paper patient assignments” were similar in that the students referred to a paper patient or a case study about a patient which had provided them with an opportunity to think about how they would apply their knowledge to their patients. The case studies were undertaken in certain classes or modules, and the paper patient assignments were assignments the students had to complete as part of their continuous assessment.

> *“Like for example like your class where you gave us like case studies to do and then we have to actually I think okay the mechanism of injury …” (Student 5)*

> *“ICU task in fourth year was really good like the reasoning for mobilising a patient and why you would do that. I really liked that because when we went to ICU that is a new block that was only introduced in fourth year so that already gives you kind of an understanding.” (Student 14)*

> *“And then in third year we had different case studies of NMS that you actually had to treat as a patient which you had to say like what is your hypothesis, what did you evaluate, what did you do and go about actually assessing and treating this patient before you would come to the treatment.” (Student 14)*

> *“I know when we did I think it was in paeds [paediatrics] once we did an assignment where we had to fully go over a child’s condition and go in-depth and have a whole assignment on it.” (Student 18)*

"But, then second year with our biomechanics class we had a task of … something about analysing movements of a joint so with that we were able to discover or to reason rather what could possibly happen with the joints in terms of movement …" (Student 4)

"And then in third year when we had our NMS assignments so a lot of that helped with either reasoning what could be wrong with the spine, what could be wrong in the peripheral joints and with those assignments it sort of helped us to combine our knowledge and then apply it to a patient." (Student 4)

The students found that when they were questioned about what they were doing and "facilitated and guided" during their practical or clinical experience, this assisted them in their clinical reasoning development. They preferred not simply being given the answers by their educators, but rather being facilitated to come up with the answer themselves.

"I would start by treating a patient and then they would ask why are you actually doing that?" (Student 8)

"… I think if like facilitation in second year where a clinician or somebody goes with you to a patient and then literally takes you through all the steps of like why would you do this … what is the reason behind this…" (Student 9)

"Also, when you let us go and do research to identify certain things instead of just telling the students what's wrong with the patient or what

the diagnosis is that the students can research and look up certain possibilities …” (Student 10)

“… your supervisor for example is there to guide you through it and facilitate your development so for them to identify something that you have to struggle at it is really, really useful for them to say okay, this is what you need help on, I think this is where you struggle a little bit …” (Student 11)

“So, with her [the clinical supervisor] I learnt a lot because you constantly have to think about the why …” (Student 2)

3.4.2.3.6 Summary (Factors related to university experience)

The students shared certain university activities which they felt contributed to their development of clinical reasoning. They highlighted the exposure to “clinical practice”, using the “mini-CEX” tool in clinical practice, “case studies” and “guidance and facilitation” as exercises that stood out for them in the development of their clinical reasoning.

3.5 Discussion

This discussion expands on how the definition of clinical reasoning provided by the study’s participants compares with definitions in literature, and attempts to understand possible reasons for the definition that emerged from this group of participants. The process of clinical reasoning is explored, and ideas connected to “knowledge”, “patient-centredness”, “time”, “experience” and “clinical practice” are interpreted through the literature.

3.5.1 Defining clinical reasoning

All the stakeholders confirmed that clinical reasoning was a mental process and that it was based on a firm foundation. For the students, the foundation was knowledge (content); for the experts, patient “data”, and for the lecturers it was both patient data and knowledge.

Modi et al. (2015) and Gonzalez et al. (2021) agree that clinical reasoning is a complicated cognitive process that leads to an interpretation of patients’ problems and then the conceptualisation of an appropriate management plan. Pinnock and Welch (2014) state that clinical reasoning consists of content knowledge as well as the mental processes of problem-solving. Similarly, according to Young et al. (2020) clinical reasoning encompasses the thinking or reasoning that a health professional undertakes to solve and manage a clinical problem. Physiotherapists participate in many different cognitive skills in effective clinical reasoning (Huhn et al., 2019).

Huhn et al. (2019) refer to clinical reasoning as the integration of thinking and decision-making involved in working through clinical cases. In addition, students and experts in the study thought it was more personal (important but difficult and always changing) and the students were the only ones who specifically mentioned that it was patient-related (“patient-centred” and “management of the patient"). Durning et al. (2011) consider clinical reasoning to include both establishing the diagnosis (diagnostic reasoning) and making a decision on a management plan that reflects the patient's circumstances and preferences (therapeutic reasoning). Ten Cate et al. (2018a) share the sentiment that decisions include patient perspectives, also noting that the relationship between the health professional and the patient, as well as the environment plays a role in decision-making.

A possible reason for the lack of consensus on the understanding of clinical reasoning could be that despite being studied for many years, a benchmark for the understanding of clinical reasoning has not yet been established (Huhn et al., 2019). According to ten Cate et al. (2018a), a vast number of health professional fields have contributed to the understanding of clinical reasoning which has led to diversity in the definition. Huhn et al. (2019) argue that this lack of consensus has negative consequences for teaching, assessment, and research associated with clinical reasoning.

3.5.2 The process of clinical reasoning

In the present study, the process of clinical reasoning was only reported on by the students and the experts. The experts relied on the use of a framework or structure (mentioning a clinical reasoning or evaluation form) and then relied on feedback from the patients and their outcome measures. The students also mentioned structure, but shared each part of the process, namely data collection, how the collected data informs their choice, the use of the problem list, the physical assessment of the patient and their interpretation of the patient problem. The processes of the two groups of participants were similar, but the experts regarded the process as part of the clinical reasoning form whereas the students mentioned each individual component of their process. In addition, students identified interpretation as part of their process and the experts mentioned using feedback from the patient. This clinical reasoning process that has been highlighted seems to present the view that clinical reasoning in physiotherapy has largely been hypothetico-deductive in nature (Higgs et al., 2008). Hypothetico-deductive reasoning occurs when health professionals attend to initial cues (information) from or about the patient and use them to generate hypotheses. After this, the patient information is analysed, and further data are collected and interpreted. Hypotheses creation and evaluation continues as the examination and management of the patient continues and the various hypotheses are confirmed or negated (Edwards et al., 2004).

The study by Young et al. (2018a) yielded similar results in that team members (participants) of the study were also asked about the components of the processes of clinical reasoning. In that study, the participants identified observation, data collection, differentiation of relevant from irrelevant clinical findings, data interpretation, problem representation, hypothesis generation and many others. These components were very similar to the findings in the current study. Groves (2003) explains the clinical reasoning process in terms of Barrows and Elstein's (1978) earlier work: clinical information is identified, the information is interpreted, hypotheses are generated, hypothesis-testing occurs and finally establishment of a working diagnosis. Additionally, "interpretation" was emphasised by the students interviewed in the current PhD study. According to McBee et al. (2018) the clinical reasoning process consists of a thorough clinical history, hypothesis generation, and testing, a preliminary diagnosis, physical examination and finally the decision on a management plan. This indicates that all health professionals engage in clinical reasoning by collecting and analysing information, generating hypotheses and composing a clinical picture, diagnosis, and finally a management plan (Young et al., 2018a).

Dual process theory explains the process of clinical reasoning and how clinicians think through a patient case. Dual process theory stems from work in cognitive psychology mostly done in the 1990s by Epstein and Hammond (Pelaccia et al., 2011). The theory incorporates two cognitive systems used to reason (Pelaccia et al., 2011). Noted in Chapter 1, System 1 is more intuitive and automatic, whereas System 2 is slower and more analytic (Modi et al., 2015). System 2 or a more analytical approach is used when one is learning; as one gains experience, there is an inclination to use System 1 (Modi et al., 2015). Modi et al. (2015) further explain that System 1 is guided by knowledge and experience, automatically activated, referred to as pattern recognition, heuristics or mental shortcuts as the information is available due to past experience and knowledge. System 2 is much more of a cognitive process as it draws on current and past information, ruling out initial hypotheses. According to recent work by McBee et al. (2018), clinical reasoning calls for the processing of an interaction of the patients' symptoms and the data (tests, reports, physical assessment, which is more analytic) and thinking (which is more rapid and non-analytic) to reach an effective outcome for a patient.

3.5.3 What needs to be considered for clinical reasoning and clinical decision-making?

The lecturers and the students thought that knowledge was important for clinical reasoning. Holdar et al. (2013) describe knowledge as that which is obtained from various sources and establishes the foundation for the physiotherapists' clinical reasoning. The study by Holdar et al. (2013), concluded that decisions were affected by the physiotherapists' knowledge. Gruppen (2017) agrees, stating that creating a mental picture of the clinical problem requires cognitive processing and is influenced by foundational knowledge.

Students and experts mentioned patient-centredness as an internal factor that could assist in the development of clinical reasoning. The students explained this as thinking of the patient and not themselves when they manage the patient (specifically in exam situations). For the experts, this means that the patients have a right to participate in the treatment/management plan being created for them. According to a systematic review by Wijma et al. (2017), patient-centredness in physiotherapy involves offering an individualised treatment, continuous communication (verbal and non-verbal), education during all aspects of treatment, working with patient-defined goals, a treatment in which the patient is supported and empowered, and a physiotherapist with patient-centred social skills, confidence, and knowledge. Holdar et al. (2013) suggest that clinical reasoning is influenced by the patient's enthusiasm to engage in the treatment plan and that decisions should be based on the patient's goal and preferences. Contrary to the current study, Cruz et al. (2012a) tried to understand the relationship between patient-centred practice and clinical reasoning by interviewing clinicians about their patient interaction during their clinical sessions. Their findings demonstrated an approach to reasoning that is more compatible with a biomedical model of care, which puts the health professional at the centre of practice. On the other hand, the patient-centred care model places the patient at the heart of the professional relationship, and supports the belief that understanding the patient's view should be the foundation of good practice within the therapeutic relationship (Kidd et al., 2011). Emphasising the understanding of the clinical condition and not the patient during the patient interaction is a feature of the biomedical model and not a more biopsychosocial approach (Cruz et al., 2012a). According to Huhn et al. (2019), the outcome of clinical reasoning in physiotherapy focuses on a biopsychosocial patient-management approach. Going through the process of clinical reasoning, diagnosing the patient and proposing a management plan allows the health professional and the patient to produce an informed position about the clinical problem. Furthermore, it assists to establish a relationship where the patient's experience can be fused into the management decisions for the patient (Cruz et al., 2012a).

The students, experts and lecturers concluded that time and experience were important for the development of clinical reasoning. This finding is similar to a study by Holdar et al. (2013), in which the finding was that acquired knowledge, through experience and education, influenced clinical decision-making. Linn et al. (2012) agree that clinical reasoning requires both the gathering of knowledge and a level of experience; this is what sets the student apart from an expert. Jessee (2018) highlights that knowledge is gained through experience during clinical exposure, while according to Huhn et al. (2019), experience is what shapes how information is organised to make a decision. Experience with patients is paramount in order to create connections in the memory between content learnt and clinical presentations to build illness scripts and the ability to use pattern recognition (Eva, 2005).

The students spoke of university activities which they believed supported their development of clinical reasoning; one of the activities mentioned was clinical practice. A range of articles highlights this point. According to Modi et al. (2015), clinical reasoning is best taught during the clinical interaction either led by clinician or clinical supervisor (for demonstration), or the clinician or clinical supervisor observing the student during a clinical encounter. In this way, the clinical encounter provides students with the opportunity to listen to their patients' stories, alter these stories into case presentations, and ultimately learn to reason about the clinical information (Bowen, 2006). This confrontation with a clinical problem enables the student to practise their clinical reasoning skills in a real-life context (Wijbenga et al., 2019). The repeated clinical exposure to a range of patients and feedback from the clinical supervisors also helps to develop clinical reasoning in this type of environment (Wijbenga et al., 2019). The learning that takes place during the clinical activity is therefore a process of learning by doing (Schmidt & Mamede, 2015).

3.6 Conclusion

Chapter 3 presented the results from exploring the understanding and process of clinical reasoning among students, experts and lecturers who participated in the study.

All stakeholders agreed that clinical reasoning was a mental process and that it was based on a foundation of either knowledge (theoretical) or data (from the patient). In addition, students and experts thought clinical reasoning was more personal; only students specifically mentioned that it was patient-related. All participants considered the mental process to be related to sensemaking. The experts highlighted decision-making and data, while the lecturers thought decision-making, problem-solving and being systematic was linked to this mental process. According to the experts, the foundation was based purely on data (from the patient); the lecturers highlighted data and knowledge, the students' knowledge, and the integration of theory and practice. This emphasises that for these participants, clinical reasoning was ultimately a cognitive process that relies on knowledge and patient data.

The process of clinical reasoning was only reported on by the students and the experts. The latter relied on the use of a framework or structure and then on feedback from the patient and their outcome measures. The students, however, also mentioned structure but shared very specific components of the structure, namely the data collection, how the collected data informs their choice, the use of the problem list, the physical assessment of the patient and their interpretation of the patient problem in comparison to the experts. Data relevant to the patient was considered a major part of the clinical reasoning process in both groups.

The student, expert and lecturer participants also expressed what they thought needed to be considered for the development of clinical reasoning. The lecturers and students reported that knowledge was important for clinical reasoning. The students also highlighted particular university tasks that they thought assisted them with their development of clinical reasoning. These tasks included clinical practice, the mini-clinical evaluation exercise (mini-CEX), case studies and guidance. What emerged was that all participants agreed that time and experience were important for the development of clinical reasoning. Furthermore, all participants agreed that being vulnerable was important and that needing to ask when faced with uncertainty is necessary to the development of clinical reasoning. The experts stated that embracing uncertainty and not always having all the answers was a significant part of their development of clinical reasoning and ultimately becoming an expert. There were many such “internal factors” that the students, experts and lecturers cited as being required for clinical reasoning development. This indicates that there is work to be done on a personal level and not only in relation to the environments where clinical reasoning develops. In addition, the students considered patient-centredness and being self-directed as necessary internal factors in the development of clinical reasoning. This highlights the need for self-awareness within the process of clinical reasoning development.

This chapter highlighted the shared understanding of clinical reasoning and the process of clinical reasoning. Although strategies were also mentioned in this chapter the following chapter presents the learning tasks used by lecturers to develop clinical reasoning in the physiotherapy students.

Chapter 4: Exploring the learning tasks used by lecturers to develop clinical reasoning in their students

4.1 Introduction to the chapter

This chapter reports on the strategies used by the lecturers to enhance clinical reasoning in the students. It includes a literature review, a brief summary of the methodology, the results and a discussion of the results. These results contribute to the identification of the problem within the DBR framework used by the researcher.

4.2 Introduction and literature review

Health professions education faculties and departments have a responsibility to educate clinically competent graduates (Audétat et al., 2017). A key aspect of clinical competence is clinical reasoning, which has been identified as an imperative skill in medical education (Schmidt & Mamede, 2015). Because physiotherapists are responsible for the decisions they make, their patient outcomes and autonomous practice, the development of clinical reasoning is a critical focus across educational and clinical practice settings (Furze et al., 2015b).

Much of the literature related to developing clinical reasoning stems from an international perspective. Montpetit-Tourangeau et al. (2017) investigated which learning condition (concept map study or concept map completion) would be more effective in promoting meaningful learning of physiotherapy intervention knowledge. Physiotherapy students in the study were engaged in either concept map completion or concept map study and the findings showed that concept map completion was more effective for fostering problem-solving skills (Montpetit-Tourangeau et al., 2017). This study took place in Canada at the University of Montreal. Sole et al. (2019) identified various key elements that all academic and teaching staff at a university in New Zealand considered to be important for teaching clinical reasoning to undergraduate physiotherapy students. Torres et al. (2020) conducted a study in Chile to assess the impact of blended training with interactive virtual scenarios to improve musculoskeletal clinical reasoning in undergraduate physiotherapy students. The findings of this study were positive, and the students' clinical reasoning seemed to improve as a result of blended learning with interactive virtual scenarios (Torres et al., 2020). A survey distributed by Kononowicz et al. (2020) aimed to collect and provide an international perspective on how clinical reasoning is taught and assessed. The survey yielded 313 responses, with only seven from Africa, which highlights a limited contribution to the development of clinical reasoning from an African perspective. In the South African context, Keiller and Hanekom (2014) attempted to address subjective evidence of poor critical thinking and clinical reasoning skills by integrating concept maps into an existing problem-based learning module. The findings showed that adding the concept map did not increase the students’ clinical reasoning measurement tools scores and so did not improve their clinical reasoning or critical thinking. The authors then suggested that the implementation of the strategies and the method of application be studied and that other South African physiotherapy departments should attempt to highlight methods for enhancing clinical reasoning and critical thinking (Keiller & Hanekom, 2014).

In some geographical areas, people come from cultures with different healthcare beliefs and healthcare delivery systems (Henley & Twible, 2008). Henley and Twible (2008) suggest that when patients have different cultural beliefs to the health professional it might be more challenging to arrive at a successful outcome for the patient. This could be true for a country such as South Africa, where the cultural landscape is very diverse. It is therefore advisable for health professions students to learn how to use sound clinical reasoning within cultural contexts as cultural awareness, knowledge acquisition, and use of knowledge about cultures are important aspects of effective clinical reasoning (Henley & Twible 2008). Hodges et al. (2009) found that comparative cross-cultural research in health professions education was lacking. Recently, Lee et al. (2021) called for more research on cultural differences in clinical reasoning.

This demonstrates the need to investigate the strategies used by lecturers in the South African context to develop clinical reasoning. Although an evaluation of culture was not part of the PhD study, it is nonetheless clear that the research regarding clinical reasoning development in South Africa is limited. It would be helpful to report on how these lecturers are attempting to develop clinical reasoning skills and perhaps provide stimulation for strategies that can be used. Accordingly, the objective for this part of the study was to explore and describe the learning tasks used by lecturers to develop clinical reasoning in their students.

4.3 Methodology

4.3.1 Research design

This aspect of the study used a qualitative cross-sectional exploratory design using in-depth interviews to collect the data.

4.3.2 Population and sampling

The population included all lecturers working at the physiotherapy department of the university where the researcher is employed. Consequently, a convenient sample of ten lecturers was used. The lecturers unpacked the learning tasks they gave to undergraduate students in order to develop clinical reasoning. They were also asked to share their beliefs about the clinical reasoning skill and how it could be developed.

4.3.3 Data collection and analysis

In-depth interviews were used to collect the data. The interviews were recorded and then transcribed. Data was then analysed using thematic analysis, which was conducted using Braun and Clarke's (2006) framework. Codes related to the strategies to develop clinical reasoning were captured and then the themes and sub themes were produced.

4.4 Results

4.4.1 Demographic data of the participants

As detailed in Table 4.1, in terms of age, 60% of the lecturers were younger than 40 years, while 40% were older than 40 years of age at the time of the study. With regard to gender, 60% were female and 40% were male. In terms of experience, the majority of the lecturers had between six and ten years of lecturing experience; only one lecturer had more than 15 years of teaching experience. The mean years of lecturing experience for this group of lecturers was 8.9 years. Only 30% of the staff had more than 15 years of clinical experience prior to lecturing. The mean years of clinical experience was therefore 7.8 years.

Table 4.1: Description of the lecturers

Participant	Gender	Highest qualification	Years of clinical experience prior to lecturing	Years of lecturing experience
1	F	MSc Physiotherapy	20 years	5 years
2	F	PhD Physiotherapy	15 years	13 years
3	F	PhD Physiotherapy	8 years	10 years
4	M	MSc Physiotherapy	1 year	3 years
5	F	MSc Physiotherapy	6 years	11 years
6	M	PhD Physiotherapy	7 years	10 years
7	M	MSc Physiotherapy	2 years	3 years
8	M	PhD Physiotherapy	2 years	7 years
9	F	PhD Physiotherapy	10 years	20 years
10	F	PhD Physiotherapy	7 years	7 years

4.4.2 Interview data

Based on the data, three themes emerged regarding the strategies used by the lecturers to develop clinical reasoning, namely:

1. Types of strategy used,
2. Challenges experienced with regard to the development of clinical reasoning,
3. Factors to assist in the development of clinical reasoning.

Although developing strategies for clinical reasoning in students still remains a challenge for lecturers, they are committed to trying various strategies. These challenges were either related to the curriculum, related to the students or to the participants themselves. Furthermore, they mentioned environments that they thought were helpful in developing clinical reasoning, and qualities which they and the students needed in order to develop clinical reasoning. Finally, the participants noted qualities that the students seemed to lack, and also mentioned assessment practices related to clinical reasoning. The themes and sub themes are captured in Table 4.2 below.

Table 4.2: Types of strategy used

Theme	Sub theme	Codes	Interpretation
Types of strategy used	Classroom strategies	Case studies (paper patients), Student engagement Scaffolding	These activities were strategies used in the classroom by lecturers to develop clinical reasoning.
	Strategies that facilitate thinking	Questioning Reflection Feedback Demonstration	These activities took place either in the classroom or the clinical environment. The activities demonstrate the lecturer's facilitation of thinking in the students in order to enhance clinical reasoning.
	Integrating theory into practice	Clinical exposure Personal experience Clinical portfolios Clinical supervision	This sub theme demonstrates the integration of theory and practical components – specifically, not to just teach content, but also to provide examples or demonstrate practically how the content is used or seen in a clinical or practical context.
	Competency development	Lifelong learning Peer learning Assessment practices	These competencies were thought by the lecturers to be important for the students to develop alongside clinical reasoning.

4.4.2.1 Theme 1: Types of strategy used

Four sub themes emerged from this theme, namely “classroom strategies”, “strategies that facilitate thinking”, “integration of theory and practice” and “development of competencies”.

4.4.2.1.1 Classroom strategies

The lecturers highlighted certain classroom strategies they used in order to develop clinical reasoning in their students. The sub themes for this theme were “case studies” (paper patients), “student engagement” and “scaffolding” as the main strategies used. The quoted extracts below highlight and bring meaning to “classroom strategies”. These strategies were specifically mentioned as part of the lecturers’ classroom activities.

In this context “case studies” refer to cases or paper patients designed by the lecturers to help students develop problem-solving skills. They usually include a patient history, patient complaint and the patient presentation. The students would then have to work through the information to develop a diagnosis and management plan for the patient in the paper-based case.

> *“It also is basically in the form of a document where there’s a scenario written on. So, we call it a case study, and so there will be Mrs so-and-so is a forty-five-year-old female, and this is how she presents in hospital and there will be questions then related to that patient.” (Lecturer 1)*

"So, with 'paeds', we do case-based studies, so we do a lot of cases where we get a scenario and then we have to look through it and then identify it and identify what are the possible treatments and solutions …" (Lecturer 4)

The code "student engagement" includes the fact that the participants thought that engaging the students via "classroom discussions" and "small group activities" was important. The lecturers noted that dividing the classes into smaller groups made it easier to talk through difficult concepts and allowed students to better grasp the concepts. In this way, engaging students helps to facilitate the opportunity for them to apply their minds, their knowledge and experience and share their thoughts on how they would approach a situation. According to the participants, these processes are aimed at helping students to develop clinical reasoning.

"I think as soon as you can get an engagement discussion, it helps clinical reasoning, but again it has to be related to a patient." (Lecturer 1)

"I feel if you get them more involved, they think more to get to a solution since we do the paper patient." (Lecturer 2)

"… if you are dealing with small groups, you will get more information because you will be targeting like a few people in a group and then that is when you will be assured that the students thought about each

scenario and thought about how they should be applying their knowledge into practice." (Lecturer 3)

Lecturers shared the need to provide students with a step-by-step approach to building and introducing clinical reasoning. This is done by either teaching theory prior to the practical application or by "scaffolding" the work or expectations from students according to year level.

> *"So hopefully what we're doing in physiotherapy is giving the students the basic knowledge in first year, second year, so that by the time they get to clinical practice in third year, they start thinking a little bit about what it is that they've learned and how that fits in to their patients." (Lecturer 1)*

> *"I think they need a certain basis of support before that, so I think they need to cover a certain amount of content or course work …" (Lecturer 4)*

> *"… build on slowly from first to fourth year." (Lecturer 5)*

4.4.2.1.2 Strategies to facilitate thinking

These strategies mostly took place during clinical practice but sometimes in the classroom as well. The participants conveyed the importance of enabling students to understand the underlying reasons for a condition – in other words, “facilitated thinking” (cognition). This type of facilitation was either done by “questioning” the students in order to allow them to justify their choices, “reflection”, providing “feedback” and “demonstrating”.

The lecturers used “questioning” as a way to facilitate the students' thinking. They did not only want the students' answers but also wanted the students to explain why they came up with their specific answers.

> *“… let’s say they discuss management, you’re not going to just tell me I am going to do this treatment and that treatment and that treatment, I want to know why. So why are you choosing these treatment techniques?” (Lecturer 5)*

> *“… not give them the answers, but guide them through the process of getting to the answer.” (Lecturer 5)*

Part of “facilitated thinking” was engaging the students in a process of “reflection”. Reflection is understood to be a process of looking back; in this case the lecturers encouraged students to reflect on patient experiences during the clinical rotation, on the exam, on issues they might be struggling with, or on the lectures themselves.

> *"So, they get a chance to think about what they've done and the others will then say I really liked this and I really like that ..." (Lecturer 1)*

> *"… on Friday they would come to campus and we will talk about the [clinical] experience." (Lecturer 4)*

> *"… and then we will go back and then we will have a discussion to check if they understand the content." (Lecturer 3)*

The participants also highlighted the importance of "feedback" in the development of clinical reasoning. Feedback refers to engagement with the student regarding where they went wrong, or what they did well during a task or assignment, or during the clinical experience.

> *"What matters is feedback." (Lecturer 6)*

> *"… well the student must have the same opportunity. So, students get feedback from me …" (Lecturer 6)*

> *"… but you can maybe ask for assistance if need be, just so that you can develop your argument or to bring across what you are trying to say." (Lecturer 7)*

Lecturers used “demonstrations” to teach practical skills but also to model behaviour. Demonstration alluded to either demonstrating techniques or to how a patient interview will be conducted.

> *“I’ll take them through the process of assessing, process of identifying problems, process of identifying treatment, techniques that they can use.” (Lecturer 3)*

4.4.2.1.3 Integration of theory and practice

The participants communicated the importance of “linking theory to practice”. They reported having done this by creating opportunities for “clinical exposure” once the theory had been taught, bringing their own “personal experience” into the classroom, through the use of the “clinical portfolio” and by lecturers themselves being involved in “clinical supervision” on the clinical platform.

Lecturers communicated that they found it useful to teach the theory then follow that up with a “clinical session” or a “practical session”.

> *“So, it’s about you giving the mental picture in class and you have to then go out and show them so that they make a strong connection.” (Lecturer 1)*

> *“… my course runs over fourteen weeks and for at least half of them, we go and spend time with patients. We go there and we go talk to*

them. We do a few tests, we do a few things so that I can say, okay this is what I taught in the class on a student with no disability, but how does this behave with someone who had a stroke?" (Lecturer 8)

"I think I at least try to do that, in that I try to always not only give them the theory. So, when I teach, I always bring in the practical example." (Lecturer 1)

Participants shared their "personal experiences" with the students, which they thought helped the students connect the theory to practical matters, which assisted in developing clinical reasoning.

"I had sixteen-plus years of clinical experience working in hospitals and private practice, so they enjoy that. Whenever I teach, I'll say oh, but I had a patient like this and she presented like this and then we tried this technique but it didn't work, and then I realised I didn't eliminate that, and so that's how you, ja, get them to see it." (Lecturer 2)

The lecturers also shared the use of a "clinical portfolio". The clinical portfolio was emphasised as a tool for clinical reasoning development.

"… we wanted specifically to make sure that the [clinical] portfolio components of the clinical practice margin have a stronger emphasis on clinical reasoning." (Lecturer 6)

Lecturers reported that they thought it was important that, besides teaching theory, they were also involved in “clinical supervision” (specifically, supervising students in areas related to the theoretical module that they taught). They saw this as another way in which they were able to link what they were teaching in class to the real world.

> *“It is important. I feel now at the moment that I, when I go and supervise, that’s why I like actually to have a little bit of supervision because it keeps me in touch with what’s happening out there in the clinical arena …” (Lecturer 5)*

> *“The most success I feel I have had in trying to help students get it is actually being with students in clinical practice.” (Lecturer 10)*

> *“… when you are with a patient and either modelling or starting a conversation or guiding the student while they are busy with a patient then I think they really start seeing the lengths or it is easier for them to bring it together with the patient.” (Lecturer 10)*

4.4.2.1.4 Developing competencies

Participants reported on “competencies” which they found related to clinical reasoning. Developing these competencies would assist in encouraging clinical reasoning in the students. These competencies were “lifelong learning”, “peer learning”, and the “assessment practices” related to clinical reasoning.

“Lifelong learning” was highlighted as an important aspect of clinical reasoning development. As part of the curriculum, the lecturers encouraged the development of lifelong learning in the students.

> *“… if I want to be a better academic, I’ve got to read, write, think, discuss. These are the only tools that we have. So, a student who is in third year who wants to develop clinical reasoning has to see a patient, write down some things that they don’t understand, go home, try and answer their questions by themselves, bring those answers to a lecturer, say I saw this patient, these are the things I didn’t understand. I went and I found these answers from these sources that I trust. I came to this conclusion, what do you think of that process?” (Lecturer 6)*

> *“So, it is about teaching our students that you are always going to need to learn.” (Lecturer 1)*

> *“That is one of our goals at the university level, is to develop students who have this level of individual knowledge seeking …” (Lecturer 5)*

Participants noted that a substantial part of clinical reasoning development involved being critical and asking for help, which led to the inclusion of “peer learning” in their modules.

“So, they get that feedback not from me now, but from their peers.” (Lecturer 1)

“… but on the different assignments and things they read others work and then they give marks to each other. I grade it as well but now they are at the point where they say ok now I deserve sixty-five per cent for mine after I have read this student’s work and the student got this mark.” (Lecturer 8)

In order to develop these competencies, the “assessment practices” were highlighted. Participants noted that a more active approach to assessment would be ideal in developing competencies.

“I can set you a case, test your clinical reasoning and then you haphazardly fail. Or I set you a test that tests your rote learning and then you are brilliant. You know.” (Lecturer 8)

“Because they don’t have a strong basis. So, I asked just the basics of information that requires students to recall, but that is, that for me is not developing, because anybody can just go to a book and memorise information and record it for an exam.” (Lecturer 7)

4.4.2.2 Theme 2: Challenges experienced with regard to the development of clinical reasoning

Based on the information presented by participants, challenges were classified into two main categories: intrinsic and extrinsic challenges (Table 4.3). The extrinsic challenges were related to the lecturer's "approach" to the development of clinical reasoning, the "exam format" and the "classroom environment". The intrinsic challenges highlighted were linked to the lecturers themselves and the students. Specifically in the students, these challenges dealt with the students' lack of having developed a "patient-centred" approach to patient care as well as a lack of self-directedness and "self-directed learning" in order to understand the theoretical content rather than just doing what is needed to pass the clinical examinations.

Table 4.3: Challenges experienced with regard to the development of clinical reasoning

Theme	Sub theme	Codes	Interpretation
Challenges experienced with regard to the development of clinical reasoning	Intrinsic challenges (students)	Lack of patient-centred approach Lack of self-directedness Need to pass versus need to understand Autonomous practitioner development	Challenges that the lecturers had with the students with regard to the development of clinical reasoning.
	Intrinsic challenges (lecturers)	New academic Not sure what other lecturers were doing in their classrooms	Challenges that the lecturers mentioned regarding themselves when attempting to develop clinical reasoning.
	Extrinsic challenges	Lack of an integrated approach to teaching clinical reasoning Exam format Classroom practice and environment	These were challenges related to the environment (teaching environment) as well as practices related to their teaching.

4.4.2.2.1 Intrinsic challenges

The intrinsic challenges that were reported were related to the students and the lecturers themselves. The participants thought the students were "not patient-centred" enough and "struggled with self-directed learning". They pointed out that these presented as challenges to developing clinical reasoning.

The lecturers thought that the students were "not patient-centred" enough in their approach which could hamper their clinical reasoning ability.

> *"… sometimes students don't talk to their patients, they don't explain anything, they say why should we? This patient is in a coma. So, the patient can't hear me, so why must I talk to the patient?" (Lecturer 1)*
>
> *"… some students just see a patient as a tool …" (Lecturer 4)*

The lecturers shared their thoughts on the students' "lack of self-directedness". They saw this as a challenge in the development of clinical reasoning.

> *"How do you improve yourself? They still have to do it. I can't do it for them. You still need to go and learn your work. You need to go back to your books and sit with your books and go and do the research." (Lecturer 1)*

"So, you must take responsibility for your own learning from day 1." (Lecturer 2)

"Willing to be proactive in those relevant content or go and research …" (Lecturer 4)

"Because if you asking the students to be more proactive in the learning strategy, they are very reluctant sometimes; they just want to sit back and absorb." (Lecturer 7)

They also mentioned that "experience" was integral to the development of clinical reasoning but that students obviously lacked this experience.

"… it's difficult if you're undergrad, because you don't have that experience." (Lecturer 2)

"Students and new graduates simply don't have that depth of experience that they can use to do the pattern recognition that's required for the more intuitive, gut-feeling approach to clinical reasoning." (Lecturer 6)

Students need to pass their exams to be able to move to the next year's level and ultimately graduate from their degree programme. Therefore, students would likely focus more on passing than on understanding difficult concepts. The participants shared some thoughts on this matter.

"… they won't come to say, 'Ma'am, why am I having less marks?' for example. 'How can you assist me, because I see that I'm having a lack of understanding of the work that was covered?' But they will only come when they see the marks." (Lecturer 3)

"… the focus should shift. It shouldn't be about the mark, because when we see the patient care and clinical reasoning and all of that, we will give you the marks for that, because that's what we mark ..." (Lecturer 4)

"That mark doesn't really mean anything. They start another block and now they're demoralised because they failed their previous block." (Lecturer 6)

"… are students interested in being challenged and to develop clinical reasoning? Or are students only interested to pass? That is the thing ..." (Lecturer 8)

"Because the system is pass and fail. I am not interested in clinical reasoning, I am interested in pass." (Lecturer 8)

Lecturers then reported on their observations of the students' superficial learning.

"… so, a lot of the times their learning is only for the sake of learning." (Lecturer 4)

"Because I think the main focus is to just focusing you know, theory and passing …" (Lecturer 7)

"So, students prefer just to learn, they don't want embedded into long memory …" (Lecturer 8)

"Yes, but they don't necessarily know what it [the content] means." (Lecturer 9)

The challenges associated with the lecturers themselves were regarding being a "new lecturer" and "not knowing what their colleagues were doing" in their classes. One interviewee mentioned the difficulty of trying to develop complex skills such as clinical reasoning as a new academic.

"So, I am still trying to grapple with all the things of being a new academic and understanding this concept of clinical reasoning and how to develop a, you know, a practitioner that is more competent when they enter the clinical environment." (Lecturer 7)

Another reported challenge was the fact that even though most participants mentioned the use of paper-based cases, these were done in isolation; everyone had different approaches in their classes, and did not know what was happening in other classes.

"… people are having different styles of teaching …" (Lecturer 3)

"So, I think I do that, I can't speak for anybody else, because I don't know what they do in their lectures." (Lecturer 5)

"Well some lecturers think that there is an answer to everything, and the student must just memorise all the answers, which is a bit bullshit really, because no one can have perfect information …" (P6)

"… like I don't specifically know what is happening in the clinical practice module at the moment …" (P10)

4.4.2.2.2 Extrinsic challenges

The participants mentioned factors such as the "exam format", the "length of the degree", the "theory–practice gap" and certain "classroom practices and environments" that hinder the development of clinical reasoning.

Although the main requirement is to pass, the lecturers shared their thoughts on the "exam format" posing a challenge to the development of clinical reasoning.

"But they're only doing mediocre, because they just want to pass the exam …" (Lecturer 4)

"I feel like they fear in doing things, because they're scared to fail." (Lecturer 4)

"They don't realise that for the last five weeks [clinical block] they've been mentally stimulating themselves, cognitively pushing themselves to high levels and maybe they just had a bad day [day of the clinical exam]." (Lecturer 6)

"… when I was studying, I found that a lot of emphasis was just placed on these big exams and big tests and if you failed, then you failed." (Lecturer 7)

This group of lecturers suggested that perhaps a four-year degree was not generous enough to learn the basic content, engage with the content, and develop clinical reasoning.

"So, we have a four-year degree, it's not long. You'll be cramming everything in four years …" (Lecturer 1)

"… we simply don't have enough time in the undergraduate curriculum to do all of these things." (Lecturer 6)

"… I don't think four years is enough to even just bridge that gap, so between you know theory and practice and clinical presentation …" (Lecturer 7)

The “theory–practice gap” was highlighted as well, referring to students who know their theory well but struggle to apply it. The lecturers found that, in general, students seemed to struggle to apply the theory they had learnt in practice.

> *“Because sometimes you have strong students, they’re very strong theoretically but they can’t apply it [theory].” (Lecturer 2)*

> *“So, what we are struggling with, when the students go on block, the theory component is missing, and we do not know why is it missing.” (Lecturer 3)*

> *“And we pick that up during our clinical practice, supervision, and I think some students struggle with the bridge between theory and clinical practice …” (Lecturer 5)*

“Classroom practices” and the “classroom environment” were also highlighted as potential stumbling blocks to developing clinical reasoning. The use of didactic teaching methods, the fact that class groups are very large, a huge focus on content and creating a passive learning environment were thought to be detrimental to the development of clinical reasoning.

> *“It’s because sometimes people teach, they just teach what they must teach. So, they look at what is on this list here, I’ve got to teach about*

hypertension … but they don't necessarily then say okay, let's go into the hospital setting and look at a patient …" (Lecturer 1)

"We still have people who believe in standing in front and teaching. And then they go out." (Lecturer 3)

"You see the module is designed to equip students with knowledge …" (Lecturer 3)

"So, a lot of the time it was you know, this is what you need to be taught and you would study for it, you write the exam paper and you would know whether you pass or not." (Lecturer 7)

"A passive learning environment says all I want is for you to passively write down on, this is how you take the exam on, this is how you take the exam, you just write it down …" (Lecturer 8)

4.4.2.3 Theme 3: Factors to assist in the development of clinical reasoning

The lecturers spoke of particular factors they thought could assist in the development of clinical reasoning. These factors were divided into two sub themes: "student qualities" and "lecturer qualities". There is a need to develop student competencies and lecturer competencies in order to have an impact on clinical reasoning.

Table 4.4: Factors to assist in the development of clinical reasoning

Theme	Sub theme	Codes	Interpretation
Factors to assist in the development of clinical reasoning	Student qualities	Self-reflective Lifelong learning Knowledge	These were the qualities the lecturers thought the students needed to have in order to assist with the development of clinical reasoning.
	Lecturer qualities	Normalise uncertainty Approachable Clinical experience Student-centred Current trends	These were the qualities the lecturers thought they needed to have in order to assist with the development of clinical reasoning.

4.4.2.3.1 Student qualities

The codes for student qualities were the following: “self-reflective”, “vulnerability” and “knowledge”.

The following extracts highlight the need to be “self-reflective”. The lecturers thought that when the students were self-reflective, it assisted in the development of clinical reasoning.

> *“So, we want students to then say I realise that now, I should have covered my patient.” (Lecturer 1)*

> *“… everything that you do is going to be based on how good you were yesterday. How good you want to be tomorrow.” (Lecturer 6)*

The lecturers believed that students needed to be "vulnerable" and ask questions when they were unsure.

> *"Yes, they [students] can ask any clinician, they can ask any other student. They can pick up the phone and phone one of us."* *(Lecturer 6)*

> *"Some students will ask. Some students are ok with being able to say 'I don't know.'" (Lecturer 6)*

> *"And if you believe you have to have all the answers, then you're not going to ask any questions, because now you're showing that you are vulnerable, weak, stupid in quotation marks …" (Lecturer 6)*

In order to clinically reason, the lecturers thought that students needed an adequate "knowledge" base.

> *"So, for me clinical reasoning is about you, a student needs to have knowledge." (Lecturer 1)*

> *"A student cannot reason if they don't have knowledge, because how can they figure things out?" (Lecturer 1)*

4.4.2.3.2 Lecturer qualities

The qualities that were mentioned for lecturers to have were to “normalise uncertainty”, be “approachable”, be “student-centred” and be “lifelong learners”.

The lecturers shared the opinion that “normalising uncertainty” was important for themselves and for their students.

> *“I feel that even if you are a qualified physio, like you need twenty odd years, you still need to be able to ask questions. I can’t pretend that I know everything.” (Lecturer 1)*
>
> *“I take the approach that the students can never have perfect information. They can never know everything.” (Lecturer 6)*
>
> *“I always tell the students that, I am not an all-knowing person, just because I am here in a position as a lecturer, does not mean I know everything.” (Lecturer 7)*

The lecturers acknowledged that it was vital for them to be “approachable” in order for the students to learn and develop.

> *“… it’s easier for them to come to you. I have an open-door policy, they can contact me any time to find …” (Lecturer 2)*

By having a more “student-centred” approach, lecturers would be able to make sure they were quickly identifying struggling students, and allowing students to challenge ideas in the classroom.

> *“What we do as an addition to what we are offering them, after their first tests, then we identify the struggling ones, and then we call them ...” (Lecturer 3)*

> *“So, just by having conversations and seeing them at the placement treating the patient, they will flag the student to see okay, this student is starting to struggle.” (Lecturer 4)*

> *“And I think that is important, so students should challenge the information that we have and that in a way also promotes that problem-solving ...” (Lecturer 7)*

Lecturers also reported that they need to keep up with current trends in their respective fields, as well as in the domain of teaching and learning.

> *“… to experience the clinical practice experience, because it’s completely different when you come here [to the clinical setting] from a classroom setting …” (Lecturer 5)*

"… and always learning more, so we've got a lot of continuous professional development courses …" (Lecturer 5)

"I try to add on or read about up about certain others ways of working with the students in the classroom to make it a little bit more enjoyable and fun for them, because I can even imagine how boring it can get, sitting in front of somebody talking for two hours." (Lecturer 7)

4.5 Discussion

The results which relate to the strategies used to develop clinical reasoning are discussed below. Furthermore, the lecturers revealed challenges they experienced while attempting to develop clinical reasoning and factors that contributed to this development. Some of these challenges and factors are also discussed.

4.5.1 Types of strategy used

Most of the lecturers described the use of case studies as a strategy to improve clinical reasoning. Case studies consist of patient history, results from a clinical examination, and investigations (Klemenc-Ketis et al., 2018). Macartney et al. (2021) describe paper patients as cases constructed using provided clinical information in case-based learning, noting that students either do them independently, or as a group. Clinical case presentations and case-based discussions are ideal for teaching clinical reasoning skills (Modi et al., 2015). According to Barrett et al. (2018), the use of case studies based on real-life patient encounters creates opportunities for students to answer questions related to the scenarios and engage in role play. Here, role play refers to the student role playing the case or performing mock evaluations (Barrett et al., 2018). These types of cases have been thought to improve students' reasoning abilities (Modi et al., 2015; Neistadt et al., 1998). According to Neistadt et al. (1998), paper-based cases inspire students and direct them to issues that must be unpacked in order to understand the case they are presented with and to then produce solutions. Case-based teaching provides opportunities and encourages students to discuss real clinical situations (Pinnock & Welch, 2014). This type of classroom activity allows multiple learners with varying levels of expertise to be involved in the same case, which assists the educator in locating exactly what the students might be struggling with (Bowen, 2006).

The lecturers in the present study communicated the importance of student engagement via classroom discussion and small group activities. Walker (2003) also describes classroom discussion as a means of encouraging critical thinking. Exposing students to a process of weighing up the pros and cons of certain issues, for example in evaluating the use of one treatment modality rather than another, will assist in their preparation for decision-making in the clinical context (Walker, 2003). Furthermore, the platform to engage in discussion allows students to think for themselves and to be cognisant of others' opinions (Walker, 2003), which will aid them when working in multidisciplinary teams. The findings by a review conducted by Murad et al. (2010) showed that when educators wanted to facilitate more thinking or cognitive activities, class discussions were found to be useful.

In the interviews with the lecturers, scaffolding and facilitating thinking in the students were recognised as important activities in the development of clinical reasoning. Likewise, according to Cutrer et al. (2013), scaffolding is highlighted as an educational strategy to improve clinical reasoning. Scaffolding is used to describe different types of support offered to students during their interaction with lecturers as they move towards competence or more advanced levels of understanding (Maybin et al., 1992). Using scaffolding illustrates the temporary but necessary nature of the lecturer's assistance, as the student progresses in knowledge and understanding (Maybin et al., 1992). Curter et al. (2013) warn, however, that in order for scaffolding to be effective it requires an active learning process and relies on feedback.

The lecturers explained facilitating thinking in terms of feedback, questioning and reflection. Rencic (2011) agrees that feedback results in a positive outcome, stating that when educators provide feedback on students' history-taking, physical exam and clinical reasoning skills, they encourage better performance. In a study conducted by de Beer and Mårtensson (2015), the authors found that when feedback was aimed at the process of students' specific clinical reasoning skills and suggestions on how to improve were aimed at the procedure and not the person, it was effective in developing clinical reasoning skills in occupational therapy students. This demonstrates the need to distinguish the type of feedback students are being provided with. Hattie and Timperley (2007) describe feedback as four levels of information provided by the lecturer regarding aspects of the students' performance or understanding. The four levels are task-level feedback, process-level feedback, self-regulation level feedback and self-level feedback. Task-level feedback refers to feedback on a task and whether it is correct or not, while process-level feedback is aimed at the process used to complete the task. During self-regulation feedback, an opportunity for self-evaluation of the student is allowed which focuses on the student's confidence. The final type of feedback is directed to the students themselves, focusing on who they are as people rather than looking at the work they have produced (Hattie & Timperley, 2007).

Barrett et al. (2018) also used questioning in their study to challenge the student to engage in deeper thought. Questioning encourages students to make a decision and respond in an organised manner (Barrett et al., 2018). Furze et al. (2015b) refer to this type of strategy as reflective questioning. By asking the student why and to defend their choices, the educator encourages the student to reflect on the experience and reinforce learning accordingly (Furze et al., 2015b). Merisier et al. (2018) point out that questioning can be used with any learning method and that when used correctly it can foster the development of clinical reasoning.

The participants in the current study thought that reflection was a useful strategy to incorporate into their teaching practice. Similarly, Donaghy and Morss (2000) note that educators have an obligation to facilitate reflection in students. Schon (1983) explains reflection as the way in which an individual develops a collection of knowledge and then draws on that knowledge in future situations. Reflection practice in physiotherapy is not a new concept; early research by Cross (1993) had already emphasised that reflection on clinical experience has the ability to develop higher order thinking such as critical inquiry. The framework by Donaghy and Morss (2000) claims to facilitate reflection in students. The framework, which is based on a hypothetico-deductive approach to problem-solving, is structured in a way that requires reflective activity during the process of assessment practice in physiotherapy. More recent research also demonstrates that reflection in clinical practice by qualified physiotherapists results in a better understanding of their decision-making (Karvonen et al., 2017). Research conducted among students also demonstrates a positive feeling around reflective practice, noting that it could promote introspection, analysis, discussion and enhanced understanding of the complexities of practice (Ramli et al., 2012). According to Mamede et al. (2012), reflection assists with the development of clinical reasoning by promoting the restructuring of existing knowledge about conditions and clinical cases encountered during clinical practice. Barrett et al. (2018) conclude that, when students are encouraged to think about a recent situation and offered an opportunity to critically appraise their behaviour through a process of reflection or questioning, they are engaging in metacognition (thinking about thinking).

Some of the lecturers believed that besides teaching theory, lecturers should also take responsibility for student supervision during clinical practice. They thought this practice would assist in the development of clinical reasoning as the link between theory and how it is applied in practice would be more apparent. A similar sentiment is shared by Barrett et al. (2018), who suggest that educators who do not have practice experience will face challenges in preparing their students to make better clinical decisions. The study by Roskell et al. (1998) describes the term “theory–practice gap” as an expression in nursing which was used to report the misalignment between what is taught about practice and what actually occurs in practice. Practical examples, exposure to the clinical setting and personal experience were used by the participants in order to bridge the theory-practice gap. In a study by Botma (2014), nursing students reported that their knowledge was retained for a lengthier period when they were exposed to practical application of the knowledge.

4.5.2 Challenges experienced with regard to the development of clinical reasoning

The lecturers who were interviewed explained that students needed to be more patient-centred in order to be better at clinical reasoning. Lee et al. (2016) state that critical thinking is a knowledge-based subject, which does not examine patient contextual situations. However, in a study by Archer et al. (2017) which aimed to explore the teaching and learning experiences of undergraduate medical students with regard to patient-centredness, participating students had a positive attitude towards a patient-centred approach and they realised the importance of patients being treated as whole people with their own expectations. This group of lecturers were of the opinion that their students were not patient-centred. The participants in the study by Archer et al. (2017) also acknowledged that they needed to remind themselves at times that the patient is still a person and not simply an item or a disease.

The lecturers in the present study were of the opinion that the students needed to be more self-directed and take responsibility for their learning. Students spend time acquiring information and learning new skills. This continuous acquisition of knowledge and skills is necessary for the creation of knowledge and information (Hiemstra, 1994). The activity in which students take the initiative to gain knowledge and skills, even in very formal settings (such as a degree programme) is known as self-directed learning (Hiemstra, 1994). Self-directed learning can empower students to take more responsibility for decisions associated with their learning and transfer their learning, both knowledge and skills, from one situation to another easily (Hiemstra, 1994). Barrett et al. (2018) suggest that including students in the planning and formation of rubrics to assess their work and encouraging them to reflect on their class assignments can inspire self-direction.

The lecturers shared their observations that students were not focused on understanding content, that students seemed to demonstrate superficial learning, and that a passive approach was still present within their own teaching and assessment practice. Most lecturers advocated for the use of more active teaching strategies and assessment methods. Participants in a study conducted by Behar-Horenstein et al. (2013) were comfortable using various teaching approaches but remained aware of the need for active learning, which may not have been the case for the lecturers in the current study. Wass et al. (2001) point out that the assessment of medical undergraduates has tended to focus on producing what the student knows (factual recall) and the ability of the student to apply knowledge (problem-solving and decision-making). The interviewed lecturers reported on the fact that recall and application of content and concepts were used in both teaching and assessment. It is important to note that according to Durak et al. (2007, p. 170), "examinations drive learning". This could be why the lecturers assumed that students were simply learning to pass and not for understanding. Wass et al. (2001) caution that factual assessment is appropriate in the early stages of the medical curriculum but, as students' progress, a more carefully planned approach to assessment should be considered. Accordingly, Wass et al. (2001) advocate for the assessment of how a student actually performs using unstandardised real patient cases to assess clinical competence, objective structured clinical examinations, and the clinical portfolio as part of the assessment. The clinical portfolio was also highlighted as a teaching strategy by the lecturers in the current study. In a study assessing the use of case-based exams by providing students with illness scripts, Durak et al. (2007) asked students to use their clinical problem-solving ability while providing written answers and feedback during the exams. This type of instructive case-based assessment at weekly intervals was found to be a potential learning tool (Durak et al., 2007).

One of the participants mentioned that being a new academic presented a challenge. The main finding of a study by Barrett et al. (2018) was that lecturers who lacked experience or teaching practice have considerable difficulty trying to prepare students to use evidence and make clinical decisions. According to Barrett et al. (2018), the role of lecturing is challenging because of the duties the lecturer must fulfil. These duties include preparation of teaching material, implementing lesson plans, providing correction of students' work and giving feedback (Barrett et al., 2018). The data collected from the current interviews demonstrates that lecturers must not only keep up with content knowledge in their respective teaching areas, but also with knowledge regarding teaching practices. Barrett et al. (2018) suggest that colleagues who have taught the course before or who have valuable experience, should provide input or offer class observation of the new lecturer with feedback, mentoring partnerships and orientation workshops. This would assist new academics to prepare students for clinical decision-making (Barrett et al., 2018).

4.5.3 Factors to assist in the development of clinical reasoning

The lecturers interviewed for this study reported that it was important to normalise uncertainty and not to expect students to know everything. According to Slade et al. (2012), physiotherapists are not comfortable with diagnostic uncertainty. This could translate into the lecturers not being comfortable with demonstrating uncertainty in front of their students. Gheihman et al. (2020) agrees that uncertainty is typical in medicine and makes most health professionals and patients deeply uncomfortable. However, Simpkin and Schwartzstein (2016) believe that a shift toward the acknowledgment and acceptance of uncertainty is essential for health professionals, for patients and ultimately health care systems, and that in order to thrive in the next health professions era, an ability to tolerate uncertainty would be necessary. Furthermore, the 21st century has demonstrated that technology is constantly evolving and algorithms will be developed to perform the routine tasks of medicine. Therefore, the value of health professionals will be in the space of uncertainty, to support patients who are living with uncertainty and to work towards building strong and meaningful health professional–patient relationships (Simpkin & Schwartzstein., 2016). The recommendation of Simpkin and Schwartzstein (2016) is that health professionals focus on changing the professional culture to provide the space for uncertainty. The study by Ahlsen et al. (2018) demonstrated that uncertainty can play a major role in therapists' investigative practice and in trying to find clues regarding the patient's physical problem. Ahlsen et al. (2018) believe that uncertainty actually activates the physiotherapist's curiosity and creativity, and is the channel which underlies their process of reasoning. Simpkin and Schwartzstein (2016, pp. 1714–1715) point out: “Only uncertainty is a sure thing. Certainty is an illusion”.

4.5.4 Comparison of studies reporting on strategies to develop clinical reasoning

The study by Barrett et al. (2018) aimed to describe challenges facing new academics and presented suggestions for teaching strategies in areas such as critical thinking and strategies to enhance clinical reasoning. Their study found that questioning, case studies and metacognition or reflection were useful in the enhancement of clinical reasoning (Barrett et al., 2018). Modi et al. (2015) offered similar strategies, including exposure to clinical conditions, facilitation of hypothesis production via questioning, discussion and feedback. It is clear that the current study’s findings regarding teaching strategies, as discussed by the lecturers, are very similar to those in the literature.

4.6 Conclusion

This chapter explored the learning tasks used by lecturers to develop clinical reasoning in their students. In addition, the lecturers highlighted challenges they experienced while developing clinical reasoning skills and factors that they thought affected the development of clinical reasoning.

The interviewed lecturers explained their use of a large range of strategies to develop clinical reasoning, including case studies, discussions and small group learning (student engagement), and scaffolding. Furthermore, they highlighted questioning, reflection, feedback and demonstration, which was interpreted as facilitating thinking. The integration of theory and practice via clinical visits and sharing personal experiences was recommended, in addition to developing competencies such as lifelong learning and assessment practices.

The lecturers also spoke of the challenges they faced when trying to develop clinical reasoning; these were related to the lecturers themselves, the students, and factors related to the environment. In terms of their environment, they experienced a lack of an integrated approach to teaching clinical reasoning. The exam format was found to be challenging, and classroom practice could be improved in terms of creating environments that encourage thinking. New lecturers found teaching or developing clinical reasoning was challenging and that they did not know what their colleagues were doing in their classrooms. They also thought the students were not patient-centred enough, were not self-directed and could be more vulnerable. As noted in the previous chapter, students thought that being patient-centred, self-directed and vulnerable was very important in the development of their clinical reasoning. This highlights inconsistencies between what the lecturers perceived about the students and what the students actually believed. Factors which the lecturers believed could assist with developing clinical reasoning were to normalise uncertainty, be more approachable, provide adequate exposure for clinical experience, be more student-centred and keep up with current trends. Uncertainty was also mentioned by the experts (particularly in Chapter 3) as an important factor in the development of clinical reasoning. This indicates that work needs to be done on a personal level and not just on an environmental level in order to develop clinical reasoning in students.

The strategies highlighted in the findings of this study could be useful for educators who are interested in the development of clinical reasoning in their own students. This chapter still forms part of Phase 1 of the study. The next chapter presents the results of the scoping review, which examines the theory that underpins teaching strategies.

Chapter 5: Theoretical underpinnings to enhance the development of clinical reasoning in undergraduate health professions students

5.1 Introduction to the chapter

This chapter presents the results of a scoping review that was conducted by the researcher as part of the first phase of the study. The scoping review explored how theory influences the teaching strategies used for developing clinical reasoning in undergraduate health professions students. The chapter includes a brief background and literature review of the topic, a brief section on the methods, and the results are then presented and discussed.

5.2 Introduction and literature review

Medical education greatly values the advancement of students' diagnostic capabilities (Al Rumayyan et al., 2018). Similarly, physiotherapy programmes aim to graduate students who have clinical reasoning knowledge and skills which are adequate for them to qualify and contribute substantively to the complex health care systems of the future (Christensen et al., 2017). Clinical reasoning is considered to be a process that culminates in deciding on a diagnosis, treatment and management plan and incorporating enhanced patient outcomes (Young et al., 2018a). As noted in the study by Young et al. (2018a) the clinical reasoning process consists of a number of features. These include determining the objectives of the clinical experience, knowledge, patient observation, collecting data, interpretation of data, generating a hypothesis, differential diagnosis, clinical judgement, and acting on and assessing the results of the action taken.

It is therefore evident that clinical reasoning and the processes concerned with it can be challenging; a host of teaching strategies have been discussed in the literature (Bowen, 2006; Cutrer et al., 2013; Rochmawati & Wiechula, 2010; Terry & Higgs, 1993). Terry and Higgs (1993) argue for teaching strategies to incorporate knowledge development, the needs of the learner, the nature of the context and the application of the principles of adult learning. A systematic review by Rochmawati and Wiechula (2010) established that problem-based learning (PBL) and the integrated curriculum were effective for teaching clinical reasoning but cautioned that the results of their review were insufficient to draw final conclusions regarding the most effective educational strategies to improve health professions students' clinical reasoning ability. The integrated curriculum refers to dividing students into small groups and participating in a combination of various methods such as reflection, feedback, and role play (Rochmawati & Wiechula, 2010). Schmidt and Mamede (2015) caution that educational innovations such as PBL cannot fill the gap entirely; it has limitations such as too few cases in the curriculum. Dolmans (2019) suggests that if PBL is not successful, it is a consequence of poor quality PBL problems or large student groups, which will hinder the achievement of deep processing. A multitude of strategies are available in the literature. Simulated patients, using high-fidelity virtual patients presented online, and clinical cases have been widely used, with a variety of instructional approaches being employed to teach clinical reasoning (Al Rumayyan et al., 2018). Cutrer (2013) however recommends that educators not only equip themselves with a toolkit of educational strategies, but also with strong theory which will help educators identify and capitalise on opportunities to assist students on the path to expertise. According to Bowen (2006), educators can encourage the development of reasoning while simultaneously diagnosing both the patient’s disorder and the learner’s abilities. But in order to achieve this, they require an appreciation of learning theory.

Learning theory is an explanation of why something happens or how it happens and is useful in understanding how people learn (Harasim, 2017). There are a variety of learning theories in the educational field (Badyal & Singh, 2017). This variety is noted by Badyal and Singh (2017) as an indication that learning theory acts as a set of guidelines that explain the connection between principles, or as the basis of what is being done. For example, a theory might explain why things in a curriculum occur the way they do, or how things in the curriculum are connected to one another (Badyal & Singh, 2017). Theory can consequently provide a foundation for the choices that educators make regarding teaching strategies, how learning objectives are framed, and how they evaluate their students (Badyal & Singh 2017).

Earlier research by Durning et al. (2013) suggests that the difficulty with clinical reasoning could be the diversity of educators' worldviews and the theories used when discussing clinical reasoning. In the Durning et al. study (2013), the authors expanded on the objectivist and constructivist approach used when teaching clinical reasoning. Durning et al. (2013), however, noted that when educators used theory it was often unintentional. Later research by Young et al. (2018b) emphasised numerous theories and attempted to explain the complexity of clinical reasoning in spite of the considerable overlap between them. The authors suggest that each theory identifies with a specific component of clinical reasoning and provides insights to assist with planning comprehensive approaches to the teaching and assessment of clinical reasoning (Young et al., 2018b).

However, the research of Durning et al. (2013) found that learning theory failed to describe the phenomenon of the clinical reasoning process in novices and students. According to Jessee (2018), the link between theory and clinical education practices that aim to develop clinical reasoning is limited and not well established. Although many diverse theoretical approaches have been used to understand clinical reasoning, the theories that advance the manner in which clinical reasoning is taught, learnt, and researched, are continually being improved (Pinnock et al., 2019). Therefore, it would be useful for educators to understand what foundational theory supports their chosen teaching strategy. By understanding which theories are used to underpin teaching strategies, educators can frame their teaching approaches based on theory rather than just choosing strategies without a rationale. Therefore, understanding the theoretical approach to the reasoning process could be useful in the development of clinical reasoning. The objective of this part of the study was to explore how theory influences the teaching strategies used for developing clinical reasoning in undergraduate health professions students.

5.3 Methodology

5.3.1 Research design

A scoping review was conducted to answer the review question and meet this objective of the study. The review was conducted by the researcher and a postgraduate student[3] who submitted her part of the review for the MSc Physiotherapy degree examination.

5.3.2 Patient Intervention Comparison Outcome (PICO)

The PICO for the review is outlined below:

The population (or participants) are health professions education students and the interventions are theories that underpin teaching strategies used by educators to inform the development of clinical reasoning. No comparisons were made and the outcome looked at a change in clinical reasoning when theory underpinned the strategies used by the educators.

[3] The postgraduate student worked under the researcher's supervision and was co-supervised by one of the researcher's supervisors. The eleven databases that were consulted were divided between the researcher and the postgraduate student. Data collection and extraction were then completed independently and reviewed with one of the researchers supervisors. The postgraduate student reported on the data collected from their assigned databases independently and the researcher reported on the data collected and extracted by the postgraduate student as well as data from their assigned databases.

5.3.3 Research question

How does theory influence the teaching strategies used for the development of clinical reasoning in undergraduate health professions students?

5.3.4 Secondary questions

1. What theories are used to inform the strategies that develop clinical reasoning in undergraduate health professions students?
2. What strategies are used to develop clinical reasoning in undergraduate health professions students?
3. How are the theories used within the highlighted teaching strategies?

5.3.5 Objectives of the review

The following are the objectives of this review:

1. to identify the theories that inform the teaching strategies for the development of clinical reasoning in undergraduate health professions students,
2. to identify the teaching strategies used to develop clinical reasoning in undergraduate health professions students; and
3. to explore how the theories were used within the highlighted teaching strategies.

5.3.6 Data collection and analysis

The databases (n = 11) that were chosen for this review were available through the University of the Western Cape library and the inclusion and exclusion criteria were based on the research question. Search strings were created combining search terms and used across the databases. The screening process commenced with reading the titles, then the abstracts and finally the full text articles. The inclusion criteria were applied at all levels of the screening process. Critical appraisal was conducted on the included studies, although none were excluded because of poor scores. The critical appraisal was conducted to provide information about methodological rigour only and not for exclusion of studies. A self-developed data extraction form was used to extract the relevant data. Finally, a narrative synthesis was conducted to report the findings.

5.4 PRISMA-ScR flowchart

The results are guided by the PRISMA-ScR[4] and presented in the flow chart in Figure 5.1 (next page), which provides a visual representation of the process of article identification, screening, eligibility and inclusion. A total of 11 databases were searched using the search terms identified by the researcher and a postgraduate student. In total there were 11 150 initial hits. After duplicates were removed a total 10 695 titles remained. At this stage titles were first read and then those that were not applicable were removed. The abstracts (n = 371)

[4] PRISMA-ScR refers to the PRISMA extension for Scoping Reviews. The extension assists researchers to understand core concepts and key items to report for scoping reviews.

were then read and inclusion criteria applied when titles and abstracts were read. A total of 10 324 articles were then removed and 61 articles remained. The full texts of the remaining 61 articles were read by the researcher and a postgraduate student and 55 articles were excluded. A final total of six studies that met the inclusion criteria were critically appraised and included in the review. The results are summarised in Table 5.1.

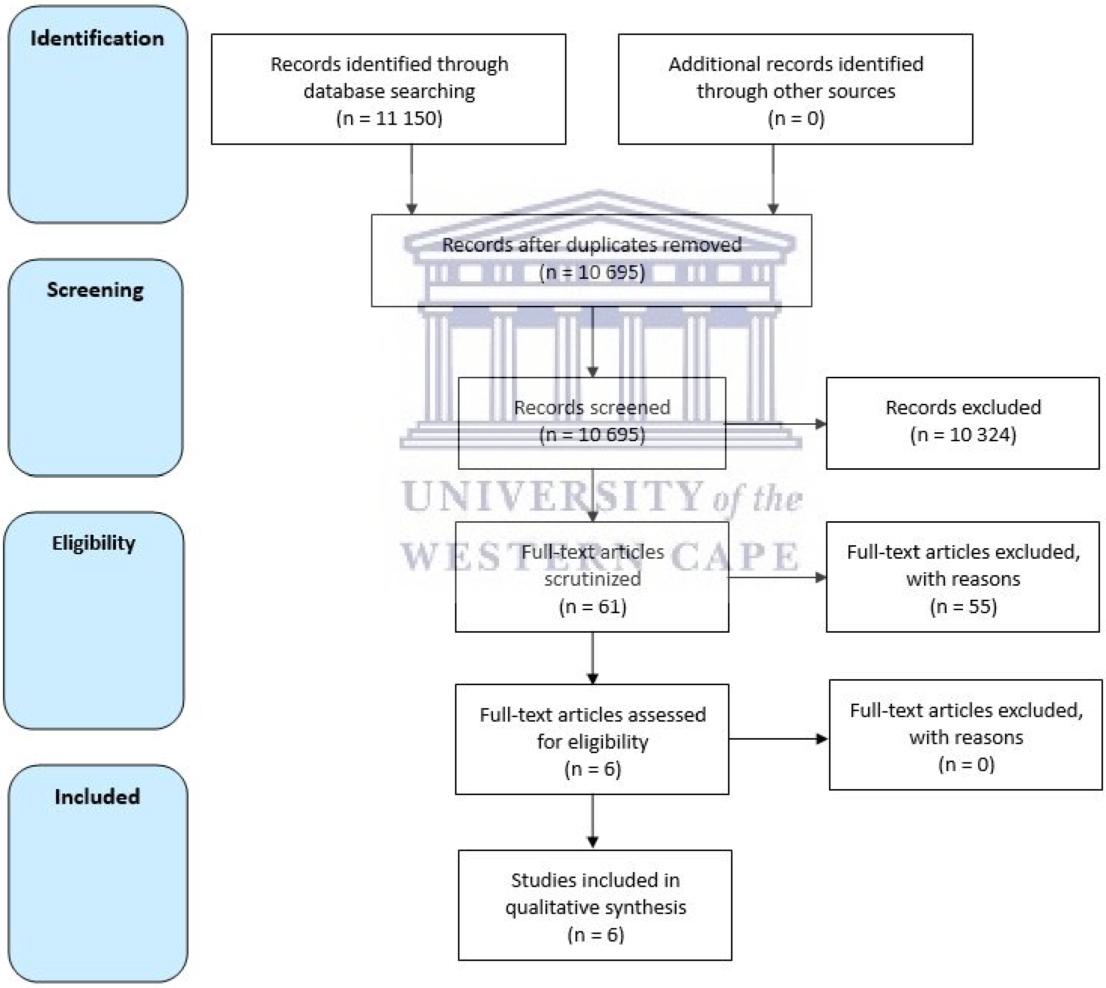

Figure 5.1: PRISMA flow chart

Table 5.1: Summary of results of review

Citation	**Carbogim, F., Oliveira, L., Toledo, M., Diaz, F., Bittencourt, G., & Püschel, V. (2019). Active teaching model to promote critical thinking. *Revista brasileira de enfermagem*, *72*(1), 293-298.**	**Costello, E., Ruckert, E., Lyons, L., Cotton, L., & Birkmeier, M. (2017). To treat or not to treat: the use of computer assisted learning to enhance clinical decision-making and self-efficacy of student physical therapists in the acute care setting. *Journal of Physical Therapy Education*, *31*(3), 27-36.**	**Kautz, D., Kuiper, R., Pesut, D., Knight-Brown, P., & Daneker, D. (2005). Promoting clinical reasoning in undergraduate nursing students: application and evaluation of the Outcome Present State Test (OPT) model of clinical reasoning. *International Journal of Nursing Education Scholarship*, *2*(1).**	**Kuiper, R., Pesut, D., & Kautz, D. (2009). Promoting the self-regulation of clinical reasoning skills in nursing students. *The Open Nursing Journal*, *3*, 76.**	**Rush, S., Acton, L., Tolley, K., Marks-Maran, D., & Burke, L. (2010). Using simulation in a vocational programme: does the method support the theory? *Journal of vocational education and training*, *62*(4), 467-479.**	**Torre, D. M., Hernandez, C. A., Castiglioni, A., Durning, S. J., Daley, B. J., Hemmer, P. A., & LaRochelle, J. (2019). The Clinical Reasoning Mapping Exercise (CResME): a new tool for exploring clinical reasoning. *Perspectives on medical education*, *8*(1), 47-51.**
Aim	To present the experience of elaborating and implementing the active teaching model to promote critical thinking (MEACP) associated with problem-based learning (PBL).	The authors hypothesised that the use of computer assisted learning (CAL) modules in a clinical decision-making framework will have a positive effect on clinical decision-making, safety and self-efficacy to practice.	To evaluate clinical reasoning skill acquisition among nursing students through the application of self-regulation learning theory and outcome present test (OPT) model of clinical reasoning.	To describe the author's reflection on research and scholarly activities from the past five years surrounding the theories and models to evaluate components of clinical reasoning.	To evaluate simulation as a learning and teaching strategy and to identify a relationship to practice learning.	To develop, implement and evaluate a novel clinical reasoning mapping exercise (CResME) tool aimed at promoting clinical reasoning.
Type of study	Case report	Quasi-experimental design	Quasi-experimental design	Descriptive study: cross-sectional	Case study (qualitative)	Case study (qualitative)

Methodological appraisal	Score was 2/8 on the Joanna Briggs Institute (JBI) checklist for case reports. The study did not conform to the checklist as set out by JBI. The methodological quality of this study was therefore poor.	There were 9 items on the checklist for quasi-experimental design. It scored 5/9; therefore the methodological quality was poor.	Only 5 statements on the JBI checklist for quasi-experimental studies were applicable to the study. The score was therefore 3/5. The methodological quality of this study was poor.	One item on the JBI critical appraisal checklist for analytical cross-sectional studies was not applicable. Therefore, this study was scored out of 7 and not 8. It scored 6/7 and therefore, the quality of this study was good.	There were 10 items on this checklist and the study scored 7/10. Therefore, the methodological quality was good.	This study scored 0/10 on the item scoring sheet. Therefore, the methodological quality was poor.
Population size and description	52 undergraduate nursing students (Brazil)	68 undergraduate physiotherapy students, 35 in the experimental group and 33 in the control group (USA)	23 nursing students who participated in a medical and surgical course (USA)	66 nursing students who were participating in medical and surgical courses (USA)	The sample size was not clear. 1st and 3rd year nursing students (UK)	185 medical students, 93 1st years and 92 2nd years (USA)
The theory mentioned to underpin the teaching strategy	Activity theory	Bloom's taxonomy	Self-regulated learning (SRL)	SRL	Constructivism and a subset of constructivism: situated learning theory	Assimilation theory of learning, situated learning theory
The teaching strategy	MEACP associated with PBL.	CAL modules embedded within clinical decision-making framework.	Clinical reasoning web (similar to concepts map of relationships among nursing diagnosis). Reflective journal. Students were provided journal prompts and then they recorded	OPT model of clinical worksheet. Worksheets for clinical assignments following clinical experiences. SRL journals (responses to SRL	Simulation – students were required to work together in order to make clinical decisions.	CResME instructional tool.

			responses to those journal prompts in a journal following clinical interaction.	prompts). Each student completed a weekly journal.		
How the theory was used by educators	MEACP was created with pedagogical structuring based on activity theory. Students were tasked to go through mental operations through the MEACP associated with PBL, creating new concepts and signs that throughout tasks were clarified to arrive at problem solutions. An organising instrument called the activity oriented teaching (AOT) conceives the process of appropriation of knowledge in a dialectical movement going from general to particular, abstract to concrete.	Bloom's taxonomy domains of learning such as cognitive, psychomotor, affective. Aligned with educational methods used to achieve the specific learning outcomes. Integration of objectives especially psychomotor and affective remained beyond the scope of CAL but cognitive was used to guide the development of CAL. Mapped the categories (qualitative data) to Bloom's 3 domains of learning: knowledge, skills and attitudes. This was done to determine if the CAL module activity met the learning needs of students.	SRL was operationalised in self-regulation prompts to help students structure journal responses.	Students journaled weekly using SRL as their prompts for their weekly journal entries.	The authors used the understanding that constructing new meaning works well when learning is embedded in the social context. Simulation was then chosen as it mimics the workplace. Concepts from situated learning were used.	Meaningful learning was used to by utilising previous knowledge (designing of the illness scripts used) and then linking to existing cognitive framework (students using the framework). The use of CResME tool in small groups is consistent with social cognitive theories such as situated cognition according to the authors.

Outcomes and outcome measurement	Critical thinking was evaluated with the California critical thinking skills test (CCTST). The CCTST was done before and after the intervention.	Student self-efficacy survey of perceived confidence, preparedness to practice. Clinical reasoning case. Clinical performance instrument (CPI). Qualitative comments.	OPT model worksheets – to measure the nursing process. Journal prompts as part of the reflective journal process.	Students were able to frame situations over time (significance). Students were able to make decisions about interventions over time. Journals – reflections were related to thinking strategies, environment situations and self-monitoring performance.	Questionnaire Focus groups Observations	5-item evaluation form (completed after each session).
Results of the study	The intervention happened over three days Day 1 Students were divided into small groups and the course was presented to them. Day 2 MEAPC associated with PBL was used to simulate critical thinking skills. They read a case then apply MEAPC, establish what is needed to	Student self-efficacy survey of perceived confidence, preparedness to practice: Significant in favour of the experimental group. Clinical reasoning case: the experimental group took less time to complete the case (significant), the experimental group scored higher on the case (significant). American Physical Therapy Association CPI: median scores on students' self-assessment	OPT model – cross-tabs with Chi tests – difference in students' ability to frame situations over time; also differences in students' ability to make decisions over time. Content analysis OPT terms knowledge, clinical preparation, resources. Thinking included activities like self-	Self-efficacy with clinical reasoning activities increased over time. Most reflection was related to thinking strategies, environmental situations, and self-monitoring performance. SRL starts with the OPT model that suggests benefits of self-observation and self-monitoring during clinical	Students' responses indicate that simulation proved to be a valuable learning experience for both 1st and 3rd years (with little difference between the two groups of students). Responses indicate that simulation as a learning approach represents situated learning.	Both groups of students found the CResME tool promoted understanding of differential diagnosis, was a valuable tool and recommended its future use.

	understand the case, find the answers and present their findings. Day 3 Post intervention CCTST.	of safety and clinical reasoning were similar for both cohorts; no significant difference between the 2 cohorts self-assessment clinical reasoning or clinical instrument assessment of safety or clinical reasoning. Clinical instruments assessment of students' clinical reasoning skills in favour of the experimental group. Qualitative comments: 12 categories between the students (1. clinical decision-making, 2. planning, 3. communication, 4. efficiency, 5. safety, 6. psychomotor skills, 7. working with complex patients, 8. determining prognosis, 9. team work, 10. managing the environment, 11. creativity (intervention), 12. confidence. Top 3 categories: clinical decision-making, planning and communication.	correction, self-reaction, self-improvement.	reasoning activities and pinpoint areas where guidance is needed for the development of cognitive and metacognitive awareness.		

Authors conclusions	There was an improvement of the critical thinking scores.	Acute care CAL modules designed to maximise learning through foundation in educational theory. Modules use scaffolding to maximise student self-efficacy. Modules designed to mimic the real clinical environment appeal to millennials learners. Engagement through multiple learning styles. Through the use of CAL instruction students demonstrate improved clinical decision-making skills, improved self-efficacy to practice in an acute care environment and develop a framework from which to base examination and treatment of patients in an acute care environment in a time efficient manner. Although the psychomotor practice was lacking.	OPT and SRL models provide teaching / learning tools that assist faculty in evaluating their students' thinking and reasoning. Combined use of models may promote the development of cognitive and metacognitive thinking skills. Use of clinical reasoning web, OPT worksheets and SRL prompts on a weekly basis seem to be effective to document students' clinical reasoning.	SRL with OPT increases benefits of self-observation, self-monitoring during clinical reasoning activities and pinpoints where guidance is needed for the development of cognitive and metacognitive awareness.	The model of simulation used at the particular institution demonstrates that simulation applies evidence to clinical decisions during simulation activities.	CResME tool was a helpful scaffold to teach clinical reasoning. Learners enjoyed the exercise. The CResME tool made implicit features of clinical reasoning more explicit.

5.5 Results and discussion

For this chapter, the results and the discussion are integrated (5.5.1) and then results are presented followed by a discussion of the results (5.5.2 and 5.5.3). The scoping review aimed to explore how theory influences the teaching strategies used for developing clinical reasoning in undergraduate health professions students.

5.5.1 Study characteristics

A range of study designs were used across the included studies. This indicates a variety of methods used to assess teaching strategies to improve clinical reasoning ability among health professions students. The study designs included a case report and case study; two studies employed a quasi-experimental design and a cross-sectional descriptive study. According to Higgs et al. (2008), diverse methodologies serve different purposes, as there is an abundance of methodologies, which all serve the purpose of investigating various aspects of clinical reasoning.

Only two of the six included studies had good methodological quality. The study by Carbogim et al. (2019) scored 2/8 on the JBI checklist for case reports. The study did not conform to the checklist as set out by the JBI; therefore, the methodological quality of this study was poor. Only five statements on the JBI checklist for quasi-experimental studies were applicable to the study by Kautz et al. (2005). The score was therefore 3/5 and the methodological quality was rated as poor. In the study by Kuiper et al. (2009), one item on the JBI critical appraisal checklist for analytical cross-sectional studies was not applicable. Therefore, this study was scored out of 7, not 8. It scored 6/7 and therefore the quality of this study was good. For the study by Costello et al. (2017), the checklist for quasi-experimental designs was used and it included 9 items. The study scored 5/9 and consequently the methodological quality was rated as poor. The study by Rush et al. (2010) scored 7/10 on the checklist; therefore, the methodological quality was good. Finally, the study Torre et al. (2019) scored 0/10 on the item scoring sheet, indicating poor methodological quality. Overall, this indicates poor strength of the evidence included in this review. Similarly, a review by Mok et al. (2016) which assessed high-fidelity patient simulation used to teach clinical reasoning skills revealed low methodological quality, which they also reported as lowered strength of evidence. There have however been discussions concerning high quality health professions education research (Ahmed et al., 2016). As stated by Ahmed et al. (2016) there has been some necessity to produce a better definition for high quality health professions education research that moves beyond methodological rigour. Yarris et al. (2013) caution against focusing only on methodological rigour for quality as this could decrease value of the results for consumers. Furthermore, although efforts have been made to establish a definition for and improvement of the quality of studies, Yarris et al (2013) concluded that a common definition for quality of health professions education research was lacking.

The study populations of the included studies were made up of nursing students (n = 4), physiotherapy undergraduate students (n = 1) and medical students (n = 1). The sample sizes were quite small, ranging from 23 to 185 students. This would have impacted on the generalisability of the studies. It is also noteworthy that the studies took place at single institutions, with the exception of the study on medical students which was a comparison of two institutions. Possible reasons for the fact that the included studies comprised nursing, medicine and physiotherapy students are that clinical reasoning research in nursing dates back to the 1980s (Holder, 2018) and the study of clinical reasoning in physiotherapy dates back to the 1990s (Yazdani & Hoseini Abardeh, 2019). The study of clinical reasoning in medicine appears to date back to the 1970s (Yazdani & Hoseini Abardeh, 2019). According to Huhn et al. (2019), the clinical reasoning process used in physiotherapy was still advancing and is largely extracted from the work done in medicine and nursing.

One of the studies took place in Brazil, three studies in the United States of America and one in the United Kingdom. When looking at the history of the study of clinical reasoning, early authors such as Elstein, Bordage and Rubin hailed from the United States of America (Yazdani and Hoseini Abardeh., 2019). therefore, it would make sense that half of the included studies shared this location. A very recent study by Lee et al. (2021) found that clinical reasoning of health professionals from Western and Eastern contexts differed from each other. According to Guraya (2016) there is a larger focus on more Western models of teaching clinical reasoning. Furthermore, health professions education embraces Western approaches as the default (Hodges et al., 2009).

The outcomes used to measure a change in clinical reasoning were different for all the included studies. Carbogim et al. (2019) evaluated critical thinking with the California critical thinking skills test (CCTST) which was done before and after the intervention. Following the intervention, the CCTST was issued to the students and Carbogim et al. (2019) note an improvement of the critical thinking scores. Kautz et al. (2005) used the outcome present state test (OPT) model worksheets to measure the nursing process as well as the journal prompts. They stated that the use of the clinical reasoning web, the OPT worksheets and the self-regulated learning (SRL) prompts were effective to document students' clinical reasoning and the combined use of models may promote metacognitive skills. Kuiper et al. (2009) used the OPT model rating scale to evaluate the clinical reasoning progress weekly. They also used the retrospective verbal protocol analysis (RVPA) to examine the nature of students' reasoning based on the words they used to record reflections (Kuiper et al., 2009). A survey demonstrated that students' thinking skills were strengthened, the OPT model made them think about patient care problems differently, and that students found new ways to think about complex patient cases. Students were able to frame situations over time (which was significant for this study) and make decisions about interventions over time (Kuiper et al., 2009). Costello et al. (2017) utilised a multitude of tools; the "student self-efficacy survey of perceived confidence and preparedness to practice", a clinical reasoning case and the American Physical Therapy Association clinical performance instrument. They also made use of qualitative comments. The clinical performance instruments assessing students' clinical reasoning skills showed an improvement when the students used the computer assisted learning module. The qualitative comments, made by the students, were related to the areas they wanted to improve during their internship which included clinical decision-making, planning and communication (Costello et al., 2017). Rush et al. (2010) used a questionnaire (qualitative and quantitative questions) to find out how students perceived simulation. They showed that a model of simulation used at their particular institution demonstrated the application of evidence to clinical decisions during simulation activities. Torre et al. (2019) used a five-item evaluation form to establish how students perceived the CResME tool that Torre et al. (2019) endorsed. The participants in this study observed that the CResME tool promoted understanding of differential diagnosis, it was a valuable tool, and was worth recommending for future use. Torre et al. (2019) concluded that the CResME tool was a helpful scaffold to teach clinical reasoning and that the tool made implicit features of clinical reasoning explicit. (See Appendix L for more detailed information on the outcome measures and how they were used.)

The abovementioned studies reported a positive change in clinical reasoning and critical thinking. However, only the studies by Kuiper et al. (2009), Costello et al. (2017) and Carbogim et al. (2019) used standardised outcome measures. The study by Kuiper et al. (2009) used a survey, and along with the studies by Rush et al. (2010) and Torre et al. (2019), they reported that the students felt confident their clinical reasoning had improved. Persky et al. (2020) highlight that many educational research projects utilise students' perceptions of learning as the only measure of success and do not measure students' actual learning. The perceptions of learning are therefore subjective measures of perceived learning, not a reflection of true learning (Persky et al., 2020). However, although educators recognise that student perception of learning is a poor measure of training effectiveness owing to its subjective nature, it continues to be used in educational research (Persky et al., 2020). This demonstrates a weakness of these studies, in that they have not attempted to use a standardised tool to assess a change in clinical reasoning. Literature, on the other hand, confirms that the use of outcome measures does effectively measure a change in clinical reasoning and critical thinking. For example, Keiller and Hanekom (2014) measured students' critical thinking skills with the diagnostic thinking inventory (DTI) and determined their clinical reasoning skills with the self-assessment of clinical reflection and reasoning tool (SACRRT). Wan (2015) used the script concordance test to measure clinical reasoning in undergraduate and postgraduate medical students. However, Covin et al. (2020) point out that even though there are many instruments available to measure clinical reasoning capability, there is a lack of evidence contextualising the scores. Daniel et al. (2019) argue that because there are so many clinical reasoning assessment methods available, it is difficult to choose appropriate tools. The use of learning theory as a guide, could assist in choosing the appropriate tools.

5.5.2 Use of theory in supporting teaching strategies

Theories used in the studies which were included in the scoping review were activity theory, SRL, Bloom's taxonomy, situated learning theory (a subset of constructivism) and assimilation theory. Two of the included studies incorporated the same theory, SRL, while different theories appeared in all the other included studies. There was a range of teaching strategies used in the identified studies, with journaling being the only strategy common to all six studies (Kautz et al., 2005; Kuiper et al., 2009). The other strategies used were unique to each study and seemed to be designed for the specific study – with the exception of simulation (Rush et al., 2010).

The third objective of the review was to determine how the theory was used within each teaching strategy. Each theory was used as a framework to design or to make the best use of the teaching strategy (Carbogim et al., 2019; Costello et al., 2017; Kautz et al., 2005; Kuiper et al., 2009; Torre et al., 2019). Only Rush et al. (2010) chose the strategy based on the theory.

5.5.2.1 Activity theory

Activity theory is a framework for studying different forms of human characteristics as developmental processes; individual and social levels are interlinked simultaneously (Jonassen & Rohrer-Murphy, 1999). It therefore provides a paradigm for the result of instructional design (Jonassen & Rohrer-Murphy, 1999). It allows for an analysis of learning that takes place as it focuses on the activity the stakeholders are engaged in, the tools that are used (during the activity), the relationship within the activity and the aims of the activity rather than knowledge states (Jonassen & Rohrer-Murphy, 1999).

Carbogim et al. (2019) used an active teaching model to promote critical thinking (MEAPC) associated with PBL. The MEAPC guides the development of critical thinking and is based on both activity-oriented teaching (AOT) and a set of skills known for the promotion of critical thinking (Carbogim et al., 2019). The MEAPC has six subdivisions, each of which corresponds to critical thinking skills. The critical thinking skills highlighted were interpretation, analysis, evaluation, inference, explanation and self-regulation.

Carbogim et al. (2019) created a MEAPC associated with problem-based learning with pedagogical structuring based on activity theory. The students were simulated to mental operations through the MEAPC, creating new concepts to arrive at problem solutions. The AOT instrument used the process of appropriation of knowledge, going from general knowledge to particular knowledge, and then from abstract to concrete knowledge.

5.5.2.2 Self-regulated learning (SRL) theory

SRL includes the cognitive, metacognitive, behavioural, motivational, and emotional aspects of learning. It could therefore be thought of as an umbrella under which a considerable number of variables that influence learning (such as self-efficacy, volition, and cognitive strategies) are studied within a comprehensive and holistic approach (Panadero, 2017). SRL therefore focuses on the principle that learning is an active and constructive process. Research has suggested that students can take control of their own learning processes, therefore self-regulation is a crucial element of the theory (Bramucci, 2013).

Kautz et al. (2005) used a tool called the clinical reasoning web which is similar to a concept map of relationships among nursing diagnoses or care requirements that stem from medical conditions. The OPT model of clinical reasoning prepares a structure for clinical reasoning, enabling students to frame and give meaning to patient stories while considering relationships between diagnoses, interventions and outcomes, and observing the evidence used to make judgements (Pesut, 2004; Pesut & Herman, 1999 in Kautz et al., 2005). The OPT model and clinical reasoning web worksheets were used in the study by Kautz et al. (2005) as a blueprint to gain cognitive knowledge, organise patient care, and serve as the stepping stone for clinical reasoning and reflective processes supported by the SRL model.

Kuiper et al. (2009) used the OPT model, which is a system that helps students organise the thinking involved in clinical reasoning, to design the OPT model worksheet. The worksheets were used for clinical assignments following clinical exposure. The students were also asked to complete SRL journals. The SRL theory was used to create prompts to guide the students' responses (Kuiper et al., 2009). Each student completed a weekly journal.

5.5.2.3 Bloom's taxonomy

Bloom's taxonomy was produced in the 1950s as a framework for describing or classifying learning objectives to promote higher forms of thinking in education, such as analysing and evaluating concepts, procedures and principles, rather than just the recall of facts (Zhou & Brown, 2015). It must be noted that one could argue that Bloom's taxonomy is not a theory but rather a classification system, however, there is significance to how educators think about education and what is being taught (Carley, 2015). Harasim (2017) then describes learning theory as a concept that aids educators to understand how knowledge is created and how students learn. According to Bloom (1956), using a taxonomy assists in developing an accurate definition and classification of vaguely defined terms such as "thinking" and "problem-solving". Mahmud et al. (2019) explain that Bloom's taxonomy makes use of three domains of educational activities: the cognitive domain which refers to mental skills (knowledge), the psychomotor domain which is the manual or physical skills (skills), and the affective domain which refers to growth in feelings or emotional areas (attitude). In education, Zhou and Brown (2015) found that Bloom's taxonomy was mostly used when formulating lesson objectives, learning goals, and instructional activities.

In the study by Costello et al. (2017) CAL activities were used. The CAL activities have included interactive CD ROM programmes to augment lectures, to assist in self-study, as well as synchronous or asynchronous activities to meet programme needs when instructing face-to-face or remotely (Costello et al., 2017). Modules were then redesigned to incorporate these CAL activities and embedded within a clinical decision-making framework (Costello et al., 2017). The module that was used specifically for the study by Costello et al. (2017) was the acute care module.

Costello et al. (2017) used the Bloom's taxonomy domains of learning (namely cognitive, psychomotor, and affective) and aligned the educational methods to achieve the specific learning outcomes with the domains of learning. Integration of objectives, especially in the psychomotor and affective domains, remained beyond the scope of the CAL module but the cognitive learning domain was used to guide the development of the CAL module. They mapped the categories (qualitative data) to Bloom's three domains of learning to determine if the CAL module activity met the learning needs of students.

5.5.2.4 Assimilation theory

When a new idea is meaningfully learnt by relating and interacting the new idea with relevant established ideas in a cognitive structure, both ideas are modified, and the new idea is assimilated into the established idea (Ausubel, 2000). The assimilation theory of learning is a cognitive learning theory developed by Ausubel in the early 1960s (Seel, 2012). Assimilation theory suggests that new meaning is gained by the interaction of new and meaningful ideas (knowledge) with previously learnt concepts (Ausubel, 2000). The new knowledge is consequently what the students gain and the old knowledge is what the student already has learnt. The interaction of new with the old produces a modification of both the potential meaning of the new information and of the meaning of the foundational concepts that then creates new meaning for the student (Ausubel, 2000).

5.5.2.5 Situated learning theory

Lave and Wenger (1991) suggested that learning is a social process during which knowledge is co-constructed and that such learning is situated in a specific context within a certain social and physical environment. Therefore, situated learning theory is always a situated, practical accomplishment, rather than an account of reality which is decontextualised from the social and material practice which created it (Fox, 1997). Arnseth (2008) describes the two important concepts in situated learning theory: legitimate peripheral participation and community of practice. The communities that are referred to are constituted by practitioners who conduct procedures; the idea is that to learn, one slowly begins to master these procedures through participation within the community (Arnseth, 2008).

Rush et al. (2010) used simulation in their study, where students were required to work together in order to make clinical decisions. Simulation was used so that students could together make clinical decisions about patient care. Torre et al. (2019) used the CResME instructional tool. Finally, the CResMe instructional tool presents clinical information for multiple disease entities as nodes (boxes) in different domains (history, laboratories), asking students to connect these nodes of information in an accurate and meaningful way (Torre et al., 2019). The CResME tool includes a brief description with the main complaint is listed at the top of the sheet. The nodes (boxes) are vertically structured and contain prototypical groups of information related to several potential diagnoses for a particular patient presentation. The nodes are haphazardly placed and students create links by making connections between the nodes and writing a final diagnosis in an empty node (Torre et al., 2019).

Rush et al. (2010) used the understanding that constructing new meaning works well when learning is embedded in the social context. Simulation was then chosen as it mimics the workplace and concepts from situated learning were used as well. Torre et al. (2019) state that meaningful learning was used by utilising previous knowledge (designing of the illness scripts used) and then linking to existing cognitive frameworks (students using the framework). The authors commented that the use of the CResME instructional tool in small groups is consistent with social cognitive theories such as situated cognition. Therefore, making use of both assimilation theory and situated learning theory to inform the use of the CResME tool.

5.5.3 Discussion

The identified theories and how the theory is used in relation to teaching strategies is discussed in the section below. The teaching strategies of simulation and journaling are also interpreted through the literature.

5.5.3.1 Theories underpinning teaching strategies

The identified theories were activity theory (n = 1), self-regulation theory (n = 2), Bloom's taxonomy (n = 1) and situated learning theory (n = 2). Therefore, a variation of theories emerged and there was no single theory consistently used. However, all the theories are linked to an overarching constructivist approach. Assimilation theory is a subset of constructivism, and activity theory can be a framework for designing constructivist learning environments (Jonassen & Rohrer-Murphy, 1999). Self-regulated learning is framed within the constructivist approach (Bramucci, 2013) and situated learning theory is considered a subset of constructivism (Rush et al., 2010). Constructivism is a learning theory which states that knowledge is best obtained through a process of reflection and active construction in the mind (Mascolo et al., 2005).

Jessee (2018) provides a comprehensive framework supporting the development of clinical reasoning during clinical education. The author also notes that situated learning theory could be used to develop clinical reasoning (similar to a finding in this scoping review). This finding corroborates other theories such as expert practice,[5] deliberate practice[6] and the Tanner clinical judgement model.[7] According to Jessee (2018), the aforementioned theories have a constructivist philosophical underpinning. On their own, the theories provide inadequate support for the development of clinical reasoning (Jessee, 2018). The theories are then combined Jessee (2018) were of the opinion that this combination of theories would better support the complex nature of developing clinical reasoning. Jessee (2018) considers the combination of theories to provide a firm, interconnected foundation for the design and implementation of clinical education that promotes the development of clinical reasoning. The suggested framework focused on all types of clinical learning and levels of student understanding, and could therefore be used across a variety of clinical education arenas. The framework focuses on context; clinical learning occurs in a supportive sociocultural context of clinical practice, and students engage as members of the team of health professionals. Secondly, multiple practice opportunities are possible, and finally one-on-one clinical coaching and timely feedback is provided (Jessee, 2018).

A constructivist approach means that the learning process involves construction of meaning from experiences through critical reflection on the students' assumptions (Torre et al., 2006). Students then create knowledge based on

[5] Expert practice notes that a great deal of practice over a period of time, not innate ability, is the catalyst of performance mastery (Simon & Chase, 1973).
[6] Most people who engage in practice will experience performance improvement until they plateau at an acceptable but less than expert level (Ericsson, 2008).
[7] The Tanner clinical judgement model is a dynamic, research-based description of the components of clinical judgement in experienced nurses (these components are noticing, interpreting, responding, and reflecting). It is a practical framework for teaching and assessing clinical reasoning and judgement in nursing students (Tanner, 2006).

their experiences which are linked to their biological, physical, and mental stage of development (Badyal & Singh, 2017). They then mould the knowledge to develop a new understanding of the experience (Badyal & Singh, 2017). Constructivism has increasingly been applied to learning and teaching (Schunk, 2012). The history of learning theory reveals a shift away from environmental influences and toward human factors as explanations for learning (Schunk, 2012). According to Barrett et al. (2018), constructivism relies on the student as an active participant in the learning process, where they must do cognitive work in order to create knowledge. Badyal and Singh (2017) also propose that when basic science needs to be integrated with clinical science, then constructivism is used as the students must link their basic science knowledge to the clinical sciences. Torre et al. (2006) present a variety of learning settings and describe the application of theory in different aspects of medical education. They state that when educators want to develop critical thinking in students, a cognitivist approach is the better choice. This stems from the fact that in the cognitivist approach, learners make use of their internal environment and cognitive structures therefore depending on thought processes rather than on the external environment. The approach is characterised by creation of meaningful learning through which learners seek to understand the structure of knowledge, and facilitates a construction of knowledge and development of learning skills that are applicable in other learning situations regardless of topic or context. Cognitive tools such as insight, information processing, perceptions and memory are used to facilitate learning by assigning meaning to events (Torre et al., 2006).

Although constructivism is favourable for the development of clinical reasoning, there is research that differs from this stance. Durning et al. (2013) present two theories used in clinical reasoning, an objectivist and constructivist worldview. Durning et al. (2013) believe that even though these views differ, they are equally relevant to clinical reasoning, adding that specific implications for learning, teaching and assessment are associated with the choice of theory (either objectivist or constructivist). This demonstrates that each theory provides a unique perspective to viewing the development of clinical reasoning. Durning et al. (2013) caution against being guided by a single theory because using more than one approach could uncover a more extensive range of solutions for practice. Viewing the development of clinical reasoning from various perspectives could allow for a more comprehensive solution. Pinnock et al. (2019) also suggest that a single theory would not encompass all aspects of clinical reasoning.

5.5.3.2 Teaching strategies: simulation and journaling

Simulation has been a popular teaching strategy that has been used to improve clinical reasoning throughout the literature. Simulation is a technique to augment real experiences with guided experiences that mimic aspects of the real world in a fully interactive fashion (Gaba, 2004). Simulation provides students with an opportunity to identify possible solutions to a problem prior to a patient encounter (Vyas et al., 2011). Therefore, training with simulation can help students develop metacognitive awareness and prepare them for patient interaction (Vyas et al., 2011). According to Trowbridge et al. (2013), the non-analytical system (System 1 or intuitive thinking) is developed through experience, but there is only limited clinical time and patient exposure available to undergraduate health professions students. Trowbridge et al. (2013) state that simulation exercises have the ability to increase the students' experience base and may be used as a reference for future patient interactions. Trowbridge et al. (2013), however, caution that although simulation has some potential to improve non-analytical reasoning, careful development and research is required in order to be successful.

Reflective journaling has been used in nursing education as a way for educators to understand and evaluate students' clinical thinking (Lasater & Nielsen, 2009). Lasater and Nielsen (2009) suggest a more structured approach to journaling, specifically when critical thinking is to be improved. In this scoping review, reflective journaling was based on the SRL model (Kuiper et al., 2009), meaning that SRL acted as the framework for the journaling activity. Jarvis and Baloyi (2020) describe a reflective journal as a personal space where students can write down their unique engagement with the reflective process activated by an experience. Furthermore, they state that reflective journaling contributes to lifelong learning and is an activity that could also assist in the students making connections between experiences (Jarvis & Baloyi, 2020). Ramli et al. (2012) also found that a reflective diary is a useful tool for developing critical self-appraisal and clinical reasoning skills in the students they studied. According to Laseter and Nielsen (2009), valuable student learning, improved evaluation of clinical thinking, and enhanced communication about clinical judgement were noticed in nursing students when a reflective guide and developmental rubric were used.

5.5.3.3 How theories were used

The studies conducted by Kautz et al. (2005), Kuiper et al. (2009), Costello et al. (2017), Carbogim et al. (2019) and Torre et al. (2019) used theory as a framework to either develop the teaching strategy or to guide them on how to use their chosen strategy. Rush et al. (2010) chose the activity or strategy (simulation) based on the theory (situated learning theory). This scoping review therefore demonstrates how theory was used to inform teaching. Kay and Kibble (2016) also present various theories and clarify how theories inform various educational choices and practices. The study by Diery et al. (2020) aimed to investigate the perceptions of teacher educators with regard to evidence-based practice and their participation in empirical evidence in teacher education. The authors demonstrate that the use of theory to plan educational interventions is relevant, basing the teaching strategy on evidence (theory). Evidence-based education is therefore the use of widespread research evidence and studies on education and associated subjects, to support educational needs and environments (Davies, 1999).

Kay and Kibble (2016) highlight the need for educators to understand and apply learning theory to both research and practice. However, a possible challenge to using theory in health professions education could be that health professions educators are traditionally clinical practitioners who move into academia (Brown & Williams, 2005). As argued by Brown and Williams (2005), evidence-based education allows academics to remain updated with curricular activities in respect of the higher education landscape. Most importantly, education which is based on evidence provides a sound foundation for the best possible learning environments for health professions students. Such education is necessary for educators to intentionally evaluate what is happening in their teaching space and make purposeful decisions about their teaching strategies (Ginsberg et al., 2011). Employing an evidence-based education approach can therefore assist educators in strengthening their pedagogical foundations for the development of clinical reasoning.

5.6 Conclusion

Chapter 5 presented the results of a scoping review that was conducted; this concludes the first phase of the study, which was to identify the problem. The results focus on various theories that underpin teaching strategies to develop clinical reasoning, the strategies used, and how the theory was used.

The results show that only six studies were fit to be included in the review. This may demonstrate a lack of research associated with theory being a basis for choosing teaching strategies to develop clinical reasoning specifically in the undergraduate health professions student population. Constructivism was the overarching theory that resonated well with a positive change in clinical reasoning. A wide range of teaching strategies were highlighted in this review. The only common strategy that came up was journaling. The included studies demonstrated how the theory was used. It was used either as a structure, being a foundation for the use of the teaching activity, the teaching strategy was developed using input from the theory or the strategy (simulation) was chosen based on the theory (situated learning theory). Furthermore, the included studies demonstrated a change in clinical reasoning in undergraduate health professions students, which must nonetheless be interpreted with caution as standardised outcomes were not used for all the studies.

Cutrer et al. (2013) suggest that educators take a well-considered approach to complete the task of developing undergraduates as decision-makers. In addition, the need for educators to understand and apply learning theories to research and practice has increased (Kay & Kibble, 2016). The findings of this scoping review demonstrate that when theory underpins a teaching strategy there is a positive change in clinical reasoning in undergraduate health professions students. Therefore, educators should choose their teaching activities and strategies based on a sound pedagogical foundation.

As previously mentioned, this chapter concludes the first phase of the study. Chapter 6 reports on the draft design principles that were produced as a result of the data collected in Stages 1 and 2 of Phase 1 of the study.

Chapter 6: Draft design principles for the development of clinical reasoning in undergraduate physiotherapy students

6.1 Introduction to the chapter

The aim of this chapter is to present the draft design principles that could guide the development of clinical reasoning in undergraduate physiotherapy students, in order to develop clinical reasoning. The chapter comprises the process used to extract the draft design principles using a document analysis, a literature review, the presentation of the draft principles and a discussion of the findings.

6.2 Introduction and literature review

Patient care is an important part of healthcare; Singh et al. (2021) called for teaching clinical reasoning across the spectrum of all health professions education. The development of clinical reasoning therefore remains a shared aim of clinical education in the health professions (Jessee, 2018). A wide range of tools has been developed in order to assist educators with the challenges of teaching clinical reasoning (Gagnon et al., 2020).

Sole et al. (2019) have developed a framework for teaching clinical reasoning (see Figure 6.1).

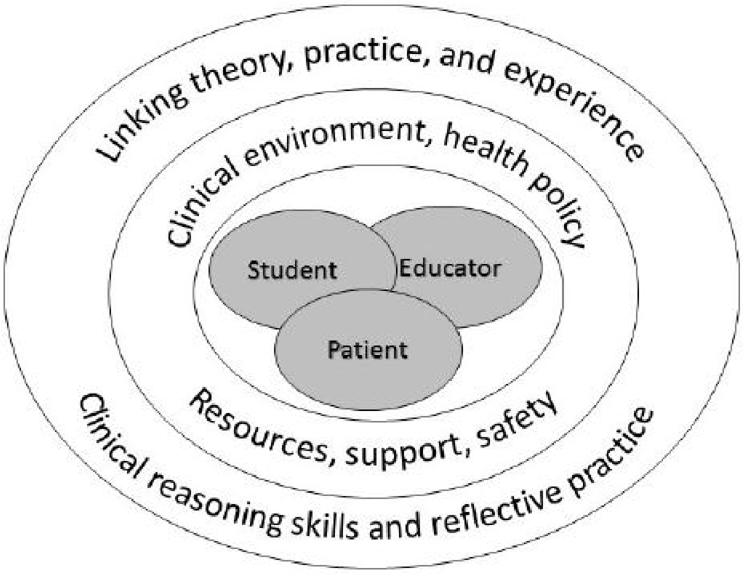

Figure 6.1: Proposed framework for teaching clinical reasoning skills across undergraduate students in physiotherapy (Sole et al., 2019)

This framework by Sole et al. (2019) portrays the student, the educator and the patient as being at the heart of the model. Patient data is collected and analysed, and planning for the patient's management takes place. These processes are situated within the clinical environment and rely on resources and policies (the second layer of the model). The students then learn to link theory and practice using reasoning methods (the third layer of the model). However, Sole et al. (2019) state that a teaching resource has not resulted from these findings. Koivisto et al. (2018) have generated design principles for using a simulation game in nursing, and Maheu-Cadotte et al. (2020) identify the design principles for the use of serious games and virtual simulation in nursing to develop clinical reasoning. Trowbridge et al. (2013) have proposed an educational programme which includes the improvement of metacognitive abilities, intuitive abilities and increasing systems awareness, and Singh et al. (2021) have designed a longitudinal clinical reasoning curriculum.

Cooper et al. (2021) specify that the domains of clinical reasoning education are what educators should focus on when teaching. These authors propose teaching clinical reasoning concepts, history and physical examination, choosing and interpreting diagnostic tests, problem identification, and shared decision-making. In addition, Cooper et al. (2021) point out that teaching the principles of decision-making to medical students or strategies to minimise error from cognitive biases did not improve performance in their study. Therefore, these authors recommend that attention be paid to clinical reasoning by reflecting on what is taught, how it is taught, and when it is taught in order to facilitate the development of clinical reasoning more effectively, through purposeful curriculum design. Salles et al. (2020) propose that the assessment and knowledge of the clinical reasoning of undergraduate students in physiotherapy should include relevant educational interventions through varied curriculum designs, validation of existing instruments and the construction of instruments for assessing the performance of diagnostic reasoning. This demonstrates that a large body of literature already exists with a focus on the educational perspective related to how learning activities should be designed to develop clinical reasoning (Gummesson et al., 2018). Singh et al. (2021), however, note that most teaching strategies designed to develop clinical reasoning have not produced positive results.

Results from the qualitative data in the present study allude to the fact that internal processing of the educator is also important when developing clinical reasoning, not just the environment in which this development takes place. The lecturers' perception of the students regarding patient-centeredness and self-directed learning and what the students believe was different for the current study. Focusing on the development of the educator in the process of clinical reasoning might close the gap between what lecturers and students perceive. The findings of the interviews and the scoping review in this study warrant a shift in the educator's approach to be able to create a curriculum that develops clinical reasoning in undergraduate physiotherapy students. The objective of this part of the study was to design a set of draft principles which could guide educators in the development of clinical reasoning in undergraduate physiotherapy students.

6.3 Methods

6.3.1 Study design

Document analysis was used to extract data in order to define the draft design principles. The process of qualitative document analysis was followed (Altheide & Schneider, 2013).

6.3.2 Data collection

The sources for document analysis were the report containing the results of the interviews that were conducted with the students, experts and lecturers (Chapters 3 and 4), the results of the scoping review and the six studies included in the scoping review (Chapter 5). The researcher applied the research problem of the overall PhD study to identify the documents that were used for the document analysis. As part of the document analysis process, a data collection tool was designed to extract the design principles. This tool used categories which were based on the literature that informed the research problem being investigated, to then collect the data. Once the data was collected and captured, the researcher organised all the data. All similar answers across the nine documents were then grouped together and compared, coded and organised.

6.3.3 Data analysis

Data was read repeatedly and common categories were highlighted. The categories were then compared, and the researcher made notes and summaries for each category. Summaries were then combined and compared with the questions. Findings were integrated with interpretations and a final set of draft principles was produced.

6.4 Results

Principles were extrapolated from the data collected during the interviews and the scoping review. Eight principles are described below.

Principle 1: Develop a shared understanding of clinical reasoning

According to the interviewed participants, clinical reasoning is a cognitive function that requires a basic foundation (of knowledge and patient data) to inform decision-making and is influenced by the person making the decision and the person providing the information (usually the patient). This was summarised after analysis of the understanding of clinical reasoning according to the students, lecturers and experts who participated in the study. Carbogim et al. (2019), Costello et al. (2017) and Kautz et al. (2005) also offer definitions of clinical reasoning. Based on the findings of the interviews and the scoping review, the definition that emerged was that clinical reasoning is a cognitive process that includes data collection, analysis and synthesis of the data in order to make a decision.

The definition of clinical reasoning varies (Huhn et al., 2019; ten Cate et al., 2018a). Researchers have suggested that the lack of consensus on the understanding of clinical reasoning is possibly because a standardised definition of clinical reasoning has not been established (Huhn et al., 2019). Furthermore, Huhn et al. (2019) argue that this lack of consensus has adverse outcomes for teaching, assessing, and research associated with clinical reasoning.

The clinical reasoning process includes various steps related to patient data (collecting the data, active reasoning by oral communication, problem presentation, problem-solving skills, reflection and hypothesis-driven query). All stakeholders agree with what is involved in the process of clinical reasoning. However, personal attitudes and beliefs, in addition to lecturer expectations, contribute to the development of clinical reasoning. Therefore, it would be important to consider the personal beliefs and expectations of those responsible for developing students' clinical reasoning. This consideration should be part of developing a shared understanding of clinical reasoning when planning learning activities and designing a curriculum that will develop the skill.

Principle 2: Accept that there is uncertainty in the process

Every patient is unique and therefore requires an individualised treatment plan. This could be interpreted as each patient encounter being seen as unique, even if the pathology is familiar to the health professional, which leaves room for much uncertainty. The lecturers and the experts in this study agreed that they accept uncertainty as part of their growth.

> *"I take the approach that the students can never have perfect information. They can never know everything." (Lecturer 6)*

"I am not afraid to say I don't know." (Expert 3)

Being comfortable with not knowing allows one to be open to learning. This openness enables knowledge to expand, and provides an opportunity for reflection. If uncertainty pushes those with experience to learn more, then an educator cannot expect students to know all the answers. It is important for students to recognize that it is acceptable not to know the answers every time. Ultimately, students, educators and health professionals are all lifelong learners and need to accept uncertainty as part of professional growth.

Principle 3: Model vulnerability

Health care professionals are often in vulnerable positions when faced with unfamiliar challenges. The students, experts and lecturers thought it was important to ask when they did not know something. No matter how shy one is or how much experience one has at a particular time, health professionals or health professions educators may not have the answers, and it is important to model this to one another and to the students.

"And the thing is especially in clinical practice you can't be shy you need to just go with it get on with it, you need to get out of your shell and go and ask if you don't know something …" (Student 6)

"Like you can always ask for clinical advice, even now at our stage." (Expert 7)

"You must be able to discuss, you must be able to accept criticism and you must be able to give criticism. But it's difficult, I mean it's difficult even for us qualified who have been qualified for years. Now you can imagine a student, and some of the doctors do make you feel like this."
(Lecturer 2)

Students must be encouraged to ask freely, without feeling shame, when they are uncertain about their knowledge application or patient diagnoses. Educators need to remain humble and demonstrate that they also ask when they are not sure. This opens up learning possibilities and is ultimately better for the patients and the students. Asking for advice is acceptable at any stage, whether one is a novice or an expert. It is a key principle to ensure that vulnerability is developed as being acceptable and not a sign of weakness. This also provides an opportunity to eliminate the power dynamic and embrace empowering all stakeholders.

Principle 4: Engage in self-regulation and self-directed learning

Self-directed learning is a skill that allows for the development of independence, professional autonomy and the ability to take responsibility for decision-making. According to Loyens et al. (2008) both self-directed learning and self-regulated learning require active engagement and goal-directed behaviour. Furthermore, self-directed learning and self-regulated learning both highlight inherent motivation as a vital component (Loyens et al., 2008). The students and the lecturers emphasised the importance of being self-directed. The experts explained that they were highly motivated people and that they participate in continuous learning and development themselves.

> *"But, I also feel that at some point in time it has to come from you and there is only so much that you can be taught so I think it has to be initiated …" (Student 1)*

> *"So, you must take responsibility for your own learning from day one." (Lecturer 2)*

> *"… drives me [to stay] afloat to keep wanting to know more so that I can be a better physio." (Expert 4)*

Kautz et al. (2005) and Kuiper et al. (2009) also highlight the use of self-regulated theory and journaling to encourage self-regulation.

Educators need to model the behaviour of continuous learning for their students. Therefore, they could be provided with opportunities to engage with and take responsibility for their own learning and allow for learning from each other. Once educators are able to model this kind of behaviour they will be able to think about developing tasks or a learning environment that requires both self-regulation and self-directed learning. Creating open-ended tasks, providing an opportunity for students to learn from each other, and being part of the feedback process, could enable educators to assist with the development of self-regulation and self-directed learning.

Principle 5: Explore a shared epistemological foundation for teaching clinical reasoning

The articles included in the scoping review reveal the importance of a theoretical (pedagogical) foundation in planning teaching activities. Carbogim et al. (2019), Costello et al. (2017), Kautz et al. (2005), Kuiper et al. (2009), Rush et al. (2010) and Torres et al. (2019) all emphasise the value of using theory as a foundation for teaching practice. The teaching activities examined in terms of this principle were produced from the previously mentioned studies as well as data from the interviews with the lecturers regarding their teaching strategies. The interviewed lecturers from the current PhD study referred to their use of a large range of strategies to develop clinical reasoning, including case studies, student engagement, scaffolding, facilitating thinking and cognition, the integration of theory and practice via clinical visits, sharing personal experience and developing competencies such as lifelong learning. In summary, the articles from the scoping review demonstrated the use of journaling, worksheets, computer-assisted modules, simulation and a clinical reasoning mapping tool. Understanding the theoretical foundations *and* the activities that can be used to enhance clinical reasoning is essential for the development of clinical reasoning in the undergraduate physiotherapy student.

Activities used to teach clinical reasoning:

- Provide opportunities for students to have multiple patient encounter experiences
- Maximise learning by encouraging students to capture various patient encounters.

- Provide students with opportunities to recall similar cases as they increase experience.
- Differentiate between likely and less likely but important diagnoses.
- Practise deliberately, request and reflect on feedback, and practise mentally.
- Generate self-explanations during clinical problem-solving.
- Talk in buzz groups with oral and written patient data.
- Listen to clinical teachers reasoning out loud.
- Teaching activities must actively engage the students. Examples:
  - Case-based studies
  - Simulation
  - Reflection
  - Questioning
  - Journaling
  - Feedback
  - Demonstration

It is important for academics to understand the difference between *knowing* and *doing* in the building of an epistemological and pedagogical rationale. Educators need to understand themselves and their theoretical foundation before choosing their teaching techniques or creating optimal learning environments for the development of clinical reasoning.

Principle 6: Engage students in cognitive and metacognitive processes during teaching and learning activities

Clinical reasoning is the cognitive process that underlies the decision-making for diagnosing and managing a patient. Kautz et al. (2005) and Kuiper et al. (2009) demonstrate the use of metacognitive and cognitive skills. Clinical reasoning has been demonstrated to be a mental process in the interviews conducted for this study.

> *"… if I want to be a better academic, I've got to read, write, think, and discuss. These are the only tools that we have. So, a student who is in third year who wants to develop clinical reasoning has to see a patient, write down some things that they don't understand, go home, try and answer their questions by themselves, bring those answers to a lecturer, say I saw this patient, these are the things I didn't understand. I went and I found these answers from these sources that I trust. I came to this conclusion, what do you think of that process?" (P6)*

This confirms the importance of developing thinking skills. It is recognised that clinical reasoning is a skill that must be developed. It is known that skills improve with practice; therefore, the actual clinical reasoning skills must be practised. This calls for educators to consider how they might model this complexity prior to attempting to engage students in the type of thinking they will need to be doing in the clinical context in the classroom. Educators have to move beyond just sharing content; they will need to understand their own cognitive and metacognitive processes and then attempt to model this to their students before planning activities that will create an opportunity for students to engage in cognitive and metacognitive processes.

Principle 7: Develop teaching and learning activities that provide students opportunities to build and grasp connections between concepts

Edwards et al. (2004) note that clinical reasoning consists of multiple components including critical thinking, hypothesis testing, synthesising information and self-reflection. This, along with the understanding of clinical reasoning that has come out of the current study, demonstrates that the clinical reasoning process is a culmination of multiple data points and concepts. Anatomical knowledge, biomechanical knowledge, knowledge of pathology, the patient's data and knowledge of physical testing needs to be integrated and used to come to a conclusion for the patient. Accordingly, multiple connections between concepts and content need to be made as part of the clinical encounter.

The students highlighted the importance of drawing on and making connections between various types of knowledge and patient data.

> *"… but also an ability to like you said reason clinically and reason out based on this person so you need to look at the individual person and use the knowledge and the tools that you have applied in a way that is appropriate." (Student 3)*

"It is the way … I think it is the way that you get to the answer of a problem that a patient presents with … so it's how you look at how the patient presents and then you make a whole lot of different links." (Student 18)

"What I understand as clinical reasoning is your ability to take your theoretical knowledge, your practical knowledge and apply it to a specific situation …" (Student 16)

Costello et al. (2017), Kautz et al. (2005) and Torre et al. (2019) also note the importance of making connections between concepts when using the teaching strategies highlighted in their articles. Activities such as using concept maps[8] can be used to assist students in making connections between concepts and knowledge.

Clinical reasoning, however, is not always as straightforward as collecting data and then making an empirical decision using objective methods. For this reason, it is important for educators to model that some clinical decisions are not as simple to arrive at. Educators need to understand how they make connections between concepts. Once they are able to do this they could attempt to model this to their students. This could be done prior to planning activities that will provide opportunities for students to make connections between concepts and how those concepts relate to their patients.

[8] Kautz et al. (2005) and Torre et al. (2019) used tools similar to concept maps

Principle 8: Align assessment practices appropriately

Engaging in curriculum design requires aligning assessment with learning outcomes. Assessment aims to illustrate how the students will demonstrate the learning. Clinical reasoning is a complex process; therefore, the assessment of clinical reasoning will not be straightforward. The lecturers specified assessment as a challenging part of the clinical reasoning development process. Although the lecturers were trying to develop clinical reasoning (which is complex) it seems the assessment remains far too simplistic, assessing rote learning or recall.

> *"I can set you a case, test your clinical reasoning and then you haphazardly fail. Or I set you a test that tests your rote learning and then you are brilliant. You know." (Lecturer 8)*

> *"Because they don't have a strong basis. So, I asked just the basics of information that requires students to recall, but that is, that for me is not developing, because anybody can just go to a book and memorise information and record it for an exam." (Lecturer 7)*

All stakeholders agree that clinical reasoning develops over time and with experience.

> *"I think from second year to now my clinical reasoning has gotten better and I can see it on my marks as well and I think it definitely just comes with experience to just know the why behind everything …" (Student 2)*

"I mean I'm now fifteen years qualified, and I would say it's only been in the last four years that I've felt competent, that's a long time to feel unsure … but that's like call it ten years for me to feel like I was … I've earned my stripes; do you know what I mean?" (Expert 6)

"It gets easier as you go year by year, because then they know what that entails." (Lecturer 5)

Educators must rethink the way they view assessment. If clinical reasoning takes time and experience to develop, perhaps the assessment could be viewed in a manner that assesses the student over a period of time, possibly several years. Assessment could also then focus on the connection's students make between concepts and not their ability to recall information, provide opportunities for feedback, and guide the thought process.

6.5 Discussion

This discussion expands on developing cognitive and metacognitive processes, and on the assessment of clinical reasoning and vulnerability. The draft design principles as a whole will then be interpreted through the literature.

6.5.1 Developing a higher order of thinking (cognition and metacognition)

One of the draft design principles that emerged specifies the need to engage students in metacognitive processes. Trowbridge et al. (2013) propose interventions that promote metacognitive techniques such as cognitive forcing strategies to be designed, implemented and their impact carefully studied. "Metacognition, the ability to step back and reflect on what is going on in a clinical situation, is essentially System 2 monitoring in action, and may save a critical miss from occurring" (Croskerry, 2009, p. 1029). It refers to the ability to "watch" the thinking process by observing one's own thoughts (Croskerry, 2000). Croskerry (2003) believes that when experts have adequate metacognitive skills, they are better able to identify when they are not performing well, monitor their progress and choose appropriate approaches for problems in decision-making. When metacognitive approaches are used, it seems likely that students' cognitive ability would improve in a number of clinical situations (Croskerry, 2000). However, these types of interventions will likely be dependent on variables specific to both students and the content (Trowbridge et al. 2013).

6.5.2 Assessment of clinical reasoning

A more aligned approach between clinical reasoning and its assessment has been described in the principles. Singh et al. (2021) present a range of assessments to evaluate students' clinical reasoning ability at all levels, using Miller's pyramid[9]. Thampy et al. (2019) concede that assessing complex internal cognitive processes that are not directly observable is challenging. In their study, Thampy et al. (2019) suggest possible strategies to address assessment difficulties using each level of Miller's pyramid. Singh et al. (2021) focus on formative methods which drive learning and deliberate practice, and inform onward progression as this assessment approach requires students to apply and be clear about their clinical reasoning.

In terms of Miller's four-level pyramid of assessment (knows – knows how – shows how – does), the highest three are all to some extent suitable for the assessment of clinical reasoning (Miller, 1990). A "knows how" test would present a patient case and ask the student to arrive at a diagnosis and/or an intervention. Singh et al. (2021) state that single best answer (SBA) questions form the foundation of applied knowledge assessments. The assessment would include a short context-rich clinical paper patient/case and the student then chooses the most likely option from a series of five plausible options relating to diagnosis, investigations or management (Singh et al., 2021). During a "shows how" test, an examiner would ask the student to clinically reason in a standardised patient encounter such as during an objective structured clinical

[9] *Miller's pyramid* is described as having *4 levels*; knows, knows how. shows how and does.

examination (OSCE) (Singh et al., 2021). These authors further recommend history-taking stations, avoiding “textbox description” presentations that are reliant on pattern recognition to arrive at a single diagnosis, and instead creating real-world patient scenarios requiring purposeful interviewing to generate, justify and prioritise plausible differential diagnoses. Another recommendation is physical examination stations adding to conventional system-based examination sequences, by introducing hypothesis-driven examinations and data interpretation. The assessment at the “does” level would ask a student to reason related to a real patient case in the hospital. The patient assessments that students present throughout their clerkships are also included in a clinical portfolio (Singh et al 2021).

Simpkin and Schwartzstein (2016) emphasise that the curriculum, assessments and evaluations should be altered to focus on reasoning, which includes the possibility of more than one right answer and integration of patients’ values. Further suggestions for educators are to ask questions that focus on how and why things occur the way they do instead of focusing on exactly what is happening. They also support the students’ curiosity to explore and be comfortable with uncertainty, acknowledging that certainty is not always the end goal. In addition, Simpkin and Schwartzstein (2016) explain that examinations such as multiple choice indoctrinate students to believe that there is always a right answer, and advocates for the focus to shift to evaluating clinical reasoning and the demonstration of tolerance for uncertainty.

6.5.3 Vulnerability

Brown (2012, p. 29) defines vulnerability as “uncertainty, risk, and emotional exposure”. In the culture of health professions education and more so in medicine, even though physicians are aware of uncertainty, a deep-rooted aversion to acknowledge and embrace it exists (Simpkin & Schwartzstein, 2016). Accordingly, if it is difficult to embrace uncertainty then it would be difficult to embrace vulnerability. Simpkin and Schwartzstein (2016) explain that teaching, case-based learning, and the research done by health professions educators all appear to propose that when presented with a host of signs and symptoms, a solution must be found. Educators demand a differential diagnosis from the students they mentor, and from themselves the minute the patient has stopped talking. Educators tend to want to package the patient's presentation so that the course of management to follow is clear. In this obsession to find *the* answer, the iterative nature of clinical reasoning is oversimplified, and patient-centred care is lost. In addition, Simpkin and Schwartzstein (2016) point out that uncertainty is usually suppressed and ignored both consciously and subconsciously. Its suppression makes intuitive sense because, in agreement with Brown (2012), being uncertain instils a sense of vulnerability, a sense of fear about what lies ahead.

Brown (2012), however, argues that vulnerability is the source of empathy and creativity. Malterud and Solvang (2005) state that vulnerability can be seen as a strength, for both the patient and the health professional. Although the health professional may feel perplexed and uncomfortable with the patient’s problem, it is important to remember that the patient has been treated as subordinate to the health professional (Werner & Malterud, 2005). In order for the health professional to meaningfully use this power , an acceptance of uncertainty and curiosity to find out more is needed (Simpkin & Schwartzstein, 2016). Therefore, embracing vulnerability rather than suppressing it, might provide health professionals with opportunities to come up with creative and innovative management plans for patients.

6.5.4 A set of draft design principles for the development of clinical reasoning

A set of draft principles was produced for the development of clinical reasoning following the data collected from the interviews and the scoping review. Previous literature highlights multiple factors that are seen to be useful for the development of clinical reasoning. Research by Sole et al. (2019) has led to an agreement on factors thought to be essential for teaching clinical reasoning. These factors are related to having a patient-centred approach, being patient-related (including beliefs, culture, social factors, physical, mental and health related status), decision-making ability, and safety. Furthermore, Sole et al. (2019) mention physiotherapy-professional and person-specific knowledge such as, integrating theory and experiences from clinical practice; and contextual factors, such as the patient's environment, current health policies, resources and best available evidence. Ten Cate et al. (2018b) report on factors necessary for students to be able to contribute to clinical reasoning. These are being prepared with a clinical vocabulary, having the ability to create clinical problem representations, having a foundational illness script mental library, hypothesis-driven inquiry and diagnostic verification (ten Cate et al., 2018b). Metacognition, fostering intuition, progressive problem solving, feedback and simulation are the educational activities offered by Trowbridge et al. (2013). A study by Cooper et al. (2021) introduce approaches such as teaching illness scripts, using thinking aloud strategies, brainstorming strategies, structured reflection, and practicing cases with feedback improve clinical reasoning performance. The educational strategies endorsed by Singh et al. (2021) are based on the foundation of enquiry-based learning[10] (EBL) as it encourages active and collaborative learning, and includes blended learning strategies such as; online interactive case-based resources; flipped classroom small group sessions; small group debrief sessions, written reflection and workplace-based patient encounters and simulated and real patient encounters. Thomas et al. (2016) propose a move from principles to implementation and provides a template that demonstrates a pragmatic six-step approach which includes problem identification and general needs assessment, targeted needs assessment, goals and objectives, educational strategies, implementation, and evaluation and feedback. There is some overlap in the principles or factors that are meant to improve clinical reasoning from the present study and what is seen in the literature. The teaching strategies highlighted in the literature are very similar to those highlighted in the draft principles.

[10] Inquiry-based learning (also spelt *enquiry-based learning* in British English) is a form of active learning that starts by posing questions, problems or scenarios.

The draft principles presented however call for educators to situate themselves and consider their own personal internal factors such self-directedness and vulnerability, and not just the environment in which the development of clinical reasoning takes place. A panel from the Academy of Science of South Africa (2018) recommended an approach to faculty development which contributes to health professions educators becoming more responsive to their internal learning community which includes transformative educational strategies, adaptive education communities, and scholarship and reflection. Furthermore, they called for the role of educators to include facilitation, trust development, role modelling, constructive communication and interaction, reflective practice and active engagement. This demonstrates the importance of self-reflection for educators within the process of developing clinical reasoning.

6.6 Conclusion

This chapter presented eight design principles that were produced to inform the development of clinical reasoning in undergraduate physiotherapy students. A process of document analysis was followed to extract the design principles.

In summary these principles were:

- to develop a shared understanding of clinical reasoning,
- to accept that there is uncertainty in the process,
- to model vulnerability,

- to engage in self-regulation and self-directed learning,
- to explore epistemological foundation for teaching clinical reasoning,
- to engage students in cognitive and metacognitive processes during teaching and learning activities,
- to provide opportunities for students to make connections between concepts, and
- to align assessment practices appropriately.

These design principles form part of developing the solution for the problem and so are the second phase of the project. The next chapter explains how consensus was reached to refine and finalise the design principles.

Chapter 7: The use of a modified Delphi study to refine design principles for the development of clinical reasoning in undergraduate physiotherapy students

7.1 Introduction to the chapter

The aim of this chapter is to present the process of refining the draft design principles and the final set of design principles. The draft principles were sent to a panel of experts for agreement and further refinement. This chapter briefly explains the process of the Delphi study and its results.

7.2 Introduction and literature review

Clinical reasoning can be explained as being both a thought process and a decision-making process (Gummesson et al., 2018). With increasing clinical experience, the clinician begins to rely more on recognisable patterns that will lead to a faster decision-making process, without a full analytical thought process (Gummesson et al., 2018). This is because clinical reasoning is based on the cognitive processes that are utilised in the assessment and management of the patient (Salles et al., 2020). This process of thinking assists in progressing the patient from illness to recovery; its effect on the patient's functionality is important for physiotherapists (Salles et al 2020). A thorough analysis of the patient information and a complete assessment of the patient will assist the health professional to come up with an adequate treatment plan for the patient (Salles et al 2020).

Physiotherapy educators focus on improving clinical reasoning skills in order to give optimal patient care (Abrandt Dahlgren et al., 2021). Therefore, the process of clinical reasoning development commences during undergraduate health professions education (Salles et al., 2020) Entry-level physiotherapy education programmes worldwide emphasise clinical reasoning skills as core competencies of physiotherapists (Abrandt Dahlgren et al., 2021). According to the World Confederation for Physical Therapy guidelines for physiotherapy entry level education (World Physiotherapy, 2011, p. 13), the curriculum must prepare students to meet physiotherapy practice expectations, which include the abilities of “clinical judgment and reflection to identify, monitor and enhance clinical reasoning to minimize errors and enhance clients/patient outcomes”. However, teaching and assessing clinical reasoning varies in its theoretical and clinical aspects across various undergraduate physiotherapy curricula (Christensen et al., 2017; Montpetit-Tourangeau et al., 2017).

Variation exists concerning what researchers have noted regarding how clinical reasoning must be developed and which aspects of clinical reasoning must be focused on. Reeves and Jauch (1978) suggest that the Delphi method is beneficial during the curriculum design process. Many researchers have used the Delphi approach to reach agreement on various aspects of clinical reasoning in the curriculum. In their study, Elvén et al. (2018a) aimed to evaluate the content validity and agreement on items in the Reasoning for Change (R4C) instrument. The instrument has four domains, namely the physiotherapist, the input from the patient, the functional behavioural analysis, and the strategies for behaviour change. This instrument targets prioritised competence areas for the physiotherapy profession, assesses the ability to make behavioural considerations throughout the reasoning process and contributes to deeper understanding of both students and clinician’s readiness to support patients in health-related behaviour change (Elvén et al., 2018b). In the study by Elvén et al. (2018a), a modified Delphi technique was used with a group of experts to collect information about the experts’ opinions regarding the item relevance and guide refinement of the items on the instrument. Forbes et al. (2018) developed a competency list for physiotherapists in the area of patient education using a Delphi consensus approach. The authors distributed a list of questions to generate themes and the results of the study provided a foundation for knowledge of the roles and competencies of physiotherapists in the area of patient education. Sole et al. (2019) identified the key elements that all academic and teaching staff considered to be important for teaching clinical reasoning to undergraduate physiotherapy students. Their Delphi study started with open-ended questions and resulted in a list of key competencies for educators who want to develop clinical reasoning in undergraduate physiotherapy students.

The literature demonstrates the use of a Delphi or a modified Delphi for agreement on principles or statements in a multitude of ways. The objectives of this part of the current study were to refine the draft design principles for clinical reasoning development and to recommend a final set of design principles that could guide the development of clinical reasoning.

7.3 Methodology

7.3.1 Study design

The Delphi study was used to seek consensus from a group of experts to validate and refine the draft design principles through consultation.

7.3.2 Population and sampling

The population for the Delphi study comprised experts who were health professions educators with an interest in curriculum development and/or clinical reasoning. Participants (n = 28) were purposively selected and a snowballing technique was used where participants and the supervisor recommended possible participants based on their expertise in curriculum development or clinical reasoning. A modified Delphi was used as the researcher collated a set of draft design principles from the data collected in Phase 1, and sent draft design principles to the participants for agreement and comment.

7.3.3 Data collection

Data was collected by means of a survey questionnaire that was developed on Google forms. The Google survey link and form were shared with the participants via their email addresses. Regular emails with reminders were sent to participants four times to complete the online survey. The consent form was included in the first part of the online questionnaire. Experts were asked to respond to a four-point scale offering the options strongly disagree, disagree, agree, and strongly agree. A neutral middle point was excluded to compel respondents to choose a particular option. Agreement on the principles was set at 70% and only one round was conducted because consensus was reached after the first round.

7.3.4 Data analysis

This Delphi process included both qualitative and quantitative data. The percentage agreement was calculated for each response to capture the agreement rate for each principle. The consensus category included the responses related to "strongly agree" and "agree" and the non-consensus category included the responses related to "strongly disagree" and "disagree". Consensus was set at 70%. Descriptive statistics were used to determine the mean and the median of the data. The qualitative data was captured, analysed and added to each principle.

7.4 Results

The response rate for the Delphi study was 57%; only 16 of the 28 participants replied to the survey and participated in the study. The demographic details of the participants are presented below (Table 7.1). The health professions educators who responded were from the following backgrounds: health professions education (n = 3), physiotherapy (n = 5), pharmacy (n = 1), nursing (n = 3), medicine (n = 2), dentistry (n =1) and occupational therapy (n = 1). The mean number of years in higher education was 19.2 years for this group of participants. In terms of higher education, 11 participants had a PhD degree and five had master's degrees.

Table 7. 1: Demographic results

No	Current area of teaching and/or practice	Area of research	Area of publications	Number of publications related to HPE* or curriculum development	Years of experience HE** and HPE	Highest qualification obtained
1	Educationalist (Teaching & learning specialist) - Background is one of HPE and biomedical sciences.	Anything HE - assessment, online instructional design, curriculum change, staff professional development! Also, the sub-speciality of Health Sciences Education. I have a couple molecular & cancer cell biology papers from my days as a biomedical scientist - but I haven't worked in that field in several years now.	Assessment, online instructional design, curriculum change, staff professional development.	1 published (& a few in draft form - just waiting for my past supervisor to sign off for submission) - they focus on assessment in medical education	7 years	PhD
2	Clinical educator	Clinical reasoning in the physiotherapy student	Clinical reasoning in the physiotherapy student	0	20+years	MPhil HPE
3	Pharmacology	HPE; cancer modelling; neurodegeneration	HPE; cancer modelling; neurodegeneration	1 - curriculum development	11 years (HE) and 4 years (HPE)	PhD
4	Cardiovascular and Pulmonary, Geriatrics, Basic Clinical Foundational Skills	Clinical Reasoning, Scholarship of community engagement	Clinical Reasoning, Scholarship of community engagement; Cardiovascular and Pulmonary, Geriatrics	9	13 years in HE and HPE	PhD
5	Community	Area of teaching/practice include community-based rehabilitation approaches to clinical training, clinical	Community-based rehabilitation approaches to clinical training,	6	14 years	PhD

No	Current area of teaching and/or practice	Area of research	Area of publications	Number of publications related to HPE* or curriculum development	Years of experience HE** and HPE	Highest qualification obtained
		education models and curriculum development including IPE***	clinical education models and curriculum development including IPE			
6	Undergraduate Nursing Education - Lecturer and module coordinator for the second-year level at the School of Nursing	Clinical supervision, Nursing education	Clinical supervision, Nursing education	1	26 years (HE) and 10 years (HPE)	Master's
7	Teaching	Disability across lifespan: Prevention and Wellness	Clinical education and curriculum development	5 (Clinical education) 1 (curriculum development)	35 years in HE and HPE	PhD
8	Musculoskeletal and Orthopaedic Physiotherapy	Clinical Reasoning, Professionalism and Professional Identity	Clinical reasoning, clinical education	2	20 years (HE) and 12 years (HPE)	MPhil
9	Higher Education Studies (HES) and HPE Both at the Postgraduate level (master's and PhD)	HES and HPE Both at the Postgraduate level (master's and PhD)	HES and HPE	8	29 years (HE) and 3 years (HPE)	PhD
10	Specialist physician in General medicine	Clinical reasoning and training of medical	Clinical reasoning and training of	0	5 years HPE	FCP (SA) and MMed (Wits)

No	Current area of teaching and/or practice	Area of research	Area of publications	Number of publications related to HPE* or curriculum development	Years of experience HE** and HPE	Highest qualification obtained
		registrars	medical registrars			Medical Education and Research Fellowship (SAFRI)
11	Programme Manager Education School of Dentistry	Clinical reasoning and case-based learning	Clinical reasoning and case-based learning	14	15 years HE/HPE	PhD
12	Research	HPE, competency-based education	HPE, competency-based education	20	10 years	PhD
13	HPE	HPE	HPE	15+	28 years	PhD
14	Undergraduate nursing: Professional Practice	Nursing professionalism	Nursing professionalism	4	17 years	PhD
15	Women's Health, gender-based violence, Gynaecology, Obstetrics, HIV, termination of pregnancy	Student-run volunteer clinics, novel teaching methods for Gynaecology skills training, Intimate Partner Violence teaching development, health needs of sexual and gender minorities.	Student-run volunteer clinics, novel teaching methods for Gynaecology skills training, Intimate Partner Violence teaching development, health needs of sexual and gender minorities.	3	12 years HPE	MPhil
16	HPE, Teaching and Learning.	Emerging technologies in HPE	Emerging technologies in HPE	15	15 years	PhD

*HPE (Health Professions Education), **HE (Higher Education), ***IPE (Interprofessional Education)

Table 7. 2: Agreement of the principles

The median is between 8.0 and 8.5, indicating that agreement was reached for each principle. Table 7.2 shows the percentage agreement for each principle.

No	Principle	Strongly agree (n)	Agree (n)	Disagree (n)	Strongly disagree (n)	Consensus (set at 70%)	Median and Standard deviation
1	Develop a shared understanding of clinical reasoning	15	1	0	0	100%	8.5 (4.93)
2	Accept that there is uncertainty in the process	13	3	0	0	100%	8.5 (4.76)
3	Model vulnerability	11	5	0	0	100%	8.5 (4.76)
4	Engage in self-regulation and self-directed learning	12	3	1	0	92.8%	8.5 (4.76)
5	Explore a shared epistemological foundation for teaching clinical reasoning	9	7	0	0	100%	8.5 (4.76)
6	Engage students in cognitive and metacognitive processes during teaching and learning activities	14	2	0	0	100%	8.5 (4.76)
7	Develop teaching and learning activities that provide students opportunities to build and grasp connections between concepts	14	1	1	0	92.9%	8.5 (4.76)
8	Align assessment practices appropriately	14	2	0	0	100%	8.0 (4.72)

7.4.3 Draft principles, quotations to support refining of the principles, and final principles

The eight draft design principles are outlined below. The quoted extracts from the data to support the refinement of each principle are added. A concluding summary explains how the additions were incorporated to produce the final principle.

Draft Principle 1: Develop a shared understanding of clinical reasoning

According to the interviewed participants, clinical reasoning is a cognitive function that requires a basic foundation (of knowledge and patient data) to inform decision-making and is influenced by the person making the decision and the person providing the information (usually the patient). This was summarised after analysis of the understanding of clinical reasoning according to the students, lecturers and experts who participated in the study. Carbogim et al. (2019), Costello et al. (2017) and Kautz et al. (2005) also offer definitions of clinical reasoning. Based on the findings of the interviews and the scoping review, the definition that emerged was that clinical reasoning is a cognitive process that includes data collection, analysis and synthesis of the data in order to make a decision.

The definition of clinical reasoning varies (Huhn et al., 2019; ten Cate et al., 2018a). Researchers have suggested that the lack of consensus on the understanding of clinical reasoning is possibly because a standardised definition of clinical reasoning has not been established (Huhn et al., 2019). Furthermore, Huhn et al. (2019) argue that this lack of consensus has adverse outcomes for teaching, assessing, and research associated with clinical reasoning.

The clinical reasoning process includes various steps related to patient data (collecting the data, active reasoning by oral communication, problem presentation, problem-solving skills, reflection and hypothesis-driven query). All stakeholders agree with what is involved in the process of clinical reasoning. However, personal attitudes and beliefs, in addition to lecturer expectations, contribute to the development of clinical reasoning. Therefore, it would be important to consider the personal beliefs and expectations of those responsible for developing students' clinical reasoning. This consideration should be part of developing a shared understanding of clinical reasoning when planning learning activities and designing a curriculum that will develop the skill.

Quotations in support of refining the principle

> *"Agree with the background information provided: if we are not all on the same 'page' (or do not know where others may fall within the 'book') then the 'story' will not make sense. You need a strong foundation or else the house will crumble." (Delphi panelist 1)*

"This would have to be one of my main arguments regarding the development of clinical reasoning in the student – do we even know what it is? Perhaps to add to the principle that we need to understand both clinical reasoning as a definition but then also understand the factors that influence its development within the student." (Delphi panelist 2)

"Holistic interpretation of basic and clinical sciences to afford the stakeholder integrative insight." (Delphi panelist 3)

"... reflection on the process in/and on action within the definition." (Delphi panelist 4)

"Absence of a shared understanding leads to frustration for both student and clinical staff." (Delphi panelist 7)

"If a shared understanding cannot be reached, it would be important for the educator and students to understand the range of meanings that exist in the shared space. Sometimes trying to reach consensus and definitions can be reductionist and nuance can be lost." (Delphi panelist 9)

"Although it will overlap with other constructs as ethical reasoning – so there will always be blurred boundaries." (Delphi panelist 11)

"This would help the steps taken in clinical reasoning processes to be laid bare for students." (Delphi panelist 15)

"The regulatory body is not included in the shared definition. What about shared understanding with clinical skills coordinators (or is this implied

by educators). Also, how do field specialists respond to this shared definition." (Delphi panelist 16)

Principle 1: Specify a shared understanding of clinical reasoning for students and educators within a department, that includes deciphering definitions pertinent to all involved stakeholders

The Delphi participants agree that educators and students need to have a shared understanding of clinical reasoning and what it means to them. Furthermore, they state that the meanings and definitions that already exist for clinical reasoning must be shared with all stakeholders as each discipline or department develops a unique definition for themselves. A host of definitions already exist for clinical reasoning and the researcher further extrapolated a definition from the participants who were interviewed. Therefore, it would be useful to make sure that both educators and students within a particular discipline or department had the same understanding of clinical reasoning before trying to enhance it.

Draft Principle 2: Accept that there is uncertainty in the process

Every patient is unique and therefore requires an individualised treatment plan. This could be interpreted as each patient encounter being seen as unique, even if the pathology is familiar to the health professional, which leaves room for much uncertainty. The lecturers and the experts in this study agreed that they accept uncertainty as part of their growth.

Being comfortable with not knowing allows one to be open to learning. This openness enables knowledge to expand, and provides an opportunity for reflection. If uncertainty pushes those with experience to learn more, then an educator cannot expect students to know all the answers. It is important for students to recognize that it is acceptable not to know the answers every time. Ultimately, students, educators and health professionals are all lifelong learners and need to accept uncertainty as part of professional growth.

Quotations in support of refining the principle

> *"It reminds me of: 'If you're not uncomfortable, you're not growing' (or something like that). Reflecting on the SA context (diversity) one-size does not fit all – learning to adapt (perhaps within a broad framing) is linked to being resilient and effective (in a largely dysfunctional healthcare system)." (Delphi panelist 1)*

> *"We do however need to understand what uncertainty is acceptable – uncertainty because the student has not done the basic ground work of revising known knowledge is to me not acceptable. The student needs to be committed to knowing what they have already been taught. New knowledge is built on existing knowledge." (Delphi panelist 2)*

> *"Health professions in its nature is dynamic, not just in terms of national disease frequency, population-specific characteristics, epigenetics, new diseases and treatment modalities, and so forth, so uncertainty should*

be an expectation and trigger for continuous professional development." (Delphi panelist 3)

"How can someone be less uncertain? Could knowledge support or practitioner experience decrease uncertainty?" (Delphi panelist 4)

"Not sure if 'uncertainty' is the right word. The process is best described as an exploratory process." (Delphi panelist 7)

"Couldn't agree more. It is incredibly harmful and unrealistic to expect students to have all the answers. No-one has all the answers and we as teachers must actively role-model knowing the bounds of our expertise so as to normalise this for students." (Delphi panelist 15)

"I agree as long as there is academic will to bridge the gap in knowledge." (Delphi panelist 16)

Principle 2: Build uncertainty into the curriculum

The Delphi panellists commented that being uncomfortable and uncertain could trigger further learning and development. However, they also noted that basic foundational knowledge as well as academic support (in cases of uncertainty related to knowledge) for the students is necessary. Therefore, building uncertainty into the curriculum in a supported manner is important.

Draft Principle 3: Model vulnerability

Health care professionals are often in vulnerable positions when faced with unfamiliar challenges. The students, experts and lecturers thought it was important to ask when they did not know something. No matter how shy one is or how much experience one has at a particular time, health professionals or health professions educators may not have the answers, and it is important to model this to one another and to the students.

Students must be encouraged to ask freely, without feeling shame, when they are uncertain about their knowledge application or patient diagnoses. Educators need to remain humble and demonstrate that they also ask when they are not sure. This opens up learning possibilities and is ultimately better for the patients and the students. Asking for advice is acceptable at any stage, whether one is a novice or an expert. It is a key principle to ensure that vulnerability is developed as being acceptable and not a sign of weakness. This also provides an opportunity to eliminate the power dynamic and embrace empowering all stakeholders.

Quotations in support of refining the principle

> *"I found this interesting: vulnerability as opposed to a more neutral 'lifelong learning' or 'growth mindset' orientation. It makes me think of something called 'brave space' (as opposed to 'safe space') pedagogy*

which was related back to ERT in early 2020: admitting that you may not know something, but are willing and able to learn." (Delphi panelist 1)

"It speaks about being student-centred and not teacher-centred." (Delphi panelist 2)

"The idea of the 'perfect expert' is outdated, and is counterproductive to development. Showcasing that all, regardless of experience, have limitations to their expertise is important to excel and promotes interpersonal skills." (Delphi panelist 3)

"The vulnerability gives confirmation that this is an exploratory process." (Delphi panelist 7)

"Sometimes students don't know what to ask, which makes them feel more vulnerable." (Delphi panelist 13)

"As above, it is critically important to patient wellbeing that HCPs know their own limits and are humble enough to ask for help." (Delphi panelist 15)

"Agree, and one often learns more from the losses, or the failures than we do from all the gains. What I'm trying to say is that you also learn when you don't know." (Delphi panelist 16)

Principle 3: Model vulnerability

This principle remains unchanged. The Delphi participants agree that it was important that experts and healthcare professionals are aware of their own limitations and ask for help when they need it. By modelling vulnerability, it could demonstrate being more student-centred. They also note that there is learning present in uncertainty.

Draft Principle 4: Engage in self-regulation and self-directed learning

Self-directed learning is a skill that allows for the development of independence, professional autonomy and the ability to take responsibility for decision-making. According to Loyens et al. (2008), both self-directed learning and self-regulated learning require active engagement and goal-directed behaviour. Furthermore, self-directed learning and self-regulated learning both highlight inherent motivation as a vital component (Loyens et al., 2008). The students and the lecturers emphasised the importance of being self-directed. The experts explained that they were highly motivated people and that they participate in continuous learning and development themselves.

Educators need to model the behaviour of continuous learning for their students. Therefore, they could be provided with opportunities to engage with and take responsibility for their own learning and allow for learning from each other. Once educators are able to model this kind of behaviour they will be able to think about developing tasks or a learning environment that requires both self-regulation and self-directed learning. Creating open-ended tasks, providing an opportunity for students to learn from each other, and being part of the feedback process, could enable educators to assist with the development of self-regulation and self-directed learning.

Quotations in support of refining the principle

> *"None, fully agree!" (Delphi panelist 1)*

> *"A necessity, particularly when taken into context of principle 2, however, it's important to acknowledge that self-regulation and -directed learning should be guided throughout development as well until such skills become properly developed. Often, I see such terms used and executed in practice without proper vetting of information or learning resources, leading to off-target learning and learning outcomes not being achieved." (Delphi panelist 3)*

> *"What components of self-regulation are most essential?" (Delphi panelist 4)*

> *"This shows that the vulnerability is not a sign of weakness or ignorance." (Delphi panelist 7)*

> *"There must however always lecturer support available." (Delphi panelist 11)*

> *"How reflective journals and tutorials are structured, could facilitate this principle." (Delphi panelist 13)*

“If we can accept that we are never finished learning, we will more easily accept needing to ask for input when necessary.” (Delphi panelist 15)

“I agree with self-regulated learning; however, I am not certain why the responsibilities of this lie with the educator. The student needs to be motivated to do this (internally and externally) and the curriculum needs to be designed in a way that may foster approaches towards self-directed learning.” (Delphi panelist 16)

Principle 4: Acknowledge that educators as well as students engage in self-regulation and self-directed learning

The Delphi participants commented on the need for resources and possible strategies that could facilitate self-regulation and self-directed learning. Furthermore, it was noted that this principle could be true for both the educators and the students. Educators are also always learning and this could ideally be modelled to students as it will demonstrate that vulnerability and uncertainty is not a sign of weakness.

Draft Principle 5: Explore a shared epistemological foundation for teaching clinical reasoning

The articles included in the scoping review reveal the importance of a theoretical (pedagogical) foundation in planning teaching activities. Carbogim et al. (2019), Costello et al. (2017), Kautz et al. (2005), Kuiper et al. (2009), Rush et al. (2010) and Torres et al. (2019) all emphasise the value of using theory as a foundation for teaching practice. The teaching activities examined in terms of this principle were produced from the previously mentioned studies as well as data from the interviews with the lecturers regarding their teaching strategies. The interviewed lecturers from the current PhD study referred to their use of a large range of strategies to develop clinical reasoning, including case studies, student engagement, scaffolding, facilitating thinking and cognition, the integration of theory and practice via clinical visits, sharing personal experience and developing competencies such as lifelong learning. In summary, the articles from the scoping review demonstrated the use of journaling, worksheets, computer-assisted modules, simulation and a clinical reasoning mapping tool. Understanding the theoretical foundations *and* the activities that can be used to enhance clinical reasoning is essential for the development of clinical reasoning in the undergraduate physiotherapy student.

It is important for academics to understand the difference between *knowing* and *doing* in the building of an epistemological and pedagogical rationale. Educators need to understand themselves and their theoretical foundation before choosing their teaching techniques or creating optimal learning environments for the development of clinical reasoning.

Quotations in support of refining the principle

"The word 'explore' made me pause (as it seems a bit open-ended?) versus 'develop' or 'establish'?" (Delphi panelist 1)

"Make the teaching of clinical reasoning explicit from first year through to completion of the course." (Delphi panelist 2)

"With a construct such as clinical reasoning, where most seasoned experts will have an intuitive approach, it's important that proper frameworks are available that can be used." (Delphi panelist 3)

"Educators do not necessarily need to understand themselves and their theoretical foundation before choosing their teaching techniques. They could reflect on their teaching techniques as a way of making their theoretical orientations explicit." (Delphi panelist 9)

"Definitely agree, this will address the diversity of the learning styles of students." (Delphi panelist 13)

"I have an MPhil in HPE and this obviously enhanced my ability to create learning opportunities to facilitate clinical reasoning immeasurably. However, I think I was already doing that innately before I studied HPE. I started my formal HPE journey because I was already seen to be a very good teacher, so I think some people are capable of doing this without the theoretical underpinnings, but their practice would be greatly enhanced with the theory." (Delphi panelist 15)

"Agree. I would add a teaching philosophy with clear theoretical underpinning." (Delphi panelist 16)

Principle 5: Establish an epistemological foundation by reflecting on current practice and how it could be enhanced by a firm theoretical underpinning for developing clinical reasoning

The Delphi participants commented that a theoretical underpinning could enhance the development of clinical reasoning with regard to their own teaching practices. Some stated that educators do not necessarily need to understand all learning theory but that learning theory could definitely augment their practice.

Draft Principle 6: Engage students in cognitive and metacognitive processes during teaching and learning activities

Clinical reasoning is the cognitive process that underlies the decision-making for diagnosing and managing a patient. Kautz et al. (2005) and Kuiper et al. (2009) demonstrate the use of metacognitive and cognitive skills. Clinical reasoning has been demonstrated to be a mental process in the interviews conducted for this study.

This confirms the importance of developing thinking skills. It is recognised that clinical reasoning is a skill that must be developed. It is known that skills improve with practice; therefore, the actual clinical reasoning skills must be practised. This calls for educators to consider how they might model this complexity prior to attempting to engage students in the type of thinking they will need to be doing in the clinical context in the classroom. Educators have to move beyond just sharing content; they will need to understand their own cognitive and metacognitive processes and then attempt to model this to their students before planning activities that will create an opportunity for students to engage in cognitive and metacognitive processes.

Quotations in support of refining the principle

> *"I agree: it's about taking that step back to draw all the puzzle pieces together into a coherent picture. Could also link to be a 'reflective' practitioner?" (Delphi panelist 1)*

> *"Learning to think is necessary to self-regulate and direct learning, otherwise passive approaches become the norm and development suffers." (Delphi panelist 3)*

> *"What processes are most essential, reflection, self-testing, evaluation of what is known and not known." (Delphi panelist 4)*

> *"Clinical reasoning is more than just a cognitive skill, in my opinion." (Delphi panelist 9)*

> *"The metacognitive is often neglected and is perhaps the most important." (Delphi panelist 11)*

“Clinical reasoning is an ongoing process and definitely develops with a lot of experience. Ongoing modelling and reflecting facilitate clinical reasoning skills.” (Delphi panelist 13)

“A space to interrogate and uncover 'automatic' clinical reasoning processes in experts would be extremely valuable to students, but I don't think it has to happen before clinical exposure. It would probably be of more benefit if it occurs concurrently, so that students can reflect on their own processes with real patients.” (Delphi panelist 15)

“Agree, and it would be interesting to state how students are taught this process of 'thinking about their thinking'.” (Delphi panelist 16)

Principle 6: Model self-reflection as educators and engage students in cognitive and metacognitive processes

The Delphi participants agree that taking a step back and looking at the clinical picture holistically was important. This is seen as being reflective. Therefore, modelling and engaging in reflective practice with the students is useful during the process of attempting to develop clinical reasoning.

Draft Principle 7: Develop teaching and learning activities that provide students opportunities to build and grasp connections between concepts

Edwards et al. (2004) note that clinical reasoning consists of multiple components including critical thinking, hypothesis testing, synthesising information and self-reflection. This, along with the understanding of clinical reasoning that has come out of the current study, demonstrates that the clinical reasoning process is a culmination of multiple data points and concepts. Anatomical knowledge, biomechanical knowledge, knowledge of pathology, the patient's data and knowledge of physical testing needs to be integrated and used to come to a conclusion for the patient. Accordingly, multiple connections between concepts and content need to be made as part of the clinical encounter.

Clinical reasoning, however, is not always as straightforward as collecting data and then making an empirical decision using objective methods. For this reason, it is important for educators to model that some clinical decisions are not as simple to arrive at. Educators need to understand how they make connections between concepts. Once they are able to do this they could attempt to model this to their students. This could be done prior to planning activities that will provide opportunities for students to make connections between concepts and how those concepts relate to their patients.

Quotations in support of refining the principle

"As you say – tying it all together (or linking those knowledge nodes in new ways)." (Delphi panelist 1)

"Included in those concepts would be the uniqueness of each patient and their set of circumstances that also needs to be considered in the decision-making process." (Delphi panelist 2)

"As per principle five, within the framework of expertise, often the concept of intuitive knowledge pops up in mastery, so at times the concepts leading to clinical reasoning outcomes is more ethereal for those that are not yet able to work through the process, while the expert thereof is not necessarily capable of articulating everything in a way that is straightforward enough for learning." (Delphi panelist 3)

"What activities would be of most benefit?" (Delphi panelist 4)

"Rather, the clinical educator should look out for the teaching and learning opportunities rather than creating these activities which are often 'unreal' experiences." (Delphi panelist 7)

"There is a huge amount to be said for a 'gut feeling' – that subliminal processing that helps one arrive at a diagnosis in many patients. This is important to acknowledge, and I teach and validate it to my students. I learned recently that there are as many nerve cells in the human gut as in a dog's brain, and there is much about the gut that we have yet to understand in terms of how it contributes neural processing. So yes, I absolutely agree that we need to openly discuss patient cases like this

and demonstrate that it's not just about facts and data for every patient." (Delphi panelist 15)

"Consider how these connections are made when interdisciplinary teaching may be required?" (Delphi panelist 16)

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Principle 7: Make the connections between concepts explicit for students

The Delphi participants agree that educators need to be able to articulate difficult concepts to students and furthermore demonstrate how the connections between concepts are made.

Draft Principle 8: Align assessment practices appropriately

Engaging in curriculum design requires aligning assessment with learning outcomes. Assessment aims to illustrate how the students will demonstrate the learning. Clinical reasoning is a complex process; therefore, the assessment of clinical reasoning will not be straightforward. The lecturers specified assessment as a challenging part of the clinical reasoning development process. Although the lecturers were trying to develop clinical reasoning (which is complex) it seems the assessment remains far too simplistic, assessing rote learning or recall. All stakeholders agree that clinical reasoning develops over time and with experience. Educators must rethink the way they view assessment. If clinical reasoning takes time and experience to develop, perhaps the assessment could be viewed in a manner that assesses the student over a period of time, possibly several years. Assessment could also then focus on the connection's students make between concepts and not their ability to recall information, provide opportunities for feedback, and guide the thought process.

Quotations in support of refining the principle

> *"For me assessment is the most important part of the entire curriculum and learning process, because 'assessment drives learning'. (Just shout if you ever want to chat about this!)" (Delphi panelist 1)*

> *"Assessment in many cases has boiled down to 'quick and dirty' or 'whatever fits the system easiest' – authentic assessment practice should be employed to measure the exact properties which are being assessed, whether it be cognitive, psychomotor or attitudinal." (Delphi panelist 3)*

> *"Constructive alignment is key." (Delphi panelist 11)*

> *"Easier said than done, but agree." (Delphi panelist 13)*

> *"Absolutely. We need to have types of assessments that allow students to demonstrate their thought processes to us – patient presentations, case reports, reflective commentaries etc. A well-designed MCQ or short answer question can absolutely test clinical reasoning, but one does need other elements." (Delphi panelist 15)*

“One would assume that this is done as this is a professional programme with the requisite professional body outcomes and requirements.” (Delphi panelist 16)

Principle 8: Align assessment practices appropriately

The Delphi participants agree with this principle; therefore, it remains unchanged.

7.4.4 Final set of principles

The final objective of the study was to recommend a final set of design principles to develop clinical reasoning in undergraduate physiotherapy students. The table below outlines the final set of design principles and the facets of each principle.

Table 7. 3: Design principles and facets of each principle

Design principle	Facets of design principle
Principle 1: Specify a shared understanding of clinical reasoning for students and educators within a department, that includes deciphering definitions pertinent to all involved stakeholders	• Review existing definitions and meanings of clinical reasoning. • Establish what clinical reasoning means for you and your department.
Principle 2: Build uncertainty into the curriculum	• Ensure students have a basic understanding of foundational knowledge. • Provide support for knowledge gaps that students may have with regard to their foundational knowledge. • Model uncertainty with regard to complex patient presentations and pathology. • Provide support when students do not know how to use their knowledge or face uncertainty with regard to their decision making.
Principle 3: Model vulnerability	• Educators must be aware of their own limitations. • Model asking for assistance so that this can be normalised for students.
Principle 4: Acknowledge that educators as well as students engage in self-regulation and self-directed learning	• Educators model that they are also learning. • Provide opportunities for students to demonstrate taking responsibility for their own learning. • While providing these opportunities ensure adequate support.

Design principle	**Facets of design principle**
Principle 5: Establish an epistemological foundation by reflecting on current practice and how it could be enhanced by a firm theoretical underpinning for developing clinical reasoning	• Educators could review their current teaching practice. • Study what the learning theory states about what the educator is currently doing. • Use the learning theory to enhance or augment what is currently being done and how it can improve. • Review teaching strategies regularly to assess whether the teaching strategies are aligned with learning theory and how they can be improved. • Engage in health professions education and the scholarship of teaching and learning.
Principle 6: Model self-reflection as educators and engage students in cognitive and metacognitive processes	• Educators could model how they work through difficult patient cases. • Engage in a process of self-reflection. • Model reflection to the students.
Principle 7: Make the connections between concepts explicit for students	• Educators could model how they link concepts together whether they are teaching theory or providing clinical supervision. These processes are always invisible to the students. They do not know how educators came to their conclusions. • Strategies such as journaling and small tutorial groups could be useful to demonstrate making connections between concepts.
Principle 8: Align assessment practices appropriately	• Clinical reasoning development takes time and experience. • Consider assessment over time rather than short incremental assessments. • Construct assessments that evaluate connections between concepts rather than isolated concepts.

7.5 Discussion

The discussion investigates other researchers' use of the Delphi in a similar manner to what was done in the current Delphi study. Furthermore, reasons for why the Delphi method might be useful are explored.

Researchers have demonstrated the use of a Delphi or modified Delphi study to reach consensus on certain aspects pertaining to the curriculum. In their study, Blair and Uhl (1993) described the use of the Delphi technique for curriculum improvement at a Canadian university. They identified necessary course components to be included in a revised office administration programme. Their findings demonstrated that the use of the Delphi technique allowed the department to receive information from valuable stakeholders and educate guidance counsellors and future employers with essential information for updating and improving the curriculum (Blair & Uhl, 1993). Frenzel et al. (2021) aimed to establish essential skills for Doctor of Pharmacy graduates. They conducted a three-round Delphi study to determine consensus among expert faculty who instruct within pharmacy skills laboratories. The Delphi technique was successful in identifying laboratory-focused essential skills that newly graduated Doctor of Pharmacy pharmacists should embody before embarking on work in the community, health-system, ambulatory care, or managed care pharmacy practice. The essential skills can be used to guide curriculum development, develop milestone markers, and help ensure students are practice ready (Frenzel et al., 2021). Huth et al. (2020) discovered the core topics that needed to be included in a standard complex care curriculum for paediatric residents. Following their Delphi study, 11 curricular priorities in complex care were identified and served as a guide for standardized curriculum development for future paediatricians (Huth et al., 2020). A project conducted by Copeland et al. (2018) developed a consensus agreement on a delirium curriculum for medical undergraduates. A modified Delphi process was also used to establish consensus among an international group of experts from a broad range of specialties in an iterative manner. Through the Delphi process, agreement was reached on the components needed for an undergraduate curriculum for delirium (Copeland et al., 2018). Viljoen et al. (2020) made use of a modified Delphi study to determine expert consensus among content and context experts on an electrocardiography curriculum for medical students. They found that a multidisciplinary expert panel reached agreement on the electrocardiography training priorities for medical students.

One of the main objectives of the Delphi technique is to obtain convergence of opinion without bringing individuals together in face-to-face meetings (Blair & Uhl, 1993). Therefore, the Delphi technique enables the ability to obtain opinions from diverse groups at a relatively low cost and effort (Blair & Uhl, 1993). Furthermore, participants' anonymity is ensured and direct confrontation in faculty or committee meetings can be avoided (Blair & Uhl, 1993).

Reeves and Jauch (1978) note that much time and effort is dedicated to curriculum development. The authors found that the usefulness of proposed curriculum changes to students was not always certain, owing to the complexity of the curriculum design. They also commented that there is often considerable disagreement on who should provide inputs to the process and how heavily these inputs should be weighted and that curriculum development in higher education is often haphazard. Changes to the curriculum are usually made at the individual educator level and not much thought is given to the entire curriculum or the future of the profession. They suggest that long-term planning with the use of the Delphi technique be employed (Reeves & Jauch, 1978). Rajhans et al. (2020) note the importance of external stakeholders' participation in curriculum development as it has proved beneficial in producing inputs on new trends and competencies involved in the professional practice. Their experience demonstrates that an expert panel that is representative of an array of dimensions of professional practice, can lead to transformation of the curriculum. Therefore, Rajhans et al. (2020) describe the Delphi method as one of the best alternatives available for transforming the curriculum in a scientific manner and also during a lockdown situation (within the COVID-19 pandemic).

7.6 Conclusion

Chapter 7 describes the Delphi study that was conducted. An expert panel was asked to provide consensus on the draft design principles and in order to refine them. Agreement was set at 70% and consensus of more than 70% was reached for each principle as well as the overall agreement. The feedback from the participants for the Delphi on each principle was integrated and a final set of design principles was produced.

The final set of design principles are:

- specify a shared understanding of clinical reasoning for students and educators within a department that includes deciphering definitions pertinent to all involved stakeholders[11],
- build uncertainty into the curriculum,
- model vulnerability,
- acknowledge that educators as well as students engage in self-regulation and self-directed learning,
- establish an epistemological foundation by reflecting on current practice and how it could be enhanced by a firm theoretical underpinning for developing clinical reasoning,
- model self-reflection as educators and engage students in cognitive and metacognitive processes,
- make the connections between concepts explicit for students, and
- align assessment practices appropriately.

The final chapter of this thesis follows, concluding the thesis and summarising the overall results of the study.

[11] Developing the first design principle was challenging as the researcher found it difficult to harmonise the definitions regarding clinical reasoning from the literature and the participants. The input from the expert Delphi panel however encouraged the researcher to focus on creating a definition that encompasses what is needed by those wanting to enhance clinical reasoning rather than using the literature to anchor a definition of clinical reasoning.

Chapter 8: Conclusion, recommendations and limitations

8.1 Introduction to the chapter

The final chapter provides a summary of the thesis and the main findings. Furthermore, the chapter provides the answer to the research question and outlines the achievements of the overall aim and objectives of the study. The limitations of the study are documented and the researcher makes recommendations for future practice.

The overall aim of the thesis was to develop design principles that could guide the development of clinical reasoning in undergraduate physiotherapy students. The study had six research objectives: The first objective was to explore and describe the views of students, experts and lecturers on their understanding and the process of clinical reasoning. This was followed by exploring and describing the learning tasks used by lecturers to develop clinical reasoning in their students. The third objective was to evaluate, how theory influences the teaching strategies used for developing clinical reasoning in undergraduate health professions students. This led to the design of a set of draft principles that could guide the development of clinical reasoning in undergraduate physiotherapy students. Thereafter, the refinement of the draft design principles for clinical reasoning development were completed. Finally, the sixth objective was to recommend a set of design principles that could guide the development of clinical reasoning.

8.2 Summary of the thesis

Chapter 1 presented an overview of clinical reasoning and the various synonyms frequently used, a review of the decision-making process, strategies that have been described in the literature to develop clinical reasoning and the literature related to the development of clinical reasoning. Accordingly, this chapter emphasises the need to conduct a study into the development of clinical reasoning as it is a complex process which is necessary for ideal patient outcomes.

The study was conducted in four phases and Chapter 2 outlined the various study designs that were incorporated into the four phases within the DBR framework that was used for this study. During Phase 1, a qualitative exploratory design was used to collect data via in-depth interviews from all the stakeholders (students, experts and lecturers). A scoping review was also conducted. Phase 2 included a document analysis which was conducted using the data collected from Phase 1. Following the document analysis, a set of draft design principles was produced. In Phase 3 of the study, the draft design principles were submitted to a panel of experts for refinement via a Delphi study, and in Phase 4, a final set of design principles was produced.

There was no separate Results chapter in this thesis. Instead, the results were presented across Chapters 3 to 7. The results in Chapter 3 follow the interviews with students, experts and lecturers, while Chapter 4 describes the learning tasks used by lecturers and additionally highlights challenges faced by lecturers when attempting to develop clinical reasoning. Factors that the lecturers thought assisted in the development of clinical reasoning in their students were also commented on.

Data from 36 interviews was analysed. According to the participants in this study, clinical reasoning is a cognitive, mental activity that requires a basic foundation (of knowledge and patient data) to inform decision-making and is influenced by the person making the decision and the person providing the information (usually the patient). The clinical reasoning process was reported on by the students and the experts. For the students, the process was very specific, as they mentioned individual components of their process. Although the process was the same for both experts and students, the experts did not mention specific components of their clinical reasoning process but approached it more holistically. The lecturers cited various tasks they used to develop clinical reasoning, namely case studies, discussions and small group learning (student engagement) and scaffolding. They also mentioned questioning, reflection, feedback and demonstration, which was interpreted as facilitating thinking. The integration of theory and practice via clinical visits and sharing personal experience was also highlighted. While attempting to develop clinical reasoning, the lecturers observed challenges that they faced. These challenges were related to the lecturers themselves, the students and factors related to the environment. In terms of their environment, they reported a lack of an integrated approach to developing clinical reasoning, challenging exam formats, and classroom practice that could be improved in terms of creating environments that encourage thinking. The lecturers said that being a new academic and developing clinical reasoning was challenging and they were not aware what their colleagues were doing in their classrooms. They also commented that the students were not patient-centred enough, were not self-directed and could be more open to asking for advice (being vulnerable, in the context of this thesis). The students, however, stated that being patient-centred, self-directed and vulnerable was very important to them in their development of clinical reasoning. This shows contradictions between what the lecturers perceived about the students and what the students believed about themselves.

Various participants discussed what they thought was needed for clinical reasoning. The lecturers and students reported that knowledge was important for clinical reasoning. The students also identified particular university tasks that they thought assisted them with their development of clinical reasoning. These tasks included clinical practice, the mini-clinical evaluation exercise (mini-CEX), case studies and guidance. All participants agreed that time and experience were important for the development of clinical reasoning. Furthermore, all participants agreed that being vulnerable and asking when faced with uncertainty was necessary in the development of clinical reasoning. The experts pointed out that embracing uncertainty and the fact that they did not always have the correct answer was important in their development of clinical reasoning and in ultimately becoming an expert. The lecturers commented that normalising uncertainty, being more approachable, providing adequate exposure to clinical experience and being more student-centred were factors that could help them in developing clinical reasoning skills in the students.

Chapter 5 presented the findings of the scoping review that was conducted as part of the problem identification. The results of the scoping review demonstrated that various theories underpinned a variety of teaching strategies. Journaling was the only common teaching strategy among the six studies that were included in the review. The included studies confirmed that theory was used either as a structure, being a foundation for the use of teaching activity, or the teaching strategy was chosen based on the theory. Although only two of the studies demonstrated good methodological quality, all six included studies showed a positive change in clinical reasoning, demonstrating that when theory underpins a teaching strategy there is a positive change in clinical reasoning in undergraduate health professions students. Educators could therefore consider the use of a pedagogical foundation when planning their teaching activities and strategies.

Chapter 6 presented the draft design principles, which were produced from the interview and scoping review data. In Chapter 7, the set of design principles for the development of clinical reasoning were refined, and a final set of design principles that could guide the development of clinical reasoning were recommended. The overall aim of the current study was to develop a set of design principles that could guide the development of clinical reasoning in undergraduate physiotherapy students. A Delphi study was conducted to refine the principles; an expert panel was consulted and their recommendations incorporated to produce the final list of design principles for the development of clinical reasoning in undergraduate physiotherapy students.

The final set of principles were to:

- specify a shared understanding of clinical reasoning for students and educators within a department that includes deciphering definitions pertinent to all involved stakeholders,
- build uncertainty into the curriculum,
- model vulnerability,
- acknowledge that educators as well as students engage in self-regulation and self-directed learning,
- establish an epistemological foundation by reflecting on current practice and how it could be enhanced by a firm theoretical underpinning for developing clinical reasoning,
- model self-reflection as educators and engage students in cognitive and metacognitive processes,
- make the connections between concepts explicit for students, and
- align assessment practices appropriately.

8.3 Recommendations

There are a few major recommendations that arose from the current study. Educators within departments need to be in agreement with regard to their own understanding of clinical reasoning before attempting to develop this complex skill in their undergraduate students. The foundational aspects of health professions curriculums would need to be reviewed in order to create sustainable change. In addition, the use of learning theory as a basis of teaching strategy choice could augment teaching and learning significantly.

Finally, educators could consider the use of the design principles that emerged from this study when creating a learning environment to develop clinical reasoning.

8.3.1 Recommendations based on the data following the interviews

The researcher reported on guidance and facilitation as mentioned by the students and curiosity as mentioned by the experts, as being important aspects of developing their clinical reasoning. Studying these aspects within the learning environments could be considered for future research as the evaluation of the clinical reasoning development continues and as faculties discover what is important to them regarding the development of clinical reasoning.

8.3.2 Recommendations based on the scoping review

The limited number of studies used in the review suggests a need to investigate the use of theory to support teaching strategies to develop clinical reasoning. This could be interpreted as educators being required to follow a more evidence-based approach to their teaching practice, which means that practice is based on evidence and not tradition, personal choice or alternative influences. Therefore, future research should consider exploring strengthening the foundation of educators' choices when developing clinical reasoning. The high number of studies with poor methodological quality also highlight the need for research in health professions education to be conducted and reported on more rigorously.

8.3.3 Recommendations based on the findings of the document analysis

Following the design of the draft principles, the researcher recommends examining the effects of long-term assessment of clinical reasoning. Van Der Vleuten et al. (2015) propose programmatic assessment as an alternative model, where decisions are separated from individual assessment moments. Individual assessment moments are only useful for gathering information on the learner. Programmatic assessment allows for a longitudinal view of learning and assessment in relation to certain learning outcomes and provides the opportunity to monitor and mentor growth and development. Therefore, instead of monitoring incremental shifts or changes in clinical reasoning, educators could consider the development of clinical reasoning over a year or two and assess the change in a more meaningful way. Vulnerability, in the context of this thesis, is defined as the acceptance of uncertainty at any level of expertise. This concept could be considered for further study in the context of developing clinical reasoning, among students and educators. In addition, reflection as practice for educators could also be evaluated specifically in relation to the development of complex skills such as clinical reasoning.

8.3.4 Recommendations following the Delphi study

The modified Delphi study proved to be a useful way to receive input regarding the design principles for this study. Therefore, using the modified Delphi for refinement or consensus across a list of statements for curriculum guidelines could be very useful for future research. Although agreement was reached in one round of the Delphi study, upon reflection, the researcher suggests adding a second round to share the updated principles in that this would be useful to the panel who contributed and shared insight into the development of the final set of principles.

8.4 Limitations

In general, the study took place at a single institution, so the results must be interpreted with caution. Although every effort was made to ensure all processes were transparent, it is important to note that the researcher is a staff member who was involved with the student population and is a colleague of the lecturers who participated in the study. Clinical reasoning is a poorly defined construct and it was challenging to harmonise the definitions offered by the literature and the participants in this study. However, the input from the Delphi participants was very useful in shaping the first design principle which centred around developing an understanding of clinical reasoning.

8.4.1 Interviews

In terms of the participants, 10 lecturers from one institution were interviewed. Again, noting that only one institution was used which will question the generalisability. Only eight experts participated, therefore, this particular sample is quite small. The 18 students who participated in the study were not representative of the cohort of students at the university. When asked about the tasks that the students thought were helpful in developing their clinical reasoning, some of them mentioned that the tasks the researcher gave them were particularly helpful. The researcher highlights this as a potential limitation as the students could have just said that because she was interviewing them.

8.4.2 Scoping review

The review only yielded six studies, which is a small amount of data to draw any definitive conclusions. The data did show that the inclusion or use of theory demonstrated a change in clinical reasoning, which was positive and made a beneficial contribution to the overall study. However, it must be noted that only two of the six included studies had good methodological quality which could impact the recommendations.

8.4.3 Document analysis

The process of document analysis called for the researcher to design a data collection tool which would assist with extracting the data across the documents included for data collection. A limitation to point out was that the tool was piloted on the actual documents that were used for data extraction.

8.4.4 Delphi study

While the number of participants in the Delphi study was considered to be within normal range a larger number may have yielded a richer set of data. The mean consensus was reached after one round, indicating that the panel reached agreement, but a second round of the Delphi may have been more appropriate for the iterative process. Furthermore, the researcher did not make the additions to the principle's compulsory, and only a few respondents provided additions to the principles. This could be seen as a limitation in that limited feedback and engagement regarding the principle was recorded.

8.5 Conclusion

The findings of this study demonstrate that clinical reasoning is an abstract, often implicit skill, which is difficult to teach. The innovations from the current PhD study suggest that educators and teams who are wanting to develop clinical reasoning do individual or collective introspection. This viewpoint could be examined by addressing personal vulnerability, uncertainty and self-regulation and modelling this to the students. Exploring and demonstrating one's personal beliefs to develop a shared understanding of clinical reasoning and establishing a foundational approach to manage engaging, physiotherapy and other health professions students, is necessary to develop clinical reasoning.

All the interviewed participants communicated that there were internal factors that contribute to the development of clinical reasoning. Both personal beliefs and the environment play a role in the development of clinical reasoning. This indicates that clinical reasoning development should also be personally addressed by educators themselves and not just associated with the environments where clinical reasoning develops. Therefore, self-awareness within the process of clinical reasoning is important.

The students reported that clinical practice was one of the tasks that they found helped them develop clinical reasoning. One of the theories that underpinned the teaching strategies in the scoping review was situated learning. Situated learning is grounded in the belief that what people learn, see, and do, is situated in their role as members in the community. This could be why the students mentioned clinical practice as an element of the curriculum that developed their clinical reasoning. The lecturers referred to a large range of tasks they used to develop clinical reasoning. These tasks were either embedded in a cognitivist (discussions and problem-solving) or a constructivist (case studies) approach. The scoping review however presented only an overall constructivist approach to clinical reasoning development from the included articles. This demonstrates that a variation of theoretical foundations is useful when developing clinical reasoning.

In conclusion, the findings of this study not only highlight the role of the learning environment and learning tasks in the development of clinical reasoning, but also emphasise the significance of the educator who is attempting to develop clinical reasoning in students. The final set of design principles presented in this study focus on a proposed shift in educators, and encourage educators to model their own difficulties and processes in order to effectively help students to develop clinical reasoning.

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Appendices

Appendix A1: Consent form students

UNIVERSITY OF THE WESTERN CAPE

Private Bag X 17, Bellville 7535, South Africa
Tel: +27 21-9592542, Fax: 27 21-959 1217
E-mail: dhess@uwc.ac.za

CONSENT FORM

For 3rd and 4th year students studying Physiotherapy at the University of the Western Cape

Title: Development of design principles in designing an intervention to enhance clinical reasoning in physiotherapy

The study has been described to me in language that I understand. My questions about the study have been answered. I understand what my participation will involve and I agree to participate of my own choice and free will. I understand that my identity will not be disclosed to anyone. I understand that I may withdraw from the study at any time without giving a reason and without fear of negative consequences or loss of benefits.

Participant's name...............................

Participant's signature.....................................

Date...........................

Appendix A2: Consent form experts

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E-mail: dhess@uwc.ac.za

CONSENT FORM

For expert physiotherapy clinicians

Title: Development of design principles in designing an intervention to enhance clinical reasoning in physiotherapy

The study has been described to me in language that I understand. My questions about the study have been answered. I understand what my participation will involve and I agree to participate of my own choice and free will. I understand that my identity will not be disclosed to anyone. I understand that I may withdraw from the study at any time without giving a reason and without fear of negative consequences or loss of benefits.

Participant's name..............................

Participant's signature.....................................

Date...........................

Appendix A3: Consent form lecturers

UNIVERSITY OF THE WESTERN CAPE

Private Bag X 17, Bellville 7535, South Africa
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CONSENT FORM

For lecturers teaching at the Physiotherapy at the University of the Western Cape

Title: Development of design principles in designing an intervention to enhance clinical reasoning in physiotherapy

The study has been described to me in language that I understand. My questions about the study have been answered. I understand what my participation will involve and I agree to participate of my own choice and free will. I understand that my identity will not be disclosed to anyone. I understand that I may withdraw from the study at any time without giving a reason and without fear of negative consequences or loss of benefits.

Participant's name.................................

Participant's signature...

Date............................

Appendix B1: Information sheet students

UNIVERSITY OF THE WESTERN CAPE

Private Bag X 17, Bellville 7535, South Africa
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INFORMATION SHEET

For 3rd and 4th year physiotherapy students studying at the University of the Western Cape

Project Title: Development of design principles in designing an intervention to enhance clinical reasoning in physiotherapy

What is this study about?
This is a research project being conducted by **Danelle Hess** a PhD student at the University of the Western Cape. We are inviting you to participate in this research project because you are a student at the University of the Western Cape physiotherapy department. The purpose of this research project is to develop design principles that could guide a physiotherapy curriculum to enhance clinical reasoning in graduating physiotherapists.

What will I be asked to do if I agree to participate?
You will be asked to be part of an interview process should you agree to participate. These are examples of the types of questions you will be asked: What is your understanding of clinical reasoning? Do you think it is something you have been taught or something that will come to you once you qualify as a physiotherapist? Do you think you clinically reason when you see patients during clinical practice? The interview can take place at a convenient place for you. The interview will not be more than an hour.

Would my participation in this study be kept confidential?
The researcher undertakes to protect your identity and the nature of your contribution. To ensure your anonymity, your name will not be used to identify you from your interview.
To ensure your confidentiality, I will keep all the data in hard copy in a locked cupboard to which only I have access and all electronic data will kept in a cloud server such as 'dropbox' or 'google drive' which is linked to my personal accounts and to which I have the passwords to. If a report or an article about this research project, your identity will be protected.

What are the risks of this research?
It is unlikely that the research will impact you and the risk from participating in this study is low, as any implementation done by the researcher will only be done with low stakes assessments. We will try and minimize any potential risks and act promptly during the process of your participation in the study. The detailed information with contact numbers of the relevant authorities will be provided to you in case you want to raise any issue relating to the study.

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This research is not designed to help you personally, but the results may help the investigator learn more about clinical reasoning and how this can better embedded in the curriculum for future physiotherapy students who will study at this institution. We hope that, in the future, other people might benefit from this study through improved understanding of clinical reasoning.

Describe the anticipated benefits to science or society expected from the research, if any.
Do I have to be in this research and may I stop participating at any time?
Your participation in this research is voluntary. You may choose not to take part at all. If you decide to participate in this research, you may stop participating at any time. If you decide not to participate in this study or if you stop participating at any time, you will not be penalized or lose any benefits to which you otherwise qualify.

What if I have questions?
This research is being conducted by ***Danelle Hess, Department of Physiotherapy*** at the University of the Western Cape. If you have any questions about the research study itself, please contact Danelle Hess at Department of Physiotherapy | 0219592542 | dhess@uwc.ac.za. Should you have any questions regarding this study and your rights as a research participant or if you wish to report any problems you have experienced related to the study, please contact:

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Appendix B2: Information sheet experts

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INFORMATION SHEET

For 'expert' physiotherapy clinicians

Project Title: Development of design principles in designing an intervention to enhance clinical reasoning in physiotherapy

What is this study about?
This is a research project being conducted by **Danelle Hess** a PhD student at the University of the Western Cape. We are inviting you to participate in this research project because you have been identified as an expert in your area of physiotherapy. The purpose of this research project is to develop design principles for that could guide a physiotherapy curriculum to enhance clinical reasoning in graduating physiotherapists.

What will I be asked to do if I agree to participate?
You will be asked to be part of an interview process should you agree to participate. These are examples of the types of questions you will be asked: Do you think clinical reasoning is an important quality for practitioners to have?, Were you taught how to clinically reason as an undergraduate student?, If yes, can you explain how you were taught or what influenced your ability to reason?, If no, when do you think you became more aware of it during your clinical practice?, What or when during your clinical practice did you start to think that reasoning was important for your practice and your patient's?, What do you do as part of your daily practice that you feel enhances your ability to clinically reason? The interview can take place at a convenient place for you or it can be done via skype or telephonically. The interview will not be more than an hour.

Would my participation in this study be kept confidential?
The researcher undertakes to protect your identity and the nature of your contribution. To ensure your anonymity, your name will not be used to identify you from your interview.
To ensure your confidentiality, I will keep all the data in hard copy in a locked cupboard to which only I have access and all electronic data will kept in a cloud server such as 'dropbox' or 'google drive' which is linked to my personal accounts and to which I have the passwords to. If a report or an article about this research project, your identity will be protected.

What are the risks of this research?
We will try to minimize any potential risks and act promptly during the process of your participation in the study. The detailed information with contact numbers of the relevant authorities will be provided to you in case you want to raise any issue relating to the study.

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What are the benefits of this research?
This research is not designed to help you personally, but the results may help the investigator learn more about clinical reasoning and how this can better embedded in the curriculum for future physiotherapy students who will study at this institution. We hope that, in the future, other people might benefit from this study through improved understanding of clinical reasoning.

Describe the anticipated benefits to science or society expected from the research, if any.
Do I have to be in this research and may I stop participating at any time?
Your participation in this research is voluntary. You may choose not to take part at all. If you decide to participate in this research, you may stop participating at any time. If you decide not to participate in this study or if you stop participating at any time, you will not be penalized or lose any benefits to which you otherwise qualify.

What if I have questions?
This research is being conducted by ***Danelle Hess, Department of Physiotherapy*** at the University of the Western Cape. If you have any questions about the research study itself, please contact Danelle Hess at Department of Physiotherapy | 0219592542 | dhess@uwc.ac.za. Should you have any questions regarding this study and your rights as a research participant or if you wish to report any problems you have experienced related to the study, please contact:

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Appendix B3: Information sheet lecturers

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E-mail: dhess@uwc.ac.za

INFORMATION SHEET

For physiotherapy lecturers in the physiotherapy department at the University of the Western Cape.

Project Title: Development of design principles in designing an intervention to enhance clinical reasoning in physiotherapy

What is this study about?
This is a research project being conducted by **Danelle Hess** a PhD student at the University of the Western Cape. We are inviting you to participate in this research project because you are lecturer at this physiotherapy department. The purpose of this research project is to develop design principles for that could guide a physiotherapy curriculum to enhance clinical reasoning in graduating physiotherapists.

What will I be asked to do if I agree to participate?
You will be asked to be part of an interview process should you agree to participate. These are examples of the types of questions you will be asked: What module are you responsible for teaching in the physiotherapy department?, What do you understand by clinical reasoning? How do you think you enhance clinical reasoning in your students/modules?, What type of learning tasks do you give to your students?, Do you think the tasks you give enhance clinical reasoning?, How do you think these tasks enhance clinical reasoning in your students? Can you explain how the tasks you give your students assist them to clinically reason or enhance clinical reasoning? The interview can take place at a convenient place for you. The interview will not be more than an hour.

Would my participation in this study be kept confidential?
The researcher undertakes to protect your identity and the nature of your contribution. To ensure your anonymity, your name will not be used to identify you from your interview.
To ensure your confidentiality, I will keep all the data in hard copy in a locked cupboard to which only I have access and all electronic data will kept in a cloud server such as 'dropbox' or 'google drive' which is linked to my personal accounts and to which I have the passwords to. If a report or an article about this research project, your identity will be protected.

What are the risks of this research?
We will try to minimize any potential risks and act promptly during the process of your participation in the study. The detailed information with contact numbers of the relevant authorities will be provided to you in case you want to raise any issue relating to the study.

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This research is not designed to help you personally, but the results may help the investigator learn more about clinical reasoning and how this can better embedded in the curriculum for future physiotherapy students who will study at this institution. We hope that, in the future, other people might benefit from this study through improved understanding of clinical reasoning.

Describe the anticipated benefits to science or society expected from the research, if any.
Do I have to be in this research and may I stop participating at any time?
Your participation in this research is voluntary. You may choose not to take part at all. If you decide to participate in this research, you may stop participating at any time. If you decide not to participate in this study or if you stop participating at any time, you will not be penalized or lose any benefits to which you otherwise qualify.

What if I have questions?
This research is being conducted by ***Danelle Hess, Department of Physiotherapy*** at the University of the Western Cape. If you have any questions about the research study itself, please contact Danelle Hess at: Department of Physiotherapy | 0219592542 | dhess@uwc.ac.za.
Should you have any questions regarding this study and your rights as a research participant or if you wish to report any problems you have experienced related to the study, please contact:

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Appendix C1: Interview guide - students

1. Describe your understanding of clinical reasoning

    a) Was it taught to you?
    b) Do you think it should be taught to you?

2. Do you think the learning tasks in your classes/modules equip you to clinically reason?
    a) How?

3. What is the basis of sound decision making?

    a) Do you have it?

    b) Do you need it?

    c) How can you get it?

4. Explain how you go about clinically reasoning with a patient in clinical practice.

Explain the process you go through when you make a clinical decision for your patient

    a) How do you think you make decisions for your patients? (Describe)

5.Will the ability to clinically reason make you a better PT?

Literature: An effortful task will deplete your self-control.

    a) E.g. of an effortful task

        - Making a series of choices that involve conflict
        - Trying to impress others

    b) Indications of self-control depletion:

    c) Performing poorly in cognitive tasks and logical decision making

6. Has this ever happened to you? When? How often? What do you do about it? How do you overcome it? Give an example of effortful task and indication of self-control depletion

7. Do you ever find yourself taking 'shortcuts' with your patients?

    a) When? Why? How do you know?

Appendix C2: Interview guide - experts

1. Understanding of CR, view of CR.
    a. Why do you think clinical reasoning is an important quality for practitioners to have?

2. How do you know you have made the right decision for your patient? Student?
    a. Benchmarks that you use to know you have made the right decision?
    b. What do you do as part of your daily practice that you feel enhances your ability to clinically reason?

3. Would you say clinical reasoning was taught to you or was it something you learned?
    a. How would you explain you learned this skill?
    b. When during your clinical practice did you start to think that reasoning was important for your practice and your patient's?

4. How do think CR can be taught to students if it comes with time / experience?
    a. Activities that might help with CR development?

5. Strategies such as mentoring / reflection to improve CR?

Appendix C3: Interview guide – lecturers

1. What module are you responsible for teaching in the physiotherapy department?
    a) How does clinical reasoning play a role in your module?

2. What do you understand by clinical reasoning?
    a) Is it necessary for the physiotherapist today/in our current times of practice?

3. How do you think you enhance clinical reasoning in your students/modules/teaching?
    a) What teaching methods or teaching style do you use or do you think will/do/could assist with enhancing clinical reasoning in the classroom?
    b) Is your class / the curriculum preparing your students for the necessary clinical decision making they require in real world practice?
    c) Do you think the physiotherapy curriculum adequately prepares the students for the required decision making / clinical reasoning in the real world?

4. What type of learning tasks do you give to your students?
    a) How do you think these tasks enhance clinical reasoning in your students?
    b) Can you explain how the tasks you give your students assist them to clinically reason or enhance clinical reasoning?

Appendix D: Initial search strings

clinical reasoning
critical thinking
clinical decision making
clinical judgement
clinical reasoning AND educators
clinical reasoning AND lecturers
clinical reasoning AND educators AND learning theory
clinical reasoning AND educators AND health professional students
clinical reasoning AND educators AND health professional students AND development
clinical reasoning AND learning theory AND students
clinical reasoning AND learning theory AND health professional students
clinical reasoning AND development
clinical reasoning AND development AND students
clinical reasoning AND development AND health professional students
clinical reasoning AND development AND learning theory
clinical reasoning AND development AND learning theory AND health professional students
clinical reasoning AND development AND nursing students
clinical reasoning AND development AND midwifery students
clinical reasoning AND development AND medical students
clinical reasoning AND development AND medical students AND learning theory
clinical reasoning AND development AND physiotherapy students
clinical reasoning AND development AND occupational therapy students
clinical reasoning AND development AND pharmacy students
clinical reasoning AND development AND dentistry students
clinical reasoning AND development AND emergency medicine students
critical thinking AND educators
critical thinking AND educators AND learning theory
critical thinking AND learning theory AND students
critical thinking AND learning theory AND health professional students
critical thinking AND development AND students
critical thinking AND development AND health professional students
critical thinking AND development AND nursing students
critical thinking AND development AND learning theory
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clinical decision making AND development AND pharmacy students
clinical decision making AND development AND dentistry students
clinical decision making AND development AND emergency medicine students
clinical judgement AND educators
clinical judgement AND educators AND learning theory

clinical judgement AND learning theory AND students
clinical judgement AND development AND health professional students
clinical judgement AND development AND nursing students
clinical judgement AND development AND midwifery students
clinical judgement AND development AND medical students
clinical judgement AND development AND physiotherapy students
clinical judgement AND development AND occupational therapy students
clinical judgement AND development AND pharmacy students
clinical judgement AND development AND dentistry students
clinical judgement AND development AND emergency medicine students

Appendix E: Excluded articles (Scoping review)

No.	Citation	Article title	Reason for exclusion
1.	Postma, T. C., & White, J. G. (2015). Developing clinical reasoning in the classroom–analysis of the 4 C/ID-model. *European Journal of Dental Education*, *19*(2), 74-80.	Developing clinical reasoning in the classroom–analysis of the 4 C/ID-model	No theory included
2.	Postma, T. C., & White, J. G. (2016). Developing integrated clinical reasoning competencies in dental students using scaffolded case-based learning–empirical evidence. *European Journal of Dental Education*, *20*(3), 180-188.	Developing integrated clinical reasoning competencies in dental students using scaffolded case-based learning–empirical evidence	No theory included
3.	Gillespie, M., & Peterson, B. L. (2009). Helping novice nurses make effective clinical decisions: The situated clinical decision-making framework. *Nursing education perspectives*, *30*(3), 164-170.	Helping novices' nurses make effective clinical decisions: the situated clinical decision-making framework	No indication of an improvement in clinical reasoning
4.	Lisko, S. A., & O'dell, V. (2010). Integration of theory and practice: Experiential learning theory and nursing education. *Nursing Education Perspectives*, *31*(2), 106-108.	Integration of theory and practice: Experiential learning theory and nursing education	No theory included
5.	Davids, M. R., Halperin, M. L., & Chikte, U. M. E. (2015). Optimising cognitive load and usability to improve the impact of e-learning in medical education. *African Journal of Health Professions Education*, *7*(2), 147-152.	Optimising cognitive load and usability to improve the impact of e-learning in medical education	No theory included
6.	Kuiper, R. A., & Pesut, D. J. (2004). Promoting cognitive and metacognitive reflective reasoning skills in nursing practice: self-regulated learning theory. *Journal of advanced nursing*, *45*(4), 381-391.	Promoting cognitive and metacognitive reflective reasoning skills in nursing practice: self-regulated learning theory	No theory included

No.	Citation	Article title	Reason for exclusion
7.	Kim, K. J., & Kee, C. (2013). Evaluation of an e-PBL model to promote individual reasoning. *Medical Teacher*, *35*(3), e978-e983.	Evaluation of an e-PBL model to promote individual reasoning	No theory included
8.	White, A. H. (2003). Clinical decision making among fourth-year nursing students: An interpretive study.	Clinical decision making among fourth-year nursing students: An interpretive study	No theory included
9.	Harbison, J. (2001). Clinical decision making in nursing: theoretical perspectives and their relevance to practice. *Journal of Advanced Nursing*, *35*(1), 126-133.	Clinical decision making in nursing: theoretical perspectives and their relevance to practice	No theory included
10.	Durning, S. J., Lubarsky, S., Torre, D., Dory, V., & Holmboe, E. (2015). Considering "nonlinearity" across the continuum in medical education assessment: supporting theory, practice, and future research directions. *Journal of Continuing Education in the Health Professions*, *35*(3), 232-243.	Considering "nonlinearity" across the continuum in medical education assessment: supporting theory, practice, and future research directions	Not meeting research question and PICO
11.	Brandon, A. F., & All, A. C. (2010). Constructivism theory analysis and application to curricula. *Nursing education perspectives*, *31*(2), 89-92.	Constructivism theory analysis and application to curricula	No specific teaching strategy – theoretical paper.
12.	Maudsley, G., & Strivens, J. (2000). Promoting professional knowledge, experiential learning and critical thinking for medical students. *Medical education*, *34*(7), 535-544.	Promoting professional knowledge, experiential learning and critical thinking for medical students	Type of study: Expert opinion (not part of inclusion criteria)
13	Linn, A., Khaw, C., Kildea, H., & Tonkin, A. (2012). Clinical reasoning: A guide to improving teaching and practice. *Australian family physician*, *41*(1/2), 18-20.	Clinical reasoning: A guide to improving teaching and practice	No theory included

No.	Citation	Article title	Reason for exclusion
14.	Hayes, M. M., Chatterjee, S., & Schwartzstein, R. M. (2017). Critical thinking in critical care: five strategies to improve teaching and learning in the intensive care unit. *Annals of the American Thoracic Society*, *14*(4), 569-575.	Critical thinking in critical care: five strategies to improve teaching and learning in the intensive care unit	No theory included
15.	Cutrer, W. B., Sullivan, W. M., & Fleming, A. E. (2013). Educational strategies for improving clinical reasoning. *Current problems in pediatric and adolescent health care*, *43*(9), 248-257.	Educational strategies for improving clinical reasoning	No theory included and type of study: Expert opinion (not part of inclusion criteria)
16.	Gillespie, M. (2010). Using the Situated Clinical Decision-Making framework to guide analysis of nurses' clinical decision-making. *Nurse Education in Practice*, *10*(6), 333-340.	Using the Situated Clinical Decision-Making framework to guide analysis of nurses' clinical decision-making	Type of study: Expert opinion (not part of inclusion criteria)
17.	Smith, A. (2013). Using a theory to understand triage decision making. *International Emergency Nursing*, *21*(2), 113-117.	Using a theory to understand triage decision making	Type of study: Expert opinion (not part of inclusion criteria)
18.	Mancinetti, M., Guttormsen, S., & Berendonk, C. (2019). Cognitive load in internal medicine: what every clinical teacher should know about cognitive load theory. *European journal of internal medicine*, *60*, 4-8.	Cognitive load in internal medicine: What every clinical teacher should know about cognitive load theory	Type of study: Expert opinion (not part of inclusion criteria)
19.	Patton, N., Higgs, J., & Smith, M. (2013). Using theories of learning in workplaces to enhance physiotherapy clinical education. *Physiotherapy Theory and Practice*, *29*(7), 493-503.	Using theories of learning in workplaces to enhance physiotherapy clinical education	Type of study: Expert opinion (not part of inclusion criteria)
20.	Harris, C. M., & Zha, S. (2017). Concept mapping for critical thinking: Efficacy, timing, & type. *Education*, *137*(3), 277-280.	Concept mapping for critical thinking: efficacy, timing and type	No theory included

No.	Citation	Article title	Reason for exclusion
21.	Hege, I., Kononowicz, A. A., Berman, N. B., Lenzer, B., & Kiesewetter, J. (2018). Advancing clinical reasoning in virtual patients–development and application of a conceptual framework. *GMS journal for medical education*, *35*(1).	Advancing clinical reasoning in virtual patients–development and application of a conceptual framework	Did not actually use health professions students
22.	Bolton, T., & Dean, E. (2018). Self-Determination Theory and Professional Reasoning in Occupational Therapy Students: A Mixed Methods Study. *Journal of Occupational Therapy Education*, *2*(3), 4.	Self-determination theory and professional reasoning in Occupational therapy students	Looked at professional reasoning and the type of study was not part of the inclusion criteria
23.	Lambie, A., Schwend, K., & Scholl, A. (2015). Utilization of the nursing process to foster clinical reasoning during a simulation experience. *SAGE Open*, *5*(4), 2158244015617516.	Utilisation of the nursing process to foster clinical reasoning during a simulation experience	No theory included
24.	Murphy, L. F., & Radloff, J. C. (2019). Using case-based learning to facilitate clinical reasoning across practice courses in an occupational therapy curriculum. *Journal of Occupational Therapy Education*, *3*(4), 3.	Using Case-based learning to facilitate clinical reasoning across practice courses in an occupational therapy curriculum	No theory included
25.	Khanyile, T., & Mfidi, F. (2005). The effect of curricula approaches to the development of the student's clinical reasoning ability. *Curationis*, *28*(2), 70-76.	The effect of curricula approaches to the development of the students clinical reasoning ability	No theory included
26.	Chebbihi, H., Varpio, L., St-Onge, C., & Chamberland, M. (2019). Self-explanation to support knowledge development for clinical reasoning: Perspectives from third year medical clerks. *MedEdPublish*, *8*.	Self-explanation to support knowledge development for clinical reasoning: perspectives from 3rd year medical clerks	Theory and how it is used not explained well.

No.	Citation	Article title	Reason for exclusion
27.	Trommelen, R. D., Karpinski, A., & Chauvin, S. (2017). Impact of case-based learning and reflection on clinical reasoning and reflection abilities in physical therapist students. *Journal of Physical Therapy Education*, *31*(1), 21-30.	Impact of case-based learning and reflection on clinical reasoning and reflection abilities in physical therapist students	No theory included
28.	Ryan, G., Dolling, T., & Barnet, S. (2004). Supporting the problem-based learning process in the clinical years: evaluation of an online Clinical Reasoning Guide. *Medical Education*, *38*(6), 638-645.	Supporting the problem-based learning process in the clinical years: evaluation of an online clinical reasoning guide	No theory included
29.	Wiesner, S. M., Walker, J. D., & Creeger, C. R. (2017). Improving critical thinking using a web-based tutorial environment. *Journal of allied health*, *46*(2), 111-116.	Improving critical thinking using a web-based tutorial environment	The sample did not actually include medical students
30.	Rowe, M. (2012). The use of assisted performance within an online social network to develop reflective reasoning in undergraduate physiotherapy students. *Medical Teacher*, *34*(7), e469-e475.	The use of assisted performance within an online social network to develop reflective reasoning in undergraduate physiotherapy students	A change in clinical reasoning is not mentioned
31.	Si, J., Kong, H. H., & Lee, S. H. (2019). Developing clinical reasoning skills through argumentation with the concept map method in medical problem-based learning. *Interdisciplinary Journal of Problem-Based Learning*, *13*(1), 5.	Developing clinical reasoning skills through augmentation with the concept map method in medical problem-based learning	No theory included
32.	de Araujo Guerra Grangeia, T., de Jorge, B., Franci, D., Martins Santos, T., Vellutini Setubal, M. S., Schweller, M., & de Carvalho-Filho, M. A. (2016). Cognitive load and self-determination theories applied to e-learning: impact on students' participation and academic performance. *PloS one*, *11*(3), e0152462.	Cognitive load and self-determination theories applied to e-learning: impact on students' participation and academic performance	A change in clinical reasoning is not mentioned

No.	Citation	Article title	Reason for exclusion
33.	Neistadt, M. E., Wight, J., & Mulligan, S. E. (1998). Clinical reasoning case studies as teaching tools. *American Journal of Occupational Therapy*, *52*(2), 125-132.	Clinical reasoning case studies as teaching tools	No theory included
34.	Johnsen, H. M., Fossum, M., Vivekananda-Schmidt, P., Fruhling, A., & Slettebø, Å. (2018). Developing a serious game for nurse education. *Journal of gerontological nursing*, *44*(1), 15-19.	Developing a serious game for nurse education	No theory included
35.	Rodríguez, G., Díez, J., Pérez, N., Baños, J. E., & Carrió, M. (2019). Flipped classroom: Fostering creative skills in undergraduate students of health sciences. *Thinking Skills and Creativity*, *33*, 100575.	Flipped classroom: Fostering creative skills in undergraduate students of health sciences	No theory included
36.	Kabanza, F., Bisson, G., Charneau, A., & Jang, T. S. (2006). Implementing tutoring strategies into a patient simulator for clinical reasoning learning. *Artificial Intelligence in Medicine*, *38*(1), 79-96.	Implementing tutoring strategies into a patient simulator for clinical reasoning learning	No theory included
37.	Heiman, H. L., O'Brien, C. L., Butter, J., Uchida, T., Yelen, M., & Garcia, P. M. (2015). Ready to Reason: Integration of Clinical Education and Basic Science Improves Medical Students' Self-Assessed Clinical Reasoning Before Clerkships. *Medical Science Educator*, *25*(4), 513-519.	Ready to reason: integration of clinical education and basic science improves medical students self-assessed clinical reasoning before clerkships	No theory included
38.	Seif, G., Coker-Bolt, P., Kraft, S., Gonsalves, W., Simpson, K., & Johnson, E. (2014). The development of clinical reasoning and interprofessional behaviors: service-learning at a student-run free clinic. *Journal of interprofessional care*, *28*(6), 559-564.	The development of clinical reasoning and interprofessional behaviours: service-learning at a student's-run free clinic	No theory included

No.	Citation	Article title	Reason for exclusion
39.	Sullivan-Mann, J., Perron, C. A., & Fellner, A. N. (2009). The effects of simulation on nursing students' critical thinking scores: A quantitative study. *Newborn and Infant Nursing Reviews*, *9*(2), 111-116.	The effects of simulation on nursing students critical thinking scores: a quantitative study	No theory included
40.	Banning, M. (2008). The think aloud approach as an educational tool to develop and assess clinical reasoning in undergraduate students. *Nurse Education Today*, *28*(1), 8-14.	The think aloud approach as an educational tool to develop and assess clinical reasoning in undergraduate students	No theory included
41.	Wolpaw, T., Papp, K. K., & Bordage, G. (2009). Using SNAPPS to facilitate the expression of clinical reasoning and uncertainties: a randomized comparison group trial. *Academic Medicine*, *84*(4), 517-524.	Using SNAPPS to facilitate the expression of clinical reasoning and uncertainties: a randomized control trial	No theory included
42.	Snodgrass, S. (2011). Wiki activities in blended learning for health professional students: Enhancing critical thinking and clinical reasoning skills. *Australasian Journal of Educational Technology*, *27*(4).	Wiki activities in blended learning for health professional students: enhancing critical thinking and clinical reasoning skills	No theory included
43.	Pereira, M. M., Artemiou, E., McGonigle, D., Köster, L., Conan, A., & Sithole, F. (2019). Second Life and classroom environments: Comparing small group teaching and learning in developing clinical reasoning process skills. *Medical Science Educator*, *29*(2), 431-437.	Second life and classroom environments: comparing small group teaching and learning in developing clinical reasoning process skills	No theory included
44.	Duca, N. S., & Glod, S. (2019). Bridging the gap between the classroom and the clerkship: a clinical reasoning curriculum for third-year medical students. *MedEdPORTAL*, *15*.	Bridging the gap between the classroom and the clerkship: a clinical reasoning curriculum for the third-year medical students	No theory included

No.	Citation	Article title	Reason for exclusion
45.	Willis Warren, B., Campbell, A., Sayers, S., & Gibson, K. Integrated clinical experience with concurrent problema-based learning is associated with improved clinical reasoning among physical therapy students in the United States. J Educ Eval Health Prof. 2018; 15: 30.	Integrated clinical experience with concurrent problem-based learning is associated with improved clinical reasoning among physical therapy students in the United States	No theory included
46.	Zarifsanaiey, N., Amini, M., & Saadat, F. (2016). A comparison of educational strategies for the acquisition of nursing student's performance and critical thinking: simulation-based training vs. integrated training (simulation and critical thinking strategies). *BMC medical education*, *16*(1), 1-7.	A comparison of educational strategies for the acquisition of nursing student's performance and critical thinking: simulation-based training versus integrated training (simulation and critical thinking strategies)	No theory included
47.	Itatani, T., Nagata, K., Yanagihara, K., & Tabuchi, N. (2017, September). Content analysis of student essays after attending a problem-based learning course: Facilitating the development of critical thinking and communication skills in Japanese nursing students. In *Healthcare* (Vol. 5, No. 3, p. 47). Multidisciplinary Digital Publishing Institute.	Content analysis of student essays after attending a problem-based learning course: facilitating the development of critical thinking and communication skills in Japanese nursing students	No theory included
48.	Carvalho, D. P. D. S. R. P., Vitor, A. F., Cogo, A. L. P., Bittencourt, G. K. G. D., Santos, V. E. P., & Ferreira, M. A. (2020). Critical thinking in nursing students from two Brazilian regions. *Revista brasileira de enfermagem*, *73*.	Critical thinking in nursing students from two Brazilian regions	No theory included
49.	Baghdady, M. T., Carnahan, H., Lam, E. W., & Woods, N. N. (2014). Dental and dental hygiene students' diagnostic accuracy in oral radiology: effect of diagnostic strategy and instructional method. *Journal of dental education*, *78*(9), 1279-1285.	Dental and dental hygiene student's diagnostic accuracy in oral radiology: effect of diagnostic strategy and instructional method	No theory included

No.	Citation	Article title	Reason for exclusion
50.	Parandavar, N., Rezaee, R., Mosallanejad, L., & Mosallanejad, Z. (2019). Designing a blended training program and its effects on clinical practice and clinical reasoning in midwifery students. *Journal of education and health promotion*, *8*.	Designing a blended training programme and its effects on clinical practice and clinical reasoning in midwifery students	No theory included
51.	De Beer, M., & Mårtensson, L. (2015). Feedback on students' clinical reasoning skills during fieldwork education. *Australian occupational therapy journal*, *62*(4), 255-264.	Feedback on students clinical reasoning skills during fieldwork education	No theory included
52.	Yang, F., Wang, Y., Yang, C., Zhou, M. H., Shu, J., Fu, B., & Hu, H. (2019). Improving clinical judgment by simulation: a randomized trial and validation of the Lasater clinical judgment rubric in Chinese. *BMC medical education*, *19*(1), 1-6.	Improving clinical judgement by simulation: a randomized trial and validation of the Lasater clinical judgement rubric in Chinese	No theory included
53.	Orban, K., Ekelin, M., Edgren, G., Sandgren, O., Hovbrandt, P., & Persson, E. K. (2017). Monitoring progression of clinical reasoning skills during health sciences education using the case method–a qualitative observational study. *BMC medical education*, *17*(1), 1-11.	Monitoring progression of clinical reasoning skills during health sciences education using the case method – a qualitative observational study	No theory included
54.	Chandrasekar, H., Gesundheit, N., Nevins, A. B., Pompei, P., Bruce, J., & Merrell, S. B. (2018). Promoting student case creation to enhance instruction of clinical reasoning skills: a pilot feasibility study. *Advances in medical education and practice*, *9*, 249.	Promoting student case creation to enhance instruction of clinical reasoning skills: a pilot feasibility study	No theory included
55.	Middeke, A., Anders, S., Schuelper, M., Raupach, T., & Schuelper, N. (2018). Training of clinical reasoning with a Serious Game versus small-group problem-based learning: A prospective study. *PLoS One*, *13*(9), e0203851.	Training of clinical reasoning with a serious game versus a small-group problem-based learning: a prospective study	No theory included

Appendix F: Self-developed data extraction form (Scoping review)

Adapted from: Hoque, D. M. E., Kumari, V., Hoque, M., Ruseckaite, R., Romero, L., & Evans, S. M. (2017). Impact of clinical registries on quality of patient care and clinical outcomes: a systematic review. *PloS one*, *12*(9).

Citation:	Date: Name:

Methods

Aim of the article	
Study design	
Data analysis	
Tool to collect data	

Population and setting

Methods of recruitment	
Number of participants/sample size	
Detailed description of the population	
Age of participants	
Country /nationality	

Citation:	Date: Name:

Eligibility – PICO (**P**opulation – Health prof students; **I**ntervention – Theory that underpins teaching strategy to improve clinical reasoning; **O**utcome – Improvement in clinical reasoning)

Health profession students' discipline	
Theory that underpins teaching strategy to improve clinical reasoning	
How theory was used by educators	
Teaching strategy used	

Citation:	Date: Name:

Measurement of the outcomes	
Results of the study / Outcome - improvement of clinical reasoning	
Rigour of the article (appraisal)	
Key conclusions made by study authors	

Appendix G: Data collection tool (Document analysis)

Date Page, section Topic	
Question 1 What is clinical reasoning?	
Question 2 How is clinical reasoning done? (Process)	
Question 3 How is clinical reasoning supported?	
Question 4 What makes one's clinical reasoning better?	
Question 5 What is the student's perspective?	
Question 6 Is there any additional information?	

Appendix H: Participant invitation (Delphi study)

University of the Western Cape
Physiotherapy Department
dhess@uwc.ac.za
021 9592542/3661

Date

Dear Participant

RE: Request for your participation in my Delphi study - for your opinion on the draft design principles for the development of clinical reasoning in undergraduate physiotherapy students

My name is Danelle Hess and I am a PhD student at the Physiotherapy department at the University of the Western Cape, South Africa. I would like to request your assistance as a participant in my Delphi study. I believe that your participation would add value to my study due to your extensive experience with regard to research within the landscape of higher education and health professions education, your vast experience in postgraduate supervision as well as your role at your university.

My thesis is entitled: *Development of design principles to guide the development of clinical reasoning in physiotherapy education.* The research project has been approved by the Humanities and Social Sciences Research Ethics Committee of the University if the Western Cape (Ethics number: HS17/5/18).

I have used a design-based research framework and have produced design principles following interviews with stakeholders and conducting a scoping review. I would like to distribute the list of draft design principles (for the development of clinical reasoning) to a group of experts for consensus in order to produce the final set of design principles through the Delphi process.

Your participation in the study is completely voluntary, and participants will be able to withdraw at any time. Data will not require any form of identification and cannot be traced back to you. Certain (demographic) information will be asked at the start of the survey such as: area of teaching and/or practice, publications, years of experience in higher education, highest qualification obtained.

I am cognisant of the fact that you have many responsibilities and that your time is precious, thus if you would be able to contribute to this study in order to achieve an objective of the overall study I would really appreciate it. If you are interested and willing to participate in this study, kindly let me know.

Should you require any additional information, please do not hesitate to contact me.

Sincerely,
Danelle Hess

DHess

Appendix I: Consent form (Delphi panel)

UNIVERSITY OF THE WESTERN CAPE

Private Bag X 17, Bellville 7535, South Africa
Tel: +27 21-9592542, Fax: 27 21-959 1217
E-mail: dhess@uwc.ac.za

CONSENT FORM

DELPHI STUDY

For health professions lecturers

Title of Research Project:

Development of design principles to guide the development of clinical reasoning in physiotherapy education

1	I confirm that I have read and understood the information regarding the above study. I have had the opportunity to consider the information, ask questions and have been answered to my satisfaction.	
2	I understand the study will have many rounds, and I am expected to willingly participate in all rounds	
3	I also understand that, my participation is voluntary and I may withdrawal from the study at any time, without giving reasons. I however, understand that the success of this study is dependent on the participants to complete all rounds.	
4	I understand that my identity will remain anonymous throughout the study and no communication regarding my answers will be made to the other experts in this study, and that is only the researcher will access the answers or responses from me.	
5	I understand that, all information and data collected will be kept in a secure place by the researcher.	

Participant's name.. **Signature**.....................

Date..........................

Appendix J: Information sheet (Delphi panel)

UNIVERSITY OF THE WESTERN CAPE

Private Bag X 17, Bellville 7535, South Africa
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Delphi STUDY
INFORMATION SHEET

For health professions lecturers who have agreed to participate in the study

Project Title: Development of design principles to guide the development of clinical reasoning in physiotherapy education

What is this study about?
This is a research project being conducted by **Danelle Hess** a PhD student at the University of the Western Cape. We are inviting you to participate in this research project because you are considered to be an expert the area of health professions education. The purpose of this research project is to develop design principles that could guide the development of clinical reasoning in undergraduate physiotherapy students.

What will I be asked to do if I agree to participate?
You will be asked to sign a consent form, which will be sent to you via email to consent to participating in the study. A questionnaire will then be emailed to you and in total three rounds of questionnaires will be sent to you to achieve consensus. You will be asked to provide your opinion on the feasibility of the designed principles for the development of clinical reasoning in an undergraduate physiotherapy curriculum. This research therefore hopes to enhance clinical reasoning in undergraduate physiotherapy students.

Would my participation in this study be kept confidential?
The researchers undertake to protect your identity and the nature of your contribution. To ensure your anonymity, your name will not be used to identify you from your responses. To ensure your confidentiality, all the data in hard copy in a locked cupboard to which only I have access to and all electronic data will kept on a cloud server such as 'dropbox' or 'google drive' which is linked to my personal accounts and only I have the passwords to. Your questionnaire will only be accessible to the researcher and your confidentiality, anonymity will further be ensured by not writing your name on your response, and no information obtained from you will be shown to other experts. If a report or an article about this research project is produces, your identity will be protected.

What are the risks of this research?
We will try to minimize any potential risks and act promptly during the process of your participation in the study. The detailed information with contact numbers of the relevant authorities will be provided to you in case you want to raise any issue relating to the study.

UNIVERSITY OF THE WESTERN CAPE

Private Bag X 17, Bellville 7535, South Africa
Tel: +27 21-959 2542 Fax: 27 21-959 1217
E-mail: dhess@uwc.ac.za

This research is not designed to help you personally, but the results may help the investigator learn more about clinical reasoning and how this can better embedded in the curriculum for future physiotherapy students who will study at this institution. We hope that, in the future, other people might benefit from this study through improved understanding of clinical reasoning.

Describe the anticipated benefits to science or society expected from the research, if any.
Do I have to be in this research and may I stop participating at any time?
Your participation in this research is voluntary. You may choose not to take part at all. If you decide to participate in this research, you may stop participating at any time. If you decide not to participate in this study or if you stop participating at any time, you will not be penalized or lose any benefits to which you otherwise qualify.

What if I have questions?
This research is being conducted by ***Danelle Hess, Department of Physiotherapy*** at the University of the Western Cape. If you have any questions about the research study itself, please contact Danelle Hess at: Department of Physiotherapy | 0219592542 | dhess@uwc.ac.za.
Should you have any questions regarding this study and your rights as a research participant or if you wish to report any problems you have experienced related to the study, please contact:

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Appendix K: Ethics letter

UNIVERSITY *of the* WESTERN CAPE

60 YEARS *of hope, action & knowledge*

09 July 2020

Ms D Hess
Physiotherapy
Faculty of Community and Health Science

Ethics Reference Number: HS17/5/18

Project Title: Development of design principles in designing an intervention to enhance clinical reasoning in physiotherapy.

Approval Period: 26 June 2020 – 26 June 2023

I hereby certify that the Humanities and Social Science Research Ethics Committee of the University of the Western Cape approved the methodology and ethics of the above mentioned research project.

Any amendments, extension or other modifications to the protocol must be submitted to the Ethics Committee for approval.

Please remember to submit a progress report by 30 November each year for the duration of the project.

The permission to conduct the study must be submitted to HSSREC for record keeping purposes.

The Committee must be informed of any serious adverse event and/or termination of the study.

Ms Patricia Josias
Research Ethics Committee Officer
University of the Western Cape

Director: Research Development
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Tel: +27 21 959 4111
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NHREC Registration Number: HSSREC-130416-049

Appendix L: Explanation of the outcome measures

Carbogim et al. (2019) evaluated critical thinking with the California Critical Thinking Skills Test (CCTST) which was done before and after the intervention. The intervention happened over three days. The students were divided into small groups and the course was presented to them. On the second day the MEAPC associated with PBL was used to simulate critical thinking skills. The students read a case and then applied the MEAPC, established what was needed to understand the case, found the answers and presented their findings. Following the intervention, the CCTST was issued to the students. Carbogim et al. (2019) noted an improvement of the critical thinking scores.

Kautz et al. (2005) used the outcome-present-state test (OPT) model worksheets to measure the nursing process as well as the journal prompts. The sheets were returned following the students' clinical experiences. Kautz et al. (2005) measured the difference in student's ability to frame a situation over time and the difference in the student's ability to make decisions over time with the OPT model using Cross-tabulation and Chi tests. They also conducted content analysis of the worksheets. Kautz et al. (2005) stated that the use of the clinical reasoning web, the outcome-present-state-test worksheets and the self-regulated learning prompts were effective to document students' clinical reasoning and combined use of models may promote metacognitive skills.

Kuiper et al. (2009) used the OPT Model Rating Scale to evaluate the clinical reasoning progress weekly. A clinical reasoning survey was designed by the researchers based on the thinking and reasoning elements represented in the OPT model. The Retrospective verbal protocol analysis (RVPA) was used to examine the nature of students’ reasoning based on the words they used to record reflections (Kuiper et al., 2009). Increased self-efficacy with clinical reasoning activities occurred over time with the group of students studied by Kuiper et al. (2009). Most reflections were related to thinking strategies, environmental situations and self-monitoring performance. SRL starts with the OPT model suggesting benefits of self-observation and self-monitoring during clinical reasoning activities and pinpoint areas where guidance is needed for the development of cognitive and metacognitive awareness (Kuiper et al., 2009). A survey was also used and demonstrated that students' thinking skills were strengthened, the OPT model made them think about patient care problems differently and that students found new ways to think about complex patient cases. Students were able to frame situations over time (which was significant for this study) and make decisions about interventions over time.

Costello et al. (2017) had a multitude of tools; they used the student self-efficacy survey of perceived confidence and preparedness to practise, a clinical reasoning case, the American Physical Therapy Association clinical performance instrument as well as qualitative comments. Costello et al. (2017) found that the student self-efficacy survey of perceived confidence, preparedness to practise showed significance in favour of the experimental group (the group who participated in the CAL modules). With regard to the clinical reasoning case; the experimental group took less time to complete the case (significant) and scored higher on the case (significant). The American Physical Therapy Association clinical performance instrument showed median scores on students' self-assessment of safety and clinical reasoning were similar for both cohorts (the other group received the usual course content without CAL); there was no significant difference between the two cohorts. The clinical performance instruments assessment of students' clinical reasoning skills was in favour of the experimental group. Qualitative comments were related to the areas the students wanted to improve during their internship. There were 12 categories between the students; clinical decision-making, planning, communication, efficiency, safety, psychomotor skills, working with complex patients, determining prognosis, team work, managing the environment, creativity (intervention) and confidence. The top three categories for the students included clinical decision-making, planning and communication (Costello et al., 2017).

Rush et al. (2010) used a questionnaire (qualitative and quantitative questions) to ask the students how they perceived the simulation. Students' responses in the study by Rush et al. (2010) indicate that simulation proved to be a valuable learning experience for both first and third years (with little difference between the two groups of students). Responses indicate that simulation as a learning approach represents situated learning. Rush et al. (2010) further showed that the model of simulation used at their particular institution demonstrates that simulation applies evidence to clinical decisions during simulation activities. Torre et al. (2019) used a 5-item evaluation form to establish how the students perceived the CResME tool. Both groups of students who participated in the study by Torre et al. (2019) felt the CResME tool promoted understanding of differential diagnosis, was a valuable tool and recommended its future use. Torre et al. (2019) state that the CResME tool was a helpful scaffold to teach clinical reasoning and that the tool made implicit features of clinical reasoning explicit.