Teaching Clinical Reasoning Skills to Undergraduate Medical Students: An action research study

Thesis submitted in accordance with the requirements of the University of Liverpool for the degree of Doctor of Education by Penny Lockwood

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Abstract

Introduction

Clinical Reasoning is an important competency for medical students to learn. I am a Clinical Lecturer in Medicine and I run a course which has clinical reasoning as a key component. It was identified at curriculum meetings, that Clinical reasoning can be challenging to teach and that there was some evidence that it is an area of the curriculum that could be further developed and improved upon.

Study Aim

To address the concern about improving the teaching of clinical reasoning skills, my study aimed to;

- Develop effective approaches for teaching clinical reasoning to medical students and evaluate them,
- Identify educational principles that would help students learn clinical reasoning and share them with curriculum developers,

The questions that I identified to support this aim were;

- What enhances the students' ability to learn clinical reasoning?
- What makes it harder to learn clinical reasoning?

New knowledge was developed by exploring how the theories around clinical reasoning and its teaching could be applied in a practical setting.

Methodology

An action research approach was used to identify the concerns and issues around teaching clinical reasoning, look for solutions, plan and implement changes and evaluate the changes. The last element of the study was the development of principles when developing a curriculum or teaching sessions for clinical reasoning.

Results

A new teaching session was designed and delivered to third year medical students. Several key factors important in designing a teaching session around clinical reasoning were identified.

Scenarios used in clinical reasoning teaching should be written so that the information in the history is nonspecific and broad enough to allow for thinking across different body systems. They also should be well written to allow actors to play the simulated patient role realistically.

The tutors involved need to have the skills to encourage the students to apply knowledge to the scenario through interaction. The tutors need to be able to engender a feeling of safety within the group being taught. There are some indications that the tutors need to have a high level of metacognition themselves.

Students need to practice using the clinical reasoning processes and receive feedback on their thought processes. The teaching sessions need to allow time for the students to think and a stop-start method was highly rated by the students as a method for doing this.

Assessments and teaching materials around clinical reasoning need to avoid the use of “buzz words” or formulaic thinking.

Further research into how novices use the clinical reasoning process is needed, as the study suggested that students use inductive reasoning and leave it late to start the reasoning process. They also try and use pattern recognition using “buzz words” very early on in their career.

Chapter 1 Introduction

The General Medical Council (GMC) is the medical profession's governing body in the United Kingdom and it has responsibility for ensuring students reach the standard required of a newly qualified doctor. It has identified clinical reasoning as one of a doctor's core competencies that needs to be achieved before qualifying in medicine (GMC, 2015).

What is Clinical Reasoning?

There are different definitions for clinical reasoning. Skakun (1982) describes it as "the cognitive abilities that clinicians demonstrate whilst evaluating and managing patient problems" (p 732), whilst Anderson (2006) says "the definition of clinical reasoning includes an ability to integrate and apply different types of knowledge, to weigh evidence, critically think about arguments and to reflect upon the process used to arrive at a diagnosis" (p1). Gruppen (2016) summarises the challenge in defining clinical reasoning when he points out the term is used to cover a variety of cognitive activities and there is no generally accepted definition for it.

Feinstein (1973) was one of the earliest authors to write about clinical reasoning. He took the view that it was "a process of converting observed evidence into the names of diseases" (pp212). In his article, Feinstein points out that early clinicians tended to consider patient illness in terms of a collection of symptoms which were given a diagnostic label. For example, consumption was used to describe chest problems associated with wasting. However, as our understanding of pathology and disease process increased the diagnostic label often becomes the cause for the symptoms so consumption becomes tuberculosis or lung cancer. As a result a clinician's reasoning then changed to considering the cause for a patient's condition rather than the collection of symptoms and signs.

Feinstein (1974) in a second article expanded on his theories of how clinicians reason by pointing out that clinicians do not just make diagnostic decisions, they also make decisions about treatment and investigations. However, Elstein, Shulman and Sprafka (1978) continued to concentrate on the diagnostic aspect of the clinician's reasoning and conducted a significant piece of research in this area that lead to the conclusion that clinicians generate and test hypotheses as part of their reasoning process.

About a decade later Turner (1989) looked at the wider picture of clinical reasoning when he suggested that the clinician develops a specific type of algorithm which he described as schema. Clinicians identify the schema appropriate for the situation. Schema inform clinicians what actions and decisions they should make when encountering certain clinical situations. Meanwhile other

literature continued to consider Elstein et al's (1978) work and Bayesian reasoning, which uses a mathematical approach to working out the probability of certain conditions occurring as information is collected from the patient (Lincoln & Parker, 1967).

This was followed by a return to mainly considering the diagnostic aspects of clinical reasoning with Croskerry (2002), who theorized that physicians carry mental templates of the top five diagnoses which need to be excluded for most of the presentations that they see. This is to help them avoid missing a potentially serious diagnosis. Other authors described pattern recognition where clinicians build up an internal library of a series of patterns, to which can be assigned specific diagnoses (Round, 2000; Elstein & Schwarz, 2002; Coderre, Mandin, Harasym, & Fick, 2003).

Later work started to recognise that clinicians used more than one method of clinical reasoning and often recommended that clinicians do not rely on pattern recognition alone (Croskerry, 2009). At the same time other authors started to explore the role of the clinician's emotions in the process. For example, Stolper et al (2009) looked at how feeling of unease could influence the reasoning process.

In 2012 a more complex approach, called Modelling using Typified Objects (MOT, was developed (Charlin et al., 2012). It combined the diagnostic process, management decisions and problem identification aspects of clinical reasoning within one model. It describes processes such as the transformation of patient data into clinical data, categorisation of data by the clinician and how things such as social knowledge impact on the process. This model recognises the complexity of the clinical reasoning process and the many components that are involved.

Clinicians continue to use the phrase "clinical reasoning" either to refer purely to the diagnostic aspect of the process or to encompass other elements of the cognitive process in patient care and management. As well as this, it is worth noting that other terms such as diagnostic reasoning and problem solving are used interchangeably with clinical reasoning. An early example is when Elstein et al (1978) used the term "problem solving: An Analysis of Clinical Reasoning" as their book title.

Why Teach Clinical Reasoning?

Diagnostic errors can have a huge impact on patients and their lives and clinicians strive to prevent them. Several authors advise that it is important to teach clinical reasoning skills to prevent the errors. For example Coderre, Wright and McLaughlin (2010) stated that "most diagnostic errors involve faulty diagnostic reasoning" (p1125) and then explained that for this reason it was important to teach clinical reasoning skills. Other authors have indicated that clinicians can often be working

with uncertainty and need good clinical reasoning skills to deal with these situations (Audétat & Laurin, 2010).

Undergraduate medical curriculums have only recently started to address clinical reasoning as a specific skill to teach. Yet in the past we have had doctors who were able to assess patients and make diagnostic decisions. So why has it become more important now to include clinical reasoning as a specific entity within the curriculum? Feinstein's (1973) paper discussed earlier may provide some insight into this. In the article he suggested that clinical reasoning only came about after advancing knowledge in science, which meant the clinician had to work out what was wrong with the patient rather than remember the name assigned to a set of symptoms and signs. From this it is possible to draw the conclusion that clinical reasoning only became important as our understanding of the science behind the diseases and their management developed.

Another factor that may be significant in the development of the teaching of clinical reasoning is the change in how medical education is delivered. Durning et al. (2013) studied how Interns and expert internists viewed the development of clinical reasoning skills. They identified the importance of role modelling from a senior clinician when reasoning. They suggested that taking part in patient care had a positive impact on learning these skills. This fitted with the traditional curriculum, which consisted of grounding in science followed by several years in a clinical setting. During that setting the students acted as apprentices and followed a "firm" of doctors learning how to assess and diagnose patients by watching what the doctors did and seeing the outcomes of the decisions made. The modern curriculum tends to include much more structured teaching and less time on the wards taking part in patient care. This structured approach along with the change to working practices mean that students no longer follow a "firm" observing how decisions are made and altered for individual patients day to day and no longer follow patients to see the outcomes of decisions made. This means within the structured approach, time needs to be given to the teaching of how to assess a patient and how to work towards making a diagnosis.

My Context

In 2011 I conducted a Masters study into clinical reasoning (Lockwood, 2011). The thesis investigated the students' cognitive processes when reasoning through a case within which the patient may have had a diagnosis that potentially had a high morbidity or mortality. It used a retrospective think aloud protocol to explore the reasoning process. One outcome of the study was the development of a model for clinical reasoning that could be used to teach medical students. During the study I became aware that often, during history taking, students are not asking questions for the reasons an educator might expect. For example, the students asked certain questions because they were

routine, not because the students were reasoning during the encounter. This meant that when teaching students I could not assume they knew why they asked the questions they did and I wanted to explore the area in more depth.

This interest increased when I developed a course to help students use their knowledge of basic science in the clinical reasoning process. My role was to teach clinical reasoning face to face, as well as to develop a curriculum that helps students to learn how to reason clinically. As part of producing a high quality teaching experience, I needed an understanding of the type of educational approach that enhances the students' ability to learn clinical reasoning and the type of approach that may not be helpful.

One of the challenges I have found when teaching clinical reasoning is its complexity and the fact that, as discussed earlier, there are different cognitive processes involved. Due to this complexity, it can be easy to confuse the students or lose the message about what they should be learning during a teaching session. For example, a recent teaching session was delivered to the students which required them to gather data to inform their reasoning process. The aim was to help them acquire skills in gathering and converting the information given by the patient into data that can be used to help identify the problem. Part of the skill they needed to learn was identifying what data they should collect to help them identify the patient's diagnoses and decide upon management. However, the students' feedback stated that they had not received enough information in the case scenarios to be able to suggest possible diagnoses and decide upon the patient's management. The students had found the session confusing because they did not appreciate that the session was about learning how to decide what data they needed from patients to help them in identifying the clinical problem. This suggested to me that there must be a better way to teach clinical reasoning that engages the students, rather than frustrates them, and that helps them understand the process.

The need to improve teaching in clinical reasoning is further reflected in the difficulties some students seemed to have in developing expertise when on clinical attachments. This difficulty was often raised in many educator forums within my medical school, such as curriculum meetings and clinical tutor feedback. This problem may not be confined to our medical school. For example Mcgregor, Calum, Paton, Thomson, Calum, Chandratilake, and Scott (2012) found that once medical students had completed the ABCD[1] management of a patient they struggled to formulate a diagnosis.

[1] ABCD refers to the algorithm used in the initial management of the acutely ill patient and stands for Airway, Breathing, Circulation, and Disability

As a practitioner, I wanted to explore this issue and find a way of improving the teaching of clinical reasoning, so I could enhance my skills in face-to-face sessions. In terms of running my undergraduate course and my responsibility for contributing to the overall medical course design, I wanted to develop important principles in terms of teaching clinical reasoning. These could be used to inform the development of my course and could be taken to curriculum development committees.

To ensure that I did not lose what was successful, it was important that I assessed what was working and what was not before I made changes to the teaching of my sessions. As well as knowing what was already working, it would have been useful to know what has been tried in other places, what worked and what did not, and to explore ideas that students themselves might have had about what helps them to understand clinical reasoning. All this information could be pulled together to develop teaching sessions relevant to my context. The structure of the medical school's curriculum, along with the context of the school, needed to be considered because students cannot be expected to use knowledge that they do not have to inform their clinical reasoning process, and the clinical reasoning curriculum needed to integrate with the rest of the medical school curriculum.

Finally, in developing these sessions I wanted to close the loop by evaluating the effectiveness of any potential changes to teaching sessions.

This thesis describes an action research study that explored the teaching of clinical reasoning in our medical school, on my course and in teaching sessions that I had designed. The results of this exploration were used to develop a new teaching session that was evaluated after being delivered. From this study, general principles that can be used on a practical level when designing and delivering a clinical reasoning teaching session were developed along with principles for curriculum design.

Refining the Area of Exploration

I wanted to focus my study on the area of teaching that I was responsible for and to be clear which aspect of clinical reasoning was being explored. My course is aimed at year one to three medical students and teaching them clinical reasoning in terms of how to reach a diagnosis. Other aspects of clinical reasoning are covered in the clinical years of the curriculum. Earlier it is highlighted that clinical reasoning to reach a diagnosis involves many cognitive abilities and requires some form of evaluating the information gained from the patient. To help me keep my study focused on my area of practice I explored the teaching of the cognitive abilities that clinicians demonstrate whilst

evaluating information from a patient and deciding upon a diagnosis. The reasoning used when deciding upon the management of a patient's condition is covered elsewhere in the curriculum.

Research Aims

The overall aim of this research was to respond to the concerns, raised earlier in my introduction, about the teaching of clinical reasoning. This was done by exploring my own teaching practice and exploring the principles that are important in designing a curriculum aimed at teaching clinical reasoning.

To help me do this my project aimed to:

- Develop effective approaches for teaching clinical reasoning to year one to three medical students and evaluate them,
- Identify educational principles that would help students learn clinical reasoning and share them with curriculum developers.

The questions I identified to support this aim were:

- What enhances the students' ability to learn clinical reasoning?
- What makes it harder to learn clinical reasoning?

To help achieve these aims my project used an action research approach, which explored why there might be concerns and any underlying causes for them. It then went on to find solutions to the problems that were identified and implement them within my practice as a teacher and curriculum designer. Any changes made were then evaluated.

Through my action research, I aimed to contribute to the knowledge of:

- How the clinical reasoning models and the teaching models, described in the literature, can be applied in practice to the delivery of teaching sessions;
- The principles of designing a curriculum for clinical reasoning that are applicable to a university teaching medicine in the UK.

Structure of Thesis Report

Several authors indicate that an action research report differs from more traditional research in that it includes a story over time and self-reflection (Coghlan & Brannick, 2010d; McNiff & Whitehead,

2009). These authors along with Kalmbach Phillips and Carr (2010) suggest a structure for the report which allows the writer to achieve this whilst writing a thesis. All the suggestions recommend the same content and indicate that the story of learning during the project should be told in the report, but each structure is slightly different. For example McNiff and Whitehead (2010c) suggest these chapters:

- Background to the research- reasons for research, concerns, underlying values leading to research;
- Contexts- personal and research context;
- Methodology-research design;
- Your Project- tell the story of your research;
- Significance of results;
- Modification of practice.

Coghlan and Brannick (2010d) suggest the following structure but do not indicate that it should fall exactly into chapters:

- Purpose and rationale of the research;
- Context;
- Methodology and methods of enquiry;
- Story and outcomes;
- Discussing quality;
- Self-reflection and learning;
- Reflection on the story and the theory;
- Extrapolation to a broader context.

For my report I have chosen Coghlan and Brannick's recommendations because I found their format easier to map to the University of Liverpool's recommendations for structuring the doctoral thesis. In my methodology section I will discuss the type of action research used in more detail.

The next chapter looks at my methodology and justifies my choices. My story then starts in chapter three with my literature review which explores clinical reasoning. It follows my methodology because it was part of the story of finding a solution to my concerns and informing the development of potentially new teaching approaches. The remaining stages of my story are presented in chronological order to show how the story unfolded. The results are broken down into the different

stages of my study, to demonstrate how the project fitted into the action research cycle which is described in my methodology.

The final chapters will look at my own learning and the principles in designing a curriculum that can be used in a wider medical education field. Coghlan and Brannick (2010d) suggest discussing the quality of the work and claims to knowledge early in the paper, but I have chosen to do this at the end because it requires the pulling together of the various bits of data that I have collected and will present in the results and conclusions.

Chapter 2 Methodology

For my research I was interested in effective teaching approaches for clinical reasoning and wanted to know what works in practice. I wanted to choose the right methodology to achieve this. Considering my worldview, when doing this study, I found the pragmatist approach described by Creswell (2007) reflected it well. He describes pragmatism as the researcher being more interested in the outcome than the methodology. He also highlights that a pragmatic researcher sees truth as something that works at the time. Mackenzie and Knipe (2006) indicate something similar when they describe the pragmatist approach as a researcher who does not adopt a single philosophical approach and uses methods for data collection and analysis that best help to answer the research question. In terms of my study I looked for a method of data collection and analysis that helped me to identify ways to teach clinical reasoning in my context that would enhance the students' ability to learn it. The data analysis needed to give me information that is relevant to the medical course and my role as described in the introduction. I was interested in choosing the right lens, paradigm and methodology to find what is effective in teaching clinical reasoning skills. This is shown in my research project as a combination of methodologies for data collection and analysis.

Action research is an approach that fits with the pragmatic worldview in research. Several authors have highlighted that like the pragmatic view, action research concentrates on the outcome of applying theory to practice rather than just gaining knowledge for its own sake (Coghlan & Brannick, 2010a; McNiff & Whitehead, 2000). It also has the advantage of allowing the investigator to look at what works in practice and to adjust their problem solution to fit the context. There is a disadvantage of using action research and multiple approaches to data collection which is not touched upon by the authors quoted. It is the complexity of the approach and the challenges of analyzing data presented in varying formats. For example data can be collected from meetings, self-reflection and students' feedback. How this data was collected for my study is described later in this chapter. To help analyse the data I found that it was important to maintain a focus on what the aims of the study were. This helped to make sense of the complex information gathered and to reduce the risk of being taken down paths that, although interesting, might not enable me to develop my ability to teach clinical reasoning or to design a curriculum that enables it to be taught.

Several authors have suggested action research is an approach that can help practitioners to problem solve and improve their personal situation or skills, or to improve a social situation (Coghlan & Brannick, 2010a; McNiff & Whitehead, 2009). This made it a good form of research for my situation as it allowed me to explore the issue of improving clinical reasoning teaching on a personal

level and to find solutions whilst looking at the social situation in terms of curriculum design and delivery.

My study aimed to explore what the issues in teaching clinical reasoning were, before planning actions to address the issues. This can be compared to single loop learning, which describes the process of learning about problems and then making change to solve those problems (Argyris, 1976; Greenwood, 1998). Single loop learning does not check to see if the adaptations are successful or not, so Argyris (2002) suggested that another stage in the learning was required. His suggestion was to evaluate the effect of the changes and he used the term double loop learning to describe this. In terms of my study, this meant evaluating the effect of changes that I might have made as a result of exploring my concerns which triggered the study. Action research allows the investigator to use double loop learning when conducting research (Coghlan & Brannick, 2010a; Greenwood, 1998; Raelin & Coghlan, 2006). This made action research particularly useful for my project.

Other research approaches were considered for this study. One of the first approaches I considered was grounded theory which allows the researcher to develop new theories from the data collected (Bryant & Charmaz, 2007; Glaser & Strauss, 1967). This approach would have been useful in helping me to produce ideas as to how clinical reasoning can be taught and learned. However some texts argue that the researcher should not have any theories prior to the data collection (Bryant & Charmaz, 2007; Cohen, Manion, & Morrison, 2011a) so that new theories can be drawn from the data rather than from preconceived ideas. Although the idea of developing theories from the data without making assumptions is a good one, it is impractical for my context. I have done a lot of reading around clinical reasoning and have taught it for many years. This means I have some theories about what works and what does not.

I wanted to ensure that I understood the issues in terms of teaching clinical reasoning in my own context, and that I did not make assumptions about what these were without exploring other points of view. I also did not want to assume what the issues are before conducting the study or to develop solutions without knowing all the problems. So I took the principle of not making assumptions or not testing existing theories when designing my research tools, and doing my data analysis for the initial stages of my study. One way I used this principle was in using open questions that asked what the problems might be and what works. The data analysis was conducted using open coding so that new ideas could emerge from it. The analysis and data collection is discussed in more detail later in this chapter.

Although I did not want to make assumptions I recognized that my personal theories would influence how I collected and interpreted the data. For example, in the focus groups I might phrase questions in such a way as to get the answers I am looking for, or I might ignore data that does not agree with my own assumptions. To help reduce the chances of this happening I worked hard at using open questions in the focus group sessions and started to keep a diary recording my own beliefs and assumptions against the data collected. More is said about the importance of being aware of your impact on the study later in this chapter.

Interpretative phenomenology was considered as a methodology, as it enables the researcher to explore the experiences of a group of people and develop meanings from them (Smith, Flowers, & Larkin, 2009). It would be possible to explore the experiences of the medical students when learning clinical reasoning skills and the tutors when teaching it. The exploration could then develop meanings from their experience by identifying what principles in teaching the subject help students to learn it. It might even address why the principles work. However as a pragmatic researcher I was keen to know if the principles actually work in practice.

Interpretative phenomenological research will help the researcher understand a phenomenon from the perspective of the participants. While it was important to know about the students' experience of how clinical reasoning is taught, it was also important for my study to use the data to find possible solutions and evaluate any actions that might have been taken. Interpretative phenomenology is not designed for evaluation of actions and so was not suitable as the sole methodology for my study. However in view of the fact that, as I investigated how to improve the current teaching around clinical reasoning it was important to understand the experiences of the students, elements of the interpretative approach were used in data analysis.

Action research can be viewed as a generic term describing research that focuses on action and research at the same time (Coghlan & Brannick, 2010a). Within this term there are several paradigms that can be chosen, which are summarized by Coghlan and Brannick (2010c). They give an outline of each referenced to the original papers that they drew the information from. The strength of the summaries are reinforced by using references to more than one author who describes the paradigm indicating a body of agreement about the descriptions. They also indicate that the different paradigms are not mutually exclusive. In the following paragraphs, I will explore the paradigms described by Coghlan and Brannick along with other authors and how they relate to my study.

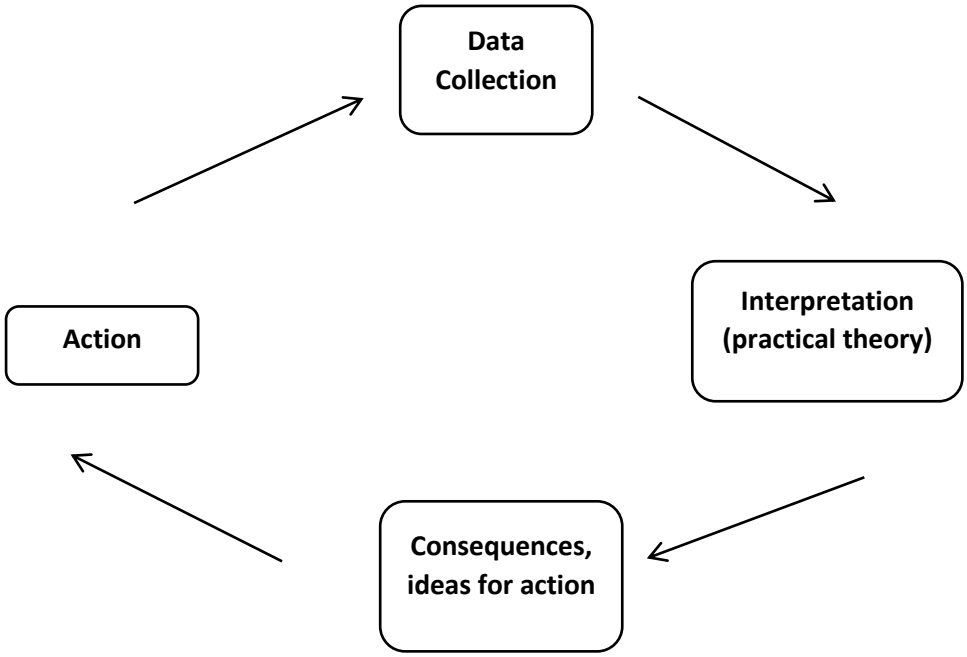
When considering the action research approach, I considered that I was learning about my practice whilst developing principles to be used at organisational level. Some authors describe action learning as being based on the principle of personal learning from actions taken (Coghlan & Brannick, 2010b; McNiff & Whitehead, 2010a). This can be related to my aim, which was to take action in improving my teaching of clinical reasoning and to learn from it. However this does not take into account the principles to be used at organisational level. As well as personal learning Kemmis (1980) described action research as a collaborative approach that can be used to develop social programs. This can be compared to the evaluative inquiry approach described by Coghlan & Brannick (2010c), which emphasizes organisational learning and is also a valid approach for my study. At the same time as personal and organisational learning it was intended that action should be taken to improve teaching, and the effects of the change evaluated. In this respect my study used action learning and evaluative inquiry, to investigate how I could improve clinical reasoning teaching and how it could be improved in the medical school's curriculum.

Action Research Cycle

Due to the nature of the double loop learning involved in action research, studies that use this approach consist of several stages in a cycle. In this section I will explore the different cycles described in the literature and justify the cycle I chose for this study.

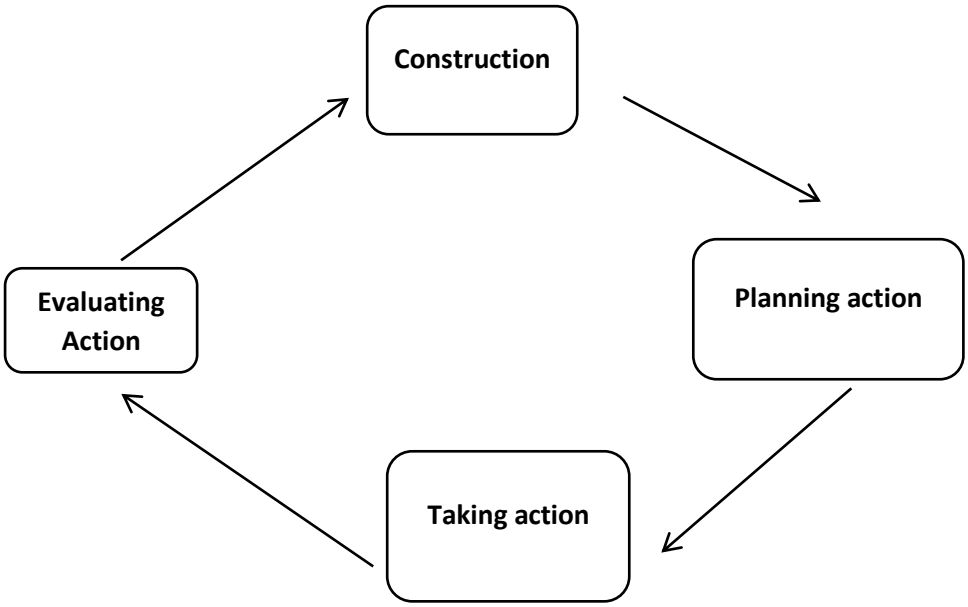
Altrichter, Feldman, Posch, and Somekh (2008) described an action cycle (Figure 1) that concentrates on reflection and action planning. The cycle captures the need for collecting data to inform learning about the situation under investigation, and it indicates that action should be taken to address any issues. I particularly liked the idea that the data should be interpreted before deciding on the consequences of that data. However the model is very generic and while it can be applied to many contexts I wanted to find a model that would give a clearer focus for my context.

Figure 1 Cycle of action and reflection (Altrichter et al., 2008, p8)



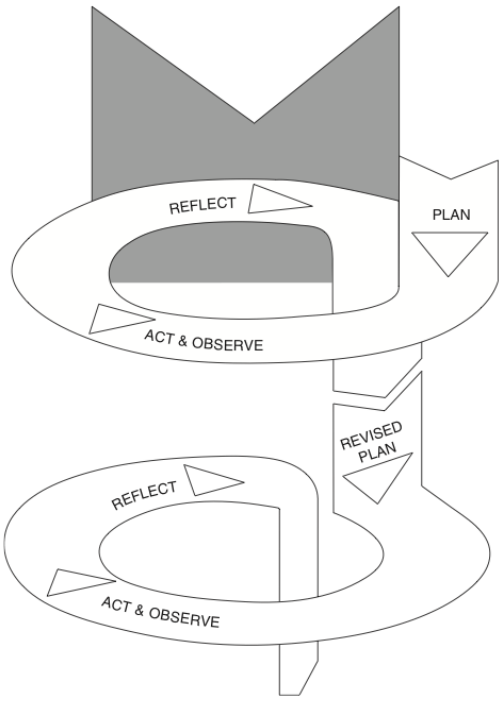
Coghlan and Brannick (2010a) described a cycle which was more focused on problems and evaluating their solutions. The stages in their cycle (Figure 2) can be compared to the cycle of action and reflection, with data being collected to evaluate action and the construction stage including an interpretation of the data. It does include concepts not captured in the action and reflection cycle, such as identifying issues and planning how change is to be brought about. These concepts are important for my study, as I need to identify the issues that impact on the teaching of clinical reasoning. The idea of planning action is a good one as it considers that ideas for action are not enough for change. Any action that is going to occur needs to be thought out and plans made as to how it might fit into the curriculum. The planning also includes planning the evaluation of the change, which is not covered in the reflection and action cycle. This cycle does include interpretation of the data as a particular step but for my study I needed to interpret the data I gathered to identify the issues in teaching clinical reasoning.

Figure 2 Coghlan and Brannick's action research cycle, (2010b, p8)



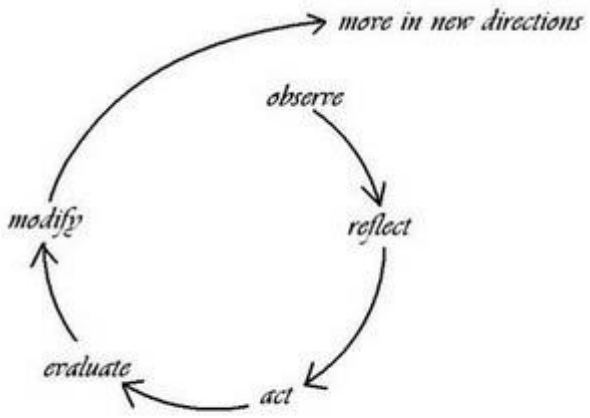
Kemmis and Mc Taggart (2007) consider action research as a spiral (Figure 3). Although it does not consider action research in terms of issues and does not specify evaluation in the same way that Coghlan and Brannick's (2010a) model does, the spiral underlines that the evaluation of your actions may lead to further changes in your plan. In my working practice this type of approach is useful as it sets a framework for reevaluating change and making necessary adjustments to the change until the required outcomes are achieved. However, it is difficult to know when the spiral will end, so I have not used this approach for my thesis as it needed a finite end. Having said that the principle of the spiral is important and this was included in my study as recommendations, developed from the evaluation of any changes to my practice that might occur because of my study.

Figure 3 Action research cycle (Kemmis and McTaggart, 2007, p278)



McNiff and Whitehead's (2006) action-reflection research cycle (Figure 4) also considers the spiral in action research. They have stages comparable to Kemmis and McTaggart (2007) but with some important differences. Kemmis and McTaggart's action research model includes planning in its cycle, which I indicated earlier is an important concept in terms of action research with a view to changing practice or policies.

Figure 4 Action-reflection cycle based on McNiff and Whitehead's (2006, p8-9) action research model.



On reviewing these cycles I used Coghlan and Brannick's (2010a) approach for my study as it included planning and evaluation as specific elements of the cycle and it allowed my project to be finite. Although they do not include it specifically in their diagram Coghlan and Brannick state in their book that the action research cycle can involve going through all the stages as frequently as needed until the change works. In my study I planned to do a full cycle plus identifying any further issues after evaluating the change.

Insider Research

I approached the study as one of the medical educators in a U.K university, with experience in using clinical reasoning in my clinical practice, an interest in how it is learned and an interest in how students think. One of the issues created by my context, in relation to this study, is that I was conducting insider research. Mercer (2007) suggests that insider research can influence how meaning is constructed from the data and I think it is important to consider how your context influences your interpretation of the data. It is difficult sometimes to remain neutral when dealing with issues that affect you directly. I needed to be aware that I might be biased in favouring data that resonates with my own experiences as an educator, student and clinician.

The need to be aware of your own biases, beliefs and assumptions are raised in the literature which recommends that an insider should have reflexivity in their research (Greene, 2014). Finlay (2002) describes reflexivity as: "where researchers engage in explicit self-aware meta-analysis" (pp209). Her article goes on to describe how the concept of reflexivity has developed over the years. It indicates that reflexivity can be thought of as critical reflection on the research process. In some cases this could be considering what the researcher's assumptions and beliefs are and how they impact upon the interpretation of the study data, whilst in other cases it could be considering the power relationship between the researcher and the participants. She concludes that reflexivity can be understood in many ways and how they are understood can be influenced by the aims of the task. This is reinforced by Shaw (2016) who also saw reflexivity as self-awareness and discusses several different interpretations of reflexivity in research. To help me have self-awareness and critical reflection I used a diary. More is said about the diary later in this section.

Earlier I highlighted that Findlay's (2002) paper indicates when using reflexive practice in research, some approaches suggest the power relationship between the researcher and participants should be explored. This is particularly relevant to my context as an insider who planned to hold focus groups with students and explore their perceptions. As a teacher in the medical school I am involved in assessing the students and the power relationship is unbalanced. This may have influenced the

information students gave me to inform my study. For example they may have withheld information that would put them in a bad light. Another risk was that I may have been influenced in how I mark students in their assessments after the study by comments they may have made. In the section on ethics and the section on data gathering I describe steps taken to manage this power imbalance.

As I was an insider researcher in the sense of being a teacher within the organization that the research is being conducted in, I explored the continuum described by Herr and Anderson (2005) to help refine my position as an insider researcher. I chose their categorisation because it used principles from other authors and summarized them nicely in a table (Figure 5) making it easy to understand and follow.

For this research study my positionality was that I conducted insider research, studying my own practice when looking at my teaching and approach to curriculum design and considering if it could be improved. According to the table in Herr and Anderson's (2005) article, which shows how different points on the continuum affect the outcomes of the research, this will improve my existing knowledge base and produce professional transformation. On the other hand when considering general principles in curriculum design I acted as an insider collaborating with other insiders with the aim to produce organisational transformation. As I reflected on this further I realized that when looking at teaching sessions around clinical reasoning, if I gain the opinions of others as to how clinical reasoning can be taught successfully it could be argued that I am collaborating with other insiders in this area as well. This is probably why the authors describe positionality as a continuum rather than discrete stages. During my investigations of the teaching sessions I would be acting as the 'lone insider' when looking at my own practice and then would move into the 'insider in collaboration' role when I am sharing my ideas and seeking opinions from my teaching colleagues about the clinical reasoning curriculum so I would not be neatly working at one level alone.

Figure 5 the Continuum of Positionality (Herr and Anderson, 2005, p30)

Positionality	*Validity Criteria*	*Contributes to*	*Traditions*
1 Insider (the researcher studies and changes his or her own practice)	Anderson(1999), Bullough & Pinnegar (2001), Connelly & Clandinin (1990)	Knowledge base, Improved/critiqued practice, Self/ professional transformation	Practitioner research, Autobiography, Narrative research, Self-study
2 Insider in collaboration with other insiders	Heron (1996), Saavedra (1996)	Knowledge base, Improved/critiqued practice, Professional/ organizational transformation	Feminist consciousness raising groups, Inquiry/Study groups, Teams
3 Insider(s) in collaboration with outsider(s)	Anderson (1999), Heron (1996), Saavedra (1996)	Knowledge base, Improved/critiqued practice, Professional/ organizational transformation	Inquiry/Study groups
4 Mutual collaboration (teams of insiders-outsiders)	Anderson (1999), Bartunek & Louis (1996)	Knowledge base, Improved/critiqued practice, Professional/ organizational transformation	Collaborative forms of participatory action research that achieve equitable power relations
5 Outsider(s) in collaboration with insider(s)	Anderson (1999), Bradbury & Reason (2001), Heron (1996)	Knowledge base, Improved/critiqued practice, Organizational development/ transformation	Mainstream change agency: consultancies, industrial democracy, organizational learning; Radical change: community empowerment (Paulo Freire)
6 Outsider(s) studying insider(s).	Campbell & Stanley (1963), Lincoln & Guba (1985)	Knowledge base	University-based, academic research on action research methods or action

There are strengths to doing research as an insider. For example, some authors have argued that being an insider can provide an understanding of the meanings and worldviews of the participants that an outsider cannot provide (Unluer; 2012, Hodkinson, 2005). In my university role I have an understanding of how the curriculum works and a realistic idea of what can be done when, in the timetable. This along with my relationships with other lecturers will make problem solution, which is one of the aims of this study, easier. I could approach lecturers who are delivering teaching on my course and ask them to incorporate changes and feedback into their teaching sessions if needed. I could also draw on my own experience of learning about clinical reasoning and using it in practice to gain insight into what the data gathered for the study meant. For example, if a student during a focus group comments that a certain teaching session is useful or not, I would probably have some idea how that session runs and what can and cannot be done to change it.

There will be a tension between experience enriching the data and not causing bias. This needs to be considered in data collection and when looking at how to analyse the data. One method suggested by Van Heugten (2004) to overcome this and to utilize the advantage of being an insider is to use conscious writing and self-interviews. This allows your values and beliefs to be recognized and taken account of. In terms of action research it also fits well into one of the forms of data collection, which is a reflective diary (Coghlan & Brannick, 2010b; Herr & Anderson, 2005). As part of the methodology I kept a diary to keep track of my data collection, my personal thoughts about the data and any assumptions made. This also allowed for reflexivity in my research, as it could help me gain insight into when my ideas seemed to conflict with my interpretations and could help to identify new ideas which came from the data.

Even in the stages when I would be acting as a 'lone researcher' I would still need to gain participation and feedback from other stakeholders within the medical school and I would be addressing a need for change perceived by others within the setting. For me, this would mean participation and feedback from other tutors and students. This led me to consider that I needed to gain data and ideas from colleagues and students about how clinical reasoning can be taught. I can understand why others in the setting should perceive a need for change: if they did not it would bring into question the validity of doing the research and whether change is needed. In my own context I am trying to address a problem that has been raised by other clinical lecturers in multiple meetings which reinforces the value of doing this research.

One other challenge to an insider researcher is whether their results can be extrapolated outside their context. I felt that whether results can be extrapolated or not partly depends on what they are.

For example, if the issues I identify are linked to certain tutors they cannot be extrapolated. In contrast identifying that a certain type of teaching approach seems to help the students learn clinical reasoning could feasibly be applied in a different context. For this reason I have discussed extrapolation in the last chapter when I also discuss the validity of the study.

There was also a risk that I might find myself in a position of a conflict of interest whilst conducting my study. For example I might have been asked to deliver a certain type of teaching around clinical reasoning in a certain way, which would make it difficult to deliver my own teaching session needed for the study. One way I reduced this risk was to share information about my studies openly and be straightforward about any conflicts that occurred and discuss them with my colleagues and seniors. My previous experience had suggested that in my current context this usually leads to a resolution of the problem which suits everyone. As it was I found that by being open with what I was doing and sharing information I gained support from colleagues in conducting the study.

In the last chapter of my thesis I discuss whether the steps taken to resolve insider research dilemmas worked in practice and unexpected insider research issues that I came across.

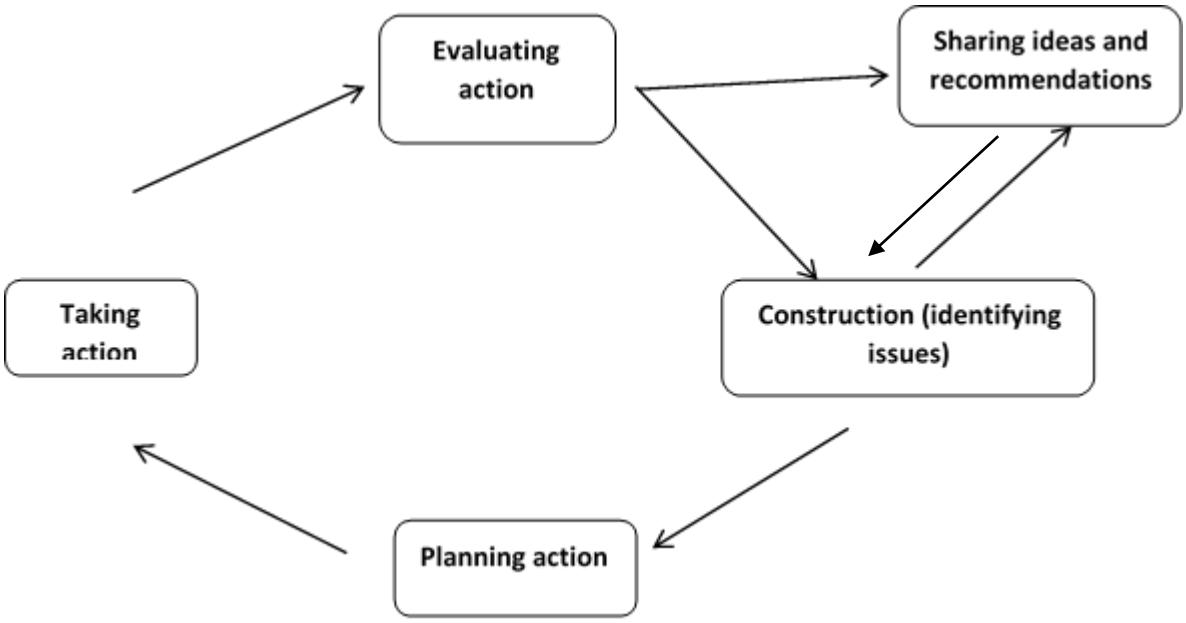
Stages in the Study

Coghlan and Brannick (2010a) describe each stage of their action research as:

- Constructing- identifying issues around the area under study
- Planning action- planning changes that are needed and how to evaluate them
- Taking action- implementing the changes
- Evaluating action-assessing the outcome of the changes
- Construction 2- identifying further issues

An additional stage was added to the cycle to allow me to create a focus on organisational learning. This stage was the sharing, with other educators, the general principles in teaching clinical reasoning that I had developed. These principles could be developed from a combination of identifying the issues and the evaluation of any changes. The cycle is shown in figure 6.

Figure 6 Action research cycle used in my project



Data Collection

The type of data collected varied according to where I was in the cycle of my study. This was to allow me to collect the right data that would answer the questions being asked during the stages of the study. For example when identifying the issues around teaching clinical reasoning and potential solutions in the construction stage I used data from student feedback, gathered as part of the routine quality assurance work over the previous year, together with the literature about the problems and successes that occur in learning clinical reasoning. The feedback is requested from students after each teaching block. The feedback for the blocks I was responsible for was reviewed for comments specific to the teaching sessions on clinical reasoning, but for the evaluation stage I used student questionnaires to identify what worked well in a newly designed teaching session from the students' perspective. The next section of this chapter will explore the data collected in each stage of the study cycle.

Self-reflection

Throughout the study I kept a reflective log and I answered the focus group questions myself before conducting the meetings to identify my own beliefs.

Data for the construction stage

The construction stage of my study was aimed at what works in teaching clinical reasoning to first, second and third year students, at further understanding the issues and problems that reduce the ability of the students to learn it and at finding possible solutions to the problems. The data needed to explore the student perspective as well as the tutors' perspective.

The data for this stage was collected:

- From the students and the tutors using separate focus groups for each,
- From my literature search,
- From my reflections on curriculum design meetings, student feedback and reports.

The focus groups were used to identify issues around learning and teaching clinical reasoning within my local context, whilst the literature search provided more generic information about how clinical reasoning can be taught, problems that are encountered in teaching it and potential solutions for those problems. Focus groups allow the researcher to use interactions between participants to increase understanding of a topic (Kitzinger, 1994).The interactions may also produce data that would not come out from individual interviews alone (Liamputtong, 2011). When considering this study I thought that the focus groups might be useful because one participant might prompt another to consider a teaching session or problem that they did not initially think about. There is less scope for this to happen in interviews or questionnaires. One of the drawbacks with using the focus groups that I considered is the risk that one individual within the group might influence the discussion and prevent all opinions being heard. To prevent this I needed to actively chair the focus group discussion and ensure everyone had a chance to offer their opinion.

Earlier I raised the issue of power imbalance between the students and me. This was particularly important in the focus groups because the students may have been concerned about how I would react to information that they shared. They may also have been worried that what they said might influence their future progression within the medical school. During data gathering, to help resolve these issues, I made it clear that any information shared would be anonymous, the names of those taking part would be kept confidential within the group. The participation information sheet (appendix 2) included this information and indicated that action would not be taken because of comments made in the focus group discussions. During the focus group discussions I planned to make it clear that it was the students' opinions I wanted to hear by clearly stating it to them.

I took notes regarding any discussion around the learning and teaching of clinical reasoning at curriculum design and feedback meetings. The feedback meetings were held between members of staff and the student representatives, either in response to concerns raised by them or as part of the end of year review. Reports, with comments regarding the teaching of clinical reasoning skills, were reviewed and my reflections recorded on paper. My reflections and notes on curriculum design meetings, student feedback and reports were used along with the results of the focus group meeting to clarify issues and to help identify potential solutions that would work within the medical school's curriculum.

Recruitment

I chose year one to three students, as this is the group of students the course I run is aimed at. Any new teaching session will be delivered to them and their views are important in helping to develop it. It was also important to get the views from each year group as I felt that their views might be affected by their experience and the stage of the course that they are at. So I aimed to run a focus group for each year. I purposively chose tutors who were actively engaged in teaching these skills, as experience in teaching them is needed to provide insight from the tutor's perspective.

McLafferty (2004) emphasises that the number of focus groups needed for a study varies and that usually several focus groups should be conducted. She also suggests that for some studies one might be enough. In this study the results of the focus groups are being used with other data so I aimed to hold one student focus group for each year and one for the tutors. By holding a focus group for each year I hoped to investigate whether their views altered according to the stage they were at in their undergraduate career. Because I might not have been able to arrange a time that six to eight of the participants could meet I aimed to hold more focus groups if needed, to ensure I could get the views of at least six tutors and students from each year.

I aimed to have six to eight participants in the focus groups. There is debate about the ideal number for a group, but I planned to have enough people to generate the concepts whilst not making it too unwieldy to manage (McLafferty, 2004). In this study the focus groups were being used to explore the participants' experience of clinical reasoning and develop ideas for improvement, so I considered a group size in terms of being able to manage the discussion and to have enough people to generate discussion.

All first, second and third year medical students were invited to take part in the study. Students not actively engaged on the course for ill health or disciplinary reasons were excluded from the

recruitment process. The medical school office did not send the invitation to take part to these students.

Tutors involved in teaching clinical reasoning skills to first year to third year medical students were contacted via the staff email system and invited to take part. Tutors who did not teach first to third year students were excluded.

The participants involved in both the tutor and student focus groups were sent a participant information sheet and consent form with the email (appendix 1 and 2). They were asked to sign the consent form before the focus group discussion commenced.

The student response rate to the emails was poor, despite multiple emails being sent and different times being offered to try and increase the response rate. As an alternative approach participants were asked to invite their colleagues to contact the researcher and to take part but this did not increase the response rate. It was decided to hold one focus group meeting for the students as their insights would provide valuable data. My study used data from many sources and cross - referenced the results, which meant the reduced number of students was less of a problem. This and the possible effects of the small numbers is discussed in more depth in the last chapter.

Focus group data collection

Each focus group discussion was audio taped, with the participants' permission, using an electronic device. Within 24 hours of the focus group the audio file was downloaded to a password protected computer and the file on the audio device deleted to free up space for further recordings. The audio data was transcribed for analysis. The focus group data was kept anonymous and each focus group member's transcription was assigned a number. These numbers were used in data analysis to help the researcher ensure that opinions from a wide range of participants were used and to help identify how many different individuals commented on any themes. Their numbers were not linked to any identifying details of the participants to preserve their anonymity.

The focus groups collected the opinions of the students and tutors as to what teaching methods and aspects of the curriculum help learners to develop clinical reasoning competencies. The focus group questions are in appendix 3.

Conclusions and recommendations for the actions to be taken were sent to those who took part in the focus groups and meetings for comment and feedback. The conclusions and recommendations were used in the development of the teaching sessions and will be used in future curriculum design.

Planning and taking action

The data from the construction stage of the study was used to inform the planning stage of the action research model being used. During this stage, the data from the construction stage was used to develop new approaches for the teaching of clinical reasoning and to plan changes to an existing teaching session. As well as changing the teaching session, the results from the planning stage were used to help develop general principles in designing a curriculum for teaching clinical reasoning and to develop notes and instructions for the tutors teaching the redesigned session. The action taken was the delivery of the new teaching session.

Data collection to evaluate the action

The aim of the data collection in this stage was to investigate whether the change to the teaching session had an impact on student learning. Kirkpatrick (1994) developed four levels of evaluation to be used when assessing a teaching intervention. They are:

- Level 1, reaction of student - what they thought and felt about the training
- Level 2, learning - the resulting increase in knowledge or capability
- Level 3, behaviour – improved capability and application to practice
- Level 4, results - the effects on the learner's performance in the work place.

Ideally I would like to know if the new teaching session effects the students' performance in the long term. However, it is difficult to assess the impact of one teaching session on first to third year students' performance in the clinical work environment due to the time span between the one teaching session and when they are working. It cannot be assumed that any improvements to reasoning over this time is attributable to one teaching session. I considered trying to evaluate the teaching session at level two and three, but realised that logistically it would be difficult to arrange a formal assessment of a students' ability to apply what they had learned to practice for the whole year after the one teaching session. There was the possibility of using the Objective Structured Clinical Exams (OSCEs) to do this but the delay between the new sessions and the OSCE would create the same problem that assessing level four has.

It would be possible to assess at level two perhaps using a think aloud approach as described by Van Someren, Barnard, and Sandberg (1994). This approach consists of study participants either talking out load as they do problem solving task or explaining their thinking as a video of them completing the task is played back. My concern was the risk of small numbers volunteering to take part in this evaluation. I wanted to get insight into the impact of the session from as many students as possible.

My concern was reinforced after the recruitment for the focus groups. I also recognised that if the stage one evaluation suggested the session helped students learn clinical reasoning, it might be possible to roll out more. As more sessions roll out the more able I would be to attribute changes in clinical reasoning assessment results to the new teaching.

Kirkpatrick (1994) suggests that questionnaires can be a method of stage one evaluations and the medical school has a quality assurance system which uses questionnaires to seek feedback for new teaching. I thought that using this system would increase my chances of getting evaluations from many students including views from less enthusiastic students who might not be interested enough to take part in an interview or focus group discussion. These students might give a valuable insight into aspects of the session which contributes to their lack of enthusiasm.

A concern with using questionnaires is that while students might indicate what they thought they had learned, they may not apply it in practice. This is something that needed to be considered in analyzing the data. The other disadvantage is that the immediate questionnaire will not demonstrate if the students will retain their learning as Patten (2016) points out questionnaires only provide a snapshot in time. This is something that might need to be revisited if the sessions were rolled out. One way to do this maybe to combine an assessment of the students' clinical reasoning skills with a study exploring their perceptions as to where they learned the skills when they are in year five or in work.

Patten (2016) highlights that there is a possibility that there is a risk that study participants may give socially desirable responses in a questionnaire. However, I would argue the risk of this is the same in a focus groups situation. Student interviews may allow the researcher to ask questions in such a way as to avoid this but I still had the possibility of a small number of participants to consider. The data from the questionnaires would be compared with other sources of data such as the tutor focus group results and literature. If the data from the questionnaires was at variance with other sources then I should consider the possibility that the answers may not be valid. My experience has also suggested that students tend to raise more issues when answering with anonymous questionnaires than when they are discussing things face to face. However it is difficult to clarify and expand on answers in questionnaires.

One advantage the questionnaires have when evaluating teaching interventions is the possibility to phrase the questions to ask what aspects of the sessions helped the students to learn and which did not help. This is valuable information when considering how to improve the teaching around clinical reasoning.

Questionnaires were handed out after the new teaching sessions as part of the standard medical school quality assurance process, which is used to audit new teaching approaches. These questionnaires are usually handed out after new teaching sessions for the students, and sometimes the tutors, to fill in. The students then leave the questionnaires either in the teaching room or department reception to be collected later by the teaching staff. The questions vary according to what is being evaluated and for this study the questions which related to the direct coding categories (discussed in the next section) where chosen. For this study, the questionnaires were handed to students who had attended teaching sessions using any new approaches to learning clinical reasoning. A copy of the questionnaire is in appendix 4.

The same questionnaire was to be handed to the tutors for their evaluations. However, this did not happen the reasons for this are discussed in the results section.

Data Analysis

For the first stage of my study, I was using the data to develop a deeper understanding of how to teach clinical reasoning skills and to identify ideas I might not have come across before. So I used an inductive approach to data analysis by developing the themes from the content of the data. The first data set came from reviewing my reflective paper notes from meetings to identify common themes across the meetings and reviewing the student feedback. I had also written paper memos to record my own reflections as to what some of the emerging themes meant in relation to my study.

Interpretative phenomenology is an approach which allows the researcher to explore the participants' experiences and draw meaning from them (Creswell, 2007; Larkin, Watts, & Clifton, 2006; Smith et al., 2009) . One of the aims of this study was the exploration of the issues around the teaching of clinical reasoning. Insight into students' experience of clinical reasoning teaching and the tutors' experience in teaching it would help me to see problems and successes from their perspective. When I set up the study I felt that as it progressed, understanding their perspective would enhance my ability to suggest any changes that might be needed. So I wanted to use a form of data analysis that allowed me to use an interpretative phenomenological approach to the focus group data. Smith et al. (2009) have stated that there are many methods to using this approach, and that it is the focus of the analysis on the participant's experience which is important. They recognize that despite the different possible approaches to doing this it is useful to have a process that researchers new to interpretative phenomenology can use. They present these suggested series of steps in doing the analysis:

- Reading and rereading the transcripts to become familiar with the data;
- Initial noting of language, descriptors or conceptual ideas within the transcripts. The things to be noted depends on the study and its aims;
- Developing emergent themes from your notes and interpretations;
- Searching for connections across emergent themes;
- Moving to the next case. This can be interviews but for my study would be the next focus group;
- Looking for patterns across cases.

Pope, Ziebland and Mays (2000) describe a different framework approach with only five steps as below:

1: Familiarisation

Read the data until you are familiar with it.

2: Identifying a thematic framework

This involves finding the key issues, concepts, and themes for examining the data and breaking it into manageable chunks for exploration.

3: Indexing

The thematic framework is applied to the data by annotating the transcripts.

4: Charting

The data are rearranged to match up to the part of the thematic framework that they relate.

5: Mapping and interpretation

The chart is used to develop theories and concepts. Relationships between different parts of the data are explored during this process.

Smith et al.'s (2009) last two suggested steps are different to the approach described by Pope, Ziebland and Mays (2000). This is mainly due to the fact that the last part of the analysis consists of analyzing new interviews and looking for patterns. The framework approach uses charting to help

the researcher identify patterns within the data giving a clear way to structure the data and capture patterns.

Using the steps in either of the framework approaches helps keep the analysis structured so I used a framework in the data analysis while focusing on the experience of the participants. This approach allowed me to develop themes from the content of the data and interpret what the students and tutors said. It gave me clear steps to follow in data analysis and provided clear guidance on how to structure the data in a way that made it easier to analyze. Each of the authors describes the steps in a slightly different way (described below) but the outcomes were essentially the same with the method of sorting through the data differing slightly.

The framework that suggested the development of codes, which then are grouped together to produce categories, gave me a clear method to develop a thematic framework from the detail provided in the focus group data. In my results I described the categories as themes to make the link more clearly to a thematic framework.

My analysis occurred in the following steps:

- Transcription of the data;
- Familarisation with the data as I transcribed and reread the data;
- Development of codes from the lines of the text;
- Codes were grouped into themes to develop the thematic framework;
- A spreadsheet that charted the thematic framework with quotes and codes was developed;
- Patterns in codes identified to develop themes, concepts and associations;
- Checking the themes and concepts by asking participants to confirm their agreement with them.

This approach combined applying the thematical framework and charting stages because my data set was relatively small and I found it easier to cut and paste quotes into the right part of the chart, rather than annotate the pages and then transfer the data. The final stage was added to help support my claim to knowledge, which is discussed in a later chapter. Codes were identified using open coding which allows for the exploration of events to develop a theory, rather than using an approach to coding that tests a theory (Cohen, Manion, & Morrison, 2011b).

The evaluation questionnaire data had a different aim to the focus group. It was needed to confirm if changes had worked and to identify what improvements, if any, were needed. For this reason it was

analysed differently using a deductive approach and content analysis with directed coding (Cohen et al., 2011b; Hsieh & Sarah, 2005).

The codes were:

- What the students had learned;
- What they and the tutors found made the session work;
- What they and the tutors found that did not make it work;
- Suggested improvements.

The final stage in data analysis was identifying themes that resonated with my own reflections and those that caused dissonance, or that I had not considered before the study. I critiqued my themes and excluded those not mentioned by other study participants unless I could defend them through the literature.

Ethical Issues

I gained ethical approval from my university's ethics committee to conduct the research as it involved the university's students and staff (appendix 5). Ethical approval was also gained from the University of Liverpool's ethics committee. Liverpool's approval is in appendix 6. I received permission from the teaching dean to conduct the research and to use my reflections on curriculum meetings and student feedback.

I am one of the tutors for the year one to three medical students and deliver teaching to them throughout the course. This means there was a risk that students might have felt pressurized to take part in the focus groups. To reduce this risk the email requesting their participation was forwarded from the medical school office as a request from me, in the same way other requests for research are made. This made the contact less personalized. It was made clear that participation was voluntary. Because of the concerns about balance of power between the students and me, discussed earlier, it was also made clear that I would not be acting as an examiner for years one to three in the academic year the study was being carried out. As the facilitator of the student focus group I aimed to keep the group discussing what they felt helped them to learn clinical reasoning and what acted as a barrier. The research protocol included a section indicating that action would not be instigated because of comments about personal weaknesses of the participants, during the focus group discussion. The participants were asked to keep the focus group discussions confidential.

I am also an OSCE examiner. This means I examine as one of 13 examiners on a circuit and the exam results are based on the judgment of 13 examiners. This dilutes the influence of one person. To

further reduce the risk of an adverse effect of being an examiner for the students I did not examine in the academic years of those taking part in the focus group and the students were informed of this in the participant information leaflet.

To further ensure that students were not adversely affected by any comments they made in the study the data was anonymized as far as possible during the transcription process. This was done by assigning a number to each participant prior to transcription and using the number in the transcription process. None of the participants' details were linked to the numbers. A record of who was assigned which number was not kept so the only identifying factor would be recognizing the voices of those on the tape. Because I am in insider researcher I would recognise the students and they would know this. This might influence their contribution to the discussion and altered the data I got. For example they might give responses which they think I want to hear or may assume I only want to hear about teaching sessions which I deliver. To help overcome this I should make it clear I would like to discuss all of the curriculum. The number of participants in each focus group was small which may have affected their contribution to the discussion. More is said about the size of the student focus group in the chapter on validation. The questionnaires which were distributed to the whole year after the teaching sessions were anonymous as well.

To help protect the tutors' and students' identities any audio files were transferred to a password protected computer and transcribed as soon as possible as people could be identified from their voices. Once the audio files had been copied on to the computer the files on the recording device were deleted.

Chapter 3 Literature Review Informing Construction

To help me review the issues around teaching clinical reasoning and the potential solutions, I structured my literature review to explore:

- The models of clinical reasoning to help identify what cognitive processes we are trying to teach;
- Educational principles and concepts that would be important when helping people to develop expertise in clinical reasoning;
- Models of teaching specifically designed for clinical reasoning.

Articles that described clinical reasoning models, educational principles and teaching models related to teaching clinical reasoning skills and how students learn the skill were included in my literature review. Because my course is designed to concentrate on the diagnostic aspect of clinical reasoning, studies that did not explore this aspect were excluded in the early stages of the review. In the later stages of the review articles that not specifically relating to diagnostic reasoning, but explained educational theories referred to by papers in the first stage were included. More is said about this later in this chapter. Other exclusion criteria were articles that did not have an English translation, were unpublished studies, abstracts, dissertations, theses, or studies published in non-peer reviewed journals. The exception to this was Elstein et al.'s (1978) book. This was included because it is frequently referenced in published papers when the hypothetical deductive approach to clinical reasoning referred to later in this chapter is discussed.

Pubmed and Medline were searched using the search terms "clinical reasoning" and "diagnostic reasoning" the modifiers were: "education", "medical students" and "models". Google Scholar was searched for appropriate references and further appropriate references from articles included in this study were included. An initial search was done from January 1970 to September 2015 to inform the construction stage of the action research. A further search was conducted in April 2017 to bring the literature review up to date with current theory. From January 1970 to April 2017, 1573 citations from Pubmed and 1439 from a search combining CINAHL, ERIC, British Education and Medline were identified. A further 21 citations were collected from Google Scholar and references in articles. After reviewing the abstracts and removing any duplications between the searches 433 papers were identified as meeting the inclusion criteria.

The papers were then read in more depth. Those describing original studies or critiquing studies in literature reviews or critiquing concepts discussed in several other papers were used. These

remaining papers were divided into those describing models of clinical reasoning and those related to how it is taught. Papers which related to the educational aspects but were not practical to apply to my context were not used in the review because its aim was to identify issues and solutions relevant to my teaching and curriculum.

Clinical Reasoning Processes

It is difficult to teach competence in something if you do not know what you want your learner to learn. In terms of clinical reasoning this would relate to knowing what cognitive processes are involved in clinical reasoning. This section looks at the models of the cognitive processes. They are described in the order in which they were developed, to display an evolving understanding of the clinical reasoning process over the years.

Bayesian reasoning

One of the earliest theories of clinical reasoning is the Bayesian approach (Lincoln & Parker, 1967), described in the introduction. The clinician estimates the probability of certain diagnoses being correct given certain observed data from each part of the patient's history and examination.

This approach depends on the clinician correctly estimating the prior probabilities of each symptom and/or sign, and accurately estimating how they influence the chances of the hypothesis being correct. Using this theory, if new data has a low probability of occurring with a current hypothesis, clinicians would look for a new hypothesis. However, a study conducted in England found that rather than knowing the probabilities accurately, the knowledge of pre-test probability of disease varied widely in experienced physicians and general practitioners (Heller, Sanders, Patterson & McAlduff, 2004). The experience of the practitioners did not correlate with their knowledge of the probabilities, which brings into question whether it is a process that clinicians use. Heller et al.'s (2004) study was questionnaire based with a response rate of 56% out of 535 clinicians, so it is possible this is not a valid finding and the results would be different if everyone responded. However, it fits with my own experience, which suggests clinicians have varying views about probabilities of certain diagnoses in a significant number of patients.

Algorithmic reasoning

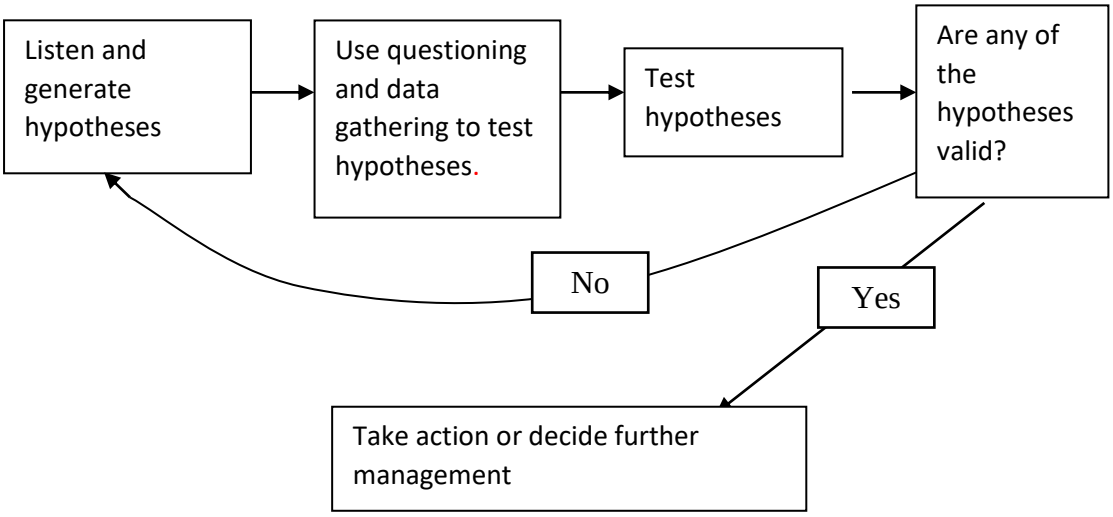
Feinstein (1974) discussed how the numerous interpretative decisions made whilst reasoning could be converted to a series of flow diagrams. When a patient is asked a question, if they answer "yes" to certain things the clinician is taken to a point in the chart which indicates another question to be

asked. If they answer “no” the flow goes elsewhere. As Feinstein pointed out this approach is very simplistic: later studies suggest that it does not fully reflect the cognitive processes in clinical reasoning. The clinician has many different sets of data to consider which probably do not have clear linear links like those in a flow diagram.

Hypothetical deductive reasoning

Elstein et al. (1978) described the hypothetical-deductive approach to clinical reasoning as a result of their research which investigated the processes used by 24 hospital physicians considering possible diagnoses for patient scenarios. Physicians in three American hospitals were asked to rate their colleagues in terms of diagnostic skills and those with the highest scores were asked to take part in the study. The authors found the physicians generated hypotheses early in the patient history and then gathered data to confirm or refute the hypothesis. If they found the data gathered did not confirm the hypothesis they would generate more to be tested. If the data confirmed the hypothesis as a possibility, further management was decided (Figure 7).

Figure 7 Hypothetical Deductive Reasoning: diagrammatic representation of Elstein et al.’s (1978) model



One drawback with this study is that it could be argued that asking colleagues to rate who is good at clinical reasoning is a subjective measure. The judgement of colleagues may be influenced by factors other than clinical reasoning itself. This selection process also means that there was not an exploration to see how clinicians perceived as less expert think.

Another drawback to this model is that it has been developed from observing hospital clinicians. However, it is possible that another approach used by doctors working in a more generalist context

where the range of diagnostic possibilities is bigger (for example community doctor) might use different cognitive processes. Having said that the finding fits my experience working as a clinician in the community. I am aware that when I consider possible diagnoses I test them in the same way I would test hypotheses.

Despite these drawbacks the study is valid in that it has used clinicians working a simulation that triggered the clinical reasoning process. The main problem is that it may not tell the full story. This is supported by models, referred to later in this literature review, which suggest more than one type of cognitive process is used in clinical reasoning.

Illness scripts and schema

Schema-based reasoning, which was described by Turner (1989), is a similar concept to algorithms and is made up of several parts. Firstly, the clinician uses the aims and features of a consultation to identify the appropriate schema appropriate for it. The schema goes on to give information for its area of use such as what the clinician should be expected to ask and how they should react. It then goes into a series of steps for the clinician to follow. The clinician may follow all the steps, miss out some of them or branch off into another schema. This considers the complexities of clinical reasoning and the fact that not all information for an algorithmic flow chart will always be available.

The Illness script model has many features like algorithms and schema. It is based on a theoretical framework developed using several psychological theories around the structure and functioning of memory (Charlin, Boshuizen, Custers, & Feltovich, 2007) . This framework describes what the human brain does when exposed to repeated experiences. 'Scripts' arise from these repeated experiences, which produce a specific organisation of information. Scripts are described as packages of knowledge that apply to certain situations (Gardner, 1987). When a script is activated it is loaded into the working memory and leads to a series of expectations of what should happen next. It also provides a framework for decision-making. The person activates the package for a certain situation, for example getting on a bus. This framework will tell them they need to decide what number bus to catch and what the options are. As the person catches more buses they refine their framework to consider new routes, late buses and so on.

Everyone has thousands of scripts stored in their memory and more than one script can be invoked at a time. In terms of clinical reasoning this theory works as follows. When a clinician sees a patient, they perceive the presenting symptoms and this activates a script about how to interpret the information and what happens next. So, a patient presenting with dizziness and nausea may activate

a script for acute labrythinitis, which leads the clinician to confirm the diagnosis. The script may also remind the clinician that they should rule out a more serious cause for the symptoms such as tumour on a nerve running through the brain. However, a set of signs and symptoms may have more than one script and the clinician then undergoes a process of hypothesis testing. A script can be rejected if any incongruent information is collected.

Ruled based decision making is similar to illness scripts except that the "rules" has been developed consciously by Essex and Healy (1994) as opposed to the subconscious development of illness scripts over time. They created these 'Rules of Thumb' by analysing general practice consultations over eight years. They do not give an exact figure of how many consultations and refer to it being thousands. The analysis distilled many rules in managing and diagnosing patients. An example given is when a patient with diabetes is found to have high blood glucose. One example of the rules of thumb indicates that compliance with their medicines should be checked in every patient in this situation.

Rule out worse case scenario

Croskerry (2002) theorized that physicians carry mental templates of the top five diagnoses which need to be excluded for most of the presentations that they see to avoid missing a potentially serious diagnosis. When I consider my own practice, I have a series of diagnoses for certain symptoms that I do not want to miss. For example, when a patient presents with chest pain I want to ensure I do not miss a heart attack or a lung clot. I am not convinced that I only have five templates as I come across a wide range of symptoms. However, his theories are based on working in accident and emergency whilst mine are based on working in general practice. It is possible that I would see a wider range of medical problems as my remit includes routine medicine as well as emergency medicine.

Pattern recognition

This form of reasoning has been described in the literature by several authors (Round, 2000; Elstein & Schwarz, 2002; Coderre, et al., 2003). Clinicians build up an internal library of a series of patterns, to which can be assigned specific diagnoses. The extent of the library depends on the clinician's experience and content knowledge. It is postulated that experienced clinicians utilize this approach for ease when dealing with cases which fall into clear patterns. This form of reasoning can be used in practice as the clinicians can rapidly recognise the patterns, but its safety is questionable as there is a risk the clinician does not consider a rarer diagnosis which gives a similar pattern. I have come

across instances when pattern recognition has led to the errors described by Croskerry (2002) and Elstein et al. (1978). One of these errors is making the diagnosis too early compounded by a second error of ignoring data which does not fit with what you would have expected from the pattern recognised. However not using pattern recognition would make it almost impossible to make diagnoses in the time pressured medical environment.

When this model is looked at more closely and related to illness scripts it seems that the activation of a script is a form of pattern recognition. The pattern recognition then moves into schema to confirm the diagnosis. If more than one script is activated then the hypothetical-deductive approach is used.

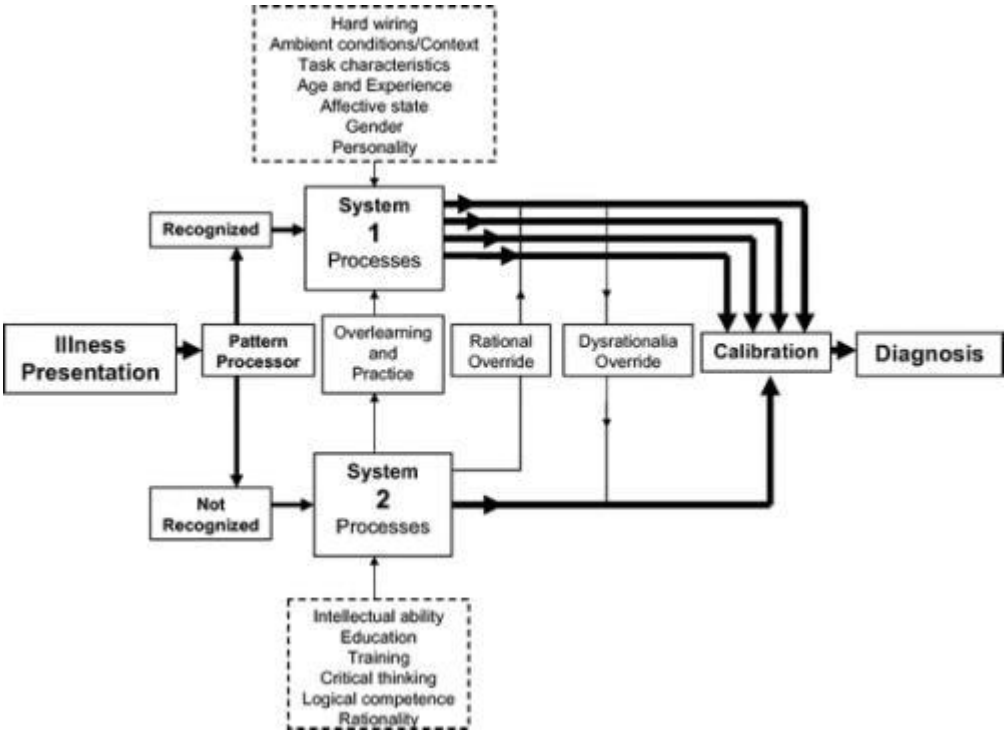
Universal or dual process model

Croskerry (2009) described clinical reasoning as two different types of approach: system one or intuitive forms of clinical reasoning, that are more rapid than system two or analytical forms which are less rapid. These differences are important when used in the clinical context, as it is often a balance between speed and accuracy.

In the article describing the two approaches Croskerry (2009) proposed a dual model of diagnostic reasoning (Figure 8), which describes how these two processes interact. If the initial presentation of illness is recognized by the observer they go into a type one process and if the presentation is not recognized they go into a type two process that is slower but helps the observer to sift through the data to reach a conclusion. This allows the clinicians deal to with the tension between the risk in using intuitive processes and the time taken to use analytical approaches discussed in the previous section. In figure 8 the dotted boxes display determinants of the system one and two processes. Repetitive processing in system two may produce a pattern, which is recognised, and then moves the observer into system one processing. One of the strengths of the model is that it indicates the ability of the observer to override system one processes, this is relevant to some theories about teaching clinical reasoning discussed later in this chapter.

This model resonates with Custers (2013) argument that clinical reasoning is a continuum with non-analytical approaches at one end and analysis at the other end of the pole.

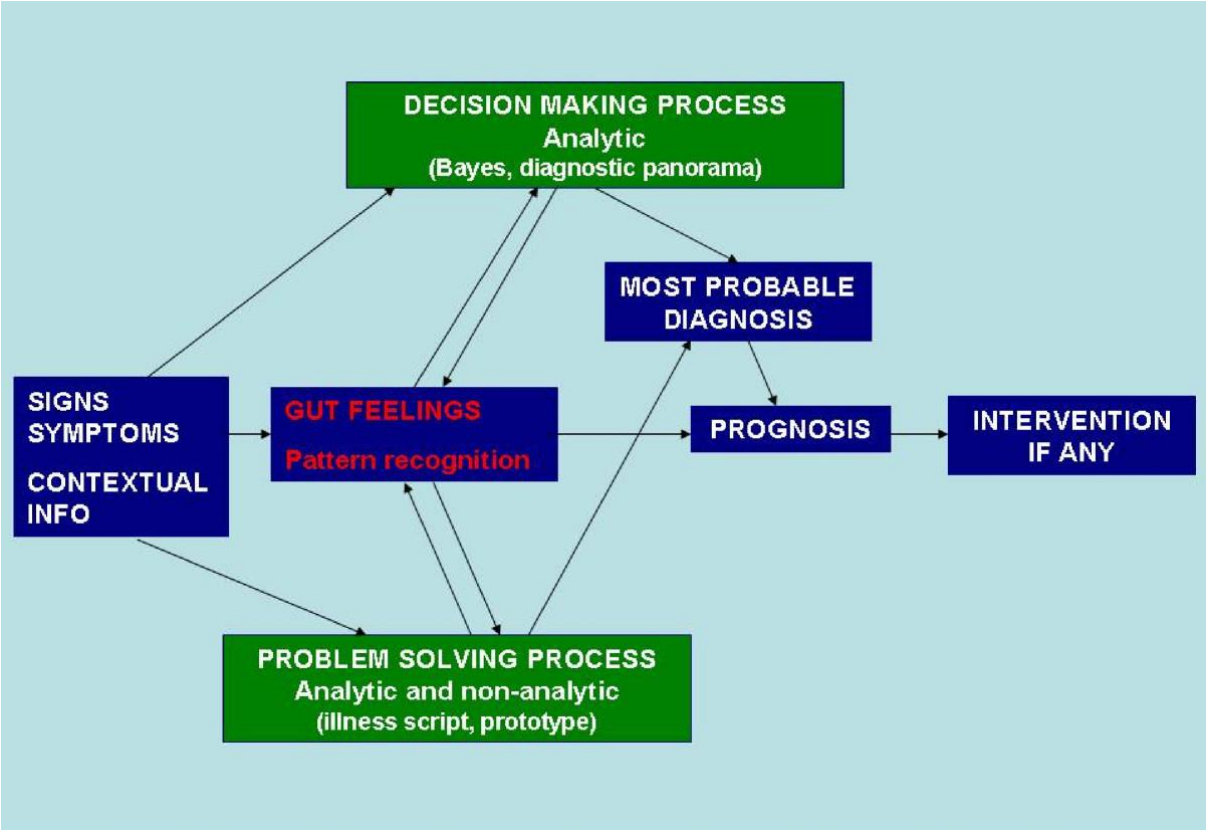
Figure 8 Universal or Dual Process Model (Croskerry, 2009, pp 1024)



Gut feeling

A type one non-analytical or intuitive form of clinical reasoning was described by Stolper et al. (2009) when they investigated the role of 'gut feeling' in the reasoning process using a focus group study using GPs. From the study, the authors produced a pathway for diagnostic reasoning which includes gut feeling which considers the other models of clinical reasoning. The patient presents with their signs and symptoms along with some contextual information. An example of the contextual information would be the patient who frequently has chest pain which after admission and investigation turns out not to be cardiac. The clinician then takes one of the pathways indicated in the diagram. For example, they may respond directly to their 'gut feeling' and pattern recognition, or use one of the other decision-making models already described. The pathway also indicates the ability of clinicians to move from one type of reasoning to another. The authors postulate that gut feelings may stimulate clinical reasoning, and if clinical reasoning does not produce a satisfactory diagnosis the clinician may respond to their 'gut feelings'. On occasions, the clinician may bypass explicit reasoning especially if a prompt intervention is considered necessary (Figure 9).

Figure 9 Pathways of GPs' diagnostic reasoning (Stolper et al., 2009)



Gut feelings can be feelings of reassurance or alarm and may occur whether or not the current pattern fits the known disease or patient. The triggers for gut feelings can be things such as what the patient says and the way the patient moves. The participants in the study indicated that a gut feeling of alarm can result in the GP looking for objective data to support the alarm. This on occasion reveals a diagnosis. Using the above example, the trigger could be the fact the patient cannot walk.

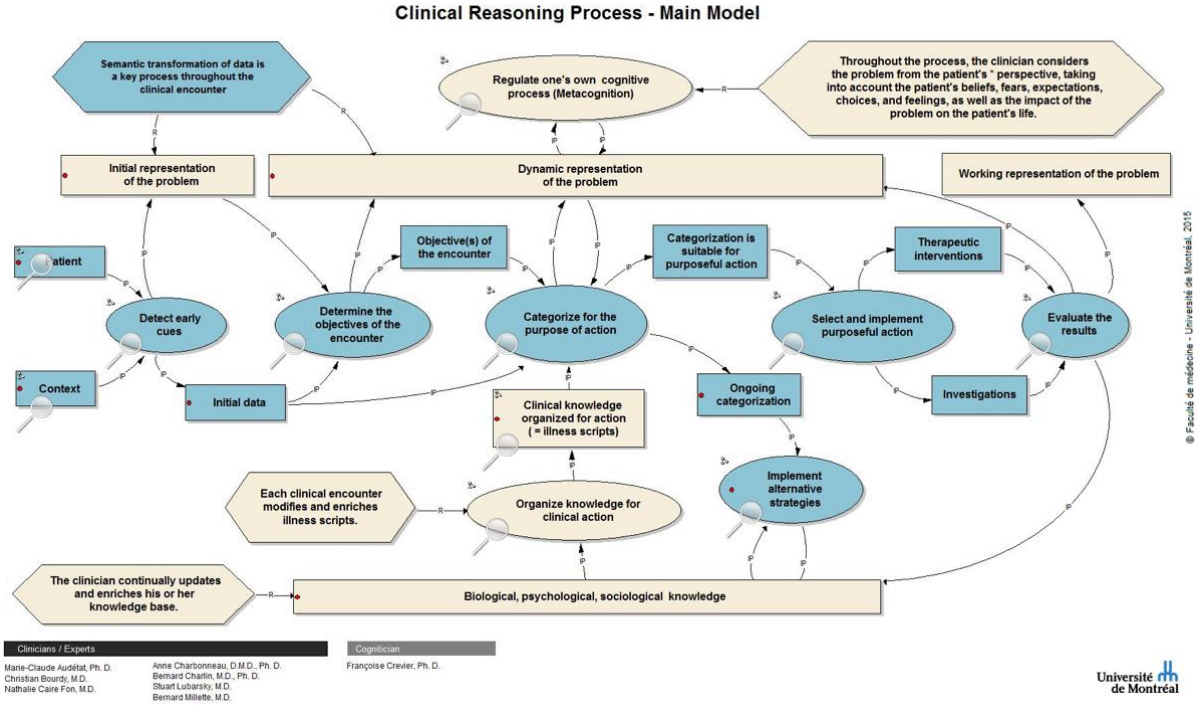
Although the authors have described gut feeling as a third process that comes from analysing patient signs and symptoms it could be argued that it is another non-analytical process akin to illness scripts and schemas but also recognising that emotion can influence cognitive processes and giving it a place in the reasoning process. The signs and symptoms that the clinician encounters may be activating a script that indicates that in this situation you need to be worried.

Modelling using typified objects (MOT)

MOT is a more complex model for clinical reasoning that combines the diagnostic process, management decisions and problem identification (Charlin et al., 2012). The authors have used a combination of current literature and a participatory action research project to develop the model. It

is a complex graphical representation of clinical reasoning that encompasses many concepts and processes and this is shown in figure 10. The approach to the study is good as it combines theoretical literature, the reflections of clinicians and observation of the process when consulting with simulated patients. Once it was developed it was further strengthened by several rounds of validation. The model describes processes such as the transformation of patient data into clinical data, categorisation of data by the clinician and how things such as social knowledge impact on the process.

Figure 10 MOT model (Charlin et al., 2012, pp 458)



Teaching Clinical Reasoning

Literature relating to this section was sorted into themes of teaching clinical reasoning. These themes were either concepts in curriculum design or specific teaching models used when teaching clinical reasoning. After critiquing the papers that referred to generic teaching theories, for example troublesome knowledge, threshold concepts, novice to expert and experiential learning in the first stages of the literature review the inclusion criteria were expanded to include original papers that described the teaching theories. This allowed me to have a more in depth understanding of the concepts described and to make a better critique as to whether they related to my context.

Troublesome knowledge and threshold concepts

One of the aims in teaching is to help students overcome barriers to understanding and learn how to apply theoretical knowledge in practice. Threshold concepts and troublesome knowledge are concepts that can be useful when considering what barriers students need to overcome. Threshold concepts have been described as the 'light bulb' moments when a learner suddenly understands a concept that changes their understanding of an issue (Meyer & Land, 2006). If a student does not understand a threshold concept they struggle to progress further in their understanding or interpretation of knowledge until they are able to do so. Students can be blocked from achieving understanding of a threshold concept by troublesome knowledge (Meyer & Land, 2006). Troublesome knowledge can take the form of incorrect knowledge or previous knowledge that does not apply to all cases. Perkins (1999) describes one form of troublesome knowledge as 'ritual knowledge' when one's understanding of the universe persists despite contrary evidence. An example of this might be when students blindly follow guidelines for history taking, rather than reasoning through why they are taking the history and how it can be used to help their reasoning process.

Both these ideas resonate with my own experience in learning and teaching. For example, recently one of my students felt that trying to determine a diagnosis without all the patient's history was going against previous teaching about taking thorough histories. His threshold concept was that a thorough history does not mean all the allergies and so on, but means a history thorough enough to gather data to help identify the patient's issue or diagnosis. Their troublesome knowledge was the idea of taking the same history in every context.

One threshold concept in clinical reasoning for occupational therapists, described by Tanner (2011), which may apply to medical students is the ability to use theoretical models in the real life situation. Her study was an exploration of the experiences of students and their interpretation of what they have observed. She found that the studenst did not apply knowledge gained to their interpretations. The observations fit with my experience of teaching, in that it is often challenging to get students to apply the knowledge that they have gained to problem solving, but once they grasp this principle they seem to move on rapidly in their learning.

Further support for knowledge application being a threshold concept is from Blackburn and Nestel's (2014) study. This had a similar finding when it explored troublesome knowledge and threshold concepts in eight paediatric surgical trainees using a semi structured interview study in the UK. One of their findings was the difficulty the trainees had applying knowledge with one stating "Well,

there's what's written in the textbook and people know that there's an inner textbook" (p757). As well as knowledge application, the researchers also identified that the breadth of knowledge that the trainees were meant to have caused difficulty in their learning and that the trainees found some areas of basic science were difficult. This relates to Land, Cousin, Meyer and Davies' (2005) suggestion that one form of troublesome knowledge is knowledge that is difficult to gain. Although the study was not observing the reasoning process directly it explored the issues from the point of view of the students using a suitable methodology to do this. Blackburn and Nestel (2014) reasonably concluded that the breadth of knowledge needed in clinical reasoning was troublesome knowledge as it made it difficult for the trainees to gain it all. I feel that this conclusion was an appropriate one, as the students' viewpoint indicated that they struggled with the range of knowledge they needed to gain.

For teaching, it would be useful to know what the threshold concepts and troublesome knowledge are so that educators can consciously design sessions to help students understand the threshold concepts and troublesome knowledge. The question is, what are the threshold concepts and troublesome knowledge in clinical reasoning? In this study, to help answer the question about what the threshold concepts and troublesome knowledge might be, barriers to learning clinical reasoning and knowledge that is difficult to gain can be explored when conducting the focus groups.

Cognitive load

There is evidence suggesting that working memory limits the amount of information the brain can process (Young, Van Merrienboer, Durning & Ten Cate, 2014). This is something that probably gets forgotten when we teach medicine. We expect the students to deal with several new issues in one teaching session. On reflection, this approach of teaching several concepts may lead to confusion as students are trying to understand the new concepts while, at the same time, they are trying to see how they relate to each other. It could be suggested that not teaching too many concepts in one teaching session is a threshold concept for the tutors. A tutor having an in-depth knowledge of all the issues involved could be troublesome knowledge for a teaching session.

This is further supported by Qiao, et al. (2014) who conducted a structured literature review of cognitive load, working memory and schema. As a result of the review they concluded that inappropriate teaching techniques in clinical reasoning, which expect students to assimilate large amounts of new information rapidly, can lead to cognitive overload. In this situation, the teaching provides more new information than the working memory can process. This leads to student demotivation and possibly the construction of incorrect principles and concepts. The authors suggest

that rather than expecting the students to perform as experts they should be given new information in stages to allow them to process the knowledge correctly and build up their schema. This theory fits very well with the principles of working through a continuum when teaching clinical reasoning skills which is discussed later in the novice to expert section of this chapter.

Further support to the theory that students can develop incorrect principles because of cognitive overload is given by Durning, Artino, Pangaro, van der Vleuten and Schuwirth's (2011) study. It used a "think aloud" study to explore what the clinicians were thinking as they conducted various reasoning tasks. The study aimed to explore the impact of context on clinical reasoning. The authors concluded that it is possible that cognitive overload leads to key data being missing in clinical encounters. The "think aloud" approach used is accepted as appropriate for exploring cognitive processes (Van Someren et al., 1994). Although the study explored the process in qualified doctors it may be relevant to teaching students, too much new knowledge may lead them to miss key data in clinical scenarios that they work with. If a tutor notices this is happening they should ask themselves if there is too much new content in the lesson. Durning et al. (2011) also found that the interaction of patient, doctor and situation factors impacted on the outcome of clinical reasoning. They related this finding to the theory of 'situated cognition' which they described as the presence of complex interactions between the outcome of a clinical encounter and the participants within it. These complex interactions may cause cognitive overload.

Novice to expert

When learning expertise Dreyfus (1981) proposed a model of how a novice becomes an expert. Recently this theory has been summarised into five stages which a learner goes through to become expert (Dreyfus & Dreyfus, 2005):

- Novice - follows the rules and does not consider context.
- Advanced beginner - situational elements are added to the rules and they recognise other situations the rules can be used in.
- Competent - starts to move away from rules and starts to organize general principles, they are starting to sort information in the problem by relevance.
- Proficient - approach to problems is influenced by perspective, and combines decision making and use of rules.
- Expert - has an intuitive grasp of the situation and does what works without consciously analysing the situation.

Although stages are described in the model, Dreyfus and Dreyfus (2005) see the model as a continuum along which the learner moves. In terms of clinical reasoning this continuum manifests itself with novices relying on analytical approaches to clinical reasoning, such as hypothetical deductive reasoning, whilst experts understand a situation rapidly and are able to think of possible problems and solutions without relying on the guidelines (Norman, Young, & Brooks, 2007). In effect experts tend to use non-analytical approaches such as pattern recognition and illness scripts whilst students need to build them. This idea is reflected in my own experience when learning clinical reasoning skills. Further reinforcement for this idea comes from a focus group study of 40 first to fifth year Brazilian medical students (Roberti et al., 2016). The authors of the study concluded that first year medical students tended to base their reasoning on using knowledge to work out the possible causes for a set of symptoms whilst more experience fifth year students used pattern recognition more.

Benner (1984) has previously mapped the novice to expert continuum on to the training of nurses in the USA. Although her work is based on a different profession and looked at post registration clinicians rather than students, I was struck when looking at her work by the way she describes the move from having a limited view of a problem to having a wider perspective. This is something which fits with my experience in that final year students can consider the wider context of the patient presentation and how this affects their decisions about possible diagnoses compared to the junior years. This highlights to me that at some stage in the curriculum we need to provide experiences that help students realise how the bigger picture influences clinical reasoning and one way to do this is to provide experience in multiple contexts.

Pena (2010) criticised the use of the Dreyfus and Dreyfus and Benner model in medicine, as he believed that clinical skills acquisition was more complex than it suggested and gave a well-reasoned argument to support this. The strongest critique for me was that the Dreyfus and Dreyfus (2005) model does not consider the use of explicit knowledge in the expert. It assumes that all knowledge is used implicitly in the expert, but this is probably an oversimplification. Pena quite rightly points out that not all problems can be solved using non-analytical approaches alone as suggested by Dreyfus and Dreyfus. This is further reinforced when looking at the dual processing model described earlier, which suggests that experts should use two types of knowledge and Custer's (2013) theory, described earlier, that clinical reasoning itself is a continuum of analytical and non-analytical thinking. When combining these three pieces of work it suggests that the implicit knowledge is needed to recognise the possible diagnoses and the explicit knowledge to double check the assumptions and hypotheses that the clinician has developed. This suggests a weakness in teaching

skill acquisition using Dreyfus's and Dreyfus's model which assumes experts use only one approach. Pena suggests that the model should not be blindly applied to teaching without considering the complexity we are trying to teach. His main warning was to avoid only teaching rules and not to assume that expert clinicians should use unchecked non-analytical thinking such as pattern recognition.

Another critic of the model is Rolfe (2010), who is based in the U.K. He argues that experienced nurses do not rely on intuition but use 'fuzzy logic'. This type of logic is based on the idea that experts work using rules which have developed based on experience. In fuzzy logic, all the rules apply at the same time but to different degrees in different situations. For example, the rule that all patients with blood in their sputum should have a chest x-ray to exclude a tumour might take second place to the rule that all patients with a high temperature are most likely to have a chest infection when considering a patient with a cough, temperature and green sputum with traces of blood. The author uses good examples to justify his claim and it is in keeping with the theories of non-analytical thinking models such as 'gut instinct' and 'rules of thumb' described earlier. His theories also resonate with Custer's (2013) theory. However, in Rolfe's (2010) model the clinicians are using different rules depending on the situation they are in. The fuzzy logic may be another way of describing schema as well. The schema that clinicians have possibly contains information as to which rules take priority in certain situations.

Perhaps the way forward is not to ignore the novice to expert continuum but to be aware of its limitations and use it in a critical way. For example, the idea of teaching rules first and then providing students with experience to refine these rules and develop their own internalised rules or schema is a reasonable way forward. We are looking for experts who can use intuitive processes but also override those processes so I suggest that metacognition, which is an awareness of their own thought processes, should be added to the requirements of an expert. Even among experts some are recognised as being better than others: perhaps it is something beyond the continuum, for example this awareness and an ability to choose which processes to use that causes this to happen. More is said about metacognition and overriding intuitive processes in the next section of this chapter.

Metacognition

Kiesewetter et al.'s (2016) work suggests that knowledge is not enough for clinical reasoning. They used a think aloud approach to explore students use of conceptual, strategic, conditional and metacognitive knowledge. They found that students who performed well used a sequence of certain

types of knowledge whilst using metacognition. This supports my theory that metacognition may be an important component when learning clinical reasoning.

Croskerry's (2003b) suggested that clinicians could use metacognition and learn cognitive strategies which force them away from the errors caused by cognitive shortcuts. He refers to the shortcuts as heuristics. In this strategy clinicians learn the types of cognitive error which occur, for example the mistake of failing to review and adjust diagnoses. They then learn situations in which the errors are most likely to occur. Once they have done this, clinicians should be able to use forcing strategies to overcome these. One example would be for clinicians to ensure they review their diagnosis and consider alternatives if all the information gathered does not fit with the original hypothesis.

Later literature identified a similar concept to heuristics when it described 'cognitive bias', which is used to describe maladaptive habits that can lead to errors in thinking (Croskerry, Singhal & Mamede, 2013a; Norman et al. 2017). An example might be when a clinician assumes a diagnosis and prematurely closes history taking because they are short for time. Croskerry, Singhal and Mamede (2013b) conducted a narrative review and suggested debiasing strategies to help correct thinking. One example of a debiasing strategy is the cognitive forcing strategy described earlier.

However, as highlighted by Croskerry at al. (2013b) there is no evidence yet that debiasing works. They do point out that we use these types of strategy in everyday life (for example when we realise we always lose our keys and force ourselves to always put them in a certain place). However, it could be argued that even in everyday life these strategies do not work when under pressure. For example, in a rush we may not put the keys in the designated place.

An evaluation study conducted in America found that students who took part in a year-long curriculum in cognitive bias could recognise it when observing a patient consultation. The curriculum was assessed using multiple choice questions and a short answer exam after watching a video of a patient consultation (Reilly, Ogdie, Von Feld & Myers, 2013). Although the results do indicate a high percentage of the students had awareness of cognitive bias, it is not clear if this was a result of the curriculum itself because the students were not compared to those going through a standard one. Although it cannot be assumed the students who could identify biases from watching a video would be able to identify cognitive bias when conducting a consultation, Croskerry et al. (2013b) did point out gaining knowledge about a concept is the first stage to applying it.

The possibility the debiasing might not work is raised by a study conducted at MacMaster University that suggested that cognitive forcing strategies do not work (Sherbino, Kulasegaram, Howey, and

Norman, 2014). The study used an appropriate evaluation technique and compared a control group to an experimental group and their conclusions fit the results, but their results seem to be at odds with the longitudinal study described earlier (Reilly et al. 2013). However, Sherbino et al.'s study (2014) used a 90-minute presentation as a teaching intervention. Perhaps the discrepancy is because the strategies need to be revisited regularly over time, or students need to actively practice using metacognition and debiasing whilst receiving feedback.

Maudsley and Strivens' (2000) paper suggests that metacognition may also help the flexible transfer of knowledge across contexts and its application. If this is the case helping students to develop skills in metacognition may help them to transfer their learning from the structured teaching environment to the ward.

Self-regulated learning

Self-regulated learning (SRL) is a further expansion on the use of metacognition. It has been described by Artino, Cleary, Dong Hemmer and Durning (2014) as students regulating and monitoring their motivation, metacognition and behaviour when learning. The authors broke SRL down into three phases forethought, performance and after the event self-reflection. A SRL tool was developed to examine the quality of regulatory processes during each phase. The study investigated second year students' strategic planning and goal setting during the forethought before a clinical reasoning task and the metacognition during the performance of the task. They found that the students did not set goals or do any planning, in terms of diagnostic reasoning, prior to the reasoning activity. However, they did concentrate on key diagnostic processes during the activity.

The authors found that comparing the use of strategic planning prior to the task against the outcomes of the activity there was a positive correlation between them. Interestingly the authors found no correlation between metacognitive monitoring and outcome. They suggest this is due to the students having been given a procedural prompt as part of the teaching prior to the study. Maybe the students followed the procedure and may not have seen the need to think much further. However, there is the possibility that metacognition is not as important as I perceive.

Recently Cleary, Durning and Artino (2016) reviewed the literature and summarised their own research into SRL and clinical reasoning. They highlight that the theory is in its infancy in medical education, but suggest some practical applications when teaching medical students. The literature they reviewed showed that students' self-evaluations across different reasoning scenarios is stable. If the tutors become aware of what the self-evaluations are, they can target their teaching

accordingly. For example, if students are over confident in their abilities and this is picked up by the tutor they can challenge this by relating the students' judgement to the outcome of the consultation or help them to reframe their metacognition as they work through a clinical reasoning task. However, this challenge would need to be done with care. A previous study which explored the impact of negative feedback on 71 second year medical students who are working through possible diagnoses in a paper based scenario, found that negative feedback caused the students to lose self-confidence and more importantly caused them to move away from strategic thinking to non-task related factors (Cleary, Dong & Artino, 2015). The sample size in the study is small with only 21% of those invited taking part, but as the authors point out, the findings resonate with other studies on self-efficacy. This suggests that how the feedback is delivered is important and is something to consider when teaching clinical reasoning to students.

Role of biomedical knowledge

During their study into clinical reasoning described earlier Elstein et al. (1978) found that the clinical reasoning ability of the clinicians varied according to the case they were looking at. He called this 'content specificity'. This can be compared to a theory in the problem solving literature, which Jonassen (2000) reviews and summarises well. The theory postulates that the ability to solve problems cannot be transferred across areas of expertise. The cognitive processes required to solve a problem are domain specific.

It is possible that problem-solving skills are transferable as I think an alternative argument can be provided for content specificity, and my experience suggests that the reasoning skills can be transferred. My argument is that content knowledge as well as the correct cognitive processes is needed to support the clinical reasoning process. To explain my assertions, I will use the example of problem solving to decide on what examinations to use. A clinician may have the cognitive processes to analyse the problem, identify possibilities, look for alternatives, and decide a plan of action, but if they do not know that a patient with vomiting might have meningitis they will not identify it as a possibility which needs investigating. This means that it is not the cognitive process which is wrong; it is the lack of underpinning knowledge.

Boshuizen and Schmidt's work (1992), which studied the role of biomedical knowledge in clinical reasoning, reinforces this idea. The study looked at how novices (medical students) and experts use biomedical knowledge in clinical reasoning. As a result of the study Boshuizen and Schmidt theorised that novice clinicians tend to use more biomedical concepts to help their reasoning process compared to experts. However, the experts tend to use more accurate concepts and encapsulate

them more with clinical ones. They called the linking of biomedical and clinical concepts the 'encapsulation theory'.

The study was conducted in two stages. The first stage used a concurrent think aloud process to explore what the study participants were thinking as they tackled a patient problem.

The second stage involved the participants writing a more detailed analysis of why they decided upon the diagnoses they did. The first stage was used to develop the theories described in the following paragraphs. These theories were checked by comparing the first and second stage results. It is worth noting that the authors only used one case based on a rare condition to do the study and the results may have been altered if a different case had been chosen. The study participants were: one second year medical student; one fourth year medical student; one fifth year medical student and a family physician with 4 years of experience. This is one of the drawbacks of the study as its conclusions are based on a small number of participants. Having said that the study does raise a possible theory as to how novices and experts reason differently and they have used participants that range from being a novice to being an expert. In view of the small sample size this theory needs to be further investigated to see if these results could be extrapolated to a larger population of learners.

The encapsulation theory was reinforced by De Bruin, Schmidt and Riker's (2005) study. The authors tested the basic science and clinical knowledge and diagnostic performances of 59 family physicians and 184 medical students in the Netherlands. The participants were given true/false questions for the knowledge test and then given case scenarios to diagnose. The results were used to test theoretical models for how basic and clinical science knowledge is involved in diagnostic reasoning using a statistical approach. The models were:

- Only clinical science is involved in clinical reasoning;
- Only clinical knowledge is involved in clinical reasoning;
- Clinical knowledge is involved in clinical reasoning, but basic science knowledge is integrated in clinical knowledge;
- Both basic science knowledge and clinical knowledge independently influence diagnostic reasoning.

They discovered that the theory suggesting that basic science and clinical knowledge are integrated best explained the results found when testing the participants. They concluded that Boshuizen and Schmidt's (1992) encapsulation theory best explained their findings. This would fit in with the novice

to expert continuum within which the learner develops a framework of knowledge, rules and principles that have complex interrelations with each other. It is also in keeping with the novice to expert model, highlighting the use of non-analytical processes in experts compared to the novice. The encapsulation of biomedical knowledge could be the reason experts are able to use pattern recognition more.

One concern I have about relying on the study is that it has used complex quantitative statistical analysis to relate its findings to the models involving cognition and I am not sure if this is the most appropriate way to explore how knowledge is used in the reasoning process. However, they did ask the participants to explain their diagnoses which might allow the authors to see how knowledge was used in their reasoning process.

During the explanation of diagnostic choices De Bruin et al. (2005) also found that expert clinicians could use a high level of expertise in using biomedical science to explain the case under study and reasonably concluded their use of biomedical science had not atrophied over time. For me this suggests that the knowledge is still used otherwise it would be less likely to remain at an easily retrievable level. In terms of my context, this study is particularly pertinent as it explores an area for the delivery of which I am responsible, in the medical school's curriculum - the integration of basic and clinical science. For me the main conclusion for this study is that medical students need to learn how to use biomedical science in their reasoning process as they are at the start of the novice to expert ladder. If they do not learn how to use the knowledge it is difficult for them to move on to the stage of encapsulation. In effect, the use of biomedical knowledge in the reasoning process is "troublesome knowledge".

A more recent study summarised the research that explored the use of biomedical science in clinical reasoning (Schmidt & Rikers, 2007). They expanded the idea of how biomedical knowledge is used and suggested that it becomes integrated with clinical knowledge and develops into illness scripts. This might explain the occurrence of content specificity: if the clinician does not have the clinical or biomedical knowledge of the patient's condition they will not have the appropriate illness script. This also possibly explains why Norman et al. (2007) found, when conducting a review of the literature, that familiarity impacted on the novice's ability to make a diagnosis. Before this review Norman (2006) had already underlined the importance of practising the clinical reasoning process in an editorial. Seeing how the integration of biomedical knowledge and clinical practice works in different contexts can allow medical students to develop a framework for better understanding.

If integrating biomedical and clinical knowledge is important students need to be able to learn the basic sciences in a clinical context. The other important point from this is that the basic sciences are an important component of clinical reasoning and medical schools need to ensure that they are still included as part of the curriculum. In my personal context, this is particularly pertinent as one of my major roles is to ensure that students are given an opportunity to integrate basic and clinical science. These studies around the role of biomedical knowledge suggest to me that I need to look at how biomedical knowledge is used in clinical reasoning and actively encourage students to include it in their reasoning process. One method for doing this is to use the sciences to illustrate the reasoning process through the use of clinical scenarios (Elizondo-Omaña et al., 2010). This fits well into my personal teaching style and can act as an intermediate stage between the theory and consulting with a patient.

To help ensure a good knowledge level the students need to be exposed to many different cases in many different contexts. This would allow them to practice organising information and formulating problems in varying situations and gain knowledge. An editorial by Norman (2006) supports this, suggesting that experience plays an important role when he states "a critical element of becoming an expert is accruing the vast experience that enables experts to recognize patterns effortlessly most of the time" (p 2252). He also suggests that learners should be encouraged to use experience to guide their search when reasoning, along with a combination of other strategic approaches. In effect, the idiom 'practice makes perfect' is relevant to the clinical reasoning process. I would add that experience is only one of the critical elements alongside others such as feedback and reflection.

Think aloud

One way to encourage students to use metacognition and self-regulation during a clinical reasoning task is to ask them to explain their cognition as they complete it. Several studies have explored the role of self-explanation in helping students to learn clinical reasoning (Chamberland et al. 2013; Chamberland et al. 2015; Peixoto et al. 2017).

Peixoto et al. (2017) conducted a randomised trial which split fourth year medical students into those who were trained using self-explanation and those who were trained without it. Both groups then had to provide diagnostic possibilities for a set of cases. The scenarios used for training and assessment were the same in both groups. The authors found that the benefits from being taught using a self-explanation process was case dependent. The students in the self-explanation group only performed better, in the final evaluation, when working on cases that had a similar pathological process to the scenarios they had previously worked with. The authors suggest that self-explanation

is only useful when using it with the same disease mechanisms repeatedly. This could be because when working through the cases with similar pathophysiology the students have an opportunity to reframe and refine their knowledge during their self-explanation.

Chamberland et al.'s (2011) study initially looks to be at odds with these results. They conducted a similar study in third year Canadian medical students and found that self-explanation only seemed to have an impact when working with unfamiliar cases. The researchers analysed the data further and found that when dealing with unfamiliar tasks the students were more likely to use biomedical concepts, whereas in familiar cases they used clinical concepts (Chamberland et al., 2013). This fits with one of the studies discussed earlier which found that first years use biomedical knowledge and fifth years use pattern recognition (Roberti et al., 2016). Most cases for the first year will be unfamiliar.

These finding could be explained by the development of knowledge encapsulation (discussed earlier in this chapter) in familiar cases. Self- explanation could be a method to help develop it. However, it is interesting to note that in both studies the cases in which the self-explanation students performed were jaundice based. Perhaps the reason for the results in both studies is that the pathological mechanisms behind jaundice are easier to remember and apply when talking it through.

A later study conducted by the authors showed that listening to an example of self-explanation and prompts to student's self-explanation in the training phase improved diagnostic performance compared to those who had learned with self-explanation alone (Chamberland et al., 2015). Students were split into three groups: one was given an example from a peer, one was given an example from an expert and the last group were given a puzzle to work through. At the assessment phase all the students had been asked to use self-explanation in analysing a case. The first two groups performed better in diagnostic reasoning than the third. When comparing results after the lesson in self-explanation and after the lesson using examples the students in the experimental groups all improved their performance suggesting that examples enhance the effect of self-explanation. The authors suggested this might be due to the students getting a form of feedback when considering the examples. The use of tutor metacognition and giving students examples is further supported by Delany and Golding (2014): they conducted an action research study into the teaching of clinical reasoning and found that educators refine their thinking to produce concrete steps which they share with the learner.

Pinnock, Fisher and Astley (2016) explored the effect of giving students feedback on their cognition when learning clinical reasoning using 48 medical students. The study was conducted in two stages. In stage one students presented a case to the supervisor who explained what they were thinking at

various points in the presentation. Stage two consisted of the students presenting a new case and explaining their own thought processes. The supervisor then gave feedback on those processes. The study was evaluated using questionnaires and showed the students appreciated the think aloud process, because the tutor's cognitive processes were explicit and the students themselves received immediate feedback on their own thoughts. The students also perceived that the prompts helped them to consider ideas and arguments that they had not thought of. Although the study was small and does not directly measure the effect of the teaching on reasoning skills it does suggest the "think aloud" approach would be positively received by students as a teaching method.

Problem formulation

As a result of their research Elstein et al. (1978) developed two different methods for teaching clinical reasoning skills:

- The students are given simulations of patient presentations and asked to generate the initial hypothesis. The clinicians give them feedback regarding the hypotheses.
- The students identify patient cues from a history that they are given and interpret them. The clinicians give feedback on the process and the outcomes of their interpretation.

When the teaching method was evaluated the authors found no difference between students taught using these approaches and those who are not taught clinical reasoning. This could be indicating that someone able to analyse data presented in a well-formulated format may not be able to formulate the raw data as presented by patients. The students in Elstein et al.'s study were presented with the full cases and cues and did not have to go looking for them. This means they were in effect being taught pattern recognition, not hypothesis testing. Perhaps presenting the students with one or two lines of information and then asking them to search for the rest of the data themselves would have produced different results.

The idea that getting students to formulate the problems themselves might help is supported by Auclair (2007). He looked at 57 medical students and compared their ability to make links between separate concepts and formulate problems when presenting the essential elements of a case history against diagnostic accuracy. He found that students who could make links and formulate problems in their presentations had better diagnostic accuracy than those who simply reported factual observations. The p values for students who could use the higher order thinking and diagnostic accuracy showed the results to be significant. This suggests that as well as learning the process of clinical reasoning the students also need to learn the skills of problem formulation. The strength of

this study lies in the fact the author found a way to identify what cognitive processes the students use when assessing a case.

Nendaz and Bordage's work (2002) helps educators to see how problem formulation can be taught. They set up workshops to teach medical students how to elicit the presenting complaint and its history, formulate problem lists and produce differential diagnoses. 60 medical students from the USA took part in the study. The results demonstrated that the students in the experimental group were more able to formulate the problems and convert the patient history into meaningful data. The study was strong in that it matched the experimental and control group for confounding factors. It could be argued that the size of the experimental group with twenty students was too small although the P values showed the difference in problem formulation between the two groups to be significant. The study also found the diagnostic accuracy improved but this was not to a statistically significant level. Although the results were likely to be valid, the amount of change was small. Having said that, Nendaz and Bordage's study along with Auclair's (2007) indicates that presenting students with full patient cases to reason with is not as effective as asking students to elicit and structure the data themselves.

Hypothesis generating

According to Nendaz et al. (2006), clinicians' abilities to collect key information and to explore many hypotheses are positive indicators of diagnostic success. They videoed 18 clinicians, ranging from second year medical students to first year internists, consulting with a standardised patient. They used a retrospective think aloud approach to exploring the reasoning process during the consultation by playing the video back and asking the participants to explain why they collected the information they did. The authors then compared the participants' responses to their diagnostic accuracy. This approach is a valid methodology for exploring the reasoning process and reduces the risks of assumptions on the researchers' part as to why certain questions are asked by the clinician, which increases the chances that this study's results are valid.

Exploring many hypotheses fits into Elstein et al.'s (1978) work, which found that narrowing down too quickly is one of the common errors in clinical reasoning. For me the 'take home message' from the two studies is that we should train medical students to consider all probable causes for a set of symptoms and not narrow down too early as they develop their reasoning skills. As the students become more expert they can move to other approaches which save them time within the

consultation. Nendaz et al.'s (2006) paper shows that asking students to formulate and elicit the history themselves helps in the learning of clinical reasoning skills.

Taking this further and considering the algorithmic and hypothetical deductive approach to clinical reasoning, it makes sense that learning these approaches will involve learning to use key information to inform you which algorithm to use and to help you test hypotheses. Experience from encountering multiple examples of cases should help to build a repertoire of the questions to ask for certain symptoms and to come across many different possibilities for a set of symptoms. This might explain why Norman et al.'s (2007) literature review concluded that exposing learners to multiple examples enhanced the reasoning process, although it is worth noting that exposure to multiple examples might also help pattern recognition by building a large cognitive database of patterns.

Teaching the clinical reasoning models

Rogers, Swee, & Ullian's (1991) study found that seminars during which the students were introduced to the hypothetical deductive, Bayesian, and algorithmic models of reasoning were not effective in increasing their clinical reasoning ability. The students were given various pieces of work which required them to use the models in problem solving. The outcomes used for the study were the students' and faculty ratings of problem solving skills after the seminars. The students were self-selected which may have led to a bias in the study. The teaching was delivered as a standalone course, which only occurred once. This means there was no reinforcement of the principles that were taught and the students did not have the opportunity to revisit the skills in a different context. It is possible that these factors lead to the seminars being ineffective.

Going on to look at a different area of clinical reasoning Essex and Healy's (1994) work, described earlier, found that exposing medical students to the rule based model for decision making improved problem perception and management decisions of undergraduates. The authors suggested that the participants internalised the rules and added them to their internal conceptual framework. They described one of the limitations of their study which was using vignettes in evaluation and suggested that further studies using real patients should be conducted to confirm their findings, which I would agree with. However, it does seem to make sense that giving students rules to work with at the start of their training would help them become experts in clinical reasoning. Dreyfus and Dreyfus (2005) believe that learning rules is needed in the early part of the novice to expert continuum. I sometimes wonder whether in our drive to make our students good at clinical reasoning, we do not spend enough time allowing the students to learn rules before learning how context impacts upon those rules.

Case presentation

One common method of teaching in medicine is asking students to present cases to clinicians. Intuitively it would seem this is a good method of teaching clinical reasoning skills, as the students could be pushed to reason through how they would diagnose and manage the patient. SNAPPS is a model that has been developed to help tutors make case presentations structured in such a way that it causes students to work through the reasoning process (Wolpaw, Papp, & Bordage, 2009).

The mnemonic SNAPPS describes what happens in the case presentation:

- Summarize the history and findings;
- Narrow the differential diagnosis down to two or three;
- Analyse the differential by comparing and contrasting possibilities;
- Probing the students by asking questions about difficulties, uncertainties or alternative approaches;
- Plan management;
- Select a case related issue for self-study

The study was well structured and used a randomized approach, putting students into one group using SNAPPS and one that did not and I find its conclusions convincing. I felt that the stages it described are what we would always do on ward rounds and in the surgery when asking students to present, so I found myself asking what the control group was doing. It could also be argued that the new approach made the tutors enthusiastic which may have enhanced their teaching. Despite that, the study does suggest that using this structured approach does help students develop the clinical reasoning skill and provides a framework for tutors to use.

Another study explored the use of case scenarios by presenting them in interactive tutorials to 44 final year medical students (Vidyarthi, Lek, Chan, & Kamei, 2015). They found that students who were taught clinical reasoning using case scenarios might be more likely to use it in their practice. The study does point out that this may only be an association and it may not be a direct cause and effect but does indicate this is a potential method for teaching clinical reasoning.

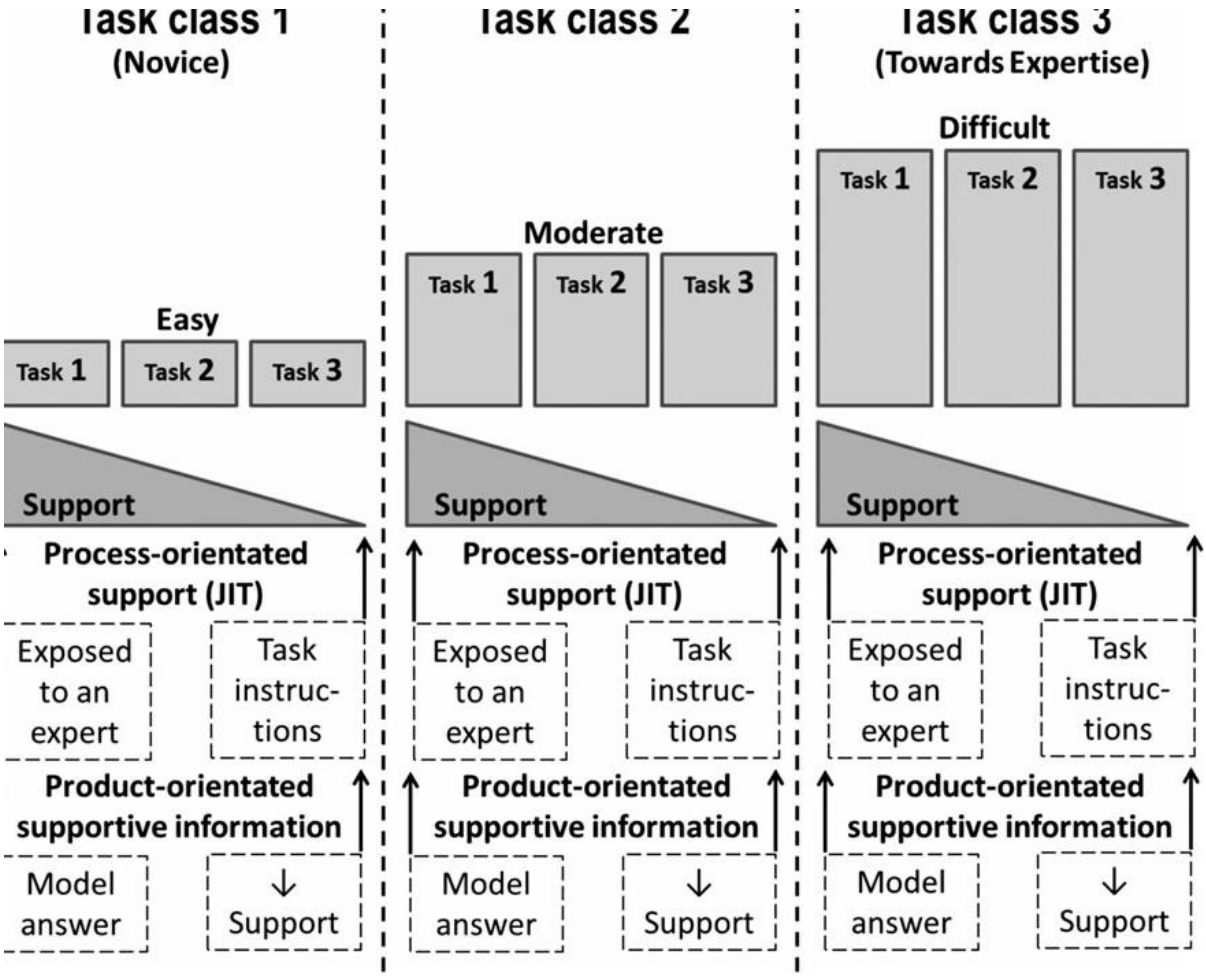
Four-component instructional design model (4C/ID)

In dentistry an adaptation of the 4C/ID (Figure 11) model has been suggested for teaching clinical reasoning (Postma & White, 2015). The model was developed from a literature review and has not been validated. On the other hand, it has summarised learning theories and findings from other

papers and the authors state that their model is a suggestion rather than claiming that it is the way to teach clinical reasoning. They suggest that authenticity is required in the teaching, and this resonates with my experience, in that students seem to engage better with sessions that are either clearly linked to the exams or to the role of being a doctor. It also resonates with literature that indicates seeing the relevance of what they are learning is important to students and adult learners (Ng, 2014; Knowles, 1968).

For my practice, this paper suggests that the cases I use to develop clinical reasoning in the medical students need to be relevant and should reflect real practice in the eyes of the students. Each teaching session needs to be carefully thought out and clear learning outcomes given, so that the tutors are clear on the processes to be taught and the students receive consistency across all the tutors. This should allow them to focus on a few specific principles and avoid cognitive overload.

Figure 11 Adapted from the four-component instructional model for complex learning by Postma & White (2015)



Varying teaching approaches as students progress

Schmidt and Mamede (2015) in a narrative study of the literature concluded that as students move through the curriculum the methods used to teach clinical reasoning should change.

They suggest the following stages:

- Development in memory of detailed causal knowledge explaining disease in terms of pathophysiological principles;
- Encapsulation of pathophysiological knowledge;
- Development of illness scripts.

This is similar to my hypothesis that students move through a novice to expert continuum and as they do, the teaching should change focus to help students move further along the particular stages of the continuum. Interestingly the stages Schmidt and Mamede (2015) suggest do not match with Dreyfus and Dreyfus's (2005) continuum, which further suggests that although there may be a novice to expert continuum in clinical reasoning Dreyfus and Dreyfus's model may not be the one to use. If teaching needs to be varied according to the stage a student is at, one challenge for the educator is trying to cater for students who might move faster or slower than their peers along the continuum.

The authors concentrate on what is needed to develop illness scripts and suggest the first stage is the acquisition of pathophysiological knowledge. The second stage is gaining knowledge about the signs and symptoms of disease. This second stage is to practice explaining signs and symptoms in terms of the pathophysiology before moving onto the final stage of practicing with patients and developing illness scripts. They point out that in this stage students need to be seeing patients in various contexts to allow them to compare and contrast the symptoms that they have. This is very similar to my current approach to the curriculum for my course. In teaching sessions, I ask students to consider the possible diagnosis for a symptom, before asking them to explain in pathophysiological terms how the conditions diagnosed cause the symptoms. One of the challenges I have found is that the students do not see this teaching as authentic and tend not to engage particularly well with it.

The role of experience and simulation

Experience seems to be as important as the cognitive processes involved in clinical reasoning, which are described by the models. Elstein et al.'s (1978) early work has shown that success in solving one

clinical problem is not a predictor of success in solving the next problem. It also depended on the physician's knowledge of the problem under consideration being correct. The authors labelled the phenomenon 'content specificity'. This finding was further confirmed when Bloch, Hofer, Feller, and Hodel (2003) concluded that knowledge and practice are both important for diagnostic success. Therefore, expertise in clinical reasoning is not entirely due to the acquisition of heuristics or reasoning strategies alone. The requirement for experience in learning is something that is reinforced by Knowle's andragogy (Knowles, 1968). He suggests that experience, including mistakes made, is an important element of adult learning.

Experience also allows the students to develop and refine their illness scripts and schema as they add each new situation to the existing framework of possibilities and actions to be taken. The students need to be taught to build their experience in many contexts. Each context in medicine gives a different range of possible diagnoses for a set of symptoms. For example, in general practice chest pain is mostly caused by musculoskeletal problems. However, we do not refer patients with this diagnosis to secondary care. So, in comparison secondary care sees cardiac problems as a more common cause of chest pain. This means it is important for students to practice clinical reasoning in different contexts so that they can learn how context impacts on their reasoning process.

The importance of experience in different contexts is underlined by Durning and Artino's (2011) AMEE guide on situated learning. They emphasise the point that learning in one context is often not transferred to another. So, a student who learns how to assess and diagnose a patient with chest pain in general practice may not make the link and use the same skills when seeing a patient with chest pain in secondary care.

In an AMEE guide which explored learning in the work environment termed 'experiential learning', Yardley, Teunissen, and Dornan (2012) highlighted that students develop proficiency in cognitive skills related to the work place when they are involved in patient interactions facilitated by a practitioner. The guide concentrates mainly on students in clerkships rather than students in the first few years of their career, but it may be relevant to the earlier years. Despite the benefits of experiential learning I am not sure that applying it early in the curriculum would provide the same benefits. Previously I discussed the issues of cognitive load and the novice to expert continuum. At an early stage there is a risk that the informal learning environment provided in a work place, before the students have the underpinning knowledge framework, will start the students off at a level too high for them on the continuum. There is a risk this leads to cognitive overload.

One way to provide students with experience in a structured way to help reduce cognitive overload is to use simulation. In a review Khan, Pattison and Sherwood (2011) discussed the strengths of simulation which included the opportunity for students to debrief and gain feedback. Feedback is an important principle in education and helps students to correct errors in their knowledge frameworks. It also provides an opportunity for the tutor to encourage students to consider alternative diagnoses and to avoid cognitive biases discussed earlier. However, as highlighted when discussing cognitive load, it has to be given in such a way that does not hinder student development.

The other issue simulation might address is the loss of the apprenticeship model highlighted in my introduction. Durning et al. (2013) found that in the view of interns and expert internists, contact with patients and taking part in their care was an important part of developing clinical reasoning skills. Simulation might be a way of providing something similar.

La Rochelle et al. (2011) looked at simulation where the students were observers. They compared three teaching interventions: paper based case, a DVD or an observation of a consultation with simulated patient. After watching or reading the material the students then took part in a group discussion with a tutor about the case. The authors found that there was no difference in learning clinical reasoning across all three methods. This may have been because the students were passive observers and did not need to formulate the problem.

The type of simulation is important as indicated by a study which explored the impact of consulting with a simulated patient and simulating patient contact in a clinical environment (e.g a ward based simulation) (Tremblay, Lafleur, Leppink, & Dolmans, 2017). They found that in the clinical environment the cognitive load and emotional stress of the students was increased and they were distracted from clinical reasoning, whereas when consulting with simulated patients the students concentrated on the clinical reasoning including possible diagnoses. Although the study was with pharmacy students its findings around cognitive overload are supported by a paper that suggested high-fidelity simulations done too early might overload the students' working memory with new concepts and produce cognitive overload. This paper suggests that the level of authenticity should be gradually increased over several simulations (Leppink & Duvivier, 2016).

Despite studies indicating simulation may not increase clinical reasoning ability other literature has suggested it improves the learners' confidence in clinical reasoning (Levinson, Kelly, Zahariou, Johnson, Jackman, & Mackenzie, 2017). The more recent literature involved students actively in the simulation. So it may be the interaction in simulation that is important, but it maybe the student confidence is at odds with an increase in ability.

Ridley (2015) questions whether using simulation has the risk that students just ask questions because it is routine to do so and they are not actually reasoning which questions to ask. Using complex cases would help to reduce the risk of students simply going through routine questions, because they do not fall neatly into anything that would indicate the right set of questions to ask. For example, a case that had features suggesting the patient's possible diagnoses are related to two body systems would not point directly to a set of questions to be asked from any one system. Burbach, Barnason and Thompson (2015) suggested that to prevent students asking questions without thinking about them, simulation in conjunction with the think aloud approach could be used.

If I was to use simulation to teach clincial reasoning I need to ensure the cognitvie load is not too high and set it up so that the students are active in the learning process.

Conclusions of Literature Review

One of the key elements in curriculum design for clinical reasoning is providing the students with plenty of opportunities to gain experience in clinical reasoning to meet patients in different contexts. It helps them to build schemas, to develop a bank of patterns to remember and to encounter different causes of the same symptoms. However, experience alone is not enough: it is also important to provide the right type of experience at the right time.

Considering the novice to expert continuum gives a framework for educators to use when deciding what experience suits which level of learner. Schmidt and Mamede's (2015) suggestion would be a good place to start with this. One example of how the framework can help is considering that before learning clinical reasoning the students also need to have the underlying knowledge to use in the cognitive process. This means that a clinical reasoning curriculum needs to be designed so that students are only expected to use knowledge that they have gained earlier in the course when assessing and deciding on a possible cause of the patient's symptoms.

In terms of a teaching session on clinical reasoning it is better that students are expected to formulate the problem themselves and gather the data relevant to their decision making rather than being given the whole scenario in one go. The session needs to concentrate on how students use knowledge gained previously to help to identify the data they need to test their hypothesis. The work on diagnostic reasoning errors also suggests that students should be trained to avoid them and that they should be encouraged not to decide what is wrong with the patient too early.

Case presentations are a useful tool in teaching clinical reasoning when students have seen real patients. If case scenarios are used they need to be realistic in the eyes of the medical students and reflect what really happens in practice. Simulation is one way of increasing the authenticity of the case scenarios further.

Metacognition and the ability to override intuitive processes may be important elements in developing clinical reasoning skills.

The teaching sessions need to have a clear focus so that the tutors are clear which processes to work on for that session and each session should not have too much new knowledge, to prevent cognitive overload. The added advantage of having a clear focus for each session is that it allows the curriculum designers to think about moving the students to becoming experts and to tailor the teaching session according to the stage of expertise the student is at.

This literature review explores and critiques potential solutions to the problem of teaching clinical reasoning skills to medical students. It has identified that there are several possible solutions for the questions and issues I raised in my introduction. My study aimed to develop new knowledge by applying the findings of my literature review along with data from other sources to my personal context and developing a more in depth understanding of how the concepts discussed in the literature review work in a practical setting.

Chapter 4 Construction: identifying the issues and planning the change

This chapter describes the results of my reflections and the focus group studies, before going on to discuss what issues have been identified and any changes that are planned in my teaching or the curriculum.

Reflections from Student Feedback and Curriculum Meetings

The results in this section are my interpretation of notes I took at meetings, when reviewing student feedback and from a UK conference on clinical reasoning that I attended. The conference was attended by educators from UK medical schools who had an interest in teaching clinical reasoning to undergraduates. The notes aimed to identify:

- Issues that made it difficult for the students to learn clinical reasoning;
- Aspects of teaching and the curriculum that made it easier to learn;
- Teaching sessions based on clinical reasoning that worked well;
- Teaching sessions that could be improved.

The notes were influenced by my literature review. I also realised during this data gathering that I had a strong belief that knowledge and clinical reasoning were not independent of each other. Because I was aware of this potential bias I actively looked for information that suggested otherwise but was unable to find any.

Difficulties

The feedback from students indicated that they did not learn much from sessions where they were being asked to use knowledge in terms of facts that they had not learned yet. They found these sessions confusing and difficult to understand.

Students found that when they were working out what was wrong with a patient, applying knowledge to the cases was challenging. They were more used to memorising and recognising certain symptoms and signs as being indicative of a certain diagnosis, rather than using their knowledge of basic science to develop a list of possible diagnoses.

At the conference one of my notes indicated that tutors themselves felt more comfortable teaching clinical reasoning if they had a good level of metacognition when they used clinical reasoning. They

explained this as being able to identify and understand their own thought processes, when assessing or managing a patient.

Staff at the medical school that attended some of the meetings indicated a lack of prioritisation of diagnoses when students were discussing a list of possibilities. In other words the students had problems in deciding the most important and less important diagnoses to make and which diagnoses are more or less likely.

Aspects to help learning

From a student perspective using case scenarios helps them to understand the relevance of what they are learning and makes it real for them. However from a tutor perspective the students may be using memorised lists to take a history and decide upon the diagnosis, rather than applying basic science knowledge. Perceived relevance of the teaching material to clinical practice was important to the students and the closer the teaching session was to real practice, the better it was evaluated. The students particularly appreciated it when simulated patients were used in the teaching and their comments indicated that it made them think more. Students put the sessions using simulated patients forward as an exemplar of a good learning experience. They indicated that they understood the reasoning process more and started to learn when certain rules do and do not apply when they practiced the skills and worked through cases.

The students' feedback indicated that the quality of a teaching session based on clinical reasoning depended heavily on the skills of the tutor in terms of their clinical background and teaching ability. Tutors who described the reasoning behind the choice of possible diagnoses, rather than just presenting the answers, were rated positively in the feedback. A feedback meeting with four students provided a similar result when the students indicated that providing feedback on the students' thought processes and encouraging them to think things through were positive elements of a tutor's teaching.

Teaching from tutors who, from the student perspective, encouraged and responded to questions during the teaching session rather than using a lecture style approach was a positive experience by students.

Teaching sessions

In my university clinical reasoning is taught through the use of written case scenarios, contact with simulated patients and contacts with real patients followed up by a written case presentation.

In one of the teaching sessions, preclinical students were given enough information to provide a range of possible answers as identified by several clinicians. This session was poorly received by the students. Although they had been informed that the session the aims of the session, the students felt they had not received enough data to draw any conclusions and to start reasoning through the possibilities. This is something which is revisited in the discussion at the end of this chapter.

Focus Group Results

Two staff focus group meetings were held. Seven members of staff attended on one or other of the focus group sessions.

One student focus group was held with three students.

The data was analysed using open coding and the framework discussed in the methodology section starting at page 29. Twenty-seven codes were identified in the initial analysis of the data and these were used to create the themes discussed below. The themes were sent out to the focus group participants for comment and a deadline given in the mailing for responding with corrections and comments. One participant verbally confirmed they agreed with the themes and there was no response from the others.

Three main themes were identified with several sub themes under each one.

Theme one: teaching sessions

Several of the themes related to the content of teaching sessions and how they were delivered.

Learning stimulus

Both students and tutors discussed the materials used as a learning stimulus in the teaching sessions. Using paper based case scenarios, real patient cases, simulated patients, case presentations to tutors and real patients as a stimulus to learning are common approaches in teaching clinical reasoning within the medical school:

> "We give them case scenarios and they have to work out differential diagnoses, the potential management and what specific things they would find in the examination." tf6[2]

> "Yeah --- like in my GP tutorials --- you try and go through cases as well." sf3

[2] The coding refers to whether the participant is a tutor or student and the number is the participant. Sf indicates a student and tf indicates a tutor.

> "We take them through a scenario with a patient kinda taking a history and examination." tf2

> "Talking through cases, --- face to face with individual students talking through some of their clerkings[3] and case discussions". tf1

All the students viewed this as a positive experience. One student found that using real patients and real cases made the learning more realistic:

> "I think just getting those kind of erm real kind of examples with a patient --- making it more realistic." sf1.

All the tutors and one of the students identified that going through cases or seeing simulated patients can help the students practise clinical reasoning:

> "In my GP tutorials er you try and go through cases as well. --- which is probably (a) really good opportunity to practice clinical reasoning." sf3

> "(In a discussion) around cases --- often through that we try to get them to get that point of working out what's going on through a kinda process of asking certain questions (as part of a reasoning process.)" tf2

Two of the tutors felt that the use of cases provided something solid for students to grasp and understand. When one of the tutors commented on this the other group participant agreed verbally with his statement:

> "Something I've noticed from what people say is --- you have to have a bit of concreteness with what you are doing, you have to have an example or case history or something there. Talking in an abstract doesn't work that well." tf4

Tutor characteristics

The knowledge, teaching approach and clinical skills of the tutors are an important issue for all the students and about half the tutors commented on it. They are considered important for a successful teaching session based on clinical reasoning. All the students highlighted tutors who encouraged

[3] Clerkings are used to describe a history being taken from a patient and then written as a clinical record of the contact

active thinking, and challenged students about their own thinking using different scenarios and problem solving, as exemplars of how to teach clinical reasoning well:

> "He would just essentially go through patient after patient and --- what would you do next, what would you do next and --- sometimes kinda challenging your reasoning behind it even if you're right." sf1

Two students found being taken through the reasoning steps provided them with feedback and gave them examples of how it should be done. They indicated that tutors who explained how decisions upon a diagnosis were reached as well as taking them through the decisions to be made helped them to develop the ability to use clinical reasoning.

This was given as an example of receiving feedback on clinical reasoning:

> "We will go and speak to them (patients) ourselves, but sometimes the clinician will go round after and they can they kinda point out key stuff in our learning---- It helps you associate ---- the various symptoms that they might have, that you may or may not have noticed, with the condition" sf1.

All the students also valued tutors who had a high level of factual knowledge as well as reasoning knowledge in the area being taught. This correlated with one of the tutors who felt that relevant factual knowledge was important for a tutor to have:

> "I really like that session --- and it can come down a bit to ---, I think, is the knowledge of the tutor." sf1

> "Last year with the comms[4] we brought in some sexual heath consultants to deliver some of the (teaching sessions) and actually that was very helpful. Because there was questions that were asked that I couldn't have actually answered because they were outwith my knowledge." tf2

About half the tutors agreed that one specific way in which it was important to challenge the students was to encourage the students to decide, for example by deciding what the management of a patient should be. One tutor felt strongly about this:

[4] This term is used to describe teaching around consultation skills.

> "I feel quite strongly --- personally that you learn clinical reasoning skills best when you have --- some weight of responsibility on the answer that you give on the decision that you make you know because ultimately that's, that's what we do as physicians particularly as general practitioners." Tf5

Whilst other tutors indicated that students are reluctant to make decisions:

> "You find that in comm skills they that when they take a history they've probably got an idea what's going on, but they won't commit themselves, they just will not they just say oh well I will tell the GP or will tell the consultant and they will decide what to do." Tf4

One tutor felt that the students are not pushed by their tutors to make decisions and this was a problem:

> "They just don't they can't get to that point of you know saying I think it maybe this." tf2

It was felt by nearly all the tutors that it needed to be experienced clinicians who taught clinical reasoning, as junior members of staff were still developing their own understanding of the cognitive process. Non-clinicians did not have the knowledge needed to assess the relevance of how clinical information related to possible diagnoses:

> "A lot of the ward based teaching is left to the mainly juniors on the ward and sometimes I know, just talking to the students, it's sometimes the FY1 or FY2 that's taking them because there's no other clinicians there. So at that level they're still trying to feel their own feet so their clinical reasoning is probably not well enough established to actually try and teach somebody else clinical reasoning, cause they haven't actually got a structured way of doing it themselves." tf6

> "A lot of our tutors are comms are not --- clinicians and so --- (I) suspect some of those sessions may be less helpful for some students, because they will ask a question and that question probably doesn't get answered ---- So they do not get a chance to work through something. Whereas if it was any of us we would be able to say right Ok well lets go back you know or how do you ask that question how do you come to that decision?" tf2

Previous experience and knowledge can help tutors use anecdotes in their teaching to underline important points, and make the teaching more relevant. This was one of the reasons it was felt that using non-clinicians to teach clinical reasoning was problematic:

> "The anecdote helps, doesn't it, in the teaching session, and I suspect that the teaching sessions that are useful are the ones where relating an anecdote ---- that's again one of the limitations of certain tutors is that they won't be able to do that." tf2

Clinicians who were used to dealing with a broader field were in a better position to help students consider more possibilities for a group of symptoms, but the tutors need to have the specialised knowledge as well for certain scenarios.:

> "General practitioners we do have the breadth as well so I think sometimes we have the breadth of it because I did an ISS (integrating science and specialities) session with --- on ankle oedema and she focused a lot on renal causes of ankle oedema but you know there's obviously about a hundred other causes of ankle oedema." tf4

Safe environment with thinking time

All the students vocalised that having time to think improved the teaching sessions, as it allowed them to think about the questions and answers rather than supplying stock answers:

> "Our tutor was pretty good she went quite slowly she took her time with it------- asked some questions about like testicle size and problems with that and that got me thinking." sf3

In both focus groups all the tutors commented on this, with a suggestion that they often felt that students were afraid of failure or of providing answers. They thought it was important to provide an environment that makes it safe for students to ask questions and to get things wrong without feeling ridiculed:

> "You know I do not know how the students feel --- I don't know if they feel under protected making those kinda calls." tf5

> "(When answering questions) they don't want to appear an absolute idiot in front of their colleagues. So --- it's something that possibly because of the fear of being ashamed that you're wrong or the fear that you'll be wrong is something we probably need to do in a smaller group and it's not really easy." tf6

> "Do you think it's a fear that they might be wrong?" tf1 (In answer to why students don't volunteer information.)

> "I suppose they are high performing students that they don't want to be wrong do they?" tf4

Asking students to come up with answers in groups was an example of providing this type of environment. One comment summarised this when discussing a positive teaching session:

> "She gave people a chance to speak in groups before anything was asked." sf1

Another example was ensuring students had the factual knowledge before coming to the session, so they had less anxiety about being wrong:

> "They were given the knowledge immediately before it so there wasn't necessarily that same anxiety we were talking about earlier about oh don't want to look stupid ---- So the theory followed by the practical application." tf2

Group size

Students indicated that small group or one to one teaching was the best format to use to teach clinical reasoning. Tutors in both focus groups stated that larger groups meant that not all students had to take part in the work, which would encourage them not to go through the reasoning process. Smaller groups seem to get a better interaction between students and tutors:

> "I think this part of the problem just talking about bigger groups, which is maybe part of the why we're seeing so poor clinical reasoning because they get lost ---- We're not picking some and you'll sometimes we've not picked up struggling students." tf6

> "And I think that makes a difference because of you are in a group with eight people you stand out more (when not taking part) than if you are in a group with 13." tf6

> "And its and it's easier for people who are not so good to get lost in a bigger group or to slip to the back and for this not to be noticed." tf7

Going through the clinical reasoning process

About half the tutors observed that sessions within which students are taken through the clinical reasoning process or had certain aspects of it explained helped the students learn the skills. This might be going through clinical clerkings that students have done or stopping and starting a simulated consultation to look at the reasoning process:

> "What probably helped was that we stopped through the history rather than get them to take all the history --- and then asked them to think what questions would be helpful next.

> Rather than specifically you know these are the questions you would ask, and once you gather all the information you will have a picture of something. You know you change what you say depends on what answers you get." tf4

> "You can see the penny dropping at the end once you've sort of discussed it (the reasoning behind the choice of diagnoses) openly with them and told them you know well you didnae look at for instance the urea or the white count. So you then sort of pick it apart the differential diagnoses and you can see a few of them the penny going God we should have looked at that oh God we should've looked at that." tf6

All the students found that discussing the clinical reasoning process helped them to understand it.

A student commented when discussing a series of sessions on how to reason through patient problems:

> "Things like the problem of the week which makes you think about the questions are based more on the basic science and clinical reasoning behind the condition rather than the condition itself, which is more just you know memorizing facts." sf2

Theme two: the reasoning process and knowledge

Several sub themes related to the application of knowledge to the reasoning process and these concepts were relevant to both teaching session and curriculum design.

Knowledge content

Several tutors described some specific teaching sessions, where the students were given the content knowledge and had time thinking about causes of various symptoms beforehand, as particularly beneficial:

> "I think the other thing that really helped them was they were prepared beforehand with the knowledge from, it was dysphagia, but you had lectures and they had pre knowledge, pre lectures. They had already come to a differential before they already had the knowledge, knowledge was not a barrier there." tf4

> "And er I thought that worked really well in that they were presented with the kinda knowledge by an expert around about genetics and certain inheritance --- Then they came

> and applied that (to a simulated patient) in a very practical sense in a within a history taking communication explanation I think there was around an explanation." tf2

About half the tutors commented that students need the underlying knowledge to work out what is wrong with the patient and that lack of knowledge is a barrier to clinical reasoning. One area which students recognised as a barrier to learning clinical reasoning was the knowledge of "buzz words" and one student commented that lack of thinking time increased the use of buzz words. "Buzz words" were phrases or words, within a patient presentation, that are often put in by scenario creators or question writers to make it obvious what the problem is. There was a feeling that they often learn these "buzz words" to provide quick answers rather than think cases through. One student commented on it and all the others agreed this was the case. An example I have since been given by the students is when a patient is short of breath and the writer has included the fact the patient has travelled in the scenario. The students recognise this as indicating the patient has had a lung clot and do not look for any other alternative possibilities for the shortness of breath.

> "I know ISS is trying to address it the lack of knowledge of the pathophysiology ----- which you know because of the lack of that knowledge, they can't always sometimes figure out of the differentials by reasoning because they don't have the pathophysiological underpinning to actually use" tf6

> "You just kinda memorize buzz words just spout it out." (When asked questions by the tutor) sf3

One student indicated they knew understanding was important but in reality if they are given the "buzz words" they don't try and understand them:

> "It's almost like applying some understanding to the buzz words. Not just knowing what they are understanding why they are there understanding what they mean, but when you give someone a set of words they are not going to sit and try and do that. Yeah" sf2

Application of knowledge

All the tutors commented that sessions which concentrated on applying knowledge to practice were the most beneficial to students and students tended to value these sessions as well and recognised that they helped them to develop the reasoning process. They suggested questions and answer sessions helped to do this as well:

"Whether that's in a tutorial or you (have) done a presentation and then you get a Q and A after ---- That I think that helps that it really shows whether you've kinda understand and got a good grasp of it or not. Whether you can think about it you can be presented with a slightly different scenario and apply what you've learned to that and I think that helps quite a lot." sf1

"Bridging the gap between the theoretical models and actually coping with a patient that they've seen in a scenario who has breathlessness is something that they find very difficult to do." tf7

A specific area of knowledge application that was discussed by all the students and most of the tutors as important was the ability to think broadly and holistically. Tutors thought that due to the way the first three years of the curriculum is taught in blocks based on body systems, students tended to think of conditions occurring within the systems which they were learning at the time and struggled to use knowledge from other systems:

"Some of them just can't think outside the system. Oh that one's obviously got back pain so it's gonna be a musculoskeletal (problem) and the scenario is a women who maybe has noticed abdominal swelling, dysfunctional uterine bleeding and they don't sort of they can't connect that it could be a gynae problem causing the back problem." tf6

"This discrete system based can be useful but also a bit of a barrier as well I think. The fact that you are teaching systems so when you ask somebody about breathlessness and you are within the respiratory block they are going to ask about respiratory questions." tf4

"Yes I notice that very much (diagnose according to block) which is partly why I produced as my example breathlessness." tf7

Students also found this an issue and indicated that learning in silos makes it difficult to think across systems. However they found that separating basic and clinical sciences in the curriculum was a bigger problem, as they felt it encouraged compartmentalised learning, rather than a holistic approach to reasoning which allowed them to apply knowledge that they had. Sessions based around problems and researching them reduced the compartmentalisation:

"We don't really have the opportunity to explore clinical reasoning much when we're learning about each system so we're focused on: so you need to learn all of this; and we need to learn all of that. We don't actually get to put much of it into practice and without

being able to put it into practice it's hard to almost want to think about why you are doing something."sf2

"And everything yeah like problem of the week just in general when you do your own so like in a presentation or something when you've had a bit if time to look into it and then you kind of develop an overall understanding of the condition ah like so you're not erm cause is less compartmentalizing if you can think about it in a wider aspect." sf3

"That worked really well --- and applied that (to a simulated patient) in a very practical sense in a within a history taking communication explanation I think there was a around a explanation and I just had the sense that was a really good way to teach it because they got the knowledge expert knowledge and they then had to apply that within a very practical context."sf1

Critical Thinking

Tutors indicated that a barrier to learning clinical reasoning was the students' expectation to be passive recipients of knowledge and that they do not critically appraise knowledge for its usefulness and relevance for the case under discussion. They also do not use it to guide them further and tend to use stock questions without critically thinking about them:

"Our medical students er become switched to the idea of absorbing knowledge but without really that that there sort of perceptive skills of understanding that it's not just a whole load of facts you have to absorb but the importance and relevancies." tf7

"And it seems to be most better they don't really want to focus you know when you ask them for a differential diagnoses, you'll get ten where you're only really wanting the top 3 or the top you know cause sometimes there only is maybe one or two potential diagnoses but they will give you ten sort of random and some of them are just not relevant to that patient." tf6

One of the teaching sessions that was given as an example as a method to overcome this was one where students were stopped throughout their history taking to critically assess the questions asked so far and to consider what else they needed to ask to help decide what was wrong with the patient:

"(Talking about a good way of teaching clinical reasoning) what probably helped was that we stopped through the history rather than get them to take all the history. Stopped through

the history and asked them to think what questions would be helpful next rather than specifically you know these are the questions you would ask and once you gather all the information you will have a picture of something. You know you change what you say depends on what answers you get" tf5

The students have a framework for thinking of possible diagnoses but many do not go on to think critically about the possible diagnoses beyond producing a diagnosis list:

> "But it's clear they have a structure for creating a list of differentials which are often quite extensive and not prioritized---, they are they just listed usually according to the VINDICATES[5] --- template that they use. But you do get that sense that to actually put some priority on that to actually think about which what's at the top of the list is you know a step into the unknown for them." tf5

> "And yet you're right they can come up with you know ten differentials using VINDICATE on somebody with breathlessness or knee pain or back pain but they can't actually link the other wee nuances of the information you give them to work out what's oh what do you think the top three diagnoses--- or the three most likely diagnoses will be." tf6

One tutor suggested that students may not know what is expected of them in terms of clinical reasoning and critical thinking:

> "I think is ambiguous (that they should reason whilst taking a history) and sometimes the students don't know you know do you want me to ask questions about management and sort of this is almost an unsaid you know difficulty that they have." tf1

Theme three: curriculum

Several of the sub themes relate to curriculum design.

Novice to expert

The tutors often indicated that what students did and what they understood depended on where they were at in the medical course and suggested that sometimes the expectations are too high in the early years.

[5] VINDICATES is a mnemonic used to help remember broad areas of conditions when considering the possible causes for a set of symptoms. It stands for Vascular Infection Neoplasm Drugs Inflammatory/Idiopathic Congenital Autoimmune Trauma Endocrine/Metabolic.

> "So it's a new it's a new sort of skill I think --- actually once we've been there and we've been doing it for years, it sort of comes naturally and but it's actually teaching that sort of conceptual jump between what they have been doing beforehand and what we might be expecting of them." tf1

> "And how far do you expect them to go in third year ---- It's pretty hard to know how to pitch things and where to pitch them. --- if we want them clinical reasoning in first and second year well that just pushing a too hard and they are not ready for it." tf4

It was identified that the start of the reasoning process for the students is later in the history taking in comparison to when an experienced clinician starts it. There was a consensus that clinicians start reasoning as soon as they get the first few sentences from a patient, whereas students wait until they have all the data before they start reasoning and this was seen as a barrier to learning:

> "I think that sometimes they think as you indicated earlier that they have to collect all this information and then do it (start reasoning) but in fact in reality clinicians are kinda doing it all the time. Right from the beginning of a history taking actually." tf7

> "In first year they got to take a history but it's kinda they got to ask the six stock questions for each system or whatever, then gather information then come together." tf4

Several tutors indicated that some students are often looking for more information, rather than using the information they have to start the reasoning process. This observation reinforced that the students start the reasoning process later than experienced clinicians. The students further reinforced this perception when they stated they felt that often a barrier to them learning clinical reasoning was not being given enough information to reason with. Overall the tutors recognised that the students need to develop their skills before becoming experts:

> "You'll always get one or two students saying there's not enough information therefore you know I need more information to prioritise these patients and you say you don't get much more information I say you probably get more information than you'll have standing in a field of a train wreck and thinking you're it." Tf6

> "I think they are useful but it's quite a fine line between getting the right amount of information. I think sometimes we're definitely not given enough and just that little bit more will help us to go and expand." Sf1

Experience in decision making

Both students and tutors felt that experience and practice with patients and making decisions was the best way to learn clinical reasoning:

> "We actually took it to the step and actually got them to say and stopped it multiple times through the history saying Ok where are we now Ok well what's our differential? Ok well how can we distinguish between out differentials and we also we also analysed how the symptoms helped you kinda make differential more or less likely." Tf5

> "Trying to get them to unpick that you know how did you get to this point from --- the points that were raised." Tf2.

> "I would say I mean on ward rounds as well, but specifically when you will go around with the clinician to see certain patients, many of them we will go and speak to them ourselves. But sometimes the clinician will go round after and they can they kinda point out key stuff in our learning---- It helps you associate erm the various symptoms that they might have that you may or may not have noticed with the condition and the they speak about the treatment and I think that's quite helpful as well." Sf1

The students discussed why practice was important:

> "you need to learn all of this and we need to learn all of that. We don't actually get to put much of it into practice and without being able to put it into practice it's hard to almost want to think about why you are doing something." sf2

> "Without a doubt I mean that I feel quite strongly as a personally that you learn clinical reasoning skills best when you have there is some weight of responsibility on the answer that you give on the decision" tf7

The tutors indicated that students do not often get the chance to practise making decisions and are not encouraged to take responsibility for decisions made. They felt this would be a useful area to develop as it allowed for improved learning:

> "Some of them (students) said they actually didn't even get to the bit where they were --- following things up --- well not explanation planning." tf5

> "Some were told you know you take the history and then --- phone me through and I'll come through and talk about you know they never develop those. It's harder for them to start to develop those skills." tf2

Assessment

The students concentrated on what they need to know for the exams and felt this was a barrier to clinical reasoning as they do not see it as something that is tested:

> "You learn the basic sciences because you know there's going to be a certain type of question for basic sciences in the exams and the clinical questions are usually to be based on guidelines or buzz words." Sf3

> "So if you're answering an exam question you're putting down the answer because you know it's right whereas we're not really being asked why." sf2

The tutors and students identified that the exams didn't necessarily test clinical reasoning:

> "There's also the funny thing that in OSCEs they often try and identify the problem by the examiner who's sitting there." tf3

> "At the end of our exams we're not going to need to think too much about kinda developing a patient and what to do even in er an OSCE scenario its to kinda a limited extent and not really on our minds." sf1

> "I think especially here when you're listening to other students whose talk about things like oh you don't need to know that for your exams or you don't need to know this, you just need to know that. Its er it just makes it difficult for you to er focus on things like clinical reasoning cause." sf2

Discussion

From the literature review, reflections from meetings and the results of the focus groups there are several important concepts and principles for teaching clinical reasoning that are emerging. The tutors and students agree on most of these, but for some of them there appears to be a difference of opinion between students and tutors. These differences and the impact of the differences are discussed toward the end of this section.

Teaching stimulus

One of the findings from my study was that using cases and simulated consultations was the main material used for teaching clinical reasoning. In the literature review I discussed the mixed evidence for using simulation. Elstein et al. (1978) found that using simulated consultations did not seem to have an effect on the clinical reasoning ability of the learners, but another study has suggested it improves the learners' confidence in it (Owen, et al, 2016). Yardley et al. (2012) thought simulation may improve cognitive skills. One explanation for the mixed evidence as to whether simulation develops reasoning skills or not may be related to the skills of the tutors running the session. For example, the tutors may need to explore whether students are using rote questions as opposed to reasoning through cases for the session to be successful. This would resonate with the focus group results suggesting that from a student perspective the skill of the tutor enhances the teaching of clinical reasoning skills. Perhaps the varying skills of the tutors facilitating the simulations are the factors producing different results in the literature. More is said about tutor skills in the next section.

One advantage of using actors and simulation as opposed to paper based cases is the ability to respond to Auclair's (2007) findings. It allows the significant information from a patient's history to be presented to the students in such a way that they must format the problem themselves, by choosing what information they need to gather from the patient. In practice this means asking the students to identify what information they need to help them decide what is wrong with the patient. Then the students have to look for it. This is easily achieved when using simulated patients because the students must ask the role players direct questions and it has a concrete feel about it, as opposed to a paper-based scenario where the students understand the data gathering in a more abstract way. It maybe is the abstract feel to paper-based scenarios that has led to the student focus group feeling that they are not given enough information to start reasoning in some situations. However, the use of simulation needs to be balanced against the resource implication in terms of funding for actors and tutor time.

Another reason the students may feel they are not receiving enough information to use in reasoning is the issue of 'buzz words'. It may be that they are expecting a certain type of information that gives them a quick answer. To help reduce the students' use of 'buzz words' and to prevent the use of formulaic thinking it is important that the cases are written so that obvious cues for certain diagnoses are avoided. Using formulaic thinking means the students do not learn how to work things out. This is probably one of the reasons why Auclair (2007) found that teaching students how to formulate the data for clinical reasoning lead to better outcomes.

Tutor characteristics

The findings from the focus groups resonate with my own reflections in that the skills of the tutor are important in teaching clinical reasoning. The tutors identified critical thinking skills as an important concept for students to learn and it could be argued that the use of critical thinking in clinical reasoning is a threshold concept. Tutor skills was not an area that came up in my initial literature review. After analysing the focus groups results a literature search to explore tutor characteristics in teaching critical thinking was conducted. It indicated that certain tutor characteristics are important in sessions which encourage critical thinking and problem solving. This literature is relevant to my study in view of my suggestions that tutor skills maybe important and the tutors' feelings that students needed to learn how to think critically and appraise the information they are working with. Maudsley (1999) and Peter, Chiuan and Payman (2008) described the skills required to teach critical thinking. One of their key points is that tutors need to move away from simply passing on facts towards helping students gain an understanding of how to apply them. This can be compared to the focus group participants who appreciated tutors who gave explanations and resonates with (Chamberland et al.'s study (2015). indicating examples of tutors working through the reasoning process supports learning.

The tutors felt that those who teach clinical reasoning should be clinicians who use it in practice. It is interesting to note that the tutors who teach clinical reasoning felt that having metacognition in terms of being able to understand their own thought processes when reasoning through cases helped them. This makes sense because working through the process is something that supports student learning and it is difficult to explain something that you do on an unconscious level. It also links with the students' preference for tutors who described their own thought processes when reasoning.

In terms of critical thinking the importance of using clinicians is supported by the need for someone who uses the clinical reasoning process as part of their day-to-day activities. In terms of biomedical knowledge if I am arguing, as I did earlier in my thesis, that content knowledge (in this case biomedical knowledge) and the ability to reason are required for a successful outcome to the reasoning process the tutors who are teaching the skills need to have the biomedical knowledge as well as being able to use the cognitive processes required.

When considering challenges for the students, relating biomedical knowledge to the clinical reasoning process is possibly a good way to ensure that students are applying their own biomedical knowledge and might explain why they find relating reasoning to biomedical knowledge is beneficial

in a teaching session. On the other hand, it is also at odds with the students' feedback indicating they do not like being challenged in the sessions and the tutors thought that fear of failure is a problem for the students and it prevents them from providing answers to questions in the teaching sessions. Some explanations for this dissonance might be the individual characteristics of the students or the way they are challenged in the sessions. In terms of the individual characteristics some students may enjoy being challenged and pushed to think whilst others might find it a stressful experience and prefer to rely on formulaic thinking.

Self-efficacy is another explanation for the differences in how students view being challenged in a session. The literature suggests that self-efficacy can influence a student's participation in learning (Schunk & DiBenedetto, 2016). Schunk and DiBenedetto summarized the literature for self-efficacy and teaching and found that those with a high level of self-efficacy will see difficult tasks as a challenge to be overcome rather than something that is too difficult. This could explain why some students actively engaged with being challenged in teaching sessions as they saw it as something to be overcome.

This possibility is supported by the students who indicated that 'buzz words' were used to provide quick answers which were correct. The finding that safety and thinking time is needed in the teaching sessions may indicate the difference between sessions where challenge was considered a positive aspect and those where it was seen as a negative issue. The tutor should be able to challenge students by asking them to provide answers to clinical reasoning problems, while providing them time to think and not producing too much anxiety about the outcome of a wrong answer. Safety also gives the advantage that students feel they can ask questions which is a positive highlighted by the students. The use of buzz words may also occur because challenging feedback has caused students to lose confidence and move away from strategic planning as suggested by Cleary et al.'s (2015) findings discussed in the literature review. This reinforces the need for tutors to provide the right type of challenge.

Encouraging students to make a decision prior to seeing the outcome of it, was not something that I came across in the literature but I can see how having to inform a tutor of your decision and then receive feedback would help the learning process. If the students are not making decisions or not sharing what they conclude then they are not receiving feedback on the outcomes of their thinking. Feedback on a specific decision would allow them to find out what works and to start building the schemas referred to in the literature review. For example, if they come across a certain situation and decide how to go forward with it only to find the option is not available or there are multiple

possible outcomes from their decision, the students can add this information to the schema for the situation. These schemas can be further enhanced by the tutor explaining alternative decisions that are appropriate and how context impacts upon these decisions.

One of the aspects picked up in my reflections was the tutors' comments on metacognition and how it helped them to teach clinical reasoning. It makes sense that to teach a process you need to understand how you unpick the information and work out what the problem is. Without this understanding, I think it is difficult to guide a student in what to do. This need for metacognition might explain why not all tutors are able to teach clinical reasoning in an interactive way and they tend to resort back to lecture format, something which the students highlighted in the feedback that I reflected on. This also links to the student feedback that tutors who explain the cognitive process helped them learn more. You cannot explain the process if you are not aware of how you use it yourself. This is further supported by the students in the focus groups indicating that tutors who explained their thought processes helped them learn.

Teaching sessions

The issue of the teaching environment and safety within it was raised by both tutors and students indicating its importance. Intuitively it makes sense that students will not volunteer answers if they feel they may receive an unfavourable response and do not feel safe. On the other hand, if students do not take part in discussions in teaching sessions there is a risk that errors of thinking do not get corrected because tutors are not aware of them and there is a loss of shared learning. This finding means that as a practitioner I need to consider how I respond to a poor reasoning strategy and try to avoid causing undue upset. I also need to be patient when asking questions and wait for answers, as well as considering methods that reduce the stress on students. An example might be to use a problem based learning approach and set them questions to work on in groups and then answer. The idea of providing knowledge before the teaching session is also a useful way forward as it can also allow the tutor to concentrate on cognitive processes rather than being concerned about what students do or do not know.

One aspect of the safety environment is the apparent conflict between the desire for safety and the desire to challenge student thinking and to encourage them to make decisions and receive feedback on those decisions. It is a fine line between doing this and preventing the students from being anxious about appearing stupid in front of their peers. This further underlines the need for tutor training and reflection on my own practice and approach to teaching. I need to consider how I can

challenge the students and encourage decisions from them without developing the fear of failure in answering questions because of corrective feedback.

When designing the teaching sessions in our clinical reasoning curriculum I need to keep the group sizes small so that tutors and students can interact more. Small group teaching and interaction make it easier for a tutor to ensure that students are working through a cognitive process rather than falling back on rote learning. As well as the reasons given by the focus group participants, small group work may be a good way forward because it lends itself to interaction between the tutors and students (Mills & Alexander, 2013). I think that this interaction makes learning cognitive processes and receiving feedback and explanations on those processes easier.

The finding that working through the reasoning process is a vital part of a teaching session around clinical reasoning is indicated through my reflections on feedback and the focus groups results. It is also supported by the literature discussed in the think aloud section of my literature review. An example is Chamberland et al. (2015) who found that third year students' self-explanation of how they reason through a case seems to improve their diagnostic ability when compared to groups taught using other methods. As well as tutors needing the skills to take students through the reasoning process the teaching sessions need to be designed in such a way as to allow the tutors to do this.

Curriculum structure

The results from the focus group interviews and the literature review strongly suggest that biomedical knowledge is important in the reasoning process. My reflections on student feedback suggested that students found learning clinical reasoning which required knowledge that they had not yet learned was confusing. As well as relating this to individual teaching sessions in terms of curriculum design it is an important factor to consider when looking at when certain scenarios can be used. For example, it is no good having a clinical reasoning session within which one of the key possibilities the students have to exclude is heart attack when they have not done any sessions about the signs and symptoms of a heart attack. This means that as I design my clinical reasoning curriculum I need to ensure that I am aware of what is happening in other parts of the course and how it relates time wise to the cases I am writing. This awareness needs to be kept up to date annually as other convenors change their course. One method to do this might be to have a group of people responsible for other parts of the curriculum who review the clinical reasoning materials and provide feedback on their content.

The student comments about buzz words and some of the suggestions from tutors about formulaic thinking resonate with my reflections that students found it difficult to use biomedical knowledge to inform their reasoning. This finding might indicate why students do not use an analytical approach to clinical reasoning and it could be argued that it is akin to pattern recognition when students recognise that a set of symptoms means a certain condition. This would aggravate one of the errors discussed in the literature review with students making up their minds too early as to what is wrong with the patient and ignoring incongruous data. The error of over-using pattern recognition and buzz words in novice students would be compounded by their lack of experience, which is needed to build appropriate patterns. To help prevent the students from overusing pattern recognition the curriculum and teaching sessions should be designed to encourage students to use the dual approach to clinical reasoning and debiasing techniques as discussed in the literature review.

Daley (1999) did a study exploring the difference between how novices and experts learn and she found that novices tend to formulate concepts. They refer to what they have seen before in terms of a specific incident and then try to follow the actions taken then, whereas experts pull in information from many sources to help them learn about individual cases. This links into the use of buzz words in that the students are using previous instances of "if you hear or see this it means a patient has that" and not thinking more broadly. This is at odds with the theory discussed in my literature review where it was thought that students use hypothetical deductive reasoning whilst experts use pattern recognition. When I write cases I either need to design the case so there is a different outcome to what might seem the obvious diagnosis at first or to design it without the formulas indicating certain conditions.

My medical school's approach to teaching clinical reasoning has relied on it developing as students meet patients and it has been thought of in terms of learning how to behave like experienced clinicians. Having said that the focus groups' results suggest that tutors have differing expectations of students according to the year they are in. There is no structure to this expectation in that it is not clear what students should be doing at each stage of the course in terms of clinical reasoning. One of the tutors highlighted that it is a skill the students are learning and used the analogy of skiing to indicate that they need to work through levels of expertise before becoming competent. They said:

> "What I say to students is, you are watching somebody who's essentially an expert in it, somebody who is really good so it's like watching somebody parallel ski and then expecting that you can suddenly do that without having to learn how to ski yourself. You must go through steps in order to do that so that's the way I try to reconcile it with students, saying,

well actually these are experts. They've taken these shortcuts because they've got years of expertise to know that these shortcuts are" (tf4).

This analogy also extends to using the novice to expert continuum to help understand what students need to learn and the stages they need to go through to be able to reason like experts.

One area that is interesting to note that did not come up in my literature review is the time at which the students start the reasoning process. The results from the focus groups suggest a difference between the novice and the expert and that is the stage within the consultation at which the reasoning process starts and this in turn puts the theory that students use the hypothetical deductive reasoning into question. If they are testing hypotheses then students would be reasoning whilst taking the history and would understand that they can start thinking about what might be wrong with a small amount of information. Whereas the students felt they needed more information to start reasoning whilst the tutors indicated that the students often asked for more information when they already have enough to reason with. The tutors also hypothesised that students would gather the data and then start thinking about diagnoses. This suggests the students are using inductive reasoning described by Overholser (1993) as an approach where students gather data and then decide what is wrong with the patient, rather than hypothetical deductive reasoning as suggested earlier in my literature review. The implications of this finding are discussed in the last chapter looking at the overall conclusions of my study

This suggests to me that one of the concepts which experts in clinical reasoning have understood is that a clinician is trying to work out what is wrong whilst getting the data from the patient and not once it is all gathered in. In fact this could be one of the threshold concepts that students need to grasp to move along the expertise continuum. One of the questions that a curriculum designer has to grapple with is how to help students grasp this concept as it was clear from the focus group the students struggled to see that they could start reasoning with a small amount of information.

Experience and practice may be a way to help the students move along the continuum. As discussed in the literature review, it is recognised that practice is important in learning how to clinically reason and this is further reinforced by the views of the students and tutors that I interviewed. The reason why experience can be important can be explained by bringing together the novice to expert model of learning and the psychological theory of schema. The novice to expert continuum describes moving through learning rules or guidelines and using them all the time, then selecting which rules for which situation before moving finally to working intuitively in most situations in your area of expertise (Dreyfus & Dreyfus, 2005). This is akin to using the buzz words, formulating concepts and

using guidelines about patient management as a novice before moving to more intuitive reasoning and knowing when to apply the guidelines or not.

I would argue that clinicians move along the continuum as they develop internal schema about actions to take in certain situations. Initially the schema is relatively simple and as the clinician gains experience they refine the schemas, which become more complex as the novice discovers new decisions and possible outcomes of the situation.

As the schema become more refined the clinician becomes more expert and starts to rely on them more than they do on external rules and guidelines. As the schema becomes more internalised the clinician can use them more unconsciously. So it looks like they are using pattern recognition when in fact they are using schema. My theory can be extended further by saying that the clinicians who go on to be good diagnosticians have a better awareness of their own schemas and can use this to override them. This allows clinicians to double-check that the decision they make is the right one and that they are not meeting a new unexpected situation. To develop these schemas and refine them the novice needs to encounter information and concepts in several different contexts so that they have an awareness of the potential decisions and outcomes for any given situation, hence the need for experience.

Earlier I discussed Pena's (2010) concern about using the novice to expert continuum and encouraging learners to stick to rigid rules and not consider the complexity of the problem. The finding in terms of buzz words underlines his concerns but also vindicates Dreyfus and Dreyfus's assertion that novices go through the stage of looking for personal rules to be followed before developing more structured thinking.

The last area of the curriculum which is important to consider is assessment. Even though we think we are testing clinical reasoning and application of knowledge in our exams the discussion with the focus group students suggests otherwise. It is known that assessment drives learning (Wormald, Schoeman, Somasunderam, & Penn, 2009) so the comments of the students about the impact of assessment on learning clinical reasoning is not surprising: what is surprising is how they view what is being assessed in terms of clinical reasoning and the use of formulaic thinking and "buzz words". The results of this study have led me to recommend at least one station from my course in their OSCE. When I write the stations I have to be careful not to use buzz words or clear-cut cases. This information also should be shared with our OSCE station writers.

Conclusions and Planning

Teaching session

My results indicate several principles that are important in the design of a teaching session about clinical reasoning:

- It should be based on cases ideally with simulated patients if financially feasible;
- The students need to work through the reasoning process themselves including formulating the data themselves and making clear decisions;
- The students should receive feedback on the reasoning process and explanations from their tutors;
- The tutors should be clinicians who work in the field being taught;
- The tutors should receive training about how to deliver a teaching session on clinical reasoning;
- The lesson materials should be designed to prevent or challenge the use of "buzz words";
- There should be room in the teaching session to allow students time to think and tutors should be encouraged to create a safe environment;
- Where possible the teaching should be delivered in small groups;
- The case should be designed to reduce the chance of compartmentalised thinking
- The students should only need content knowledge that they have already gained to assess the patient presented in the teaching session.

Some of these results resonate with Kassirer's (2010) suggestions when he recommends that the cases used in teaching stimulate the reasoning process rather than relying on recall and he suggests that a coach who asks the students to explain and justify their reasoning should run the teaching session.

A teaching session based on clinical reasoning when seeing a patient with confusion that used simulated patients was identified as meeting several of the principles listed above. It was reviewed and redesigned so the focus of the session was on clinical reasoning. The case was written to encourage clinical reasoning and the tutors were briefed in relation to encouraging the reasoning process. More detail is given in the chapter on implementation.

Curriculum design

This section discusses the results in terms of curriculum makes some interim recommendations for its design. Further recommendations for the curriculum and teaching around clinical reasoning are discussed in the next chapter after the evaluation of the new sessions.

When considering a curriculum to teach clinical reasoning the most important factor is providing opportunities for experience. The curriculum at my medical school has moved towards a very structured approach to teaching medicine by using tutorials and set pieces of work. This moves away from the old apprenticeship model where students followed colleagues around the wards and observed what was happening or saw patients every day and were expected to clerk them in on a regular basis. While the old approach lead to the risk of the students having gaps in their knowledge if they did not encounter certain patients or situations, it did allow for multiple experiences with patients in different contexts. Both the literature and focus group data indicate that experience is an important part of learning clinical reasoning. This means I would recommend that as the curriculum develops we continue to ensure students have experiential learning with patient contact in different contexts starting from year one as well as the structured approach to providing learning experiences.

As well as experience the novice to expert continuum needs to be considered. The medical school I work at already uses a 'spiral curriculum' (Harden, 1999) for teaching undergraduate medicine where subjects are revisited over the years in increasing complexity. This approach is well suited to allow the development of novice to expert as students encounter situations which are more complex as the years go on. To start with a novice needs rules to work with and in terms of clinical reasoning these rules can be viewed as the full history that should be taken when seeing a patient and the guidelines. Then as time goes on the students should be guided to identifying which of the rules they apply in certain situations. In terms of the curriculum this would mean ensuring the students know the format of a formal history and the relevant guidelines. Then once they have learned that, they can be moved to taking histories and thinking about why they are asking the questions they are. From there they can be moved into situations where they have minimal information and start identifying how they can get more information, for example from examination and investigations. This approach may also help them to grasp the threshold concept of using clinical reasoning early in the consultation.

To help design a curriculum with the novice to expert continuum in mind it is important to gain more insight into how novices move towards being an expert in clinical reasoning. My study has identified

that as well as approaching the problem differently novices start the reasoning process very late on in the consultation and has suggested that students do not use hypothetical deduction as previously thought. However the sample size was small so this may not apply to the majority of students. On the other hand it was a theme that came up in all three focus group meetings. This suggests it might be a valid finding. I had not thought of it myself before and I did not bring it up so it is unlikely to be due to bias. If the students do leave it late to develop hypotheses they cannot be testing them during their history taking as previously thought. The question is, are they recognising patterns at a stage when they do not have enough knowledge to know all the patterns? In this case, they need to be encouraged to test their theories to prevent early closure and some of the errors described earlier in this paper. This is an area that needs more exploration in future studies.

Assessment is the last area to look at. One major recommendation is to look at OSCE stations to look for buzz words and situations that might make answers obvious without having to think the problem through. One way to do this is to write the stations so that the diagnoses are not clear and the marks are gained for assessing the problem and not necessarily for getting the right answer. This marking scheme then needs to be shared with students so that they are aware the question is not about getting the right answer.

Although I am advocating early experiences in clinical reasoning it is also important to ensure the possible diagnoses of the patients or cases that the students are expected to work with are ones they have covered in the curriculum so far. It is also important that they have covered the underlying basic science that is needed to understand the case under discussion. For example if we were to use a case of shortness of breath the students need to know the pulmonary anatomy and physiology of the lungs.

The design implementation and evaluation of a trial session teaching session carried out within this thesis will provide a solid basis for broader and more long-term curriculum change within the whole programme.

Chapter 5 Implementation and Evaluation

Designing and Delivering the Teaching Session

The Implementation stage of Brannick and Coghlan's model (2010a) was conducted with the agreement of the teaching dean. A new session on clinical reasoning was delivered as a pilot to all of the third year students. He gave me permission to evaluate the sessions using the questionnaires (appendix 4) and methodology as discussed earlier in this paper. Funding for actors to play simulated patients was secured to allow me to meet the recommendation of using simulated patients within the session.

I identified a teaching session, based on acute confusion, to be developed in line with the recommendations listed at the end of the previous chapter and delivered as a new session. Acute confusion is a condition that has a wide range of possibilities for the cause of symptoms and this could reduce compartmentalised thinking. Due to the wide range of causes for acute confusion the risk of 'buzz words' occurring was less and the case was deliberately written so there were still several possibilities as to what was causing the confusion prior to arranging investigations. The wide range also meant the students had to reason through the signs and symptoms to decide upon possible diagnoses.

To redevelop the session, I discussed the recommendations with staff involved in designing case scenarios used for teaching. I worked with a colleague in developing the content of the case. This was to help increase the chances of the case being realistic and to ensure the clinically accuracy by having the opinion of two clinicians on the content of the case. After the clinical aspects of the case were developed I reviewed it to identify and remove any buzz words and to ensure the signs and symptoms were not so specific that only one diagnosis was a possibility once the patient had presented all their history.

The session was delivered at the end of a week during which the students learned about the conditions causing acute confusion and the signs and symptoms they can produce. This was to ensure that they had covered the content knowledge to assess the patient with confusion and to reduce anxiety that students may have had about not knowing the answers.

Prior to the session students were informed of its format and that it was based on a case of acute confusion. They were encouraged to consider possible causes of acute confusion and to consider how the history taking would guide them in making a diagnosis. It was emphasised that the session

was about the clinical reasoning process rather than identifying the correct diagnosis. During the sessions students were encouraged to ask questions to help them clarify how the history taking fits into the diagnostic process. The relevance of history taking in relation to clinical reasoning was reinforced by the tutors.

Six tutors delivered the sessions to year three students. The year was split into 16 groups of eight to ten students to allow for small group work as recommended earlier. Actors were employed as they could be given clear directions as to how much information to give a student in response to questioning. By limiting the information given the students might have to consider what data they needed and what questions they needed to ask to get it. This was a way of getting them to work through the clinical reasoning process. To facilitate this approach the actors were given briefing notes about what information was to be given. The tutors met with the actors 10 minutes before the session to reinforce this information and to let them know about the frequent stops in the consultation. The actor briefing notes and scenario are attached in appendix 7.

The tutors were all GPs. This meant that they were used to dealing with patients who had confusion and had the content knowledge required for this, allowing me to meet the criterion of using clinicians who work in the field. Although one of my recommendations was to provide tutor training, it transpired that it was not practical to provide face-to-face training regarding the session. This was due to the challenges of coordinating dates and times for myself and all the tutors to meet between the initial set up of the session and when it was to run. The main reason for this challenge was the use of clinicians. Their available days for teaching activities are restricted by clinical commitments which means their diaries are less flexible making it difficult to identify mutually available sessions. So, clinical tutors experienced in interactive teaching in problem based learning or communication skills were used and they were given clear briefing notes which are attached in appendix 8. The tutors were encouraged to avoid using formulas such as ‘always check the glucose’ in their teaching. Instead they were asked to say things like ‘how would checking a blood sugar help you in this case? The difficulty and resource issue in training tutors is discussed in the section on my learning later in this thesis.

The tutors were asked to use a stop-start method to the consultation by stopping it at various points and asking the students to explain why they were asking the questions they were, to unpick the diagnostic possibilities at that stage and explain how the information gathered so far had influenced those possibilities. Then the consulting student and the rest of the group were asked to consider what other questions needed to be asked. This helped the tutors to provide feedback and

explanation regarding the reasoning process. It also pushed the students to make decisions about patient management that they would share with the tutor. The final reasoning for using this approach is that it gave the students time to think about the patient problem, the data they were gathering and what it all meant.

The learning outcomes for the session were designed to encourage clinical reasoning. By the end of the session the students would have:

- Taken the history and suggested examination and investigation of a patient with acute confusion,
- Used basic science to help develop a differential diagnosis and management plan,
- Thought across different specialities,
- Applied their knowledge of basic science to a clinical problem,
- Applied knowledge to tailor history taking and discriminate between the different types of data to gather.

The questionnaire was handed out to students at the end of the session and returned anonymously.

Initially the aim was to send questionnaires to the tutors. However, they wanted to meet rather than complete the questionnaires. This was because there was potential to roll the teaching session out, so they wanted the opportunity to discuss it in more depth. This highlighted one of the challenges of insider research. The tutors are my colleagues and peers which made it challenging to insist on the questionnaires and their point was a valid one. I was concerned that there was a potential that not meeting would reduce the chance of the tutors engaging with any future roll out of the sessions. As ethical approval had not been gained for a focus group discussion and to obtain it would involve a significant delay between the teaching session and the data collection, I gained their agreement for me to take notes and use my reflections on the discussion as part of my research and did not record the sessions. More is said about the potential impact of this in the study evaluation.

Student Evaluation Results

125 students attended the teaching session and 110 questionnaires were returned (88%). The questionnaires were handed out during the teaching session and the students left to fill them in at the end. The tutors then collected completed questionnaires from the rooms as the students left them in the rooms they had been taught in rather than taking them to reception. The data from the

questionnaires was analysed using the deductive approach using the content analysis and directed coding discussed in the methods section. The results are given under each directed code.

What the students learned

Three subthemes were identified under student learning.

Differential diagnoses

The quotes in this section were given in response to the question "what did you learn?"

Most of the students reported that they learned what the possible diagnoses were for the case under discussion and found that they understood that there were several possibilities for the initial presentation and not to make assumptions:

> "Have an open approach to making a diagnosis" [6]
>
> "Consider a wide variety of possibilities" 24
>
> "Don't presume things" 38
>
> "Potential causes of delirium" 84
>
> "Not going in with any preconceptions" 89

The students felt that they learned that prioritising diagnoses was important and started to consider the most probable diagnoses first:

> "Good to prioritise diagnoses according to likelihood and seriousness" 32
>
> "Consider most likely diagnoses first" 47

The students developed an awareness of the need to exclude certain possibilities and check for red flags indicating these possibilities:

> "Considering excluding most serious diagnosis and sequelae" 47
>
> "Differentiating if serious or not" 36

[6]Each questionnaire was assigned a number to be able to identify the range of questionnaires the quotes came from.

"On how to spot a red flag on a confused patient" 101

Case specific issues in clinical reasoning

About half the students found that because of the teaching session they learned issues specific to acute confusion. Examples were how to use the screening tools for confusion and the need for a collateral history to inform the reasoning process:

"When not to perform 4AT or MMSE" 15 (Both are screening tools that are used to help decide what type of confusion the patient has)

"How to manage a confused patient" 23, 26 (Both questionnaires gave the same response)

"Investigations: head CT, resp, GI, cardio exam, bloods and how they all relate to confusion" 53

"Learned important socials aspects to address i.e. drugs and alcohol" 34

"Comparing dementia and delirium" 43

"Talking to a confused patient without a collateral history" 61

"It helps to understand the aetiology of delirium and differentiation between delirium and dementia clinically" 93

Reasoning process

Most of the students reported that after the session they understood how the science and previous learning can relate to assessing the clinical presentation and be used in the reasoning process:

"Helps to knit together all the system and science knowledge very well" 92

"Thinking of differentials from each system with the patient in front of you and why each of these are possible really helped integrate knowledge" 91

"Linking together patient presentation, pathophysiology as well as clinical management and reasoning" 75

Many realised by the end of the session that a holistic and multisystem approach was needed to assess the patient:

"It helped me think about a multisystem approach to delirium" 110

"Made me think across all systems to get a DDx (differential diagnoses) of the delirium" 67

"Consider the patient from the perspective of the whole body rather than specific systems" 88

"Reminds to stop and think about what can cause a symptom including all systems" 63

They also felt they had learned the questions that would help them assess the patient and that the clinician is actively thinking whilst gathering information:

"What questions to ask and what examinations to do." 70

"Questions to ask answers to explore" 12

Students indicated that they had learned how to think widely in terms of integrating the history taking, examination and investigations together during the reasoning process:

"How investigations and examination findings relate to the pathologies suggested by the history" 64

"How the investigation results link to the signs you would expect from a differential diagnosis" 59

What the participants thought made the session work

Six subthemes were identified under this theme.

Scenario factors

As well as identifying that they had learned that a multisystem approach was important the students also indicated that using a realistic scenario that clearly crossed several systems help them to learn clinical reasoning. Some students expressed this as using a vague scenario and others as using a complex scenario:

"Vague presentation of confusion meant that the lot of pathophysiological causes was made greater" 28

"No clear causes but many possible" 65

"Patient scenario- vague presentation allowed us to explore causes" 74

"It was good it was so vague- highlighted the difficulties that can be faced in real practice" 81

"It was such a broad history - which was new challenge which demonstrates the need to think behind your actions" 86

They also found that using a scenario that was realistic made the learning more relevant for them:

"Realistic scenarios" 1 and 107

"A very realistic patient" 10

Simulated patient factors

The students identified that having good actors who played the role of a confused patient realistically helped them to develop their clinical reasoning ability:

"Good getting from a patient makes it more realistic" 73

"The patient great actors" 9

"SP (simulated patient) is excellent in simulating a real confused patient" 19

"Very good simulated patient helped me see how this situation could play out in reality" 32

"Symptoms which are well played by the actor" 42

"Having a real person who was good at acting confused" 45

"The patient was good at acting out the role of a delirious women" 110

Clinical reasoning process

Students found that practising and thinking of differentials themselves helped them to develop their skills:

"Coming up with a differential diagnosis before taking a history then refining it as we went along" 79

"Gave a well-rounded differential and let us practice lateral thinking" 29

"The thinking process on taking a history" 46

"Putting together the differentials and practice excluding them" 52

The discussion with colleagues about the reasoning process also seemed to support their learning:

"Discussing whether to keep it (diagnoses) on the list or not" 43

"Very good session- good history followed by discussion about management" 50

"General discussion about how to progress when there are no clear causes but many possible" 64

They found that the tutor pushing them to justify the questions they asked and the hypothesis they had developed helped them gain insight into the reasoning needed and to think about their own thought processes:

"Pushing for more when we suggested examinations tests/questions-really helped think why and what we are actually looking for" 92

"Being able to use a patient example history and interrupting the consultation to examine thought process" 83

Stop-start method

The method used of stopping and starting the consultation to allow the tutors to explore the reasoning process was highlighted by most students as a technique that helped them to learn how to assess a patient and decide upon possible diagnoses. It allowed for discussion of the cognitive processes involved:

"Time out consultation- made it better directed gave better depth" 92

"Stopping the Consultation to talk everything through" 104

"It was really useful to stop take a pause to really think of the thought process behind the consultation" 86

"Regular pauses to discuss patient responses and what they imply" 34

"Could discuss as we went along this helped learn alternative ways of thinking" 63

Prior teaching

The session provided good integration of knowledge taught previously and this helped them to learn the process:

"Good integration of teaching from the rest of the week" 2

"Looking at the underlying causes of confusion and linking these into the session we had earlier in the week" 7

"Putting the information from the previous week into a clinical context" 30

Teaching session factors

The tutor using real examples to demonstrate the process and answering their questions was appreciated by the students. Keeping the session relaxed and informal was valued by the students:

"Real examples from tutor's experience" 25

"Tutor feedback was useful-happy to answer any queries" 75

"Tutor good at answering questions" 28

"Group discussion with GP and her real-life situations" 37

"It was very relaxed which made group discussions good" 37

The opportunity for discussion was highly valued:

"The discussion with the tutor and the group was helpful to decide on a differential list" 97

"Group suggesting causes and reasons, examinations tests and reasons helped knit it all together" 92

"Just thinking about the scenario as a group is helpful" 54

"Helpful to have the session still fairly guided by the tutor, who gave good feedback and asked for opinions suggestions from the group at large" 90

What did not work and suggested improvements

This section combines the results of what the participants found that did not make the session work and suggested improvements because the results were very closely linked.

More time

The students indicated they wanted a longer session so that they could complete more aspects of the clinical reasoning process or go over what they did in more depth:

"Add in an extra ½ hour so it isn't rushed" 103

"Perhaps a slight longer session so that a more comprehensive assessment can be done" 67

"More time to discuss management plan" 84

"I think the session could be longer with more situations that we could practice" 43

Extend the case

The students suggested including more investigations and results or adding in examination to the case:

"It would be better if we could do an examination and share management plan. The session with integration of history taking, investigation and management plan would be good" 94

"Could follow the case all the way and end up with results from hospital admission" 102

"Could go through the next part of care" 106

"Including the actual examination in the scenario would make the session more realistic and engaging for everyone in the group" 89

Concreteness

Several students wanted concrete answers such as what was the patient's diagnosis or a clear history from the relative:

"Finish with an actual diagnosis after investigations" 106

"Make the diagnosis less ambiguous with a clear management advice" 66

"To find out what happens "at the end" helps our knowledge of delirium" 15

Include everyone

Several students requested that more people have a chance to take part as a history taker:

"More people to take part of the history" 77

"Swapping in and out to consult (as opposed to) one person consulting throughout" 85

More cases

A small number of students suggested more cases to help them see how differences change things:

"x2 consultations to provide contrast e.g. a delirium patient and a demented patient-see the shared skills required but also the variation" 93

"A different array of cases" 47

"Potentially more than one patient" 91

"It could be improved with a second person" 27

Nothing

At least 50% didn't want anything to change or left this section blank:

"No way" 104

"I think it was conducted really well- Nothing else I can think of" 101

"No well-structured and everything at an appropriate level" 50

Reflections on Tutor Feedback

Five of the six tutors attended the debrief meeting. Due to the challenges in coordinating our schedules and ensuring as many as wanted could attend, the meeting was held one month after the teaching sessions. This may have impacted the results of their evaluation as they might not have remembered important issues as much as they would have done nearer the event. On the other

hand, it may provide richer data because they would have had time to reflect on the sessions and draw conclusions about their experience. The meeting lasted an hour and was chaired by me. The tutors were reminded of the aim of the teaching session and asked to discuss the strengths and weaknesses of the teaching session and to suggest improvements. The tutor questions in appendix four were used to structure the discussion. At the end of the meeting I presented a verbal summary of what was discussed to the tutors. The summary was clarified or modified as needed according to their responses as is presented in the next few paragraphs.

The tutors reported that the students appeared to be learning how to think across systems and learned about the impact of context on their reasoning process, particularly the impact on management and possibilities for referral. They found that the prior teaching had ensured the students came to the teaching session prepared with the appropriate foreknowledge.

The tutors found that discussing why certain questions were asked and pushing students to justify them appeared to enhance the students' understanding of the reasoning process. Discussing how the answers helped the reasoning process and relating what they had learned the previous week to a patient context also helped this. The teaching session about applying pathophysiology to signs and symptoms was better received than it had been in previous years. Although this might not be a valid finding it is worth taking note of it and observing how the session is received next year. Using a broad scenario allowed for several diagnoses and made the students think about what to ask. Tutors who had had time to look at investigations found that the discussion about how the investigation would change management enhanced students' understanding of the cognitive processes in assessing a patient. Linking the science to why they were doing what they were doing helped them to develop their reasoning process.

The students' comments about "buzz words" were shared with the group and they agreed that the session gave no obvious answers, which made students realise that the answer is not always clear and generated discussion. It was useful to discuss the prioritisation of differential diagnoses according to probabilities and "must not miss" diagnoses. The key to a good scenario was the undifferentiated problem. After this discussion it was decided to review our assessments for any potential "buzz words".

They suggested that the session could be enhanced by removing some distracters from the scenario, which made it difficult for the actor to play. The quality of the actors made it easier to teach the students. They also suggested that the tutors should get a briefing on how the tools that assess

whether the acute confusion is more likely to be due to a mental health or physical problem can be used in the clinical reasoning process.

Discussion

Case scenarios

There is agreement across all data sources in my study that using case scenarios is an important aspect in designing a teaching session on clinical reasoning. The evaluation of the teaching session adds that a scenario which is realistic in the eyes of the student supports their learning and the use of actors enhances the case scenario approach further. This realism relates to the issue of authenticity which is discussed under the next section.

From the results of the student evaluation and tutor discussion, the way the scenario is written influences the success of the teaching session. One which is written so that it is not initially clear what the diagnosis is and which has a lot of extra information which may or may not be relevant pushed the students to use their reasoning. This links well with Auclair's (2007) work on problem formulation. Through putting information into a scenario that is vague and ensuring that it is presented to students in such a way that they must recognise it as significant seemed to encourage students to think about the data that they were gathering and why they were gathering it. As part of the process of doing this the students had to translate the information given by the patient into medical data and then use a cognitive process to match the data with medical terms.

The vague scenario prevented pattern recognition and the reliance on buzz words by the students and pushed them to use hypothetical deductive reasoning. This is shown by the tutors and students reporting that they practised working out what the differentials were and learned what questions needed to be asked. It is worth noting that the success of using a vague case that forces students to use clinical reasoning supports Kassirer's (2010) theory about the need to use cases that do not rely on recall and stimulate clinical reasoning instead.

Simulated patient

When using simulated patients, the quality of the actors is an important part of the teaching session. Both the tutors and students highlighted that the ability of the actors was important to them and they recognised the situation as realistic. The tutors felt it was challenging for the actors to play the role but the actors used knew how much information to give out and when. They were directed not to give out a lot of information, which pushed the students to consider what questions they needed

to ask to work out the possible diagnoses. One aspect not covered in the literature is the briefing of actors and simulated patients who take part in teaching clinical reasoning skills. Papers have described the use of simulated patients in assessment and teaching (Burbach et al., 2015; Cioffi, 2001). However, the focus of the papers was how the teaching was delivered and the simulation itself rather than how actors were briefed and their interaction with the students.

The results of my study indicate that the skills of the person role-playing a patient are important. They must have a good memory otherwise the constant checking of the script detracts from the teaching. They also must play the role realistically as the students valued the realism of the actors and it appears that the more realistic the case is the more the students positively rate the teaching. This may be because the students can directly relate what they are learning to the reality of patient care and this validates their learning for them. It also highlights the relevance of the learning to them.

One of the important steps in lesson planning is agreeing what the students need to learn and indicating the relevance of something that helps them to identify why it is important. Ng (2014) uses Gagne's (1985) instructional design to highlight this point. Two of the stages in Gagne's design are gaining attention and informing the learner of the objectives. Ng indicated that discussing when the students would use the skill they are learning would gain their attention. He also felt that discussing why the students had the learning objectives they had rather than just telling them what they are would make the learning more meaningful. The realism of the teaching is a way to make the relevance of the material clear to the students and may explain why consulting with an actor was considered important by the students. Earlier in the literature review the importance of authenticity in teaching clinical reasoning was raised by Postma and White (2015) and this finding in my study reinforces their suggestions. The realism of the case and the acting appears to have made the teaching authentic for the students and may explain why it was considered important enough for them to mention in the feedback.

In terms of clinical reasoning the simulated patient needs to follow clear directions about how much information to give the student without seeming obstructive and this can be a fine line to walk. The use of actors, who were trained to respond to direction and who could 'get into the shoes' of the patient, appeared to enhance this session. As well as good actors, good briefing material is needed for them as indicated by the inclusion of unnecessary information in the scenario used for this teaching session.

Stop-start method

One of the key findings from this study from several of the data sources used is the importance of the students actively working through the reasoning process and getting feedback and explanations about what they are doing. The evaluations of the teaching session indicated that a specific area of the reasoning process was undertaken during the teaching sessions when students had to assess where they had got to and then decide on questions to ask and how the answers would be used in assessing the case. The stop-start method allowed the students to start thinking about the reasoning process and to practise it during history-taking rather than once they had gathered all the information from the patient. This is an area of teaching not discussed in the literature in relation to a consultation with a simulated patient. Having said that, the stop-start method can be compared to recent suggestions in the literature regarding the use of "think aloud" protocols to help teach clinical reasoning skills in nursing (Burbach et al., 2015; Pinnock et al., 2016). These studies indicate that asking students to think aloud when working through a patient problem helped them to understand their clinical reasoning and that observing a tutor thinking aloud made the reasoning process explicit. These were done when presenting cases rather than during an actual consultation. My study builds on the suggestion that thinking aloud helps students to learn clinical reasoning skills by indicating that it may encourage them to think about the reasoning process and practise it during a consultation.

Another area to consider in terms of when the students start to use reasoning is whether one of the threshold concepts might be realising that reasoning starts as soon as you see the patient. The students who have not grasped this concept may be leaving it late to start their reasoning process as indicated in the focus groups. In this case taking the students through the thought process step by step during the history-taking will highlight to them the importance of reasoning through potential causes of the patient's symptoms early. A more in-depth assessment of when students start to reason needs to be conducted to indicate if this an area to target during their undergraduate years. A think aloud study of how they are reasoning when consulting with a patient would help to explore this cognitive area in a more objective manner than the focus groups or questionnaires.

The focus group in the early stages of my study indicated that thinking time was something needed to allow the students to work out answers to questions rather than using memorized phrases. Stopping and starting gives the students time to think about and discuss questions to ask and what the data means with each other. This reinforces the finding in the focus group that teaching sessions around clinical reasoning need time built in them to allow students to think rather than just to react.

The stop-start method also seems to have built some safety into the session as students described it as relaxed. This is even though the students had to consult with a patient in front of their colleagues.

Another factor that may have contributed to the relaxed atmosphere is that the students had had teaching sessions around the causes of acute confusion and its assessment prior to this teaching session. This meant the students went into the clinical reasoning session with the required knowledge for the consultation and this could have reduced the anxiety of getting the possible causes of the confusion wrong. One indicator suggesting their anxiety was reduced is that many students felt that more of them should have had an opportunity to consult with the patient despite it being in front of their peers.

One of the issues discussed by tutors in the focus group was that students may not know what is expected of them when reasoning and it might be one reason the students are not using critical reasoning skills. The stop-start method allows the tutor to take students through what is expected of them and this may be a reason it was rated positively by the students.

Tutors

The tutor selection and briefing seems to have been successful, as indicated by the students who found the sessions relaxed. This suggests that it was a safe environment whilst it also provided challenge. It is interesting to note that getting students to justify their answers and explain their thoughts was a positive aspect rather than a negative one. The tutors were also able to get the students to think broadly across the specialities when considering the possibilities for diagnoses. They were all GPs so they all felt comfortable doing this. I am not sure if the result of thinking across all systems would occur if specialists were to teach this session. It is possible that they would with a case of confusion as it lends itself to cross-systems thinking but it would need a study to find out if this was the case, as there is a possibility that specialists are more likely to focus on the body system they are comfortable with.

Asking tutors and students to think aloud through their reasoning and explain their cognitive processes was discussed in my literature review as a potential method for teaching clinical reasoning skills. Pinnock et al. (2016) suggested that students found the instant feedback from thinking out loud in front of a supervisor useful. I critiqued their study for its small sample size but my findings reinforce its results in that I found students appreciated instant feedback and an insight into how their tutors think when using a think aloud approach.

The evaluation from the teaching sessions suggests the students were using metacognition, in that they were aware of their own thought processes when considering the possible causes for the patient's presentation and justifying their decisions. The question is whether they would continue to use metacognition once a tutor is not present pushing them to think aloud. There are some suggestions earlier in the literature review that metacognition is important in the reasoning process, for example it can help the clinician to consciously override intuitive processes. If using the think aloud approach stimulates metacognition as my study suggests, it may help students to develop the skills for doing things such as overriding intuitive processes. Despite Cleary et al.'s (2015) study suggesting negative feedback causes students to move away from strategic thinking, this research suggests that feedback was a positive factor and helped students to understand what is expected. This reinforces the possibility that it is not the negative feedback itself that causes students to move away from strategic thinking but the way in which it is given.

It is interesting to note that Cleary et al's (2015) research did not find a correlation between the students' reasoning ability and metacognition but the students in my study found that thinking about their reasoning and justifying their decisions helped them understand the process. The impact of metacognition on the ability to teach and learn clinical reasoning is an area that needs further research.

Resources

One of the issues with this teaching session was the use of resource and its availability, in this instance the resource being time and funding for actors, tutors and training. The students made some sensible suggestions for improving the teaching session by including more scenarios with different outcomes or extending the session. However, this would require more tutor and actor time. The main restriction that I found when running this pilot was the availability of tutor time, which made the session only an hour long and meant a mutually suitable time for training could not be found. One way to overcome this might be to recommend that this style of teaching is rolled out to be delivered several times during the curriculum in place of other sessions that may not be working as well.

Currently the medical school's curriculum uses small group teaching and actors for the consultation skills element of the student learning. Some of these sessions are aimed at diagnostic history-taking and this is an area that could be reviewed to see if the new teaching style would improve the teaching. For example, during these sessions the student takes a full history and then the possible diagnoses are discussed with the tutor and the students receive feedback on their communication

skills. If these sessions are altered to the new style, this would mean the additional resource required would be less as tutor time is already budgeted for this teaching and actors are already used.

The small group approach seems to have been appreciated by the students and an important factor in its strength was using the group to support the teaching and make suggestions for questions. The interaction in small groups is something to preserve in future sessions.

I noted that several of the students wanted clear answers to the question and concreteness about what they should do. This was despite the learning outcomes indicating the session was about developing a management plan and considering different diagnoses. For me this raised several questions: had the students grasped the concept of the session, that there is not always a clear management path and it often needs to be thought through? Were they grappling with the lack of "buzz" words and the lack of a well formulated history? Or would it have been reasonable to be given a clear pathway for this particular scenario? I have concerns that giving a clear answer to the diagnosis and how the condition should be managed might have sent the wrong message and helped perpetuate the formulaic thinking that we are trying to avoid. But the number of students indicating this problem was small compared to feedback in other sessions in the past and perhaps the new session had enabled others to grasp the concept of reasoning things through rather than looking for a formula to give the answer.

Summary of Conclusions and Recommendations for Teaching Sessions

Several key factors appear to be important in designing a teaching session around clinical reasoning. The nature of the scenarios is important as they must be written so that the information in the history is non-specific so that more than one diagnosis is a possibility while it is not so non- specific so that everything is a possibility to allow for reasoning. They also need to be broad enough to allow for thinking across systems. They should be well-written to allow actors to play the simulated patient role realistically. The actor playing the scenario needs good acting skills and to be able to follow clear direction. The brief they receive needs to be clear about what information they give the students and when.

The tutors need to have the skills to encourage the students to apply knowledge to the scenario through interaction and to avoid reverting to lecturing the students. They need to be experienced in working with the knowledge being used and should use anecdotes and personal experience of the reasoning process to support their teaching. It may be beneficial to use tutors who are used to

working across systems but this area needs to be explored more fully. The tutors need to be able to engender a feeling of safety within the group being taught so the students are comfortable volunteering information and taking part. There are some indications in this study that the tutors need to have a high level of metacognition themselves.

Students need to use the clinical reasoning processes themselves and receive feedback regarding their thought processes and explanations about how the reasoning process should run. Asking students to clarify and justify their decisions in terms of questions they ask and what the data means helps them to move forward in the reasoning process and this is one way that they can be challenged. The teaching sessions need to allow time for the students to think when they are being challenged in their cognitive processes and when they are explaining their decisions. The stop-start method combined with a think aloud approach is a method that can be used to achieve this when students are consulting with a simulated patient.

Assessments and teaching materials around clinical reasoning need to avoid the use of “buzz words” or certain formulas. This can be done by writing cases that have several diagnostic possibilities and making it clear to the students that the assessors and learning outcomes look at the process the students are going through, not whether they have the right diagnoses.

Further research into how novices use the clinical reasoning process is needed. The results from the focus groups suggests that students use inductive reasoning and leave it late to start the reasoning process. They also try and use pattern recognition using “buzz words” very early on in their career. This approach leads to the risk of early closure and assumptions about what is wrong with the patient. If the findings are confirmed educators will need to develop teaching strategies to overcome these issues.

As well as exploring how the undergraduate novice reasons, further work in developing the novice to expert continuum would be a useful addition to medical education. Having an idea of how learners need to develop expertise makes it easier to assess where the learner is at and then move them on. It would make learning more student-centred, as the teacher after assessing where the students are at could tailor their teaching accordingly.

Chapter 6 Validation and Overall Conclusions

Validation

It has been suggested that action research consists of two types of validation, social and personal (McNiff & Whitehead, 2010b). For personal validation I compared the findings to my own beliefs and values as recommended by McNiff and Whitehead. I found that my beliefs matched many of the conclusions in the study but there were some conclusions that I had not thought of and that do not appear in the literature. These conclusions are mentioned below as I presented them along with all my conclusions for social validation.

For social validation I used the approach described by some authors which is to ask whether person reading the data you have would reach the same conclusions as you. Cohen et al. **(**2011a) and Coghlan and Brannick (2010d) suggest that you should allow your results from an action research project to go for public scrutiny. In the initial stages of my study I sent the results of the focus groups out to the participants and invited comments for corrections or alternative views thus allowing scrutiny at this stage. A further episode of public scrutiny of the results occurred when I presented the results to my colleagues in the university department for discussion. My colleagues confirmed the consistency and authenticity of most of the findings, but were taken aback to learn that the students do not start clinical reasoning until late in the consultation. However they felt on reflection that this was a possibility as we teach the students to take a history, do an examination and then decide upon possible diagnoses.

Some of my conclusions are further validated by the link between the results of student feedback, the focus groups and the literature. However one aim of this project is to create new knowledge and there is potentially an alternative theory arising from this study in relation to the processes novices use in clinical reasoning. In the literature review I discussed current thinking that students use hypothetical deductive reasoning but my study suggests that some of them may use inductive reasoning instead. It has been validated through the email to the participants but a further investigation using a think aloud protocol which would explore what was happening when the students are working through a case without tutor feedback would enhance this validation further. It would be particularly important to do further validation in view of the number of participants in the focus groups.

As well as suggesting inductive reasoning as an approach used by students this thesis has identified that students need to be considering the possible diagnoses whilst taking a history. Suggestions as to

how students can be taught to reason during their history taking have been developed and an evaluation suggests that these suggestions may be effective. These suggestions can be applied in other medical schools and modified to suit their curriculum, an example of this might be modifying and using the tutor briefing notes.

The concept of “buzz words” and their impact on learning clinical reasoning was a significant finding for my thesis that came from the student focus group. The validity of this finding was reinforced when I came across the phrase in a teaching session with other students who indicated that they had decided a patient had a particular condition because they had travelled. When questioned further they informed me that travel in a patient with shortness of breath was a “buzz word”. Further research would help to explore the extent to which buzz words are used and if they are troublesome knowledge and prevent students from using the reasoning process.

Further investigation into whether novices use hypothetical deductive reasoning, inductive reasoning or try to develop pattern recognition is needed. If the students are using inductive reasoning and not thinking about the possible diagnoses early in the patient’s history it could be argued that the concept of testing hypotheses is a threshold concept in clinical reasoning. If it is confirmed that it is a threshold concept then educators can explore how they can help students to grasp the idea of reasoning throughout the history taking.

Limitations

Despite my comments on validation, there are several limitations to the study which may potentially affect its validity. Some of the findings relate to the curriculum where I work such as the systems approach to undergraduate medical teaching and clinical contact from first year. The findings of this study may not be relevant to a curriculum designed in a different way. For example students from a curriculum that organises its teaching by building knowledge before clinical contact may have different perceptions of what helps them to learn clinical reasoning. Due to lack of experience consulting with patients in their earlier years they may perceive translating information given by an actor into medical concepts as more challenging than the students I work with. On the other hand they may not find potential lack of knowledge as concerning if their students’ knowledge content is built in more detail in the first few years of the curriculum compared to ours.

The research was conducted by an insider so there is significant potential for bias. The students in the focus group may have been answering questions in a way they thought the researcher wanted them answered and colleagues may have been biased in the answers by being aware of the interests

of the researcher. I tried to address this during my study by identifying my own thoughts and beliefs in completing the focus group questions and comparing them to the results and keeping a record of my own ideas. During the focus group discussions I advised the participants that I wanted to hear their ideas and thoughts. However, during the discussions I was aware that students appeared to assume I was looking for answers related to my course. I often needed to remind them I was looking for information about all their curriculum. I think trying to resolve insider issues is challenging and one way for me to try and do this in future research as an insider is to arrange for someone who is not a part of the teaching staff to run the focus groups.

Another potential source of bias is my interpretation of the literature and data. As well as inviting the study participants to comment on my interpretations I used the feedback and comments from my supervisors as a source of critique for my interpretations.

Only having three students in the focus groups meant that the study had a narrow perspective from the students prior to the new teaching sessions. They may have been part of a very enthusiastic minority who have insight into clinical reasoning or they may have been a few students who are very unhappy with the teaching, in which case their opinions may not be a true reflection of the whole student body. The other issue to consider is that the small number may have made the students reticent to talk and it will have provided less opportunity to bounce ideas off each other. This may have been exacerbated by my presence and the fact they were not anonymous to me. This means important themes may not have been raised within the student focus group. However, the results from the focus groups appear to agree with the results from other data sources.

The evaluation from the teaching session which was developed as a result of the data from the focus groups indicates that the concepts raised by the focus group students were valid. The session was valued by the student body and the changes made because of the focus groups results are some of the positive aspects drawn out in the evaluation of the session. However, given the small number in the focus groups, further research needs to be done to explore some of the hypotheses developed from this study. These hypotheses, which I will go on to discuss further, cannot be confirmed from the evaluation of the teaching session but are important in curriculum design.

One drawback of social validation through presentation of the results and discussions with colleagues is that your colleagues may view you as the expert in the area. This may occur because of the background reading and studying that has been done to produce the results. An ideal approach to validation would be to have another person look at the primary data from the focus groups and teaching evaluation to see if they would draw the same conclusions as you or to see if they can offer

alternative explanations. This approach is particularly useful if new ideas and theories emerge from the data. As this research has been conducted for a thesis it was important to ensure the work and critical thinking was my own.

The evaluation of the teaching session was conducted at a low level on the Kirkpatrick scale (1994). This means that although the students felt they learned from the teaching, it may not be the case when assessed objectively. The other problem with the immediate evaluation of the teaching sessions is that it does not ensure the learning stays with the students in the long term. Earlier in this paper I highlighted that it is problematic to explore the long-term impact of one teaching session because it cannot be assumed that evidence of learning a year after a session is a result of the one event. One way to evaluate the long-term impact of the new teaching sessions is to use a mixed method approach once the teaching sessions are rolled out. One method should be to explore any changes to results in assessments which involve students in a clinical reasoning task after the roll out. This would look at long term learning. The second method would be to investigate from a student perspective where clinical reasoning is learned to help identify if the new sessions are contributing to their learning. Even with this approach it may difficult to confirm fully if the new type of teaching has a long-term impact on learning.

The other aspect to consider is the tutor's evaluation of the teaching sessions. It was not recorded and it relied on note taking and my interpretation. Although I confirmed my conclusions at the end of the discussion with the tutors, there is a possibility that the tutors were influenced by my statements and may have changed their own perceptions as a result of what I had stated. Not using the questionnaires also means I have missed the opportunity to see what they think as individuals. This may have raised issues that the participants did not want to discuss in front of colleagues.

Overall Conclusions

This study has identified some potential principles and concepts that are important to consider when designing a curriculum to teach clinical reasoning. This section will discuss these and some recommendations that arise from them.

Experience

The literature review indicated that experience is an important aspect in helping students to build their schemas. Norman et al. (2007) summarise this in their article when they suggest that experience in dealing with multiple examples of patient presentations helps the learner to develop

an appropriate bank of previously encountered situations. As the learner becomes more expert this bank of encounters is used to inform the reasoning process.

The importance of experience was reinforced by the focus groups. The tutors felt that experience in making decisions during clinical reasoning and seeing the outcome of the decision was important and students found that experience in using the clinical reasoning process was important. The evaluation of the new teaching session indicated that one of its strengths was providing the students with an opportunity to practice the clinical reasoning process.

One of my recommendations for the future, when discussing curriculum changes, will be to ensure that activities which require students to use the reasoning process are not reduced. Currently the medical school I work at is looking at taking on more students and this will increase the number of students per patient. If the student numbers increase the educators need to ensure that they find a way to increase the patient pool or that the loss of patient contact is replaced with learning opportunities which allow students to practise clinical reasoning. This principle is also important for other universities who might face the same pressures on patient contact.

Biomedical knowledge

While experience in clinical contact is important, it is also important to ensure that students learn the biomedical knowledge that is required for the reasoning process. One of the issues highlighted in the focus group discussions was that the fear of not knowing the correct knowledge might prevent students from making the decisions needed for their learning. However to become experts the students need to be able to encapsulate their link to their biomedical concepts with their clinical knowledge (Boshuizen & Schmidt, 1992). More recently Woods (2007) did a review of the literature and supported this theory of encapsulation that was discussed in more depth in my literature review.

Woods also looked at the literature on memory and studies that looked at how biomedical knowledge related to student learning of clinical reasoning. She concluded that simply learning the signs and symptoms of a condition would be affected by the natural decay in memory that occurs as a result of simply learning facts. She suggested that using biomedical knowledge and understanding why the symptoms occur leads to the information going into long term memory. She used several papers to make her point but does not provide a critique of them and uses them as a support of the theory. Despite this her suggestions seem to make sense and do relate to the theory of memory. She

goes on to suggest that the educators should allow learning opportunities that enable the students to see how biomedical knowledge links to clinical practice.

My recommendations for curriculum design are to allow opportunities within the curriculum for students to link their biomedical and clinical knowledge and to ensure that students have the knowledge needed for the cases they are asked to use when learning clinical reasoning.

Novice to expert

In the literature review it was identified that novices and experts reason differently and this was borne out by my study. My thesis suggests that students use inductive reasoning rather than the hypothetical deductive approach as the literature suggests. This could be as a result of teaching the students to start to list possible diagnoses after taking a history rather than thinking of a list whilst taking the history. Although recent literature as discussed in my review suggests students use hypothetical deductive reasoning there is a paper from many years ago suggesting that this approach leads to inductive reasoning which in turn leads to the risk of making assumptions about the diagnoses rather than testing diagnostic possibilities to find the most likely one (Overholser, 1993). Although this is an old paper the argument is well reasoned and would explain the diagnostic errors described by Croskerry (2003a) and Elstein et al. (1978) of deciding upon the diagnosis too early and not ensuring it is correct.

The recommendation I would make to any medical curriculum to help overcome this is to include learning opportunities that encourage students to start reasoning as soon as they take a history. The current teaching for clerking gives the students a structure which provides possible questions to ask the patient and reminds the student of the steps involved in the diagnostic encounter so it is a useful part of their learning which should remain. Rather than remove it, the clerking structure can viewed as the first step on the novice to expert continuum in providing rules for the students to learn before they go on to grasp the concept of using the questions to test hypotheses.

In my literature review I identified that the learning experience for clinical reasoning needs to be altered as the students become more expert. I have suggested Schmidt and Mamede's (2015) model to map the alterations against but I would also recommend that the educators remember to teach multiple methods of reasoning rather than just relying on schemas alone.

Sharing my Information

The findings from the initial data collection cycle were sent to study participants inviting them to comment on them. They were also offered an opportunity to see a copy of the final report.

Although I have been researching in my own context and action research is looking at my own practice my study findings have identified some new concepts that are important to anyone teaching clinical reasoning. Due to the fact that clinical reasoning is an important topic for medical students, the findings of my study are relevant to the tutors locally and other medical schools so I plan to disseminate the results beyond the university. In this section I will look at how I have already shared the results locally and how I plan to share them more widely.

Locally

I disseminated the results to curriculum designers and teachers by presenting a report of the findings and any recommendations from the study at an academic meeting within the medical school. At the meeting those involved in writing OSCE stations planned to review their stations with a view to removing any buzz words from them. It was also agreed to roll out the new style teaching sessions and provide a series of them to year three students. It was thought that the consultation skills curriculum would be a good place to include more of these sessions as they already have funding for actors. As part of this roll out I will be delivering workshops and presenting the findings at staff development sessions for tutors who will take part in these sessions.

There is a new tutors' induction program for those who teach consultation skills, so the training for the clinical reasoning sessions can be carried out. This will help with the resources issues identified in the previous chapter, because extra resources will not be required other than time within the training days.

Once the series of new sessions have been rolled out, they should be evaluated at a higher level on Kirkpatrick's (1994) hierarchy to see if the sessions impact on learning. To do this another cycle of the action research should be carried out and a methodology to evaluate the sessions developed. This methodology may use the think aloud protocols to see if cognition changes or it could use assessments to see if there is a change in results in relation to clinical reasoning. One drawback with using assessment as a measurement of change is that teaching elsewhere in the curriculum may be the reason for any improvement.

More widely

I will be running a workshop that shares the results of my study and explores the implications in curriculum design at the national educators' interest group in clinical reasoning (CReME) conference.

My Personal Learning

As I gathered data about how the students learned clinical reasoning I learned a lot about my approach to teaching and its effectiveness. One of the key findings for the project was the critical importance of providing a safe environment for asking questions and to give time for students to think. This is something I did not pay much attention to in the past so the study made me reflect on whether I do this. If I am completely honest I suspect I did not give students time to answer questions and think and now I actively pause for about 30 to 60 seconds to allow students to think when asking a question. I also allow and do not penalise them for discussing the answers with others before answering. In terms of providing a safe environment I provide feedback to incorrect answers by indicating I can understand why the student might think that but actually the answer is something different. Since doing this I have found this approach seems to encourage more willingness on the part of students to ask and answer questions.

In terms of leadership, before this project I had assumed that everyone was able to deliver interactive teaching and was surprised at the comments about tutors reverting back to lecturing. As a leader it is my role to ensure tutors are provided with training in the teaching methods they are expected to use and I should not assume everyone understands what is required in a teaching session. As a result of this reflection I have started to send out more detailed briefing notes and to offer tutor development for those who teach clinical reasoning. In future as new tutors join the team they will be asked to spend time shadowing others teaching clinical reasoning to get a feel for how it should be delivered.

As well as learning about how to deliver my teaching and the general principles in curriculum design, conducting this research has helped me to learn more about data gathering. One of the challenges of this study was recruitment of students for the focus groups. Although in this study the number of participants was not crucial due to having several data sources to confirm my findings, in other studies it would have significantly impacted on the validity of the results. For example if I was conducting a study and just used focus groups for data collection, as discussed in my methodology section, I would have needed significantly more participants in the focus groups to make the results valid.

I have come to realise there is a tension between protecting students in a vulnerable position and gathering meaningful data to inform future developments. I have questioned whether we are being fair to the students by protecting them to such a degree that we cannot gather enough data to find out their viewpoint and ensure we are making appropriate decisions in curriculum design. Their viewpoint is so vital to understanding the impact of how teaching is delivered and to understanding how what we are doing is perceived. Without their input we may design teaching that is not achieving what we want from it. We can gather feedback from them and this can be useful and we can do curriculum evaluations without needing ethical approval. If these results are to be shared in publications and presentations then we need their permission to gather and use the information in order to gain ethical approval. However it could be argued that it is unethical not to share data about what works in a curriculum and what does not to allow other institutions to learn from our results. It could also be argued that it is unethical to instigate innovations and not fully explore the best way to bring them in by seeking the student view.

Another lens through which I looked at the issue of using students in studies was their vulnerability. I agree with the principles of protecting students and not putting them under pressure but this experience has left me asking whether the students feel particularly pressurised to take part in research studies. I wondered if asking them directly during a lecture to the whole year or via a personal email account would make a difference to the pressure they feel. To help me explore this issue further I have discussed the issues I had with colleagues who had gained ethical approval to use this more direct approach. They reported that they still struggled and it did not affect their recruitment rate. In the end they offered book tokens to those taking part in studies. This drastically improved the uptake of the study. I am also aware that our BMSc students have similar issues in recruiting their colleagues.

As a result of this reflection I plan to challenge some of the ethical assumptions made regarding to the pressure students feel under when asked to take part in research studies, by developing a study exploring students' perceptions of being asked to take part in studies by university staff and the pressure they feel to take part. This will provide an objective view of the issue from the viewpoint of those we are trying to protect and can be used to inform ethics discussions in the future. I will also consider using rewards such as book tokens as an incentive for students to take part in research studies.

My second main learning point was the challenges in a larger study requiring the integration of multiple data sources. I found it challenging not to concentrate on one source. I had a tendency to

think about and reflect on the most recent data source that I reviewed. When I conduct action research in future I will tabulate the results of the first data set and add new information and themes to the table rather than using a diary format to record my learning. This will help to ensure I do not forget ideas or themes that occur early in my research. This is because with the diary method I discovered that I was not going back to previous entries early enough when considering my conclusions, whereas using a table will mean I revisit those ideas every time I look at the table.

Lastly, I learned that it can be challenging conducting ideal research within your own organisation, an example being the questionnaires for the tutors. In future when conducting insider research, I will be more proactive in finding out how the participants are willing to take part before submitting paperwork for ethics. If I had discussed how the new session were to be evaluated with my colleagues I would have been aware that a discussion was needed and would have applied for ethical approval to record the discussion.

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Appendices

Appendix 1

Tutor Participant Information for study entitled Teaching Clinical Reasoning Skills to Undergraduate Medical Students: An action research study

.

As part of her doctoral degree Dr Lockwood is conducting a study into how clinical reasoning can be taught. She will be conducting the study as a researcher and not in her role as a tutor.

You are being invited to participate in a research study exploring the barriers to learning clinical reasoning and the things that help you to understand the skill. Before you decide whether to participate, it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and feel free to ask us if you would like more information or if there is anything that you do not understand. You do not have to accept this invitation and should only agree to take part if you want to.

Thank you for reading this.

1. What is the purpose of the study?

Clinical reasoning is core skill that all doctors need to learn. This study aims to gather information that can be used to help develop teaching sessions that enhance the ability of students to use clinical reasoning. Data collected from the focus groups that you are being invited to be part of will be used to help design and plan teaching sessions around clinical reasoning and to inform curriculum development.

2. Why have I been chosen to take part?

I have invited all tutors involved in teaching clinical reasoning skills to year 1 to 3 medical students to take part. I am interested in the views of tutors regarding where students get stuck with their clinical reasoning and when they seem to leap forward in their understanding. You have been invited as one of these tutors.

3. Do I have to take part?

No, participation is entirely voluntary and you can chose to withdraw at any time in the study without any consequence.

4. What will happen if I take part?

You will be asked to take part in a focus group meeting lasting up to an hour. The focus group will consist of up to 8 tutors from different disciplines. Dr Lockwood will be conducting the focus group and analysing the results. You will be asked to comment your experiences of teaching clinical reasoning skills. The focus groups will be held in either the meeting rooms in Ninewells or in a meeting room in the Mackenzie building.

The focus group discussion will be audiotaped with the permission of the participants and the electronic files transferred to a password protected computer with 24hours. The files on the recorder will be deleted.

Once the results of the focus group discussions are summarised you will receive an email of the results and will be asked to give comments and feedback on them.

You will be asked to keep the identities and contributions of other focus groups members anonymous and confidential.

5. Are there any risks in taking part?

You will be discussing your experiences in teaching in clinical reasoning and ideas with colleagues. If you feel uncomfortable doing this at any time during the focus group you can withdraw.

You may be recognised by other participants in the focus group and they will be aware of any comments that you make. All the participants will be asked to keep the discussions within the focus group confidential and not to reveal the identities of those taking part.

All participants will be asked to keep the content of the focus groups discussion confidential.

6. Are there any benefits in taking part?

The knowledge gained from the study will help tutors understand where students are getting stuck when learning clinical reasoning and the important concepts they need to grasp. The information will also be used to develop a teaching session about clinical reasoning and develop some principles based around teaching it that can be presented at curriculum committee meetings to provide information useful in curriculum design.

As a tutor the discussions from the focus group may provide valuable ideas and insights from colleagues that you can use in your teaching practice.

7. Are there any reimbursements?

There is no reimbursement for taking part in the study

8. Data Storage

Within 24 hours of the focus group the file will be downloaded to an university password protected computer and the file on the audio device deleted. The audio data will be transcribed for analysis. The files will only be accessed by the researcher. The data on the password protected computer will be kept for 5 years before being deleted.

The paper copy of the data from the transcriptions will be filed for 5 years in a locked filing cabinet.

9. What if I am unhappy or if there is a problem?

If you are unhappy, or if there is a problem, please feel free to let us know by contacting Janet Strivens at (strivens@liverpool.ac.uk) or Dr Lockwood (penny.lockwood@online.liverpool.ac.uk) and we will try to help. If you remain unhappy or have a complaint which you feel you cannot come to us with then you should contact or the RPA at (USA number) 001-612-312-1210 or email address liverpoolethics@ohecampus.com. When contacting the RPA, please provide details of the name or description of the study (so that it can be identified), the researcher(s) involved, and the details of the complaint you wish to make."

10. Will my participation be kept confidential?

Yes. The audio file will be stored on a password protected computer and transcribed without any personal identifying information. Each tutor's transcription will be assigned a number so you can't be identified.

Only the researcher and other members of the focus group will be aware you have taken part. You will not be identifiable when the data is shared with tutors and curriculum designers

After the focus group your data can't be identified due to being anonymised and so can't be removed from the study after this point.

All members of the focus group have signed to agree to keep your participation confidential and anonymous.

11. What will happen to the results of the study?

The results will be shared with tutors and the curriculum design team. The finalised results will be presented as part of a thesis to supervisors at Liverpool University for assessment. There is also a possibility the results will be published. You will not be identified in any publications and your data will be anonymous

12. What will happen if I want to stop taking part prior to anonymisation?

Contact Dr Lockwood at penny.lockwood@online.liverpool.ac.uk and she will remove your data from the study.

13. Who can I contact if I have further questions?

Appendix 2

The institution's Research Ethics Committee has reviewed and approved the study.

Student Participant Information for study entitled Teaching Clinical Reasoning Skills to Undergraduate Medical Students: An action research study

As part of her doctoral degree Dr Lockwood is conducting a study into how clinical reasoning can be taught. She will be conducting the study as a researcher not as your tutor. She is also refraining from being an OSCE examiner for your year this academic year. You are being invited to participate in a research study exploring effective methods for teaching clinical reasoning. Before you decide whether to participate, it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and feel free to ask us if you would like more information or if there is anything that you do not understand. You do not have to accept this invitation and should only agree to take part if you want to.

Thank you for reading this.

1. What is the purpose of the study?

Clinical reasoning is core skill that all doctors need to learn. This study aims to gather information that can be used to help develop teaching sessions that enhance the ability of students to use clinical reasoning. Data collected from the focus groups that you are being invited to be part of will be used to help design and plan teaching sessions around clinical reasoning and to inform curriculum development.

2. Why have I been chosen to take part?

You have been invited to take part because you have had experiences in learning clinical reasoning skills. This study is aimed at improving how the skill is taught to year 1 to 3 students. The students' perspective on what has worked well and what has created a barrier in learning clinical reasoning is important as sometimes they will see things educators might not. Your insight into the teaching in this area will help to the researcher to develop improvements in how this area of the curriculum is taught.

As a student in the first 3 years of the medical course you will be able to the researcher insight into whether certain approaches are being used too soon in the curriculum and highlight what you have found useful.

3. Do I have to take part?

No, participation is entirely voluntary and you can chose to withdraw at any time in the study.

4. What will happen if I take part?

You will be asked to take part in one focus group which can last up to an hour. The focus group discussion will be audio taped with **the permission of the participants**. Within 24 hours of the focus group the audio file will be downloaded onto a password protected computer and the file deleted from the tape recorder. The data on the computer will be stored for 5 years before being deleted. The focus groups will be held in either the meeting rooms in Ninewells or in a meeting room in the Mackenzie building

During the discussion you will be asked about your experiences whilst learning clinical reasoning skills. You will also be asked to highlight things which made it difficult to learn the skill, things which made it easier to understand and any suggestions for developing a teaching session around them.

You will be asked to keep the identities and contributions of other focus groups members anonymous and confidential.

Dr Lockwood will be chairing the group and analysing the anonymised results.

Once the results of the focus group discussions are summarised you will receive an email of the results and will be asked to give comments and feedback on them.

5. Are there any risks in taking part?

All the data will be stored on a password protected computer in an anonymised format. Other colleagues in the focus group will hear your views regarding how clinical reasoning is taught and learned.

You may be recognised by other participants in the focus group and they will be aware of any comments that you make. All the participants will be asked to keep the discussions within the focus group confidential and not to reveal the identities of those taking part.

The focus group discussion will explore your thoughts on how clinical reasoning can be taught. Dr Lockwood will steer discussions way from individual strengths and weaknesses as this is not the area under research.

No action will be taken as a result of comments made during the focus group discussion.

If as a result of the discussion you feel uncomfortable during the focus group any time during the focus group you can withdraw. There will be no penalties for doing this.

6. Are there any benefits in taking part

The knowledge gained from the study will help tutors understand where students are getting stuck when learning clinical reasoning and the important concepts they need to grasp. This information will be used to develop or improve upon existing sessions for teaching clinical reasoning skills. These sessions will be delivered within the curriculum and will increase the likelihood that students will develop a high level of competence in clinical reasoning.

On a personal level having the opportunity to discuss clinical reasoning and how it can be taught can help you to gain a deeper insight into this skill.

7. Are there any reimbursements?

There is no reimbursement for taking part in the study.

8. Data Storage

Within 24 hours of the focus group the file will be downloaded to an university password protected computer and the file on the audio device deleted. The audio data will be transcribed for analysis. The files will only be accessed by the researcher.

The data from the focus groups will be filed for 5 years as paper transcripts stored in a locked filing cabinet. The data on the computer will be filed for 5 years before being deleted.

9. What if I am unhappy or if there is a problem?

If you are unhappy, or if there is a problem, please feel free to let us know by contacting Janet Strivens at (strivens@liverpool.ac.uk) or Dr Lockwood (penny.lockwood@online.liverpool.ac.uk) and we will try to help. If you remain unhappy or have a complaint which you feel you cannot come to us with then you should contact or the RPA at USA number 001-612-312-1210 or email address liverpoolethics@ohecampus.com. When contacting the RPA, please provide details of the name or description of the study (so that it can be identified), the researcher(s) involved, and the details of the complaint you wish to make."

10. Will my participation be kept confidential?

Yes. The audio file will be stored on a password protected computer and transcribed without any personal identifying information. Each student's transcription will be assigned a number so you can't be identified.

Because the data from the focus group will be stored in an anonymous format I will not be able to remove your data from the study after the focus group.

Only the researcher and other members of the focus group will be aware you have taken part. You will not be identifiable when the data is shared with tutors and curriculum designers.

All members of the focus group have signed to agree to keep your participation confidential and anonymous.

11. What will happen to the results of the study?

The results will be shared with tutors and the curriculum design team. The finalised results will be presented as part of a thesis to supervisors at Liverpool University for assessment. There is also a possibility the results will be published. You will not be identified in any publications and your data will be anonymous

12. What will happen if I want to stop taking part prior to anonymisation?

Contact Dr Lockwood at penny.lockwood@online.liverpool.ac.uk and she will remove your data from the study.

13. Who can I contact if I have further questions?

Dr Penny Lockwood

Address removed to provide institutional anonymity

If you have any concerns about clinical reasoning skills after taking part in the study please contact Dr Lockwood who will arrange for you to meet up with an appropriate tutor to discuss them further and give feedback if needed.

The Institutional Research Ethics Committee has reviewed and approved the study.

E-mail requesting participants to take part

Dear Students,

I am contacting you to ask if you would be willing to take part in a focus group study exploring how the teaching of clinical reasoning can be improved. The focus group will last between half and one hour. You will be asked to discuss what you understand about clinical reasoning and learning experiences that have helped you to develop your clinical reasoning ability.

An information sheet and consent form are attached to this email for you to look at. If you are willing to take part please e-mail me at p.lockwood@ to let me know.

I look forward to hearing from you.

Best wishes Penny

Dear Tutors,

I am contacting you to ask if you would be willing to take part in a study exploring how clinical reasoning is learned and the best way to teach it. The study consists of focus groups which will last between half and one hour. You will be asked to discuss what teaching strategies you have found successful when looking at clinical reasoning and what elements of the curriculum helps students to learn about it.

Can you pass this email on to any tutors who teach clinical reasoning within your system. If you or any of your colleagues are happy to take part in the study please contact me at p.lockwood@ .

A participation information sheet and consent form are attached to this email.

Best wishes Penny

PARTICIPANT CONSENT FORM

Title of Research Project: Teaching Clinical Reasoning Skills to Undergraduate Medical Students: An action research study

Researcher(s):Dr P Lockwood

Please initial box

1. I understand that I may be recognised by other participants in the focus group but they have signed to agree to maintain confidentiality and anonymity. Outside the focus group confidentiality and anonymity will be maintained and it will not be possible to identify me in any publications ☐

2. I understand other members of the group may be known to me and that I should not disclose the identities of those taking part to any other parties. ☐

3. I confirm that I have read and have understood the information sheet dated ------ for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily.

4. I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason, without my rights being affected. In addition, should I not wish to answer any particular question or questions, I am free to decline. ☐

5. I understand that, under the Data Protection Act, I can at any time ask for access to the information I provide and prior to anonymisation. I can also request the destruction of that information if I wish. ☐

6. I understand that confidentiality and anonymity will be maintained and it will not be possible to identify me in any publications

7. I understand and agree that my participation will be audio taped **with my permission** and I am aware of and consent to you transcribing the recordings and using the data to develop themes about how clinical reasoning is learned.

8. I agree for the data collected from me to be used in relevant future research.

9. I understand that my responses and identity will be kept strictly confidential. I give permission for members of the research team to have access to my anonymised responses. I understand that my name will not be linked with the research materials. I understand I should keep the responses and identities of other participants confidential.

10. I understand and agree that once I submit my data it will become anonymised and I will therefore no longer be able to withdraw my data.

11. I agree to take part in the above study.

Participant Name	Date	Signature
Name of Person taking consent	Date	Signature
Researcher	Date	Signature

Principal Investigator:

Dr Penny Lockwood

The information you have submitted will be published as a report; please indicate whether you would like to receive a copy.

Appendix 3

Schedule for student focus group

Thank you for agreeing to take part in the study.

This study is exploring the teaching of clinical reasoning to help develop a teaching session basd around it.

For this study clinical reasoning skills have been defined as “as the cognitive abilities that clinicians demonstrate whilst evaluating information from a patient and deciding upon a diagnosis. The information may be symptoms, signs or investigation results”

Can you describe some incidents when you have learned clinical reasoning skills as defined above?

One of the areas I would like to explore is the difficulties or barriers that students experience when trying to develop their clinical reasoning ability.

- What challenges have you faced in developing skills in clinical reasoning
- Are there any aspects of the curriculum that make it more difficult to move forward in clinical reasoning
- Have you had times when you have found there is conflict between what you know and what you are learning about clinical reasoning- describe those times
- Are there any preconceptions that you found made it difficult to learn how to use clinical reasoning

The last area I would like to explore is times when you feel you have learned something about clinical reasoning.

- Describe any moments of sudden realisation that you have had that has helped you to develop your skills in clinical reasoning
- Describe any ideas or principals that you have learned that makes clinical reasoning easier
- Describe any elements of teaching that has helped you to move forward in your skills

Finally are there any other comments you would like to add or suggestions for developing teaching approaches to clinical reasoning.

Schedule for tutor focus group

Thank you for agreeing to take part in the study.

This study is exploring the teaching of clinical reasoning to help develop a teaching session based around it.

For this study clinical reasoning skills have been defined as “as the cognitive abilities that clinicians demonstrate whilst evaluating information from a patient and deciding upon a diagnosis. The information may be symptoms, signs or investigation results”

Can you describe some incidents when you have taught clinical reasoning skills as defined above?

One of the areas I would like to explore is the difficulties or barriers that students experience when trying to develop their clinical reasoning ability.

- What challenges do you think students have in developing skills in clinical reasoning
- Are there any aspects of the curriculum that make it more difficult to move forward in clinical reasoning
- Have you had times when you have found there is conflict between what is taught around decision making and reasoning
- Are there any preconceptions that students have which make it difficult to learn

The last area I would like to explore is times when you feel that teaching about clinical reasoning has helped students to learn.

- Describe any of these sessions
- Describe any ideas or principals that students need to learn around clinical reasoning
- Describe any elements of teaching that you feel helps students develop their clinical reasoning ability

Finally are there any other comments you would like to add or suggestions for developing teaching approaches to clinical reasoning.

Appendix 4

Evaluation questions for new teaching session (acute confusion) on clinical reasoning

STUDENT QUESTIONNAIRE

Dear students, please could you provide feedback on the teaching session "assessing the patient with acute confusion" delivered during the ISS week in March.

During the session you worked in small groups and one of the group consulted with a simulated patient who had acute confusion. The group then went on to discuss differential diagnoses to guide investigations and management.

Please answer the following questions thinking **only** about your learning from this session, not other aspects of the ISS week. The feedback is being collected as part of the quality assurance process and will be used to further develop similar sessions in 2nd and 3rd year ISS weeks.

Thank you for your time.

Questions

What in the teaching session helped you to learn about assessing a patient and deciding upon diagnoses and management?

How could the session be improved to help you learn about assessing a patient and deciding upon diagnoses and management?

Was there any additional learning from the session?

TUTOR QUESTIONS

What in the teaching session helped the students to learn about assessing a patient and deciding upon diagnoses and management?

How could the session be improved to help them learn about assessing a patient and deciding upon diagnoses and management?

Was there any additional learning from the session?

Appendix 5

University of S Research Ethics Committee

University of.
Dundee,
DDI 4HN.

2 July 2015

Dear Ms Lockwood

Application Number: UREC 15087

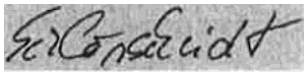
Title: Teaching clinical reasoning skills to undergraduate medical students: An action research study

I am writing to you to advise you that your ethics application has been reviewed and approved by the University of Dundee Research Ethics Committee.

Approval is valid for three years from the date of this letter. Should your study continue beyond this point, please request a renewal of the approval.

Any changes to the approved documentation (e.g., study protocol, information sheet, consent form), must be approved by UREC.

Yours sincerely,



Dr Astrid Schloerscheidt
Chair, University of R ' Research Ethics Committee

Appendix 6

Dear Penny Lockwood	
I am pleased to inform you that the EdD. Virtual Programme Research Ethics Committee (VPREC) has approved your application for ethical approval for your study. Details and conditions of the approval can be found below.	
Sub-Committee:	EdD. Virtual Programme Research Ethics Committee (VPREC)
Review type:	Expedited
PI:	
School:	Lifelong Learning
Title:	Teaching Clinical Reasoning Skills to Undergraduate Medical Students: An action research study
First Reviewer:	Dr. Lucilla Crosta
Second Reviewer:	Dr. Marco Ferreira
Other members of the Committee	Dr. Anthony Edwards, Dr. Jose Reis Jorge, Dr. Janet Strivens, Dr. Trish Lunt, Dr. Martin Gough
Date of Approval:	23rd September 2015
The application was APPROVED subject to the following conditions:	
Conditions	
1	Mandatory — M: All serious adverse events must be reported to the VPREC within 24 hours of their occurrence, via the EdD Thesis Primary Supervisor.

This approval applies for the duration of the research. If it is proposed to extend the duration of the study as specified in the application form, the Sub-Committee should be notified. If it is proposed to make an amendment to the research, you should notify the Sub-Committee by following the Notice of Amendment procedure outlined at http://www.liv.ac.uk/media/livacuk/researchethics/notice%20of%20amendment.doc.

Where your research includes elements that are not conducted in the UK, approval to proceed is further conditional upon a thorough risk assessment of the site and local permission to carry out the research, including, where such a body exists, local research ethics committee approval. No documentation of local permission is required (a) if the researcher will simply be asking organizations to distribute research invitations on the researcher's behalf, or (b) if the researcher is using only public means to identify/contact participants. When medical, educational, or business records are analysed or used to identify potential research participants, the site needs to explicitly approve access to data for research purposes (even if the researcher normally has access to that data to perform his or her job).

Please note that the approval to proceed depends also on research proposal approval.

Kind regards,

Lucilla Crosta

Chair, EdD. VPREC

Appendix 7

Actor Briefing notes

Reason for interaction: Why the patient has come to see the doctor/nurse or other healthcare Professional.

Appears more confused over the past week.

Background: Only use relevant information as this prevents the scenario becoming too large.

Your daughter has arranged for the GP to visit as you have appeared more confused over the past week. You are normally a bit forgetful but over the past 7 days have been found wandering at night, forgetting conversions you had earlier in the day (not normal for you) and this morning you didn't recognise your daughter. You have no obvious associated symptoms except possibly a complaint of chest pain this morning which you don't think is affecting your activity levels.

Pain Descriptions and score[3]:

Non-specific left sided chest pain, unable to quantify severity accurately due to your current confusion.

Lives with: Alone with a carer twice a day. (If asked say two or three times a day – you can't be sure)

Employment history: Work related conditions if applicable or use own

Retired primary teacher (unable to recall year of retirement)

Lifestyle:

Ex-smoker.

A couple of 'nips of whiskey' in the evening if you fancy (you are unable to quantify further).

Generally you manage and get out the house most days.

Activity levels and hobbies – weekly social club. See's family (usually daughter) approx 1/week. You have friendly neighbours and can get to the local shops to get basic messages through the week as required.

Past Medical History[4]:

(not recalled by you – will be given as a list to the student)

Stable angina

COPD

Osteoporosis

Recurrent UTIs

Family History:

Nil known

Medication: Prescribed, over the counter, complimentary and recreational and what condition they are for.

(not recalled by you – will be given as a list to the student)

Adacal D3 1 tablet twice daily

Alendronic acid 70mg weekly

Salbutamol inhaler as required

Tiotropium 1 puff at night

Aspirin 75mg daily

Simvastatin 20mg at night

GTN spray 2 puffs as required

Allergies: If Reaction describe

None known

Last ate or drank:(If applicable) –

Be ambiguous, say you might have had something with the carer this morning but can't be sure.

Patients:

Ideas, Concerns, Expectations:

You don't believe there is anything wrong with you and don't understand why the GP has been asked to visit. Your main concern is that you find the cat so you can feed it. You think you saw the cat this morning despite the fact your cat died over 1 year ago (representing a visual hallucination). You expect to carry on with your day and would be upset should anything else be suggested.

Behaviour[5]:

This is quite important for this consultation as the idea is you are suffering from delirium. The key is a **short (less than 2 week) history of memory problems with **fluctuation** in your behaviour and memory over that time.

Appear confused and distracted (avoid eye contact with the student, looking around, over your shoulder etc). Ask them to repeat questions on occasion or just fail to offer an answer. If you don't feel the student is making the effort to engage with you, you might even stand up at which point the student should try and reassure you/sit you down (this should be done with little persuasion). At times it would be appropriate to engage normally with the student and comply with their questions, with no clear pattern to your behaviour.

Opening Line[6]:

My daughter seems to think there is something wrong with me but I can't imagine why as I feel fine.

If asked: Please only give these answers if asked

You have been feeling generally well recently as far as you recall. You think you felt a slight pain in your chest a couple of days ago but haven't had it since and you can't remember how long it lasted or what you were doing at the time you experienced it. You seem to remember tripping and falling last week but cannot recall if you lost consciousness. You don't have a headache and can't recall vomiting. You don't have any specific injuries following this except a small bruise above your left eye which you think occurred at that time.

Specifically asked:

Please don't volunteer the information unless asked. The aim of this session is to get the students to work out what information they should be getting.

You were on your own last week when you fell (unwitnessed) and can't really give any detail as to what happened.

No recurring chest pain over recent weeks/months.

You think your sleep has been a bit worse over the past week but don't have any recollection of wandering in the night.

You always have a mild cough but no worse of late, no sputum, no blood in spit, not more short of breath than usual.

No diarrhoea, no blood with vomiting or bowel movements.

No stomach pains and passing urine normally with no urinary symptoms to your knowledge

You think your weight is stable but can pass comment that your skirts have been getting a bit baggier over the past few months.

No specific joint or muscle pains and you feel your mobility is normal.

No weakness or problems with sensation. Normal speech.

****The student may ask you some specific memory questions. Please answer as follows:**

- Answer any questions relating to your name, date of birth, age, address, month, season of the year or current location (building and geographical) correctly.
- If asked the date or time give a slightly wrong answer e.g. one day out (date), a couple of hours out (time).
- If asked to recall some objects, provide correct immediate recall of these but if asked to remember these later in the consult, decline any memory of being told them.

- If asked refuse to engage with any counting, spelling or writing/drawing tasks or naming the months backwards. State you're sure you've been asked to do these tasks before and don't see the point.

Interventions/Interactions[7]: Ward simulation/Acute care and RADAR

Will patient require clothing specific to session:

This teaching session doesn't include an examination and the SP is asked to dress casually.

Any other relevant information that you think is important: (Interactions, interruptions with timings for Ward Simulation, Acute care and RADAR,

This case has been developed to test the students' reasoning and rationale thinking. There are numerous possible diagnoses and the tutor may stop the student on more than one occasion whilst the student is taking a history from you. If this occurs simply stop and let the student answer any questions asked by the tutor and then allow the student to pick up with you where they left off.

Appendix 8

Tutor notes for teaching clinical reasoning and integration of specialities

These notes have been developed as a result of an action research study into how to enhance the teaching of clinical reasoning. The data to inform these notes has come from focus groups studies with tutors and students, conferences, the literature and curriculum meetings.

We have given students the knowledge they need to consult with a patient who has (insert the condition and they are now being asked to apply it to a consultation.

The key to teaching clinical reasoning is the application of knowledge and translating patient information into clinical data that is used to help the reasoning process. Students tend to rely on buzz words and formulas to help them through the exams. This session is designed to avoid the need or the possibility of using these. If for some reason this seems to be happening then unpick the reasoning behind the formulas and buzz words. The students in the study used the concept of using guidelines without thinking as examples of formulas. The buzz words were words, if used, were clearly linked to a diagnosis, for example travel in a patient who had diarrhoea.

One challenge in teaching clinical reasoning is that we are experts at it (hopefully) and the students are novices. They start their reasoning after they have collected all the data in rather than doing it while they are taking a history and examining the patient. The aim of this session is to encourage them to start reasoning early in the consultation

One of the teaching approaches the students value is to undertake reasoning and receive feedback on what they conclude and how they are going through the process. Below is the advised format of the session to allow you to do this with them.

One of the students should start to take a history and after two or three sentences stop the consultation and ask them what information we have so far and what the possible problems are. Ask them to justify the problems they have chosen. Provide feedback on the questions asked already and get the consulting students colleagues to suggest further information that is needed to help clarify the problem or cause of the confusion.

Let the consultation run on and stop and start it at relevant points as above.

Things you could feedback on are:

- Questions that help decide if this is delirium or a mental health problem
- Tools that can help them to decide and how they can be used e.g 4AT MMSE
- Questions to clarify what might be causing a delirium
- Information that helps them decide if the patient needs to be admitted or not

Two other finding from the study was that students need time to think of the answers to the questions asked and often they are not given this and they find it difficult answering questions if they feel they may be looking like idiots. This is difficult thing to manage in the group but asking the group for possible answers to the questions rather than the one consulting seems to help.

Word count

Total thesis excluding references: 52287 +135 for footnotes (52413)

Without appendices footnotes: 45954

Acknowledgements

I would like to give my thanks to Dr Janet Strivens for her time and patient in supervising me, Dr Morag Gray for her helpful feedback and the staff in my medical school who supported this project.