THE DEVELOPMENT OF CLINICAL REASONING IN VETERINARY STUDENTS

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Abstract

Clinical reasoning is the skill used when veterinary surgeons make a decision regarding the diagnosis, treatment plan or prognosis of a patient. Despite its necessity and ubiquity within clinical practice, very little is known about the development of clinical reasoning during undergraduate training. Even less is understood about how veterinary schools should be helping students improve this skill. The aim of the research presented within this thesis was to, firstly, examine the development of clinical reasoning ability within veterinary students and, secondly, to investigate possible methods to aid this process. The University of Nottingham School of Veterinary Medicine and Science (SVMS) was used as a case study for this research.

In study one, focus groups and interviews were conducted with SVMS staff, students and graduates to investigate the development of clinical reasoning. A curriculum document content analysis was also performed. The findings suggested that clinical reasoning development is not optimal, with alumni facing a steep learning curve when entering practice. These results were used to design study two, in which a simulated consultation exercise utilizing standardised clients was created and implemented for final year students. The success of the simulation was measured using both quantitative and qualitative methods – all of which supported the use of the session for clinical reasoning development. The final study, also building on the findings of study one, aimed to improve the accessibility of veterinary surgeons' decision-making processes during student clinical extramural studies placements (CEMS). A reflective Decision Diary was created and trialled with third and fourth year SVMS students. Diary content analysis showed the study aim was met, triangulated by survey and focus group findings.

During the research, wider issues relating to clinical reasoning integration into veterinary curricula were unearthed. These included low student awareness of the subject and the misalignment between the skill learnt during training and the skill required when in practice. Several recommendations have been made to improve the design of the undergraduate curriculum in relation to clinical reasoning.

‘I may not have gone where I intended to go, but

I think I have ended up where I needed to be.’

-Douglas Adams

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Chapter 1 Introduction

The aim of the research presented in this thesis was to investigate the development of clinical reasoning in veterinary students. The School of Veterinary Medicine and Science (SVMS) at the University of Nottingham is at the centre of this research, with current staff, students and recent graduates from this institution used as participants.

The impetus for the study arose from the increasing interest in clinical reasoning within the fields of medicine and veterinary medicine. Over the last few decades, medical researchers have attempted to understand the phenomenon of clinical reasoning, and determine the most effective ways to teach it. This interest has 'spilled-over' into veterinary medicine, where clinical reasoning has recently been accepted as an important skill that will not necessarily develop without educational input. As a result, the Royal College of Veterinary Surgeons (RCVS) have recently made understanding of clinical reasoning a Day One Competency required of graduates (RCVS 2014a). However, despite the surge of interest there has been little research conducted; thus, the understanding of clinical reasoning within veterinary medicine is poor. In 2011, a doctoral thesis was published that took the first steps towards exploring veterinary decision-making (Everitt 2011). This 'glimpse' of how veterinary surgeons make clinical decisions in practice, alongside the new RCVS requirements, has led veterinary educators to review how reasoning is taught, or not taught, within their curricula. Through this introspection, it has become clear that research needs to be done to determine firstly how clinical reasoning currently develops in veterinary students, and secondly what can be done to improve this process.

1.1 Thesis structure

Three separate studies were conducted to contribute towards the overall research aim. Ethical approval was granted for all studies prior to commencement (reference number 722121108). The three studies are presented in consecutive thesis chapters to replicate the research process: where the outcomes of the first project were used to inform and develop the later studies. For that reason, there is not a dedicated 'results' chapter – instead the findings are provided and discussed within each study chapter.

The thesis is structured into seven chapters. This introductory chapter will familiarise the reader with the history of veterinary education, the SVMS curriculum and the transition to practice faced by veterinary students – providing a context for the remainder of the thesis.

Chapter Two contains a review of the literature surrounding clinical reasoning, considering both medial and veterinary domains. This includes sections on the development, teaching and assessment of clinical reasoning.

Chapter Three provides an overview of the research methodology and methods. This chapter was created to familiarize the reader with the principles of mixed methods research. Additionally, as certain methods are used within all three studies, a description and evaluation of them is given within Chapter Three to prevent repetition.

Chapters Four, Five and Six present the three research studies:

- Study one – An investigation into the development of clinical reasoning
- Study two – The use of standardised client simulation to develop clinical reasoning
- Study three – 'Decision Diaries' - stimulating conversation about clinical reasoning during extramural studies

Each chapter is split into introduction, methods, results and discussion sections. Finally, Chapter Seven considers the impact of all three studies on veterinary education and provides recommendations for curricula reform.

1.2 The history of veterinary education

The research within this thesis falls within the academic discipline of veterinary education. Thus, the history of veterinary education is described here to familiarise the reader with the 'story-so-far'.

The first British veterinary school was opened in London in 1791. At this point in history, the focus of the veterinary profession was working horses, and the short course developed concentrated on the practical care of equines. Throughout the 1800's, three more veterinary schools opened, mostly in Scotland. These were unregulated, and the standard of the courses (and graduates) varied. To address this, in 1844 a Royal Charter was created, which put the RCVS in control of regulating veterinary education. This meant that those wanting to enter the profession had to pass examinations set by the RCVS, ensuring a consistent standard of veterinary surgeon (Gardiner and Rhind 2013).

The state of veterinary education then remained somewhat constant, with the gradual addition of more schools, until the Loveday Reports of 1938 and 1944. These reports called for greater emphasis on basic scientific principles within veterinary curricula and the incorporation of working farms and clinical facilities into the schools. A government enforced student entrance quota was implemented, in response to a post-war need for agricultural expansion. The focus of the profession began to shift towards farm animals, particularly the dairy cow; but this was not to last.

In the 1950's and 60's, companion animals became very popular. This, once again, caused a reform of the veterinary curriculum, to incorporate species such as cats and dogs in more detail. At this point, the number of women enrolled in veterinary courses started to increase until, in the 1990s, female students began to outnumber males in UK veterinary schools.

In the late 1990s, veterinary courses were criticised for not developing practical and clinical skills to a high enough level. This triggered interest in the competences of graduates – leading, eventually, to the creation of the RCVS Day One Competences in 2001 (RCVS 2001). The competences provided a list of skills, knowledge and attributes that should be possessed by graduates, allowing veterinary curricula to focus their content to produce capable veterinary surgeons. To test the acquisition of these skills – to prove competency - practical examinations were introduced in the form of Objective Structured Clinical Examinations (OSCEs), adapted from human medical education (Harden and Gleeson 1979). The structure of the standard veterinary curriculum also began to change – the huge amount of scientific knowledge that had developed in the preceding years could no longer all be timetabled within a curriculum, leading the RCVS to recommend undergraduate tuition focussed on the needs of society (May 2008).

In the early 2000's, the development of professional attributes such as communication, ethical decision-making and reflection became an important feature of veterinary curricula. This is likely due to the importance placed on these abilities within the Day One Competencies. Clinical skills also increased in prominence within curricula – with the use of part-task simulators and models becoming widespread across the UK. Concern about exposure to routine clinical cases during work placements led to the incorporation of more first-opinion practices within university hospitals, or (as is the case at the SVMS) the distribution of the curriculum to community-based primary care practices. Schools began to change the fundamental structure of their curricula - replacing discipline-based modules with more integrated body-system modules. These were no longer run by departments, but collectively monitored by the school as a whole, reducing the duplication of information and increasing the curricula cohesion (May 2008).

Currently, there are eight veterinary schools in the UK, each part of an established university. Numbers of registered students have increased steadily over the last 20 years, and are continuing to grow. The latest figures produced by the RCVS show that 813 veterinary students graduated in the UK in 2013 (RCVS 2014b). The curricula of veterinary schools are increasingly utilising technology to improve education and student involvement. Generally, schools are moving away from the teacher-centred model, putting more emphasis on lifelong and independent learning. Evidence-based teaching methods from the field of medical education are being implemented at veterinary schools, and the importance of student wellbeing is increasingly recognised. In 2014, the RCVS published an updated list of Day One Competencies, extending the focus on student capability rather than knowledge.

The importance of veterinary education has grown so much in recent years that a new academic discipline has formed. Now, many UK veterinary schools have 'lecturers' or 'professors' in veterinary education that are responsible for overseeing the curriculum, pedagogical methods and assessment. There has also been a rise in experimental-based publications relating to veterinary education and the number of Doctoral Theses submitted on the topic.

The future of veterinary education may hold a reduction in the breath of material to accommodate greater depth. Curriculum tracking has been proposed, which would require students to select their desired area of expertise when starting veterinary school – for example, large animals - and then follow a curriculum specific to that group of species. However, a development of this scale would require a total restructuring of the veterinary profession and licencing process, so is unlikely to happen without extensive input from the RCVS (Prasse et al. 2007, Crowther et al. 2014). A more definite component of the future of veterinary education is an increase in student numbers. This is due in part to the expansion of current veterinary schools, and the opening of new schools already scheduled.

1.3 The University of Nottingham School of Veterinary Medicine and Science

The School of Veterinary Medicine and Science (SVMS) at the University of Nottingham was opened in 2006, making it the first new veterinary school in the UK for over 50 years. The opportunity to design a new veterinary curriculum 'from scratch' allowed the incorporation of many forward-thinking concepts from medical education, resulting in a modern, student-centred degree course. The school gained accreditation in 2011, meaning students are automatically registered with the RCVS upon graduation.

The five-year SVMS curriculum is outcome-based; designed around the competences expected of graduates as defined by the RCVS (RCVS 2014a). Students are awarded the Bachelor of Medical Sciences (BVMedSci) at the end of year three, and the Bachelor of Veterinary Medicine and Bachelor of Veterinary Surgery (BVM BVS) on completion of year five. There are roughly 120 students within each year group, with this figure likely to rise in the future.

The curriculum follows a spiral structure; system-based modules are encountered originally in years one and two, when the emphasis is on the basic sciences, then repeated in year four with a clinical focus. Subjects such as anatomy and physiology are horizontally integrated into the curriculum within the systems modules, which each last between two and eleven weeks. Three long modules – personal and professional skills, animal health and welfare, and veterinary public health – are delivered alongside the systems modules throughout each academic year. In the third year of the course, students undertake a 12-week research project culminating in the production of a dissertation.

The fifth year of the course is lecture-free, spent entirely on work-based learning (WBL) placements. There is no on-site teaching hospital at the SVMS; instead, students rotate around clinical associate veterinary practices – both first and second opinion – in fortnightly blocks to gain practical experience. SVMS clinical staff are in place at these practices to ensure that students receive an effective learning experience. This model of work-based learning is known as a ‘distributed curriculum’, as teaching and learning is distributed throughout the community.

The SVMS curriculum was designed to integrate clinical skills from day one, to allow practical application of the basic sciences. As an example, first year students learn how to perform equine distal limb nerve blocks to reinforce their understanding of neurological anatomy and function. Sign-posting lectures are kept to a minimum, making-up less than a third of the student contact hours. Instead, all modules are student-centred, encouraging independent learning within facilitated small groups.

There are five main teaching formats used at the SVMS:

- Lectures – teacher-centred provision of information to the entire year group
- Self-directed learning (SDL) – small group or individual completion of a task or series of questions without facilitation
- Case-based learning (CBL) – facilitated small group work focused on clinical cases related to topics presented in recent lectures
- Practical Classes – learning through practical engagement; can include laboratory work, live animal classes, computer-based classes, offsite travel or dissection
- Seminars – take a variety of formats, but essentially involve small group tuition by a clinician on a certain topic; only in the final year of the course

In addition to the SVMS curriculum, students are required to complete 12 weeks of Animal-husbandry Extramural Studies (AHEMS) and 26 weeks of Clinical Extramural Studies (CEMS). This requirement is set by the RCVS and is necessary for acceptance into the college.

An overview of the curriculum is provided in table 1.1

Feature	Year One	Year Two	Year Three	Year Four	Year Five
Systems modules	MSK 1 LCB 1 CRS 1 NEU 1	ENI 1 GIL 1 REP 1 URI 1	Principles of Clinical Veterinary Science Veterinary Practice Techniques Veterinary Research Project	MSK 2 LCB 2 CRS 2 NEU 2 ENI 2 GIL 2 REP 2 URI 2	Equine Practice Small Animal Practice Farm Animal, Veterinary Public Health, Zoo and Wildlife Practice
Long modules	Personal and professional skills Animal health and welfare	Personal and professional skills Animal health and welfare	Personal and professional skills	Personal and professional skills Veterinary Public Health	None
Teaching formats	Lectures Self-directed learning Case-based learning Practical classes	Lectures Self-directed learning Case-based learning Practical classes	Lectures Self-directed learning Case-based learning Practical classes	Lectures Self-directed learning Case-based learning Practical classes	Work-based learning Seminars

Table 1.1 Key features and structure of the SVMS curriculum. (MSK = Musculoskeletal System, LCB = Lymphoreticular Cell Biology, ENI = Endocrine and Integument Systems, GIL = Gastrointestinal System, REP = Reproduction, CRS = Cardiorespiratory system, NEU = Neuroscience, URI = Urinary System)

1.3.1 Clinical reasoning in the SVMS curriculum

Clinical reasoning is integrated throughout the SVMS curriculum within CBL sessions. As these involve working through a clinical case in small groups, reasoning skills are presumed to develop as a product.

The theoretical basis of clinical reasoning is presented to students within a short series of lectures and practical sessions held in year three. At this point students are taught the SOAP method to assist decision-making and case presentation (Subjective observations, Objective observations, Assessment, and Plan) (May 2013). Students are then encouraged to use the SOAP method when on WBL placements both within and external to the university. It is during these WBL placements that students are expected to develop the majority of their clinical reasoning ability - through observation and participation.

In years four and five, students complete ‘clinical reasoning’ examinations. These involve the sequential presentation of clinical information about a case, accompanied by short answer questions. The examinations take place online and usually require the interpretation of clinical information, production of differential diagnoses and description of a treatment plan.

Clinical reasoning ability plays a key role in the ease of the transition from student to veterinary surgeon. The next section of the chapter will discuss the literature relating to this transition to practice.

1.4 The transition to practice

When leaving university, veterinary graduates face what is known as the 'transition to practice'. This phrase encapsulates the changes confronted when moving from WBL placements to practicing alone as a veterinary surgeon – changing from a position of safety to one with full responsibility. It has been shown that veterinary students struggle during this period (Mellanby and Herrtage 2004, Jaarsma et al. 2008, Gilling and Parkinson 2009, Rhind et al. 2011, Boulton and McIntyre 2012, Cobb et al. 2015). Could veterinary school be better preparing their students for work? Or is easing the transition to practice the responsibility of employers?

The first clinical experiences of new graduates appear to have a lasting effect on their view of the veterinary profession and their career direction (Mellanby and Herrtage 2004, Gilling and Parkinson 2009). For this reason, it is worrying that graduates are finding the transition difficult. High stress levels are reported in several recent graduate studies (Routly et al. 2002, Gilling and Parkinson 2009), signalling the learning curve upon entering the profession is too steep. Combining this fact with the high pressure graduates put on themselves to perform well (Kogan et al. 2004) and the isolation imposed by starting a new job in a new area (Garrett 2009) can result in considerable emotional distress (Mellanby and Herrtage 2004, Garrett 2009). Exposure to high levels of stress is a leading cause of high staff turnover in new graduate employees, causing problems not only for graduates but also for businesses (Routly et al. 2002). In order to maintain happy, healthy veterinary surgeons (and employers), the transition to practice needs to be improved.

The support of colleagues is paramount to easing the transition to practice. However, it has been identified that the level of support for new graduates in their first job is variable. Mellanby & Herrtage (2004) found that only 42% of graduates felt they could rely on support from their colleagues, yet 82% frequently worked unsupervised. However, in contrast, Gilling & Parkinson (2009) reported that 82% of surveyed graduates were happy with the level of support they received. This difference is most likely due to location – Mellanby surveyed British graduates, whilst Gilling & Parkinson conducted their research in New Zealand. The biggest disparity between the UK and New Zealand is the nature of veterinary work, not the content of veterinary curricula, which could indicate that the profession – in particular employers – are not doing enough to ease the transition to practice in the UK. Employers have already expressed concern about the amount of time they need to commit to supporting new graduate students, and the financial considerations of this (Routly et al. 2002). The implication of these findings is that either students need to be graduating with a higher level of autonomy and confidence, or employers need to improve their provision of support.

Both alumni and employers have consistently expressed concern about the non-technical skills of recent graduates (Routly et al. 2002, Gilling and Parkinson 2009, Rhind et al. 2011). In addition, the Veterinary Defence Society has declared that a high proportion of complaints against veterinary surgeons involve a lack of clear communication, particularly amongst new graduates. However, in recent years, veterinary curricula have improved their provision of professional skills, particularly focusing on communication (Gray et al. 2006, Latham and Morris 2007, Mossop and Gray 2008). As a result, alumni surveys performed in these 'reformed' curricula show improved non-technical skills (Jaarsma et al. 2008, Cobb et al. 2015).

There is disagreement in the literature on the level of clinical reasoning achieved by graduates. While some studies have suggested a good level of reasoning ability (Gilling and Parkinson 2009), others list it as an area for improvement (Cobb et al. 2015). Responsibility for case management is a worry of final year students (Tomlin et al. 2010), suggesting that they do not feel confident in their decision-making skills prior to qualification. Garrett (2009) explains the cause of this lack of confidence:

> *'Veterinary students are essentially sheltered from real responsibility and consequences of poor decisions. Although most veterinary students eagerly await*

the day they can make the decisions, the sudden assumption of responsibility after graduation can be unnerving.' (p.445)

More research is needed to examine exactly how the changes in responsibility are dealt with by new graduates, and what can be done to reduce this burden.

In 2007, the RCVS introduced the Professional Development Phase (PDP) (Johnson and Andrews 2007). This is a record of experience intended to allow self-assessment of confidence in the 'Year One Competences' set by the RCVS. All new graduates must complete this record, as it is intended to ease their transition into practice. The implementation of this scheme suggests the RCVS recognise that the transition period is very challenging for graduates; however, whether the PDP improves this situation is yet to be measured.

1.5 Chapter summary

This chapter has discussed the history of veterinary education and the current structure of the SVMS curriculum. It has also considered the literature surrounding the transition from student to practicing veterinary surgeon, and the challenges new graduates face. The next chapter will move on to discuss the phenomenon of clinical reasoning by reviewing the wide range of literature pertaining to the subject.

Chapter 2 Clinical reasoning: a literature review

This literature review will begin by defining clinical reasoning. It will then discuss the methods practitioners use to make clinical decisions, both consciously and unconsciously. It will then move on to look at the development of reasoning skills and the impact that studies into medical expertise have had on the understanding of clinical reasoning. Teaching and assessment of clinical reasoning ability will then be discussed, before the review ends by examining decision-making in a veterinary context. The majority of the research presented in this chapter is drawn from human medicine, as the veterinary literature is extremely limited. However, as discussed in the final section of this chapter, the similarities between medical and veterinary clinical reasoning make the wealth of research in the medical domain highly relevant to this thesis.

2.1 Defining clinical reasoning

On a daily basis, healthcare professionals are expected to diagnose patients under their care and select the most effective treatment plan for them (Thammasitboon and Cutrer 2013). Eva (2005) compares the diagnostic process to that of deciphering the villain in a crime novel; a task that involves 'considering each piece of available information and determining the most plausible explanation for the illustrated pattern' (p. 98). However, unlike the novel reader, the physician must make choices about where to look for information, which findings are relevant, what is the likely cause and what is the best way to treat it. This decision making skill, often termed 'clinical reasoning', is a fundamental aspect of many disciplines including medicine, veterinary medicine, dentistry and nursing – so much so that Croskerry & Norman (2008) claim 'effective problem solving, sound judgment, and well-calibrated clinical decision making are considered to be among the highest attributes of physicians' (pS24).

There is no single accepted definition of clinical reasoning. The interpretation varies even between authors within the same discipline. Clinical reasoning has been defined as 'The cognitive processes physicians use to diagnose and manage patients' (Cutrer et al. 2013, p. 248). This explanation gives a concise overview of how clinical reasoning skills are used, but it stops short of describing the cognitive processes in question. Simmons (2010) goes further to describe these processes as 'formal and informal thinking strategies to gather and analyse patient information, evaluate the significance of this information and weigh alternative actions' (p.1155).

Clinical Reasoning is required to ascertain the risks and benefits of any medical action taken, to select appropriate tests to perform and to judge a patients' prognosis (Kassirer 2010). It is also needed for non-clinical decisions surrounding a patient, for example involving cost or practicality (May 2013).

Within this study, clinical reasoning will be defined as: the thought processes involved in making a clinical decision about a patient or population; including diagnoses, prognoses, testing, and treatment regimes. This broad definition has been chosen for two reasons: 1) to allow all activities of clinical reasoning to be included, not solely diagnostic tasks and 2) to include all possible cognitive activities that may contribute to them. It must also be noted that 'clinical reasoning' has many different aliases within the literature, and is often used interchangeably with the terms 'clinical decision making' and 'clinical judgement' (Simmons, 2010). In this thesis, these terms are also used interchangeably.

2.2 The clinical reasoning process

There are several well-researched methods used by practitioners to make clinical decisions. This section will begin by looking at system two reasoning, also known as 'hypothetico-deductive' or 'backwards' reasoning (Wessel et al. 2010). This method is analytical and thorough but slow. Although it may seem contrary to begin with the second system rather than the first, system two reasoning was the first theory developed by researchers trying to explain the phenomenon of clinical reasoning (Norman 2005). The discussion will then cover the fast and intuitive System one reasoning method, often referred to as 'pattern-recognition' or 'forward reasoning'. Next, dual-process reasoning will be covered, which is a theory that combines system one and two reasoning. Finally, a mathematical approach to clinical reasoning – decision analysis – will be explored.

2.2.1 System two reasoning

Research into clinical reasoning began in the 1970s, with researchers trying to establish one overarching theory to describe the process of making a diagnosis. The underlying belief of researchers was that if this universal reasoning process could be learnt, it could be applied to any area with successful results, even if the practitioner had no previous experience there (Schmidt et al. 1990, Norman 2005, May 2013). Early experimentation (Feightner et al. 1977, Neufeld et al. 1981, Barrows et al. 1982) repeatedly demonstrated that most clinicians would follow the same basic steps when trying to reach a diagnosis during a consultation:

1. Rapid diagnostic hypothesis generation
2. Hypothesis testing via data collection
3. Hypothesis acceptance and management decisions

These findings led to the development of a 'hypothetico-deductive' theory of reasoning – also known as 'analytical' or 'system two' reasoning.

During their studies on the medical general practitioner, Feightner et al. (1977) found that a physician generates between four and six hypotheses within 20-30 seconds of the start of a consultation. These hypotheses will then determine the questioning and examination undertaken – with the aim being to confirm or reject each hypothesis until there is one left. It was found that 94% of hypotheses used were generated in the first half of the consultation, leaving the remainder of the time for the sorting process. Once a diagnosis is decided upon, the physician can then explore management options. System two reasoning is 'slow, deliberate, conscious and effortful' (Thammasitboon & Cutrer 2013, P.234) and although normally successful is less accurate in emergency situations.

There are limitations to the explanation offered by system two reasoning. The model was constructed from studies that asked clinicians how they *think* they reasoned in a given scenario either by talking aloud during the process or by watching a video recording of themselves (Norman 2005; Feightner et al. 1977). This method, although hard to avoid, is subject to a large amount of bias as it relies on the subjects having an accurate view on their own thought processes. The data generated is likely not a complete representation of what occurs in the minds of the practitioner because, as Bargh & Chartrand (1999) explain 'One cannot have any experiences or memories of being nonconsciously influenced' (P.462).

It can also be argued that within these studies, the hypotheses that clinicians produce may not be true hypotheses generated through interpretation of the patient's condition, but simple labels assigned as a practitioner recognises a set of symptoms they have met before (McGuire 1985). The findings of Feightner et al. [1977] support this – rapid diagnosis is more characteristic of fast pattern matching than lengthy hypothesis generation.

In 1981, Neufeld et al. showed that both students and experienced doctors use hypothetico-deductive reasoning in the same way to reach a diagnosis. This finding suggested that system two reasoning could not account for all clinical reasoning, as it remains unchanged and thus leaves no explanation for the progression to expertise. Furthermore, Patel & Groen (Patel and Groen 1986) demonstrated that the diagnosis made by an experienced clinician was more likely to be correct if forward reasoning, rather than the hypothetico-deductive method of backwards reasoning, was used. While hypothetico-deductive reasoning certainly was a method that was used by medical practitioners, it was apparent that it could not explain all thought-processes that occurred when searching for a diagnosis

2.2.2 System one reasoning

The next stage in the development of clinical reasoning theory was to investigate the access of knowledge. Norman et al. (1985) had already shown that there was no correlation at an individual level with knowledge of a subject and reasoning ability in that area. It had also been found that the prior knowledge used by senior clinicians to solve a diagnosis had much individual variation, compared to a cohort of medical students given the same task (Grant and Marsden 1988). These findings suggested that reasoning expertise relied more on the medical experiences of an individual, rather than a growing knowledge base.

Brooks et al. (1991) found that previous exposure to resolved dermatology cases led to increased diagnostic accuracy - even when tested two weeks later - suggesting that practitioners may recognise similarities between cases and use these to help reach a diagnosis. This effect was later shown to be strong even with medically irrelevant similarities. Hatala et al. (Hatala et al. 1999) presented family medicine residents electrocardiogram cases with different diagnoses but a similarity in an aspect of unrelated history (for example, the patients occupation). The results showed a 50% decrease in diagnostic accuracy when residents had been exposed to a case with an irrelevant similarity prior to the test case, demonstrating the use of case matching to reach a diagnosis was not based solely on medical findings. The study sample size was only 27, which may limit the generalisability of the findings. However, the nature of the experiment increases its own validity, as described by Norman et al. (2007):

> *'What is interesting about these findings is that the specific features being manipulated were objectively irrelevant to the diagnosis, so if residents were aware that they were being influenced by this information, they would not have been biased, suggesting an unconscious retrieval process.' (p. 1142)*

In 1997, Norman & Brooks proposed that much of clinical reasoning occurs by the matching of current cases to past ones, unconsciously and quickly (Norman and Brooks 1997). This idea was adapted from studies in psychology examining the domain of categorisation (Norman & Brooks 1997; Norman et al. 2007), whereby an exemplar model stored in memory is used to identify which category an object belongs to – e.g. car, tree, book etc. They termed this 'non-analytical reasoning' - although the process is now also known as 'pattern recognition' or 'system one' reasoning. They supported their theory with evidence that experts are unable to predict the errors made by other clinicians (Norman & Brooks 1997), citing this as proof of individual exemplars with variation between clinicians. The findings of Norman et al. (1989) further supported their theory, which demonstrated that the shorter the length of time used to reach a diagnosis, the more accurate it is likely to be at all levels of medical expertise. System one reasoning is always quicker than the deliberate analysis of hypotheses used in system two reasoning as it is unconscious and automatic, involving no considered thought.

Norman & Brooks' theory is now widely accepted as a method of clinical reasoning used increasingly as a novice progresses towards expertise. System one reasoning is described by Croskerry & Norman (2008) as 'fast, associative, inductive, frugal,' (P.S24) and involves solving a diagnostic problem by referring to a very similar problem already dealt with in the past. The process is often referred to as pattern-recognition, as clinicians match patterns of signs and symptoms from one patient to another. The process is unconscious and is used for most daily decision-making tasks. It is based around heuristics (Croskerry & Norman 2008), allowing problems to be solved quickly and effectively. A comparison between system one and system two reasoning is shown in table 2.1.

Characteristic	**System one reasoning**	**System two reasoning**
Method	Heuristics	Systematic
Operation	Intuitive	Deductive
Cognitive awareness	Low	High
Conscious control	Low	High
Speed	Fast	Slow
Effort	Low	High
Context dependence	High	Low
Emotional attachment	High	Low

Table 2.1 Features of system one and system two reasoning. Adapted from Croskerry & Norman (2008) and Croskerry (2009).

2.2.3 Limitations of system one and two reasoning

While both of these methods of clinical reasoning are used successfully by clinicians in all domains, they both have limitations and lead to certain decision making errors. The main limitation of system two reasoning is that it is slow, deductive and resource intensive. These factors make it impossible to use for the majority of decisions encountered, as there is simply not enough time (Thammasitboon & Cutrer 2013). This also means that in situations where a decision must be reached quickly, such as emergency medicine, it may not be appropriate or possible to use system two reasoning. Additionally, there is the possibility of bias due to the systematic and often mathematical nature of the method, which can highlight the tendency of humans to want to see patterns and rules in data that do not necessarily exist (May 2013).

System one reasoning is successful in the majority of cases (Croskerry 2009) and used commonly but also has its own set of limitations. As the method relies on exemplars to reach a diagnosis it can fail to recognise a patient that presents atypically (Croskerry 2009) or miss-identify similar symptoms belonging to different conditions. The other main drawback of system one methods is the emotional component that is activated when reasoning intuitively. Practitioners may opt to follow their 'gut-feeling' when such an approach is not justified (Croskerry & Norman 2008). They may also unconsciously allow their decision to be led by emotion (Slovic et al. 2004). The thought of a positive outcome may reduce the practitioner's perception of risk and vice versa with a negative scenario. Slovic et al. (2004) also highlights that the perception of emotionally charged 'stories' surrounding the patient can cause an irrational decision to be made.

Klein (2005) highlights five additional common diagnostic errors that are encountered when using any heuristic-based reasoning method, including system one reasoning:

- Representativeness – the assumption of a diagnosis based on symptoms, ignoring probabilities and epidemiology
- Availability - the tendency to over-diagnose conditions that come to the mind easily, possibly due to recent encounters or popular culture
- Overconfidence – unsubstantiated confidence in a diagnosis that can lead to inadequate testing and suboptimal treatment
- Confirmatory bias – the tendency to look for and recognise data that fits with an expected diagnosis and ignore or miss information that contradict it
- Illusory correlation – the assumption that two factors are related, when in fact they are not, and the use of this to support a diagnosis

Both system one and system two reasoning methods have strengths that should dictate their use in practice, and weaknesses that practitioners should be aware of to avoid.

2.2.4 Dual-process reasoning

In the mid-1990s, researchers within cognitive psychology developed what is known as the dual process theory (Epstein 1994, Pelaccia et al. 2011). This proposes that system one and system two reasoning methods are used together to make decisions. It was brought into the clinical setting by Kulatunga-moruzi et al. (2009) who demonstrated that both models of reasoning are used during dermatological diagnosis by medical students. Ark et al. (2006) showed that diagnostic accuracy increased by 10% when students were instructed to combine system one and two reasoning when diagnosing cardiac conditions from electrocardiograms, compared to using one alone. This suggested that dual-process reasoning was not only a valid method; it was a more effective method.

The model of dual process reasoning is described by Croskerry (2009) as 'a cognitive continuum with oscillation occurring between System 1 and 2' (P.1025). It begins with an encounter between a patient and practitioner, leading to an initial response to the symptoms presented. If the clinician recognises the pattern of symptoms immediately, a system one approach is triggered, whereby pattern-recognition led diagnosis occurs. This is often accompanied by the emotional component of non-analytical reasoning. If there is some uncertainty in the diagnosis or if the combination of symptoms is not easily recognised, the clinician will engage system two reasoning. Therefore, expert clinicians will mainly use system one reasoning, but if presented with a case they are unsure about they will revert to the more complex system two method. System two reasoning may also be initiated when there are high-stake outcomes, or simply if there is enough time to use it (Pelaccia et al. 2011). The initial reasoning method, whether system one or two, can persist until the process is concluded, or the practitioner may switch systems. This switch can happen in three ways:

- The initial triggering of system one mechanisms may solve the 'first piece of the puzzle' which then requires a system two analysis to complete the diagnosis
- System two systems may override system one decisions – for example if symptoms are examined more closely and appear not to correspond entirely to the working diagnosis (rational override)
- System one mechanisms may overrule system two analyses when contextual factors are applied – the clinician may choose to follow their intuition rather than known best judgement or clinical rules (irrational override)

The result of these interactions is synthesised into a conclusion, with contributions coming from both system one and two processes if available. This conclusion then forms the diagnosis, or treatment choice. An illustration of the possible dual process reasoning pathways is shown in figure 2.1.

One of the most important features of dual process reasoning is the ability of system two to override intuitive system one thoughts if necessary. This forms the basis of self-monitoring by physicians in practice and is necessary to ensure that incorrect decisions are not being made based on ‘gut-feeling’. Diagnostic mistakes are often a consequence of this checking process not occurring, or the clinician choosing to ignore analytical reasoning and trust their instincts (Marcum 2012).

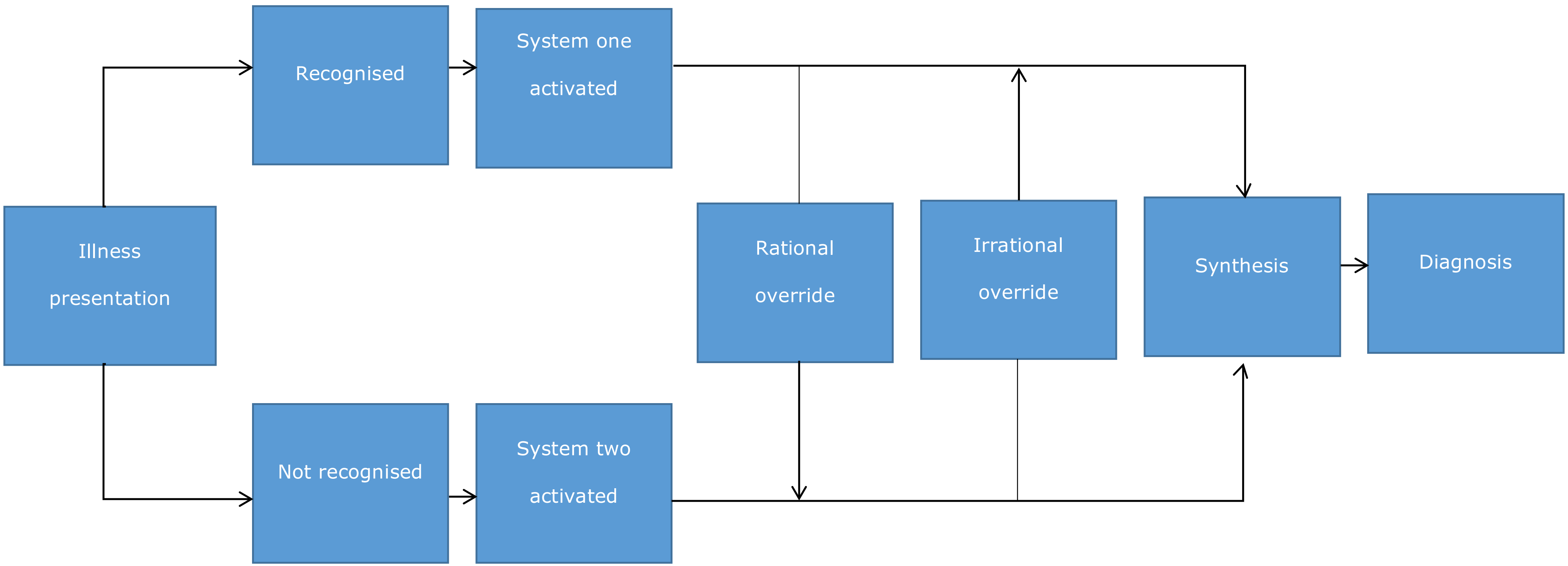

Figure 2.1 The cognitive steps in the dual process theory, adapted from Croskerry (2009). The process begins with the presentation of a patient with an illness, which is either intuitively recognised or not. If the illness is recognised, the unconscious, pattern-recognition methods of system one reasoning begin. If the illness is not recognised then the logical, analytic system two reasoning process starts. During the process, either system may override the other. This is termed 'rational' if system two overrides system one, or 'irrational' if the opposite occur. In the synthesis phase, the information from one or both methods is calibrated and used to conclude a diagnosis.

2.2.5 Decision analysis

Decision analysis is a form of reasoning that utilises mathematics, Bayesian statistics and percentages to calculate the best outcome and decision path to take. Cockcroft (2007) defines it as 'The application of explicit quantitative methods to analyse decisions under conditions of uncertainty' (p.499). Kassirer (1976) describes decision analysis in more detail as 'laying out the options and possible outcomes in explicit detail using a "decision tree," assessing the probabilities and values of each outcome, and selecting the "best" choice' (p.150).

The process of decision analysis begins by noting all the possible outcomes of the decision at hand and writing them in the form of a decision tree. It is vital that this list is exhaustive (Cockcroft 2007). The second task is to assign a probability of occurrence to each of the possible outcomes based on information from patient history, scientific research and the current circumstances (Kassirer 1976). If there is no available information in relevant literature to base a probability on, Kassirer (1976) recommends using the opinions of experts in the field. The third stage is to assign a utility score to each outcome – this is a figure used to represent the value of the outcome to the patient. For example, a curative treatment would have a high utility score whereas a treatment with little effect would have a low utility score. This score needs to be formed through discussion between the physician, the patient and their family (Kassirer, 1976). When both the probability and utility have been assigned to each decision, the outcome value can be calculated by multiplying the two numbers. The correct decision to make will then be the outcome with the highest value. A representation of a decision analysis is shown in figure 2.2.

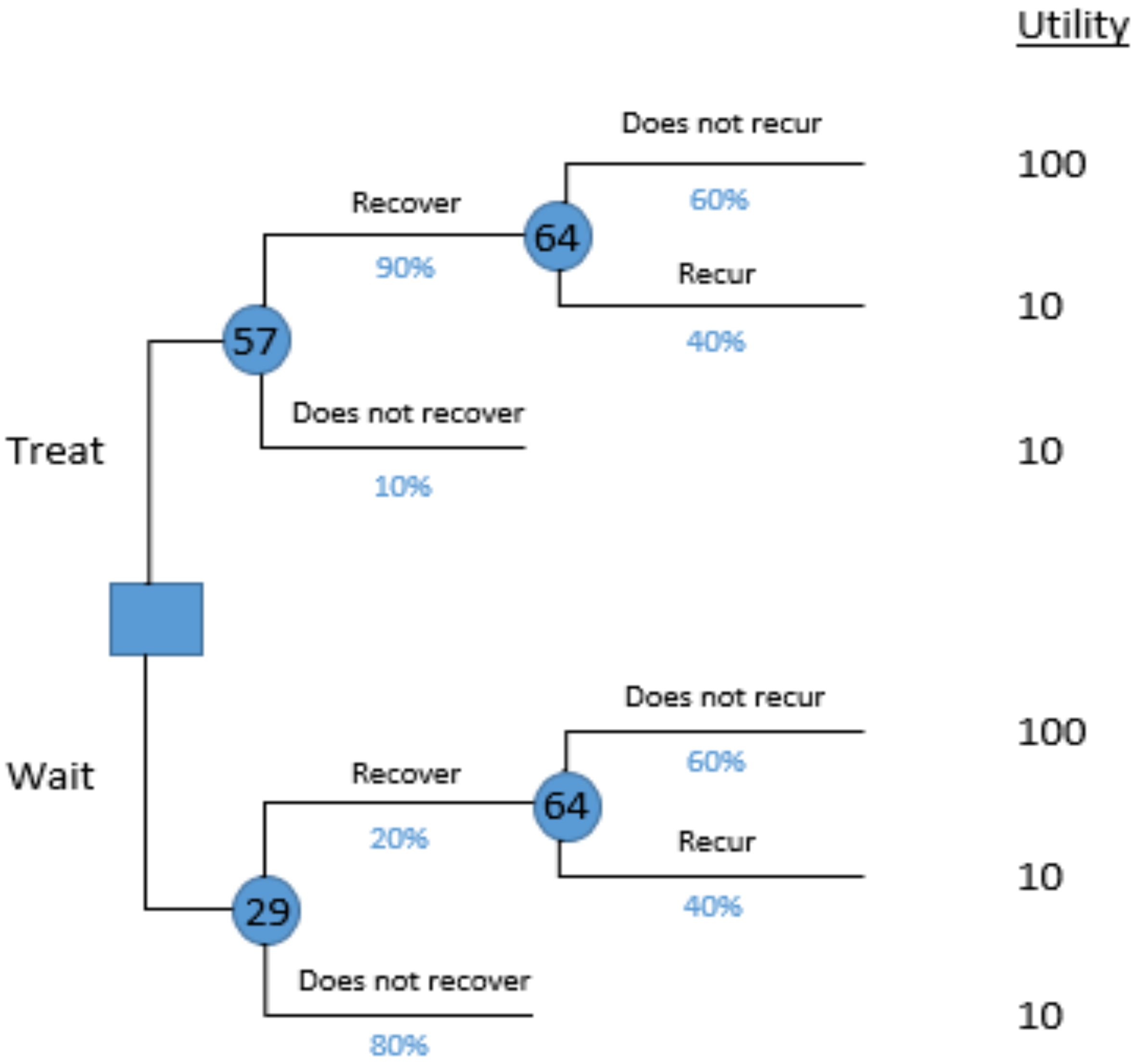

Figure 2.2 An example of decision analysis. In this example, a clinician is deciding whether to treat a particular case, or wait for the case to resolve itself. Squares represent a choice made by the clinician; circles represent an outcome relying on chance. For both the 'treat' and 'wait' options there is the possibility of recovery or not. When recovery occurs, there is the added possibility of relapse. Each of these options is represented as a branch on the decision tree. The percentages show the probability of each option, and the utility score is shown at the end of each branch. The numbers within the circles show the calculated outcome for the branches behind it. The method is taken from Kassirer (1976) – first multiplying the utility score with the probability and then adding the values of parallel branches together to get a total. It can be seen in this scenario that choosing to treat the patient has a higher outcome score than waiting and therefore is the recommended option.

There are benefits to using a rigorous decision making system such as this in a clinical setting. Cockcroft (2007) describes how using this method enables practitioners 'to be more confident in the conclusion' (P.499). This is a sentiment echoed by Kassirer (1976) who argues that decision analysis allows the clinician to ensure they have covered all possible outcomes to a scenario, as well as providing a clear framework for justifying any decisions made.

The major disadvantage to the method is the large amount of time and labour needed to perform the analysis (Cockcroft, 2007) and this is the main reason the method is not used commonly in clinical practice. Decision analysis also relies heavily on the correct information being input into the decision tree to create probabilities and utilities (Cockcroft, 2007; Kassirer, 1976). If this information is not available, which may be the case in domains such as veterinary medicine where fewer clinical studies have been performed, the process is invalid.

The main application for decision analysis in medicine is to calculate the best option for a community of patients. For example, Johnson et al. (1992) used this method to calculate the optimum treatment for microinvasive cervical cancer, which could then be referred to by doctors facing treatment decisions with their own patients.

2.3 Development of clinical reasoning

The *development* of clinical reasoning is considerably understudied; only five empirical research papers have been identified that address the topic. Groves et al. (2003) demonstrated that clinical reasoning ability was positively predicted by course progression in graduate-entry medical students, but did not explain how this occurs. In her doctoral thesis, Anderson (2006) found that the development of clinical reasoning ability is not uniform across a student population, and that those who struggle initially appear to maintain this disadvantage as the course progresses. Van Gessel et al. (2003) reported improvement of clinical reasoning as students progressed from science-based to clinically-based curriculum phases, however this was measured using self-evaluation questionnaires which have been shown to be inaccurate, particularly among those least skilled (Weller et al. 2005, Baxter and Norman 2011). Krupat & Pelletier (2015) reported progressive improvement of clinical reasoning during a four-year medical course, but again relied on student self-perception. To add to the confusion, Neufeld et al. (1981) claim that limited development in clinical reasoning occurs during medical school – although the study sample is only 22 and was conducted over 30 years ago, during which time curricula have changed significantly. In summary: the understanding of the development of clinical reasoning is very limited.

Research into medical expertise has provided a degree of insight into clinical reasoning development. Although reasoning is not the focus of these studies, it is such a fundamental component of successful clinical practice that researchers have been able to suggest several theories of mental development that lead to expert decision making. These theories, and the research contributing to their formation, are discussed below.

2.3.1 The history of expertise research

It was originally hypothesised that experts differed from novices by possessing a 'reasoning skill' that allowed them to be more proficient at solving any medical problem in any domain (Schmidt et al. 1990; May 2013). This theory was questioned after early research showed an apparent context specificity – the standard of case diagnosis by any particular clinician was dependant on the area being investigated (Elstein et al. 1978). Norman et al. (1985) even showed that, given two cases of the same condition presented in two different ways, the problem-solving ability of an individual varied dramatically.

Attention then turned to knowledge as a basis for clinical reasoning expertise. Norman (2005) calls the next phase in research 'The age of memory' (P.420) and describes how scientists tried to draw on fields other than medicine to find the explanation for medical expertise. They focussed in particular on the ability to recall vast amounts of data, which had been shown to be key to expertise in chess (Simon and Chase 1973). This theory, however, was largely unsuccessful when applied to medicine (Norman 2005). In fact, studies failed to show any correlation at an individual level with knowledge of a subject and reasoning ability in that area (Norman et al. 1985). As amount of knowledge did not seem to create expertise, focus turned to organisation and availability of knowledge. This led to an explanatory model of expertise development proposed by Schmidt et al. (1990).

2.3.2 Stages in expertise progression

In 1990, Schmidt et al. examined research into expertise outside of the field of medicine and amalgamated it with medical decision making research to produce a theory of clinical reasoning expertise development (Schmidt et al. 1990). They identified four different stages of development that are represented by different knowledge structures. These are as follows:

1. At the start of their medical career, students form an elaborate causal network of knowledge that explains diseases in terms of the detailed pathophysiology behind them. As this is often based on textbook information, explanations have been shown to be long-winded and lacking understanding of the variation of disease manifestations in the real world.

2. As students' progress through to the later years of their medical education, they abridge these extensive networks, allowing them to describe a disease process more accurately and concisely. The knowledge is arranged into disease categories, and focuses more on symptoms present than the science behind them. This process is the result of patient encounters and diagnostic tasks forcing the student to link underlying knowledge with a real case presentation – with repeated exposure the student creates shortcuts in their knowledge to access these items more easily (Schmidt et al. 1988).

3. When students have been exposed to a large number of clinical cases they start to develop and utilise illness scripts (Feltovich & Barrows 1984 cited by Schmidt et al. 1990), which are discussed in more detail below. These scripts are formed by repeatedly experiencing the same condition in a number of patients; encouraging the student or clinician to further simplify their pathophysiological knowledge into a readily accessible mental model. This process is known as knowledge encapsulation. The illness scripts contain practical information on the presentation and treatment of the condition, alongside contextual patient information, stored in the order they are likely to be encountered. At this stage, clinical reasoning consists more of an unconscious 'script search, script selection and script verification' (Schmidt et al. 1990, P.615) process than the pathophysiological based reasoning that is encountered in the first two stages.

4. The authors describe the final stage to expertise as 'instance script' formation (Schmidt et al. 1990, p. 617), characterised by a large store of previous patient information. They hypothesise that clinicians unconsciously search for similarities between their current and previous cases in order to make a diagnosis. This method of reasoning is more accessible than the methods used in stages 1-3, as the information is stored in episodic memory - which is generally associated with faster learning and easier retrieval. Hypothetico-deductive system two reasoning still occurs, especially when the clinician is in a novel situation; but the more efficient instance script is used the majority of the time. Biomedical knowledge remains encapsulated within the memory to be accessed when needed.

Schmidt et al. (1990) note that the progression of knowledge structure in this model follows the pattern of the general medical education program – starting with detailed physiological science and progressing to dealing with individual cases. They also discuss that each stage is progressive, but that previous methods are still available should they be needed, although the authors do not provide evidence to support this statement.

Norman (2005) critiques the work by Schmidt et al. (1990) claiming 'What was alluded to, but left unanswered in that paper, was the relative contribution of the various knowledge forms to expert performance, and whether each representation is available and used depending on the particular context' (p.421). There is also no attempt by the authors to explain this theory in relation to the prominent clinical reasoning methodologies in the literature, such as dual process reasoning, or explain the relationship between the two.

2.3.3 Illness scripts

Illness scripts are the key component of stage three in the progression to expertise proposed by Schmidt et al. (1990). They were initially proposed by Feltovich & Barrows

(1984) and have been developed by Schmidt et al. to explain clinical reasoning development in students. Illness scripts are important as they represent the stage of development that medical (and veterinary) students should be aiming for by graduation. Therefore, educators need to be aware of how best to encourage their formation.

Scripts, in general, are a form of mental representation of information that allows quick interpretation of new situations by providing a 'check list' for comparison. This checklist is formed by previous experiences. Charlin et al. (2007) provides the following description of the nature of scripts:

> *'A script is about what is normal and what acceptable variations are, and how these variations hang together. It captures what one can expect in a frequently encountered setting, such as having a meal at a restaurant. Once established, the script then allows one to make sense of different restaurant visits and differences among them, ranging from a fast food snack to a banquet in a select restaurant. Such a structured framework allows the 'understander' to deal expeditiously with a variety of otherwise difficult-to-understand situations.' (p.1179)*

In this situation, as the 'understander' visits various restaurants they will build up a check list or script of common features of the experience, which can then be used to judge other places visited as either a restaurant or not. Built into scripts are expectations (for example a restaurant will always serve food) and features that can have several options that are acceptable (for example the style of food the restaurant serves could be Indian, French, Chinese, etc.). Another important aspect of the script is that is has a temporal dimension, in which events occur in a set order (Charlin et al. 2000).

Illness scripts are the name given to mental representations of disease processes used to aid clinical reasoning. Novice clinicians build up a checklist of symptoms and signs that a disease always or might include, as well as the corresponding temporal considerations. This is used automatically when presented with a new patient. Every activated illness script represents a diagnostic hypothesis. The diagnosis is automatically inferred if only one illness script is triggered for a patient, but if there is more than one script activated, system two reasoning will take over (Charlin et al. 2007).

In the model proposed by Schmidt et al. (1990) the illness scripts form as knowledge representation moves away from the biomedical basis of the student and towards the clinical basis of the expert. It has been shown that experts use less biomedical knowledge when solving a diagnosis than students do (Boshuizen and Schmidt 1992) but the researchers propose this is due to knowledge encapsulation rather than loss. Boshuizen & Schmidt (1992) explain that this 'reformatting' of knowledge to make it directly relevant to clinical work means that is it still present – probably even improved – but quiescent until needed. The illness script is a form of encapsulation that is triggered when students begin to have contact with patients, due to the need for clinical information to be quickly accessible and a reduced need for detailed biomedical knowledge. These scripts stay with the practitioner for the rest of their career, but are used less frequently once the clinician progresses to stage 4 of the model, where instance scripts take over.

2.4 Teaching and assessing clinical reasoning

This section will review the literature describing optimal methods for teaching and assessing clinical reasoning. However, both areas are lacking empirical evidence of best practices and substantial disagreement is present between authors (Schmidt and Mamede 2015).

2.4.1 Teaching clinical reasoning

Schmidt & Mamede (2015) suggest that clinical reasoning development could be the 'most important objective of medical education' (p.962). It is vital to produce competent clinicians (medical or veterinary) that can diagnose and manage their patients' problems. However, due to a lack of research, recommended methods of teaching clinical reasoning are mostly based on expert opinion (Kassirer 2010).

In the past, clinical reasoning was assumed to develop to an acceptable standard during the WBL placements in the later years of medical courses (Schmidt and Mamede 2015). However, Rattner et al. (2001) discovered that there were large variations in the cases encountered by each student whilst on clinical clerkships. Furthermore, the exposure to high-prevalence cases was low, with less than half of all students encountering the most common medical problems (Rattner et al. 2001). The high validity of this study, which involved 647 third year medical students completing 86011 patient encounter records, gave credibility to the theory that WBL alone would not provide sufficient case exposure for clinical reasoning development.

Since this discovery, many institutions have introduced clinical reasoning courses into the pre-clinical years of their medical curricula (Schmidt and Mamede 2015). However, there is no evidence that this approach succeeds in preparing students for clinical practice. In fact, Rogers et al. (2009) found no difference in problem solving ability when students took part in a clinical reasoning course compared to a control group. This study used the perceptions of supervising clinicians as the measurement tool and thus the assessment of problem solving skills may not be wholly accurate; however, it does demonstrate that further research is needed in this area.

In 2015, Schmidt & Mamede conducted a narrative review of the literature describing methods to teach clinical reasoning. Of 48 papers identified, only half attempted to measure the impact of the teaching activity; the other half simply offered a description. Clinical cases were used as the basis for almost all the activities, with two modes of presentation being utilised. The first of these, the serial-cue approach, is the predominant method reported in the literature (Schmidt and Mamede 2015). This involves the gradual release of case material in a serial fashion, often in response to student data gathering. This format can include real, simulated or virtual patients. Alternatively, peers and facilitators may play the role of the patient. Serial-cue presentations mimic the real-life process of gathering information and reaching a diagnosis. This high face-validity may be the reason for the methods' popularity – educators think replicating genuine clinical encounters is the best way to develop reasoning skills (Eva 2005, Kassirer 2010). However, Schmidt & Mamede (2015) warn that this method may actually hinder learning, as it relies on the student to use pre-formed illness scripts. If those scripts have not yet been developed, the cognitive demand on working memory is high and thus not optimal for learning. Work by Nendaz et al. (2000) supports this theory, by demonstrating that full clinical vignettes produce higher diagnostic accuracy in students, residents and practitioners when compared to serial-cue methods. Schmidt & Mamede (2015) conclude that there is insufficient evidence that serial-cue cases exposure is effective at developing clinical reasoning.

The alternative way of presenting a clinical case to students is to provide a full clinical vignette at the start of the encounter, containing all of the information needed to reach a diagnosis (Schmidt and Mamede 2015). This method is not representative of reality, as rarely do patients provide a full clinical history without prompting. However, it has been shown to improve diagnostic accuracy, as discussed above. Using this method may limit the development of illness scripts in students that would be capable of using them (Kassirer 2010).

Additional recommendations for clinical reasoning instruction have been developed from an understanding of clinical expertise (Eva 2005, Kassirer 2010, Cutrer et al. 2013). During medical school students transition from casual networks to illness scripts as the predominant clinical reasoning process (Schmidt et al. 1990); therefore educators should be helping students develop these scripts. Eva (2005) claims that being able to guess the likely diagnosis from the start of a clinical case (for example, when the case is part of a chapter on gastrointestinal parasitology in a textbook) prevents illness script formation and the ability to differentiate similar clinical presentations. He recommends, instead, mixing case topics. An additional benefit of mixed case practice over blocked case practice is the chance to compare pathologies with similar presenting features. For example, by considering congestive heart failure in juxtaposition to pneumonia, students can clarify the clinical signs that should be within the illness script of both conditions. Studies in medical education have demonstrated that superior diagnostic ability is associated with this contrasting-cases approach (Hatala et al. 2003, Ark et al. 2007) and thus is it recommended by Schmidt & Mamede (2015).

Another implication of illness script development is the need for repeated exposure to common presentations. As scripts grow and become more accurate with each clinical encounter, the more times a student can become involved with a particular presentation the stronger their script will become (Cutrer et al. 2013). As time constraints mean multiple exposures to all cases is not feasible, focus should be placed on the presentations most frequently encountered in practice (Eva 2005, Cutrer et al. 2013, Schmidt and Mamede 2015). However, this is just a theory, and no experimentation has been conducted to determine if this is the case in reality.

Finally, there is one recommendation for teaching clinical reasoning that the literature does agree on; that both system one and system two reasoning should be encouraged. This is the result of research demonstrating that use of the two methods in combination provided superior diagnostic accuracy in students (Ark et al. 2006). This study measured only the ability to interpret electrocardiograms – so may not be generalizable to all areas of medical expertise – but did include a control group for comparison and a reasonable sample number (48). The combination of system one and two reasoning methods – described as dual process reasoning – allows students to approach a problem in whichever way suits them best. This is important due to the variation in clinical experience during training, meaning illness script formation and availability will differ between students (Eva 2005).

2.4.2 Assessing clinical reasoning

A valid and reliable assessment of the clinical reasoning ability of students remains the 'holy grail' of medical education (Schuwirth 2009). Assessing clinical reasoning is hard, as it is not directly accessible – only the effects or consequences of decision-making can be measured (Patel et al. 2005). There have been many proposals, some of which have been adopted by medical licencing boards (Higgs 2008) – for example, the Key Features method is used within the Canadian Qualifying Examination in Medicine (Page and Bordage 1995). However, all have lists of limitations that prevent them from being universally adopted. For that reason, research studies that require measurement of clinical reasoning improvement vary in the technique chosen – with none being considered superior. Further still, some studies avoid measurement entirely and rely on surveyed student perceptions of clinical reasoning (Cockcroft 1998, Patterson 2006, Baillie et al. 2009).

Table 2.3 presents the most common methods of clinical reasoning assessment used in both educational and research contexts. Simulation is not listed within this table, as it is not an assessment method in itself. Instead, simulation requires an additional tool to measure the clinical reasoning occurring. The tools utilised for this purpose are diverse, but fall within two major categories: global rating scales and checklists (De Galan et al. 2007). These are discussed at length in Chapter Five, so not presented here.

Assessment	Main use	Authors	Description	Advantages	Criticisms
Patient management problems	Examination	McGuire & Babbott (1967)	Attempts to examine overall problem-solving ability by asking students to manage a clinical case. Usually completed online. Students are presented with an introduction, followed by a choice to make regarding history taking. The student is then provided with the answer to their selection. This is used to inform their next choice etc. until the case has been resolved and treated.	Has a high face validity, corresponds to the real-life decision-making process Simultaneously measures all components of clinical reasoning e.g. examination, testing, diagnosis etc. Objective	Errors are cumulative: once a wrong option is selected, students may be down the 'wrong branch' thus cannot compensate The performance of one student across different PMPs has been shown to have very low correlation, suggesting an 'overarching' reasoning skill is not being examined
Key features	Examination	Page et al. (1995)	Focusses on the key steps in managing a case. A vignette is provided, and then students are questioned on just the key features of the case using short answer, MCQ or EMQ formats.	Reduced time to complete each case, meaning more can be included in the examination – increasing reliability Objective	Still requires roughly four hours of testing If MCQ or EMQ formats are used, the presence of the answer may prompt students
Script concordance test	Examination	Charlin et al. (2000)	Based on the use of illness scripts to solve clinical problems. Usually completed online. Students are provided a limited case vignette. Then, further case information is given and the student must indicate how this influences the case progression. It is scored by aggregate in relation to the answers of experts.	Mimics the uncertainty and limited information present in real-life Reliability is good – Cronbach's alpha of roughly 0.8 when 80 questions are answered over one hour (Charlin 2004) Scores weakly correlate with knowledge tests, suggesting it examines a different construct	The structure is complicated; students may score poorly if they do not understand the format By avoiding the extreme responses on the agreement scale, students can manipulate the test to achieve a higher score

Clinical reasoning problems	Examination	Groves et al. (2002)	Focusses on the process of clinical reasoning, rather than the outcome. Clinical history and examination information are given to students, who must provide and explain the two most likely diagnoses. Answers are compared to that of an expert panel. Usually paper-based.	Preliminary reliability appears to be good Appears to separate clinical reasoning and clinical knowledge	Examines only the diagnostic aspect of clinical reasoning Psychometric characteristics have not been researched thoroughly yet
Diagnostic thinking inventory	Research	(Bordage et al. 1990)	Aims to measure flexibility in thinking and knowledge structure in memory. A six point semantic differential scale is used by students to self-assess their own methods of reasoning and capability.	Objective, easy to score Appears to separate clinical reasoning and clinical knowledge Good reliability and validity	Self-reported, so results may not be accurate as clinical reasoning is normally an unconscious process Does not measure behaviour, just perceptions of behaviour
Extended matching questions	Examination	Beullens et al. (2005)	A clinical stem or vignette is presented with 8 or more possible diagnoses from which the student must choose the most likely. Usually completed online.	Objective, easy to score Appears to have good validity	Psychometric characteristics have not been researched thoroughly yet Content validity reduced by low number of different topics assessed

Think aloud	Research	Ericsson & Simon (1998) provide a description of applications	Students are required to describe their thinking as they solve a clinical problem. The problem can present in a variety of formats e.g. simulation, written.	Allows the process of decision-making to be assessed Appears to separate clinical reasoning and clinical knowledge	Rely on the participant to accurately describe their thinking – may not be representative as clinical reasoning is often unconscious The verbalisation of thinking may affect the process of clinical reasoning May be affected by communication barriers

Table 2.3 Techniques used to assess clinical reasoning ability (McGuire and Babbott 1967, Bordage et al. 1990, Page et al. 1995, van der Vleuten and Newble 1995, Page and Bordage 1995, Jones 1997, Charlin et al. 2000, Groves et al. 2002, Van Gessel et al. 2003, Charlin 2004, Anderson 2006, Higgs 2008, See et al. 2014, Hrynchak et al. 2014)

2.5 Clinical reasoning in veterinary medicine

Despite four decades of research into clinical reasoning within the field of medicine, there has been very little investigation into the decision methods used specifically by veterinary surgeons. There are only two studies, to the authors' knowledge, that have researched veterinary clinical reasoning. Furthermore, no investigations into the teaching and assessment of veterinary reasoning have been conducted. Thus, all current recommendations for teaching decision-making in veterinary education have been extrapolated from medical research (May 2013).

Everitt (2011) provides the most detailed investigation into the reasoning habits of veterinary surgeons. As part of her doctoral thesis, Everitt filmed first-opinion veterinary consultations and then interviewed the practitioner involved, hoping to understand the factors influencing their clinical decisions. The interviews were prompted by the consultation recording. This method is widely believed to be inaccurate, as it relies on the introspection of participants. Furthermore, watching a recording can prompt false memories – relating more to what the participant thinks at the point of recall than during filming (Ericsson and Simon 1998, Lyle 2003). However, as previously noted, exposing the clinical reasoning process is difficult – especially when the researcher needs to avoid influencing the process herself.

The other key study comes from Vandeweerd et al. (2012), who surveyed first-opinion veterinary surgeons on their reasoning methods both by telephone and in person. Again, this research approach relies on spontaneous recall by participants, whose recollections may not be based in fact, reducing the validity of the findings. In the case of Vandeweerd et al. (2012), participants did not have any prompt to stimulate recall – they were simply trying to 'think-back' - making the results particularly unreliable. Both studies interviewed veterinary surgeons from all species specialisations, but used small sample sizes – 22 in Everitt (2011) and 31 in Vandeweerd et al. (2012) - which limits the generalizability of the findings. In summary: the results from these studies may not give a true representation of veterinary clinical reasoning – but are the best insight available.

Both studies identified the use of dual process reasoning by veterinary surgeons in a very similar way to medical practitioners – using system one processes initially and switching to system two when faced with uncertainty. Everitt (2011) reports the dominance of system one reasoning in participants. This contradicts the findings of Vandeweerd et al. (2012), who report that veterinary surgeons felt they used system two reasoning more often. As the participants in Vandeweerd et al. (2012) were questioned out of context, it is possible that this viewpoint is inaccurate, based on a lack of understanding and insight by the veterinary surgeons. Everitt (2011) describes the challenge that the use of dual process and system one reasoning presents to new graduate veterinary surgeons – who feel that they were not taught to 'think that way' during their degree course.

Shared decision-making was found to play a large role in first-opinion consultations, with the process resembling a negotiation between owner and veterinary surgeon (Everitt 2011, Vandeweerd et al. 2012). In contrast to other medical practitioners, veterinary surgeons involved the client in the diagnostic process and well as management decisions. This is likely due to the financial constraints owners may impose on the selection of diagnostic procedures. Everitt (2011) also found that veterinary surgeons shared the decision-making process with clients to a greater degree when they were unsure how to proceed. Interestingly, decision-making appeared more paternalistic within charity practice consultations (where owners are not required to pay for treatment). The latter situation resembles the current medical situation in the UK, where the NHS covers all the costs of healthcare.

Both studies noted that decision-making was often influenced by the personality of the veterinary surgeon involved – varying by confidence, optimism, and thoroughness

(Everitt 2011, Vandeweerd et al. 2012). Additionally, the temperament of the animal and the emotional attachment of the owner influenced clinical reasoning – both factors which are unlikely to be considered in human medicine (Everitt 2011). Everitt (2011) described the pragmatism involved in decision-making in equine and farm animal practice, where the worth and function of the animal can heavily influence the reasoning of the veterinary surgeon. A study into the effect of objective scoring methods on metritis management supports this finding (Lastein et al. 2009); where veterinary surgeons' approach to metritis was found to be influenced by economic, public health and welfare factors, alongside practice-protocols.

Overall, veterinary clinical reasoning appears to integrate non-clinical factors to a larger degree than in human medicine, particularly financial and business considerations. The majority of decision-making seems to be shared with the owner, again most likely because they will need to pay for any diagnostics or treatment. However, the overarching method of dual process reasoning is used in a similar way to medical practitioners.

2.6 Chapter summary

This chapter has discussed the available literature surrounding clinical reasoning processes, development and assessment. It has also considered the similarities and differences between medical and veterinary clinical decision-making.

The next chapter will guide the reader through the ontological, epistemological and methodological approaches to the research within this thesis.

Chapter 3 Research methodology and methods

This chapter will provide an overview of the methodology and methods used within this thesis. Hitchcock & Hughes (1995) describe a process used to identify appropriate research methods for a given question (figure 3.1). This involves defining the ontological, epistemological and methodological assumptions of the study before selecting specific data collection methods. This process has been used to both design the studies presented in this thesis and structure the following chapter. It was chosen as it clearly defines a transparent approach to research design, without grouping the different considerations under the term 'paradigm' - which has been observed to hold several different meanings within the literature and be used non-specifically by authors (Morgan 2007).

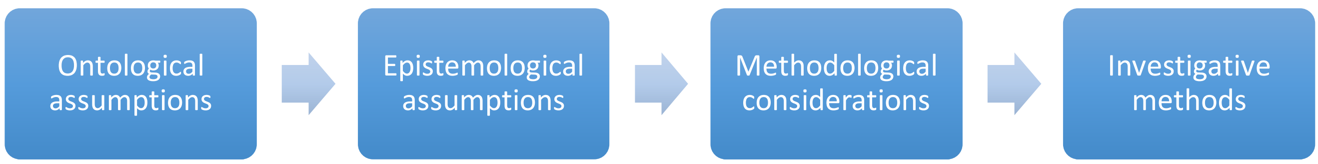

Figure 3.1 The process used to design the studies within this thesis, adapted from Hitchcock & Hughes (1995)

3.1 Ontological assumptions

Ontology is concerned with human perceptions of reality and being (Braun and Clarke 2013). It questions whether there is a 'true' reality that can be accessed through research, or whether reality is only formed through human experience and interpretation. The extremes of ontological belief are realism and relativism (Kam et al. 2011, Braun and Clarke 2013). Realism assumes that the human view of the world *is* reality, that there is only one reality, and that reality does not vary according to the individual perceiving it. This implies that the world can come to be 'known' through research, when the right techniques are selected. To paraphrase: 'what you see is what you get'. Quantitative research almost always adopts a realist viewpoint – presenting results as factual descriptions of the world (Bunniss and Kelly 2010, Cohen et al. 2011, Braun and Clarke 2013).

Relativism opposes this philosophy, instead claiming that reality is constructed within the mind. Reality is inseparable from human perception. Relativism believes that research will yield different results when interpreter is changed, as no two people view the world in the same way. Even simply varying the time or place of a study would influence the findings. Several qualitative research approaches are built upon a relativist ontology, including certain variations of discourse analysis (Bunniss and Kelly 2010, Cohen et al. 2011, Braun and Clarke 2013).

Critical realism falls in-between realism and relativism on the ontological continuum. It accepts that there is a fixed reality, but believes researchers can only access it through their own subjective perspective. The objective reality is nuanced by each individual such that the complete 'truth' can never be known, but a representation of that truth can provide a foundation for knowledge (Braun and Clarke 2013). This is the most common ontological approach in qualitative research, and the assumption that underpins the studies presented in this thesis.

3.2 Epistemological assumptions

Epistemological assumptions concern the nature of knowledge. Specifically, they consider whether knowledge is *created* or *discovered* and how (Morgan 2007, Braun and Clarke 2013). There are several epistemological viewpoints, each one with a different perception on knowledge gained through research. Epistemological considerations are important when conducting research, as they determine the methodology and methods that will be most appropriate for data collection (Cohen et al. 2011). They are strongly linked to the ontological assumptions of the research; often guided by them (Braun and Clarke 2013).

The positivist paradigm is the most prolific in modern society. It underpins all quantitative research and scientific reasoning, and is a very popular in healthcare research (Pope and Mays 2006, Schifferdecker and Reed 2009, Cohen et al. 2011, Tavakol and Sandars 2014). Positivists search for the absolute truth using objective experimental design, careful monitoring of variables and repetition (Bunniss and Kelly 2010, Cohen et al. 2011). They believe that knowledge is *discovered* through research, as it exists separately from human interpretation. At any given time or place the answer to any specific question will be identical (Braun and Clarke 2013).

Post-positivist epistemology also considers there to be a singular reality, but believes research is unconsciously influenced by the researcher – meaning this reality is never objectively measured. Post-positivists believe that knowledge is an interpretation of 'the truth' by an individual. This perception is common amongst qualitative researchers within healthcare and education (Clark 1998, Pope and Mays 2006).

Constructivism is the main epistemological paradigm that structures qualitative work in sociology (Braun and Clarke 2013). It argues that knowledge is constructed by an individual through interaction with the world in a specific historical moment and social context. Any social or cultural changes to that person will affect how the world is perceived and therefore their knowledge of reality will be different (Bunniss and Kelly 2010, Cohen et al. 2011). For this reason, constructivists believe there are multiple 'knowledges' that become accessible at different points in time – not simply one universal truth. However, Braun & Clarke (2013) are careful to point out that constructivists do not think knowledge can be created from nothing. Instead, they explain that 'knowledge of how things are is a product of how we come to understand it' (p.30); meaning is built by the interpreter. Research within this paradigm creates results through interaction between investigator and participant.

Several more paradigms exist, including contextualism, critical theory and feminism (Bunniss and Kelly 2010, Cohen et al. 2011). All describe variation in how knowledge becomes known and the role in which the researcher plays in this process. They each lie somewhere on the continuum between the extremes of positivism and constructivism (Pope and Mays 2006). Some epistemologies introduce the influence of external factors into knowledge formation, for example feminism places emphasis on the effect of gender discrimination on the construction of reality by a subject (Cohen et al. 2011).

The studies within this thesis were developed from a post-positivist epistemology, selected to function harmoniously within the critical realist ontology. Therefore, the researcher acknowledges that the findings within the results have been subject to interpretation and thus does not represent the 'absolute truth', but instead they represent reality as closely as humanly possible.

3.3 Methodological assumptions

Research methodologies are distinct from research methods. The latter refers to specific tools or processes used to collect or analyse data. The former is described by Braun & Clarke (2013) as 'the framework within which our research is conducted' (p.31). The methodology provides a theory that describes how the research should be conducted, guiding the methods selected. The chosen methodology should reflect the ontological and epistemological assumptions of the researcher (Hitchcock and Hughes 1995). Quantitative and qualitative methodologies are the two overarching research approaches, the second of which can encompass several methodologies in their own right – for example, grounded theory (Braun and Clarke 2013). Quantitative and qualitative research methodologies are described and compared in table 3.1.

	Quantitative methodologies	**Qualitative methodologies**
Theory	Hypotheses should be tested objectively using scientific method	Research questions should be investigated in real-world settings without researcher interference
Research aim	Determines *If* and *How*	Determines *Why*
Advantages	Can find cause-and-effect relationships; results independent of researcher; high level of generalisability when conducted properly; data collection and analysis relatively quick; can use large sample sizes	Provides a detailed narrative of research topic; can be iterative and flexible; allows theories to *emerge* from the data, not be *tested* by the data; can access participant experiences and viewpoints; conducted with a natural context
Disadvantages	May miss new theories as focussed on validating hypothesis; participants have to *choose* a perspective, rather than describe their own; categories assigned by the researchers may not represent the opinions of participants; superficial numerical descriptions of phenomena	Data collection and analysis is time consuming, leading to smaller sample sizes; generalisability can be limited; researcher are not objective and can affect results; certain methods require a level of skill to perform e.g. focus group facilitation
Validity and reliability	Calculated objectively using psychometric methods	Built up through data triangulation, researcher reflexivity, respondent validation and inclusion of negative cases
Associated methods	Surveys, content analysis, skill measurement	Interviews, focus groups, observation
Analysis	Mathematical and statistical	Interpretational
Example study	Buzzeo et al. (2014) conducted a quantitative survey to understand the current state of the veterinary profession in the UK	Prince et al. (2004) conducted four focus groups with a total of 17 recent medical graduates to understand the experience of moving from medical school to practice

Table 3.1 The features and uses of quantitative and qualitative research methodologies (Pope and Mays 2006, Braun and Clarke 2013)

3.3.1 Mixed methods research

Mixed methods research involves the use both quantitative and qualitative methodologies within one project (Pope and Mays 2006, p. 102). Some authors distinguish mixed methods research from mixed-model research. The latter has been described as combining quantitative and qualitative methods within one phase of research, for example choosing different methodologies for data collection and analysis (Johnson and Onwuegbuzie 2014). This is compared to mixed methods research, which involves 'conducting a quantitative mini-study and a qualitative mini-study in one overall research study' (Johnson and Onwuegbuzie 2014, p. 20). Mixed methods have been growing in popularity in healthcare research due to the increasing interest in the psychological and social effects of medical interventions in combination with efficacy data (Pope and Mays 2006). Medical education, too, is increasingly encouraging the combination of approaches within studies (Schifferdecker and Reed 2009). Using mixed methods allows the advantages of quantitative and qualitative methodologies to be combined, reducing the effect of the disadvantages. In particular, it facilitates the combination of large sample sizes and statistics with in-depth investigation of lived-experiences.

Schifferdecker & Reed (2009) report four common uses of mixed method research in medical education:

1. Triangulation – where the validity of results is increased through convergence of both quantitative and qualitative data
2. Instrument development – where qualitative data are collected to inform the development of a quantitative survey or checklist
3. Explanation – where qualitative methods are used to further explore the results of a quantitative study
4. Longitudinal transformation – where data is continuously gathered from multiple populations over a long period of time using both methodologies

Several additional factors need to be considered when designing and conducting mixed methods research. Firstly, the relative dominance of quantitative and qualitative aspects of the study should be identified (Schifferdecker and Reed 2009). Secondly, the sequence of data collection should be planned – if the researcher intends to switch iteratively between approaches then the practicalities of this should be considered. Finally, it should be decided at which point the methodologies will be integrated; combining raw data will produce a different outcome than if findings are integrated post-analysis (Pope and Mays 2006).

The use of mixed methods within this thesis developed from the individual consideration of each research question in combination with the overarching ontological and epistemological assumptions. Overall, mixed methods were chosen to triangulate findings in order to increase the validity of the conclusions, as there is no reliable method of measuring or evaluating clinical reasoning. However, this process has also led to a wider and deeper understanding of each of the phenomena examined. Table 3.2 lists the qualitative and quantitative components of each study within this thesis. The rationale for the methodological choices of each research question are discussed in context within each study chapter.

Study	Quantitative methods	Qualitative methods	Data integration stage	Dominant research approach
1. Perceptions of clinical reasoning development	Content analysis	Focus groups Interviews	Post-analysis	Qualitative
2. The use of standardised client simulation to improve clinical reasoning	Self-assessed and research grading of clinical reasoning skill using a rubric Survey	Focus groups	Post-analysis	Quantitative
3. 'Decision Diaries' – stimulating conversation about clinical reasoning during CEMS	Content analysis Survey	Focus groups	Post-analysis	Equal priority

Table 3.2 Quantitative and qualitative methods within each study and the point of data integration

3.4 Methods

This section aims to introduce the data collection methods used within this thesis. It is intended to prevent repetition, as most of the methods are used in more than one study. As noted previously, the methods chosen should directly reflect the methodological approach. The specific justification of each method to answer specific research questions will be addressed in the corresponding study chapter. The examination of clinical reasoning ability has already been discussed in Chapter Two and thus will not be repeated here.

3.4.1 Case studies

Case studies involve the in-depth investigation of one example of a naturally-occurring phenomenon (Green and Thorogood 2009). It is a method commonly used for qualitative research – particularly within healthcare, when examining the functioning of large organisations (Stake 2005, Pope and Mays 2006). The main focus of a case study is the subject; which can range in magnitude from a single child to a whole profession (Stake 2005). This subject is studied in great depth and accuracy, albeit at the expense of large-scale generalisability (Green and Thorogood 2009). However, the generalisability aimed for relates to 'theoretical propositions, not to populations.' (Silverman 2013, p. 145), and thus usual requirements of statistical sampling do not apply. In fact, cases are often selected based on their availability, making statistical sampling impossible (Silverman 2013). Case studies expose experiential knowledge of a situation, gained from studying the participants within context (Stake 2005, Green and Thorogood 2009). They normally involve the use of multiple methods, aiming to strengthen the claims of the research using triangulation.

This thesis uses the SVMS as a case study into clinical reasoning development. This is most obvious within the first study chapter; however, some qualitative insights from studies two and three also contribute to the case. The SVMS was used as an 'instrumental case study', as described by Stake (2005); researched to provide insight into a broader issue (i.e. clinical reasoning development).

3.4.2 Content analysis

Pope & Mays (2006) define content analysis as 'a technique for categorising data into themes that can then be counted and converted into frequencies' (p.149). The data in this instance is normally textual, but can range in format from newspaper articles to novels. Performing a content analysis uses coding and categorisation to compresses the data into more manageable chunks that can then be analyses using statistics. The end product is a summary of the content of a document that can be replicated by any researcher (Cohen et al. 2011).

The advantages of content analysis methods include the objectiveness, unobtrusiveness and replicability of the technique (Cohen et al. 2011), leading to valid and reliable results. However, it cannot account for the credibility of a source, or judge the trustworthiness of data. Furthermore, it can only describe, not explain, the content of a document.

The classification of content analysis as either quantitative or qualitative is debated in the literature. Some authors claim that the process is purely quantitative, as it involves interpreting data using numbers and statistics (Silverman 2001, Braun and Clarke 2013). Others consider the use of text as data a cornerstone of qualitative research (Pope and Mays 2006). In an attempt to clarify the situation, some researchers describe two different types of content analysis – a numerical quantitative method, and an interpretive qualitative method (Silverman 2001, Hsieh 2005). In this thesis the focus of the content analysis was to produce replicable, reliable results; therefore the process described is considered a quantitative method (Silverman 2001, Hsieh 2005, Braun and Clarke 2013)

3.4.3 Surveys

Surveys are widely used within educational research, partly because they are a quick and easy method for collecting a large volume of data. Surveys can vary greatly in terms of scope, complexity, length, format and design (Cohen et al. 2011). They can be either quantitative, using closed questions and pre-defined answers; qualitative, providing space for participants to write their thoughts; or a combination of both (Braun and Clarke 2013). The appropriate method of analysis must be implemented – most commonly involving statistical analysis.

Other advantages of surveys include the flexibility of administration, leading to increased participant accessibility. For example, it is now easy to survey participants across the globe using internet-based questionnaires. Surveys can also gather data on a broader variety of subjects than an alternative method such as interviews. Finally, quantitative surveys can be analysed statistically - useful for providing an 'overall picture' of the situation (Cohen et al. 2011).

The main disadvantage of surveys is the limited 'snapshot' they provide of a phenomenon, normally including very little detail. Participants may, or may not, answer the questionnaire truthfully, and sometimes pick their responses at random when disinterested. When answers must be selected from a list or scale, variations in interpretation may occur and the 'next-best-thing' may be chosen if their ideal response is not available (Cohen et al. 2011).

All surveys within this thesis are quantitative, featuring a Likert-scale mode of response. Likert scales can be used to determine agreement with given statements, or answer questions relating to frequency. The format usually involves five or more categories that can be chosen by the participant in response to a statement, ranging from strongly disagree (1) to strongly agree (5). The scale is ordinal meaning that, for example, the difference between level one and two is not necessarily the same as that of four and five (Jamieson 2004, Cohen et al. 2011). However, it is possible to rank the responses in order to perform non-parametric statistical tests (Jamieson 2004).

When designing surveys, both acquiescent and extreme-response bias may be reduced by reverse wording. Acquiescent bias occurs when participants simply agree with all questions to reduce cognitive effort, and extreme-response bias occurs when participants are drawn towards the extremes of the Likert scale (i.e. indicating they feel more strongly than they do) (Anastasi 1982). Including a question twice within a survey – once with positive wording ('I enjoyed the lecture) and once with negative wording ('I did not enjoy the lecture') – may prevent participants from answering inaccurately or may highlight any error if they do (Anastasi 1982). If this method is employed, the responses to the negatively worded questions must be reversed (i.e. agree becomes disagree) when performing certain statistical tests, for example when calculating Cronbach's alpha for internal consistency. All surveys within this thesis use reverse wording in an attempt to minimise participant bias.

3.4.4 Focus groups

Focus groups were developed in the 1940's as a way to investigate the impact of wartime propaganda on radio-listeners (Silverman 2013). They involve the encouragement and facilitation of a small group discussion relative to the subject of interest. The groups usually contain between six and ten participants, normally with an interest or involvement with the research topic (Green and Thorogood 2009). A facilitator guides the discussion, often prompted by a list of topics or questions. Groups are usually structured to contain only one population type (Silverman 2013) – for example, in this study staff and students are separated. However, this population can be artificially gathered or naturally occurring, and may not have had any previous contact (Green and Thorogood 2009).

Within focus groups, data is generated by participant conversation; therefore social interaction is central to the method (Braun and Clarke 2013). By addressing a subject as a group, participants can explore their views and perceptions through discussion – thus providing a data set different to a traditional interview (Pope and Mays 2006). The method is particularly useful when investigating sensitive subjects, as the group dynamic can give participants the confidence to be truthful about their opinions. Additionally, it can be used when a natural discourse is required as it mimics a normal conversation. Because of this, participants are more likely to use their normal vocabulary (Braun and Clarke 2013).

Focus groups can be used to gather new knowledge about under-researched areas with a degree of flexibility (Braun & Clarke, 2013). Another benefit of focus groups is the effect they have on reducing the influence of the researcher/moderator (Braun & Clarke, 2013) – useful for this set of studies as the researcher has extensive experience and prior knowledge of the curriculum being investigated. Finally, focus groups can allow access to a large number of participants at once, reducing the time required for data collection and analysis (Pope and Mays 2006).

There are, however, several challenges faced when using focus groups in research. Firstly, a skilled facilitator must be recruited to ensure the group address all the required questions, do not spend excessive time off-topic and contribute to the discussion equally. This is important, as one member may dominate the discussion while others say very little. Participants may not feel able to discuss certain topics openly within a group, especially when there is stigma attached or members present with very strong viewpoints. Additionally, hierarchal relationships between participants and/or the facilitator may prevent group members from expressing their true perspectives. Focus groups can be hard to organize, as participants must be in the same place at the same time for roughly one to two hours. Even locating the target groups to invite can be hard, as well as convincing members to take part. Focus groups are almost impossible to hold when participants are geographically dispersed or have busy schedules (Braun and Clarke 2013).

Sample size within focus groups is usually determined by the data collected. Research should continue and further groups held until the participants are not discussing anything 'new' – the data is saturated. In practice, other factors can affect the sample size – for example, within the third study of this thesis the sample size was limited by the population size and student willingness to participate.

3.4.5 Interviews

An interview consists of a conversation between a researcher and a participant. This conversation is normally audio recorded, and the researcher may make additional observational notes. Braun & Clarke (2013) describe the aim of an interview as 'getting a participant to talk about *their* experiences and perspectives, and to capture *their* language and concepts, in relation to a topic *you* have determined' (p.77). Interviews generally fall into one of three types: 1) structured – where the questions are responses are pre-determined and fixed 2) semi-structured – where there is an outline of topics to be covered but new issues or topics raised by participants can be incorporated or 3) unstructured – where the participant controls the direction of the discussion. The semi-structure interview is the most common qualitative data collection method (Braun and Clarke 2006, Green and Thorogood 2009). Interviews can be conducted through several mediums – including telephone and email. However, some degree of social interaction will be lost if conducting interviews in any way other than in person (Braun and Clarke 2013).

Interviews are popular in qualitative research because they provide a rich and detailed insight into participant opinions and experiences (Braun and Clarke 2013). This allows a deeper understanding of a phenomenon, from a personal perspective. As there is only one participant, the interview can probe more deeply than a focus group, and the direction of questioning can change if something interesting is raised (Pope and Mays 2006). Additionally, some participants may feel more comfortable discussing sensitive topics in private with an interviewer than within a focus group. Interviews are also useful when potential participants are unable to take part in a focus group due to dispersion or scheduling. The disadvantage of the interview is the time required to conduct, transcribe and analyse them – resulting in a reduced sample size and reduced breadth of data (Braun and Clarke 2013). Also, it is important to remember that what people *say* is not necessarily what they *do,* thus observational methods might be more appropriate when investigating actions and reactions (Green and Thorogood 2009). Finally, the relationship between the interviewer and participant is critical to the success of the interview. For that reason, factors such as organisational hierarchy must be considered.

3.4.6 A note on sampling

There is contention in the literature over the sample size required when conducting interviews and focus groups. This is largely the results of inappropriate positivistic principles being applied to qualitative research, in which statistical analyses are ineffective at making such decisions (Braun and Clarke 2013). Generally, statistical sampling aims to determine the number of participants needed to accurately represent an entire population. In contrast, theoretical sampling – predominately used in qualitative research – aims to select a sample based on the ability to answer the research question (Pope and Mays 2006). Thus, the aim of the research should guide sample size when conducting interviews or focus groups. For example, if the aim is to present an in-depth case study then the ideal sample size might be one; but this would be inappropriate for an investigation into the experiences of students within a veterinary curriculum (Pope and Mays 2006).

Two sampling methods are used within this thesis: purposive and convenience. Purposive sampling involves the conscious selection of individuals for participation, as they are likely to be a rich source of data or expertise. This allows the majority of research time to be spent with the most productive participants. Convenience sampling is based on availability of participants, with those most easily accessible chosen. Both methods are nonprobability based and used frequently in educational research. However, the strength of generalisability they provide is disputed, particularly when convenience sampling is used (Braun and Clarke 2013, Tavakol and Sandars 2014).

3.5 Chapter Summary

This chapter has described the theoretical and methodological approaches used within this thesis. It has also introduced the reader to the methods used within the research studies. The thesis will now move on to present the research chapters, which contain the details of each of the three studies conducted. The first of these, an investigation into the development of clinical reasoning, is the focus of the next chapter.

Chapter 4 An investigation into the development of clinical reasoning

The aim of this study was to investigate perceptions of clinical reasoning development. This was done by using the SVMS as an instrumental case study; providing an in-depth insight into the wider concept of clinical reasoning development that can then be used to form a theoretical generalisation (Stake 2005, Silverman 2013).

This chapter will present the first study of the thesis: an investigation into the development of clinical reasoning. It will begin by describing the methods and methodology used for the study. This is followed by the results of the research, and finally the implications and weakness of the research are discussed.

4.1 Methods and methodology

4.1.1 The research question and framework for analysis

Clinical reasoning is a difficult topic to research as it is a mental process to which neither the subject nor the observer have direct access to (Patel et al. 2005). Researchers often have to rely on the limited introspection of participants (Feightner et al. 1977, Everitt 2011, Vandeweerd et al. 2012) or poorly-validated examination techniques (see Chapter Two). A universally accepted method of clinical reasoning investigation does not exist at present.

As the development of clinical reasoning during the five-year SVMS course is a very broad research question, with several possible methods of approach, it was decided that a framework of analysis was needed to structure this investigation. This would allow the question to be broken down into simpler sub-questions about the curriculum to address individually. Harden's curriculum model (Harden 2001) was utilised as it defines three clear, easily accessible, components of a curriculum that can be investigated individually but sum to create a 'bigger picture'.

Harden's model describes three components to any curriculum:

1. The declared curriculum - information declared to be taught, usually within curriculum maps and documentation
2. The taught curriculum - what is *actually* taught by staff
3. The learnt curriculum - what the students actually learn

Figure 4.1 shows the relationship between these elements. The more the three aspects overlap, the more aligned the curriculum is.

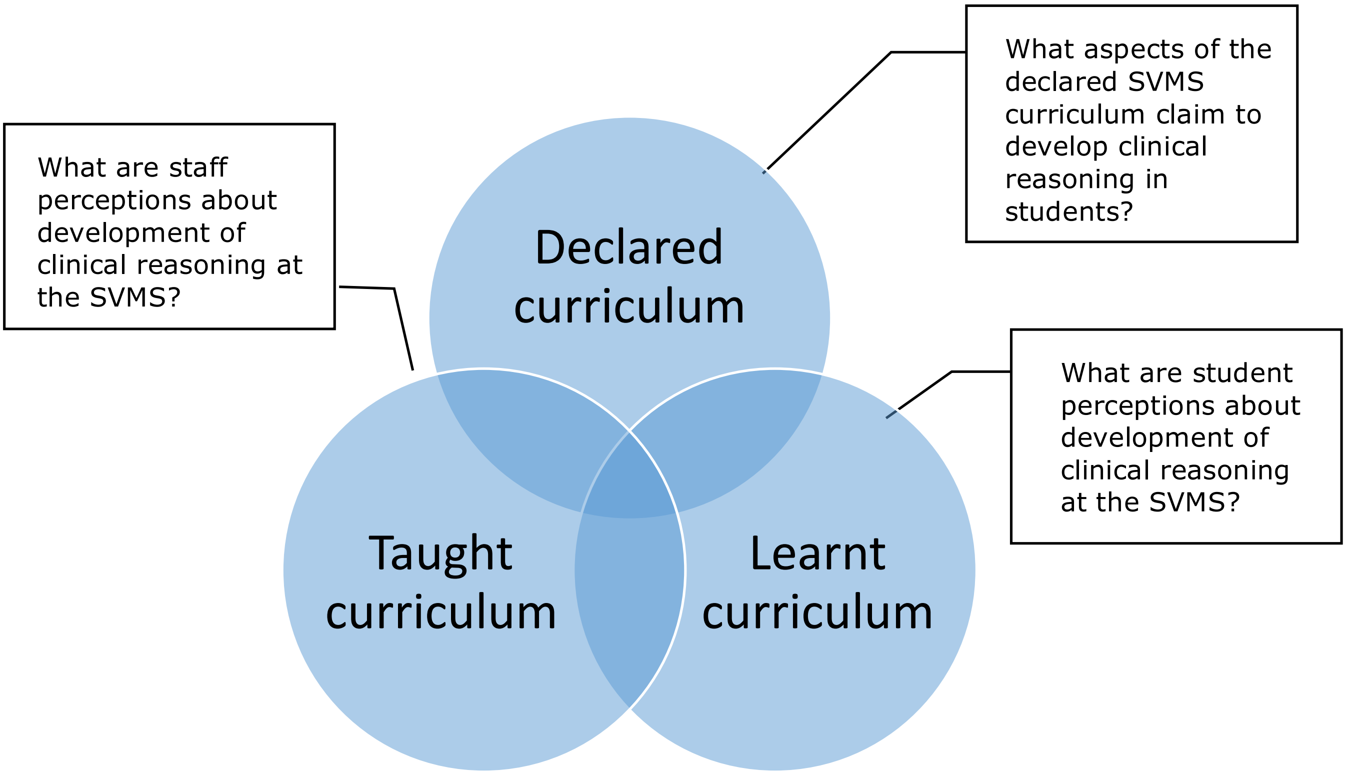

Figure 4.1 The Harden diagram describing the three aspects of the curriculum, with the associated research question shown in the boxes. Adapted from Harden (2001)

This framework provided three research questions to be addressed during the investigation:

1. What aspects of the declared SVMS curriculum claim to develop clinical reasoning in students?
2. What are staff perceptions about development of clinical reasoning at the SVMS?
3. What are student perceptions about development of clinical reasoning at the SVMS?

To structure data collection, the three research questions were investigated separately and their data amalgamated at the end. This allowed the correct method and methodology to be chosen for each sub-question whilst retaining the curriculum overview.

4.1.2 Methodology

The methodology for each of three research questions were considered individually, to ensure the right approach was chosen for each research sub-question.

The declared curriculum

The first sub-question created from Hardens model was:

- What aspects of the declared SVMS curriculum claim to develop clinical reasoning in students?

Deciding a methodological approach for this question was difficult; it has some properties of a qualitative approach – no fixed hypothesis or comparison between groups – but lacks other fundamental aspects such as theoretical interpretation (Pope and Mays 2006, Braun and Clarke 2013). Ultimately, the information needed to answer this question is finite and measurable (i.e. formal descriptions of the SVMS curriculum). For this reason, it would be expected that any results from this investigation would be replicable by other researchers – a quality best suited to a quantitative methodology (Braun and Clarke 2013).

The taught and learned curricula

The second and third sub-questions to be addressed were:

2. How do staff perceive the development of clinical reasoning at the SVMS?
3. How do students perceive the development of clinical reasoning at the SVMS?

As both questions are similar in structure and require almost identical data (just from different cohorts), it was decided they should follow the same methodology and methods.

Qualitative research aims to capture the participants perspective in depth and detail (Denzin and Lincoln 2011). It is concerned with uncovering the experiences of participants and how they build meaning around them. As these two sub-questions aimed to discover the *experience* of students and staff in regards to clinical reasoning development, a qualitative methodology was selected as the research approach.

4.1.3 Methods

Analysis of the declared curriculum

The declared curriculum was analysed by conducting a document content analysis. This method was chosen as it allows documentation to be analysed with a high reliability and validly (Silverman 2001, Cohen et al. 2011). As the declared curriculum is stated in documentation, this was appropriate for the aim of replicability and objectivity in determining the extent of its influence on clinical reasoning development.

Document selection

Documents for the curriculum analysis were selected using a purposive sampling technique, whereby all documents referring to the content of the SVMS curriculum were sourced. This method allowed a thorough examination of all curriculum information available. Documents were obtained from the Teaching, Learning and Assessment department of the SVMS

.

Content analysis

The content analysis method was adapted from Cohen et al. (2011) who describe an eleven-step process for defining, coding and analysing a document in order to draw conclusions from it.

Selective, deductive coding was performed on the documentation. This facilitated data reduction during the analysis, so that only information relevant to the research question was coded (Braun and Clarke 2013). Two codes were created for identification within the text. These are shown in table 4.1. A whole sentence or learning objective was chosen as the unit of analysis to ensure correct interpretation of codes. Coding was performed systematically and repeated to ensure accuracy. Each code was recorded and the total for each document section summed.

Code	Inclusion Criteria	Exclusion Criteria
Clinical reasoning	the term 'clinical reasoning' or 'clinical decision making' or 'clinical judgement'	References only to assessment methods
Related skills	A reference to the development of or importance of ○ Diagnosis ○ Differential diagnoses ○ Diagnostic testing or planning ○ Clinical and historical data interpretation ○ Treatment options or planning ○ Prognosis ○ Critical thinking	References to Problem-Based Learning without a clinical context

Table 4.1 Deductive codes generated for content analysis of the curriculum documentation

Learning objective analysis

In two of the sourced documents curriculum learning objectives were recorded next to the session type they are delivered in (i.e. Lecture, practical, SDL, seminar or CBL). This allowed an additional analysis of the 'learning objective' documents to determine the relative contribution to clinical reasoning development of each session type. After following the process outlined above, the total number of codes (and therefore learning objectives) that were delivered within each session type were summed.

Analysis was then done to determine how the coded learning objectives were distributed in relation to the frequency of the sessions – i.e. were there less learning objectives attributed to a certain session type because there are fewer of those sessions timetabled? The number of coded learning objectives delivered in each session type was calculated as a percentage of the total number of coded learning objectives across the curriculum. This gave the percentage of coded learning objectives that occur in each session type. This figure was then compared to the percentage of total learning outcomes that occurred in each session, calculated using the same method.

Analysis of the taught and learnt curricula

To uncover the taught curriculum, staff perceptions of clinical reasoning development were investigated using focus groups. This method was chosen as it allowed access to a greater number of participants. To determine the learned curriculum, two groups of participants were consulted using two different methods:

a) current SVMS undergraduate students – investigated using focus groups
b) recent SVMS graduates – investigated using interviews

As graduates have the most complete experience of the SVMS curriculum, it was important they were included within the learnt curriculum analysis. Due to their limited availability and dispersion throughout the country, interviews were used in place of focus groups to collect graduate data.

Focus group recruitment and design

Using a purposive sampling technique, all senior staff involved in the teaching or planning of key curriculum areas were invited to participate in a focus group investigating clinical reasoning development. Thirty-two staff members were invited and sixteen agreed to take part. Two focus groups were held - with six and ten participants respectively. Group selection was based on participant availability. No incentive was given for participation.

Students were recruited via an email advertisement sent to all undergraduates at the SVMS. The invitation was open to all students excluding those in their first year, due to their limited experience of SVMS teaching (data collection took place in September, immediately after a new student intake). Students were offered a £20 voucher in exchange for taking part and were given the option of two focus group times. In total 70 students responded. The focus group size was set at eight people based on recommendations in Kitzinger (1995). Two focus groups were held, each with two students from each year group (total of 16) chosen at random to participate from the list of volunteers.

Both staff and student focus groups were scheduled for 90 minutes. The participants of both groups were provided with a definition of clinical reasoning during the introductory phase to ensure all participants were using the same meaning. They were also required to sign a consent form (appendix 1). Both groups used a semi-structured approach, consisting of a warm up question and four discussion questions (appendices 2 and 3). A 'discussion guide' document was used by the facilitator – this contained further questions that the moderator should ask participants if they did not naturally cover all areas during the course of the discussion.

Graduate interview recruitment and design

A convenience sample of recent SVMS graduates were invited to take part in the study via email. A convenience sample was used as difficulty in obtaining participants due to heavy workloads and distance from the SVMS restricted those available to partake. Graduates were required to fill the following criteria:

1. Graduated less than two years previously
2. Went straight into clinical practice after graduation
3. Have worked in clinical practice for a minimum of two months

Three graduates were recruited initially; two took part in person, one via telephone. A consent form was signed by those physically present (appendix 1), and consent was given via email for those interviewed via telephone. Data collection was iterative, and additional interviews were held until data saturation was reached. Five interviews took place in total. Of the two additional participants, one took part in person and one via telephone.

All interviews were scheduled for 30 minutes. They were semi-structured, consisting of three questions (appendix 4). All participants were provided with a definition of clinical reasoning prior to the interview to ensure comprehension.

Pilot study

The ‘taught curriculum’ focus group was piloted with five staff members that could not be included in the data collection due to prior involvement in the study. The pilot study demonstrated that all areas of interest were covered using a combination of the questions posed to the group and the cues in the discussion guide used by the moderator. A few minor changes were made to question phrasings following the pilot.

The 'learnt curriculum' focus group pilot was held with recruited participants. As the pilot was successful, with no necessary changes, the data from the session was used in the study analysis.

The graduate interview was piloted with one recent SVMS graduate. The pilot was successful at prompting discussion around the topic. The order of the questions and some minor phrasing details were altered as a result of the pilot. The data was not included in the analysis due to the structural changes required.

Data collection

All focus groups and interviews were recorded using two audio recording devices, and subsequently downloaded to a computer for storage. The audio files were sent to an external source for transcription. Once returned, the transcriptions were checked by the author for accuracy and stored electronically.

Data analysis

Transcriptions from all focus groups and interviews were combined into one dataset for ongoing analysis. Data collection ceased when two transcripts had been collected for each focus group cohort (staff/student) and when data saturation was reached within the graduate interviews.

Thematic analysis was performed using guidelines developed by Braun & Clarke (Braun and Clarke 2006). Complete inductive code generation was performed, managed through NVIVO (QSR, version 10). Codes were then interpreted and grouped together to form subthemes and themes. These themes were iteratively revised and edited. A 10%

selection of the data was coded by a second researcher and agreement reached in order to ensure a consistent approach. Once coding was complete, all themes were defined and explained.

4.2 Results

This section will first present the results of the document analysis. It will then describe the findings from the qualitative investigation into the perceptions of clinical reasoning development of staff, students and graduates.

4.2.1 Content analysis of the declared curriculum

Document sourcing

Eleven documents were sourced for document content analysis. These are described in table 4.2. Detailed curriculum mapping and description had not been completed at the SVMS at the time of data collection and analysis, resulting in limited amount of information about the curriculum available for this study. Some of the documentation was created several years ago and may have contained incorrect information. However, the research question was to ascertain the declared curriculum and as these documents remain accessible, they were included in the study.

Document	Content	Year created
Student animal husbandry extramural studies handbook	Information and aims for students undertaking AHEMS	2012
Student clinical extramural studies handbook	Information and aims for students undertaking CEMS	2012
SVMS RCVS self-evaluation report 1	Overview of the structure and function of the SVMS for the purpose of RCVS accreditation	2010
SVMS RCVS self-evaluation report 2	Overview of changes in curriculum content and course structure since the previous self-evaluation report	2011
BVMedSci BVM BVS programme specification	Description of every module of the BVM BVS course	2005
Student handbook	Information and instructions for new students starting the BVM BVS course	2012
Teaching learning and assessment handbook	Information for students about methods of teaching and assessment during the BVM BVS course	2006
Final year student handbook	Information and aims for students entering their final year of study, spent on WBL	2013
Curriculum timetable	Overview of the timetable for students in each year of the BVM BVS course	2010
BVM BVS learning objectives	A detailed list of the learning objectives of the BVM BVS course, arranged by module	2012
Learning objectives (rotations)	A semi-complete list of the learning objectives of the final year WBL modules, arranged by placement location	2012

Table 4.2 The documents sourced for content analysis, their content and their creation date

Document content analysis

All eleven documents were coded using the method described above. An example of the data recorded from one document is shown in table 4.3, the remaining content analysis data is presented in appendix 5. Two of the documents did not contain any coded text:

- Student handbook
- Animal husbandry extramural studies handbook

Document Section	Code	frequency
Cardiorespiratory module – year one	Related skills	1
Neurology module – year one	Related skills	1
Endocrine module – year two	Related skills	12
Personal and professional skills module – year three	Clinical reasoning	5
	Related skills	2
Principles of veterinary science module – year three	Clinical reasoning	2
	Related skills	2
Cardiorespiratory module – year four	Clinical reasoning	1
	Related skills	62
Endocrine module – year four	Related skills	95
Gastrointestinal module – year four	Related skills	73
Lymphoreticular module – year four	Related skills	22
Neurology module – year four	Related skills	22
Reproduction module – year four	Clinical reasoning	3
	Related skills	75
Urinary module – year four	Related skills	93

Table 4.3 Content analysis distribution of codes within 'BVM BVS learning objectives' document

By considering the location and frequency of the clinical reasoning codes found within the documentation the following key findings were identified:

1. There is limited declared clinical reasoning exposure before fourth year. All modules in years one to three have very little coding in both qualitative descriptions and learning objective lists. The modules in fourth year are highly coded, suggesting that clinical reasoning is a more frequently taught concept

from fourth year onwards, or is only made explicit to students from this point onwards.

2. There is very limited occurrence of codes in reference to Extramural Studies (EMS) throughout all of the documentation. This is despite coding two student manuals dedicated to EMS. This suggests that either EMS is not expected to be a source of clinical reasoning exposure, or that staff did not feel the need to make clinical reasoning involvement with EMS explicit in materials produced about it.

The two learning objective documents allowed mapping of the delivery of clinical reasoning. Learning objectives from the final year of study, spent completing workplace-based learning, were classified as a practical session. Table 4.4 presents the results of the learning objective analysis. It shows 39.2% and 32.4% of clinical reasoning learning objectives are scheduled to be delivered within lectures and practical sessions respectively. CBL and seminar sessions have the lowest percentage of clinical reasoning learning objective occurrence.

	Lecture	**Practical**	**SDL**	**CBL**	**Seminar**
Total number of coded learning objectives	258.0	213.0	114.0	54.0	19.0
Percentage of coded learning objectives	39.2	32.4	17.3	8.2	2.9
Percentage of total learning objectives	2.5	2.0	1.1	0.5	0.2

Table 4.4 The number of learning objectives coded as relating to clinical reasoning within each session type; this value as a percentage of both the total number of learning objectives and the total number of coded learning objectives

4.2.2 Thematic analysis of the taught and learnt curricula

The graduate interview participant demographics are listed in table 4.5. Each have been assigned a code in order to anonymise the data and will be referred to by this within the results. The codes assigned to each focus group are shown in table 4.6.

The thematic analysis produced six overarching themes, each with corresponding subthemes (shown in figure 4.2). Each theme is described in the following section. Quotes from the focus group/interview transcriptions are used to demonstrate each theme and the participants are identified as graduate, staff or student.

Code	Gender	First job	Year graduated
G1	Female	Intern at first opinion farm animal practice	2013
G2	Female	Veterinary assistant at first opinion equine practice	2013
G3	Female	Veterinary assistant at first opinion mixed practice	2013
G4	Female	Intern at first opinion farm animal practice	2014
G5	Male	Locum veterinary assistant at first opinion equine practice	2014

Table 4.5 Graduate interview participant demographics, including the nature of their first veterinary position upon graduation

Code	Group
STA1	Staff group one
STA2	Staff group two
STU1	Student group one
STU2	Student group two

Table 4.6 Codes assigned to each focus group

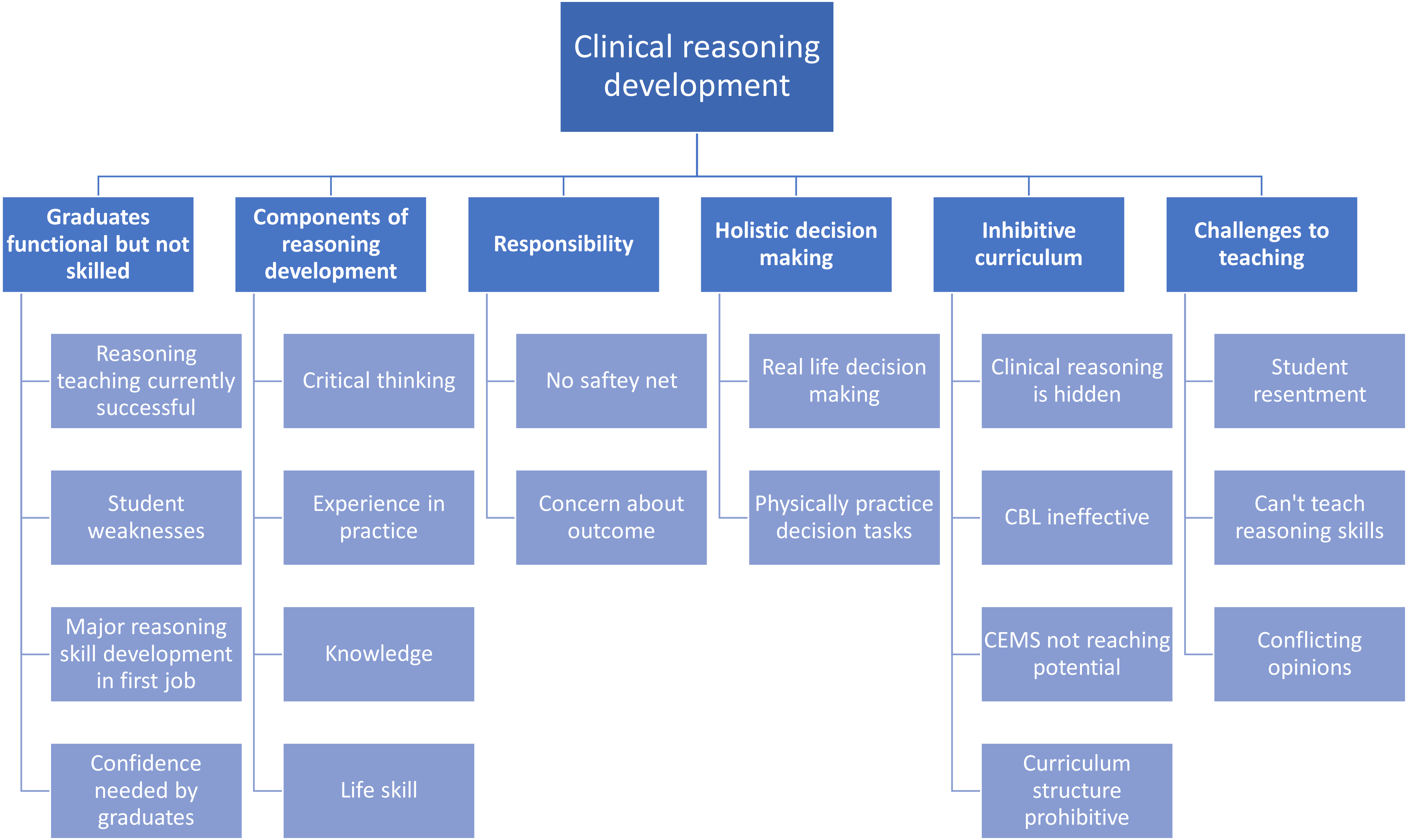

Figure 4.2 The themes (level one) and subthemes (level two) identified during the thematic analysis

Theme one: Graduates are functional, but not skilled

This theme developed from the contrasting views of clinical reasoning skill attainment. Some participants felt that SVMS instruction in clinical reasoning is successful, particularly in diagnosis. They suggested that students leave capable of performing decision-making tasks. In particular, it was felt that years four and five of the BVM BVS course contribute to clinical reasoning development.

> *'I think they prepared us really well. For making a diagnosis, I think it was really good.' G3*
>
> *'I think we think we are being effective (at teaching clinical reasoning)…' STA1*
>
> *'I think fourth year in particular it's a lot based on clinical reasoning and that actually does set you up quite well for going into practice...' STU2*
>
> *'It's a steep learning curve when they go onto (WBL); I think that's when they develop their clinical reasoning.' STA1*
>
> *'I felt quite confident going out there to diagnose.' G3*

This opinion was counteracted by deficits observed in students by staff and a varying reasoning ability level within each year group. In particular, staff were concerned about the ability to formulate differential diagnoses lists and prioritise them accordingly.

> *'The fourth years… just come up with a whole list of tests and they can't prioritise them, so I don't think they learn to develop clinical reasoning' STA1*
>
> *'(The students) haven't learnt by fourth year to prioritise because you know I don't think they've really got the concept of clinical-reasoning' STA1*
>
> *'(The students) come out with a huge number of differentials, which are completely irrelevant, thinking that the longer the list of differentials, the better.' STA1*
>
> *'(Clinical reasoning ability) is very variable on the individual.' STA2*

Additionally, graduates describe a lack confidence in their clinical reasoning ability, and as a result go through a steep curve of reasoning improvement in their first job. This opposes the initial assertions of competent graduates, and may be the cause of significant stress. The main weakness appears to be self-confidence in decision-making ability once in practice. Graduates are also not used to making decisions without the support of a mentor.

> *'When I first started, there was no way I would have gone to a farm and elected not to give an animal any treatment… I just didn't have the confidence.' G1*
>
> *'Something like a wound, that was a big learning curve coming out of vet school. 'Do I stitch this or not? Do I give it antibiotics or not?' all those sort of choices… I just didn't feel that well prepared in making that choice.' G5*
>
> *'There's no one else to help you (when you are making decisions in practice). You just have to get on with it.' G3*
>
> *'I remember my first day… I was like, 'Oh god. Have I done this right? Have I done that right?', and really worried about it…' G2*

Together, these elements seem to demonstrate that students are achieving a certain level of proficiency at clinical reasoning, but lack the confidence to use these skills when in practice. There is a period of adaptation when graduates start their first job during which they feel uncomfortable making decisions alone. The level of clinical reasoning mastery is low; advanced tasks such as dealing with complex cases usually requires support of colleagues. Overall, students are capable of clinical reasoning, but are by no means skilled and do struggle when starting out in practice.

Theme two: Components of reasoning development

Perceptions of the factors contributing to the development of clinical reasoning skills in students fell into four categories. Firstly, participants felt that students need some kind of formal teaching in critical thinking methods and problem solving. Certain features of SVMS teaching, for example the using the 'SOAP' mnemonic to structure clinical reasoning, were identified as ways of providing this education. Most staff also felt that CBL sessions teach students how to think and reason. This was disputed, however, by the student groups – demonstrated in the theme 'Inhibitive curriculum' discussed later in this section.

'You must teach the (clinical reasoning) process.' STA2

'…If you haven't got the theory in place you can't really then apply it.' STU2

Staff 1: 'I mean there will be I'm sure a couple of lectures on decision making …'

Staff 2: I'm not sure there are…'

Staff 1: 'Well there should be then… I have assumed that there were sessions somewhere in the curriculum that actually spelt out, this is clinical decision making, this is how we could do it, these are some models.' STA2

'I thought the SOAP stuff helped.' STU1

'The reason why we do clinical relevance is to develop those reasoning skills.' STA2

Secondly, it was felt students must *experience* clinical reasoning by spending time in practice. This could mean watching clinicians make decisions – but the biggest gains come from experiencing the reasoning process themselves. Again, aspects of the SVMS curriculum - such as WBL - were identified to demonstrate the need for this component. CEMS was included in this category and was considered key to clinical reasoning development, despite being largely out of the control of the SVMS.

'I think when you're actually on (intramural WBL)… you do realise then, actually I am starting to do (clinical reasoning) subconsciously.' STU2

'(During) CEMS you learn a different way of making decisions more around clients' requirements than actually academic requirements.' STA1

'The only way the students are going to get (clinical reasoning) is by seeing it in action.' STA1

'You learn a lot from (seeing) people making bad decisions.' G4

'Doing (decision-making yourself) is the only thing that's really going to get you exposure and practice to it.' STU1

Thirdly, participants felt that there is an underlying clinical knowledge requirement to successful decision-making. They expected this to develop throughout the BVM BVS course. The term 'baseline' knowledge was used frequently – suggesting there is a minimum amount of information required before clinical reasoning is possible.

'You can't do a proper clinical reasoning if you don't have the base knowledge there…' STA1

'I think some people can't clinically reason because they haven't got enough knowledge to be able to reason.' STA2

'There is a baseline of knowledge that you need in order to do clinical reasoning.' STA2

'You need the basic knowledge in place before you can properly start the clinical reasoning in your head.' STU1

Finally, participants felt that clinical reasoning skills require ongoing development through non-clinical decision-making experience. It was suggested that the ability to reason clinically develops from ability to reason generally – which is practiced throughout life.

'(Reasoning ability) evolves as you're going through life.' STA1

'I think there's a big overlap between your clinical decision-making and the rest-of-your-life decision-making.' STA1

'The process is sorting through your facts that you've got in front of you and prioritising them and then formulating a plan. That applies to much in life, doesn't it?' STA2

The data indicated that participants viewed these four components – experience in practice, critical thinking, knowledge and life skills – as required to produce an expert in clinical reasoning.

Theme three: Responsibility for decisions

It emerged that students need a sense of responsibility for their decisions before they really learn from the outcome. This had two dimensions: independence and consequences. Firstly, it was suggested that students need the opportunity to make decisions alone, without a clinician acting as a safety net. Participants felt that having 'backup' reduced the effort given to decision making and thus reduced the learning potential of these decisions. Students are aware they cannot harm a patient, as the clinician present will not allow it, and so do not make their decisions as cautiously. As a result of this, staff and graduates believed SVMS students do not get the opportunity to clinically reason independently.

> *Staff 1: 'But does that not drive the quality of the reasoning if they realise that they might kill the cow or kill the horse?*
>
> *Staff 2: 'No, I don't think students ever do feel that pressure because they're still in a very cossetted environment… There's always that safety net there.' STA2*
>
> *'(During intramural WBL) you made the treatment decision but you had someone behind you and you'd go, 'This is what I've decided to do', and they'd go, 'Yeah. That's fine.'' G1*
>
> *'As a student… if you do make a mistake, there's someone behind you right on your shoulder going, 'No. You don't want to do that.'' G2*
>
> *'I think (during WBL) you always have the vet behind you and it's not the same as being in practice at all.' G3*

Secondly, students need to feel there will be real consequences as a result of their clinical reasoning. Without this, students do not invest in their decisions or feel a strong desire to make the correct decision.

> *'It's the outcome, isn't it, of the decision? Is that going to fall on your shoulders or somebody else's shoulders? And that triggers you perhaps to think about it maybe slightly differently.' STA1*
>
> *'I didn't make a decision that I could claim until, you know, I was on the line and I had to do something. So once it became my responsibility, then I think I started making decisions, and prior to that I think it was something else.' STA1*

These consequences could include personal embarrassment at performing badly, irritating superior clinicians, animal welfare issues or legal action.

> *'You don't want to be rubbish with a client, you don't want to get a bad (WBL) report.' STU1*
>
> *'You want to be able to justify (your clinical decisions) and not get sued.' STU1*
>
> *'You're responsible for somebody, you're responsible for a real live animal. It's not on something on a piece of paper, it's somebody's pet. It's like my dog… if I said the wrong thing then a) my parents would be annoyed with me, b) I'd look like an idiot when my parents went to the vets back at home.' STU1*

'Don't you think people still put their best effort into making a decision because they don't want to look stupid?' STA1

This theme emerged strongly from the data, suggesting that decision-outcomes play an important role in clinical reasoning development.

Theme four: Holistic decision making

This theme developed from the impression that certain components of clinical reasoning are not covered in the SVMS curriculum. In particular, students are rarely confronted with several problems of 'real-life' decision-making – including finances, drug course length, clients and ineffective treatment regimes. Graduates reported difficulty factoring these aspects into their clinical reasoning once working in practice.

'I think we don't have any idea about finances. Well I didn't anyway and I think that we should know what drugs are expensive, what drugs are cheap.' G3

'No one ever really teaches you how long to give an antibiotic necessarily … 'Do I do a week? Do I do ten days? Do I do fourteen days?' … I was just basically making it up with course length…' G5

'I think my biggest shock of starting work was the financial constraints…' G3

I remember writing in my exams what all my treatments would be - You wouldn't even think about how you would give them. You'd just think people can give tablets. But when you get into real-life practice and people go, 'No. Actually I can't tablet my cat. That's not going to happen', then you have to think differently…' G3

Students and graduates indicated that they would like to practice clinical reasoning *in situ*, so all components of the decision making process are included. They felt that physically 'going through the motions' of diagnosis and treatment planning would be beneficial, especially when coupled with the distractions that often interrupt decision-making in practice. Standardised patient (SP) simulation, already a feature of the SVMS communication skills curriculum, was suggested as a way to expose students to a more holistic clinical reasoning experience. Student and graduates recommended expanding the use of SP simulation to include clinical decision-making, providing practice in a genuine environment,

> *'If you just had, say, half hour consults… and then you had to type up the notes and then you had to dispense what you would… I think that would build your (clinical reasoning) confidence and just prepare you for being in practice.' STU2*
>
> *'The hardest thing is… putting everything else on the side, like the computer system, printing labels, sorting out the nurses. So I think if you kind of had that in a (simulated) practice situation… that might be quite useful.' STU2*
>
> *'(I would have liked) maybe more interactive sessions where we have the actors… almost like simulating what would happen in a consult if you see what I mean. So you'd have someone with a cat with renal disease that's brought it in, tells you its clinical signs and then you have to do it as a consult.' G2*

It became apparent that students develop clinical reasoning without context, and this can lead to difficulty applying the skill in reality. The way in which decision-making is learnt is not necessarily the way in which the skill is applied in practice.

Theme five: Inhibitive curriculum

There are features of the SVMS curriculum that appear to unintentionally impede the development of clinical reasoning skills. The most significant of these is that clinical reasoning exposure is not made overt to students. They described being unaware of the terminology, process or role of clinical reasoning until fourth year, when 'clinical reasoning' is the title of a set of examinations. However, staff, students and graduates agree that exposure to clinical reasoning occurs from the start of the BVM BVS course.

> *'I think we subliminally subject them to clinical-reasoning.' STA1*
>
> *'Looking back now you are exposed to (clinical reasoning) from the start but you don't know it.' STU1*
>
> *'I don't think you're aware of (your clinical reasoning development) to be honest.' G2*
>
> *'I do think it's something you're working towards throughout your course and then by the time you hit fourth year it's suddenly labelled as clinical reasoning.' STU1*

'I remember in third year not having a clue what clinical reasoning was, just thinking it's these scary exams that were on the horizon... And I don't think I necessarily even associated the name of the exam with the process to start with. It was just a name that the exams had…' STU1

There appears to be an assumption by staff that students should be developing the skill from day one, but this is not clearly articulated to the students themselves. Several staff members described instances where clinical reasoning development is an 'unwritten' learning objective in teaching sessions.

'You might actually implicitly be (encouraging) clinical-reasoning in a (CBL session) but not putting it as a learning objective.' STA1

'I think it's implicit (during CBL) that (clinical reasoning is) what you're doing…' STA2

Alongside this, both CBL and CEMS do not seem to be achieving their potential for clinical reasoning development. Both sessions were described as being key for student improvement; however both appear to be limited in their impact due to problems with implementation. CBL sessions appear to have become more 'question-answer' focussed than student-directed problem solving. Students are also able to predict answers, based on the content of the week's lectures – thus requiring less active reasoning.

'The (CBL) sessions are actually on the whole they're quite directed… which doesn't exactly always lend itself to clinical-reasoning' STA1

'If (CBL) is supposed to be clinical reasoning, it's not.' STU1

'You go through (CBL) and you're learning about the disease rather than about the decision-making process.' G2

'My idea of clinical relevance in the first two years is to reinforce what they've been taught in the rest of the course, so that way it reiterates the anatomy and the physiology… The clinical slant is to make it more interesting for them, not to actually teach them clinical-reasoning.' STA1

'You've always got the thing of if (the CBL case) is in parasitology week it's a parasite kind of thing, so obviously you can take a lot of shortcuts…' STU1

CEMS was suggested previously as a key opportunity to observe clinical reasoning made by clinicians. However, students can lack the confidence or motivation to question decisions made by veterinary surgeons, and thus learn little about the reasoning process.

> *'The only way the students are going to get (clinical reasoning) is by seeing it in action; seeing it in EMS, but therefore the EMS needs to be effective... But as I said, EMS is not necessarily conducted well' STA1*
>
> *'(Your clinical decision) is a conclusion you put in your notes most of the time, so unless the vet actually takes the time to go through that, they don't see it going on. They don't realise what's happening.' STA1*
>
> *'I think there would be a huge scope to improve the teaching on clinical EMS, just to give the people with whom students do EMS some guidelines in saying don't forget to quiz a student, or explain your thought process…' STA1*
>
> *'Sometimes in busy practices… the clinical reasoning is there but (the clinicians) are so busy that they're not actually explaining it to you so you just think, "Oh, well they've just decided to give it that," and actually you might not understand their reasons for giving it what they've given it.' STU2*

Other structural features of the curriculum were described as preventing student development. These include the body-systems modular structure of the course, the lack of effective clinical reasoning examination and the lack of clinical tutorials. Some of these aspects, particularly examination techniques, are not unique to the SVMS curriculum.

> *'I think, because of the way that (the SVMS) runs in a body systems based way it's very easy to go, right, this has a cardiovascular disease, and this has a neurological disease, and not really link them. And I can only think of one, maybe two (CBL) sessions where we actually brought things from different modules together and everyone was like, "Whoa, mind blowing, this is a different module, I can't remember any of this."' STU2*
>
> *'I would appreciate some kind of regular, smaller group learning, so like maximum three, four students where say a tutor group picked up a case or something.' STU2*

Overall, participants indicate that some areas of the current SVMS curriculum could be functioning more effectively to promote clinical reasoning skills in students.

Theme six: Challenges to teaching

It emerged that there are inbuilt challenges to providing a comprehensive education in clinical reasoning. It seems that, even with an effective curriculum, there are human factors that may interfere with reasoning development. Throughout the investigation, students were opposed to any suggestion that would involve more work. They also expressed disinterest in being aware of their own decision-making ability, wishing instead not to have to worry about it.

> *'I know (practicing clinical reasoning) would be a lot of work for us and I think I'd hate it.' STU1*
>
> *'There's enough (work) volume as it is, I don't want to take on something else.' STU1*
>
> *'It almost panics people when you give (clinical reasoning) a label.' STU1*
>
> *'I think it's nice to have a subconscious confidence in my clinical reasoning, I think (being aware of clinical reasoning) would just bring more and more questions into my mind and then panic me more.' STU1*

There was an underlying assumption by staff and students that direct teaching on clinical reasoning topics would not be absorbed. It was suggested that teaching the theory of clinical reasoning (e.g. system one vs system two) in a similar way to ethical decision-making (e.g. Deontology vs Utilitarianism) would not be beneficial for the students. Many participants, particularly students, did not think any knowledge of clinical reasoning theory was necessary because it would not affect practice. Additionally, students felt apprehensive about having to understand the topic - perceived as difficult - and wanted to limit their exposure to it.

> *'If we brought in clinical-reasoning in Year 1… are they actually going to get anything from it?' STA1*
>
> *'I think (clinical reasoning theory) is like a lot of theory… that it's probably not going to change anything about (how you act).' STA1*
>
> *'I think (clinical reasoning theory) just makes it too complicated and that scares me.' STU1*
>
> *'I don't know if knowledge of different (clinical reasoning) methods is particularly relevant' STA1*

'It wouldn't encourage you, it would probably give you a negative perspective of clinical reasoning rather than helping it.' STU2

It became clear during the analysis that there was little agreement across, and even within, groups about the importance of clinical reasoning and the best ways to teach it. Several conflicting codes arose – for example, students believed that clinical reasoning is taught during lectures, whilst staff strongly disagreed. Additionally, students and graduates had conflicting opinions on what is taught well in the SVMS curriculum. There appears to be substantial 'mixed-messages' within the SVMS which may impede efforts to develop clinical reasoning.

'You're taught clinical reasoning in lectures.' STU1

'I think the lectures are almost the least likely place that clinical reasoning takes place.' STA1

'I think during vet schooling the treatments regimes are probably taught better than how to diagnose things.' STU1

'I think treatment decisions are more tricky than diagnosis decisions to be honest.' G2

These factors would all present a challenge if encouraging clinical reasoning education – but they argue for the non-necessity of the topic as a whole.

4.3 Discussion

This study has highlighted the successes and the shortcomings of a veterinary curriculum when trying to foster clinical reasoning development in students. It has shown students are perceived to reach an adequate level of decision-making proficiency at the SVMS; but are still facing a steep learning curve when starting work. Key components of clinical reasoning development have been identified: Critical thinking, experience in practice, veterinary knowledge and general decision-making ability; and where they occur within the SVMS curriculum has been explored. It has been discovered that taking responsibility for decisions is an important step in clinical reasoning development - one that students often do not experience until they start their first job - and that a lack of contextualisation may be making the transition to practice harder than necessary. Finally, some of the barriers to clinical reasoning development at the SVMS were identified, including staff and student attitudes, learning opportunities such as CBL and CEMS not achieving their potential and the fact that clinical reasoning remains largely hidden within the curriculum.

This study indicates that the SVMS appears to be producing graduates that can function as veterinary surgeons and are confident in certain aspects of decision-making, but are by no means 'skilled'. As a result of this, they may need to significantly develop their reasoning ability once in practice. Although new graduates are not expected to be expert clinical decision makers, their current shortfall is such that it may be increasing their stress burden during their 'transition to practice period'. While the specific level of confidence appears to vary with personality, all graduates reported some clinical reasoning challenges they felt unprepared for. This appears to contradict opinions of surveyed graduates from other veterinary schools (Jaarsma et al. 2008, Gilling and Parkinson 2009) and even the SVMS (Cobb et al. 2015), who report a solid grounding in clinical decision making skills during their courses. SVMS Graduates rated their 'Clinical case management and therapeutic strategies' education as 'Good' on a Likert-scale survey investigating how prepared they felt they were for working in practice. However, quantitative survey data are limited, providing only very superficial insight into experiences and opinions. Further qualitative investigation in one study (Gilling and Parkinson 2009) revealed a lack of confidence in new graduates similar to that reported here, despite high survey scores. This is also seen in the qualitative comments received by Cobb et al. (2015), in which graduates seem to struggle with decision making more than the survey depicts. It has been observed previously that the self-evaluation of skill level by veterinary graduates can be significantly different to the evaluation given by their employer (Doucet and Vrins 2010, Cobb 2015). Although survey data are useful and convenient, the conflict between this study and those mentioned questions the accuracy of using one data collection method alone to review curricula. Despite the disagreement, as the RCVS have recently included clinical reasoning as a day one competency (RCVS 2014a), more research to clarify the competence of new graduates is needed.

It can be argued that the reasoning shortfall experienced by SVMS graduates can only be filled once working alone in practice, and it is impossible to produce a graduate that is fully competent in this skill. However, the theme *holistic decision-making* suggests methods, such as simulation, to try to fill this gap in experience and create a more 'practice-ready' graduate. Simulation has been shown to improve clinical reasoning in other disciplines (Steadman et al. 2006, Kneebone and Baillie 2008, Powell-Laney et al. 2012, Kelly et al. 2014). It was also recommended by Cobb et al. (2015) as a method to improve the clinical reasoning of graduates at the SVMS. Currently the SVMS and other veterinary schools use SP simulation to help teach communication skills to students (Adams and Kurtz 2006), but do not include clinical decision making as an intended learning outcome in these sessions. There is scope to expand the use of SP simulation to include clinical reasoning development. In veterinary medicine, one study has already demonstrated the potential of contextualised simulation to improve decision-making skills (Baillie et al. 2010). Although this research relies on student 'self-assessment' data, therefore lacking objective measurement, it provides good reason to investigate simulation further as a method of clinical reasoning development.

The findings of this study suggest that the ‘real-life’ aspects of decision-making (e.g. clients, finances, stress) should be incorporated into veterinary teaching. This recommendation has been made in previous studies (Baillie et al. 2010, Patel et al. 2014) and is supported by work by Routly et al. (2002), who demonstrated that 47% of new graduate veterinary surgeons find dealing with client finance implications difficult. It is clear that veterinary reasoning is more complicated than simply applying clinical knowledge (May 2013) – there are many external factors that influence clinicians ability to make decisions. Research in human medicine has demonstrated that decision-accuracy is affected by context and interference (Durning et al. 2011, 2012), indicating that these factors need to be integrated into teaching. The idea of contextualised learning is rooted in situativity theory, which views social interaction, culture and physical environment as fundamental to a learning experience (Durning and Artino 2011). It is interesting to note that direct effort by SVMS to teach students clinical reasoning - including lectures, practicals and evidence-based medicine sessions – were not described by students as influencing their skill development. This may indicate that students do not associate the ‘classroom’ version of decision making with the ‘consultation room’ version. The current study highlights the importance of contextualisation of decision-making during the curriculum to ease the transition to practice.

Creating responsibility for decisions is a theme that emerged very strongly in this study, but is incredibly difficult to recreate. Due to animal welfare concerns, students will never be able to have the ‘last say’ on a case. This is detrimental to development, as graduates – including those from the SVMS - cite lack of experience working with responsibility as a key factor that makes the transition to practice difficult (Jaarsma et al. 2008, Cobb et al. 2015). This, of course, is a problem for all veterinary schools; making the need to find a solution urgent. In this study, students indicated that substituting medical responsibility for another high stakes outcome - particularly embarrassment at poor performance in front of a client or clinician - might be an effective way to replicate pressure and improve performance. This would simply replace one incentive (responsibility to the patient) with another of similar magnitude (avoiding embarrassment). Further research into the comparison of 'true' responsibility and other motivators to perform well is needed, but this idea corroborates research by Baillie et al. (2010) which suggests that using real or standardised clients during decision-making sessions to create this 'performance-pressure' may achieve that aim.

The components identified as contributing to clinical reasoning development – critical thinking instruction, experience in practice, knowledge and life skills - are similar to findings from studies examining individual interventions (Facione et al. 1994, Baguley 2006, Lasater and Nielsen 2009, Chamberland et al. 2013, Seif et al. 2014). The fact that knowledge is perceived by staff, students and graduates to be a key dimension of clinical reasoning may explain why the largest proportion of SVMS coded learning objectives are delivered in lectures. It is likely, however, that these perceptions are based on a lack of insight into the clinical reasoning development process; meaning the use of lectures to 'deliver' the skill may be misguided. As understanding of clinical reasoning grows misconceptions about how best to teach the skill – particularly within staff designing curricula – must be addressed. It is clear that clinical reasoning tutelage needs to be based on evidence, not tradition.

The lack of awareness by students of the concept of clinical reasoning, and the attitude that students should 'assume' they should be learning it, is evident within the SVMS curriculum. It was suggested by staff that learning objectives relating to decision-making do not need to be written, because reasoning should be occurring naturally within sessions such as CBL. This viewpoint is reminiscent of the way veterinary communications skills were 'taught' previously – by passive absorption – until it was realised that this was not providing graduates with the skills they needed. By not making clinical reasoning overt within the curriculum, educators are making it difficult for students to track or reflect on their reasoning skill development. It also creates difficulty in determining whether a teaching session aims to promote clinical decision-making. For example, in this study there was little evidence of CEMS contributing to reasoning development. This could be the result of a) decision-making experience not being a learning objective of CEMS or b) the aim of experiencing and understanding decision-making not being made explicit. In this case, the findings from other studies suggest that CEMS requires improvement (Routly et al. 2002, RCVS 2014c), but triangulation with other data sources may not always be possible.

Curriculum transparency is a wider issue of clinical curricula. Acceptance that much student learning occurs within informal interactions, rather than just in declared teaching sessions (Hafferty 1998), has led to a call for greater accessibility of medical curricula generally (Harden 2001). To make curricula more transparent, Harden (Harden 2001) advocates the use of curriculum mapping. This allows students to identify exactly where in the curriculum they are given opportunities to develop knowledge and skills, and is being adopted by many medical schools (Willett 2008) and some veterinary schools (Bell et al. 2009). Currently the SVMS uses curriculum mapping purely as a management tool for accreditation purposes. Expanding this to include the mapping of embedded topics, and formatting it for use by students and staff may, as described by Harden, 'make explicit the implicit…' (P.124).

4.3.1 Limitations

The SVMS has been used as a case study (Denzin and Lincoln 2011) in this research. Although it investigates only a single institution, there is a degree of generalisability (Silverman 2013) to other veterinary curricula within which clinical reasoning is an embedded skill (see chapter three for more detail on the generalisability of case studies). Comparing this research to similar case studies from other veterinary schools, if they were performed, would enhance our understanding of the subject and provide greater evidence for extrapolation of findings.

Harden’s curriculum model – consisting of declared, taught and learnt curriculum domains - was used as a framework for analysis within this study (Harden 2001). Sometimes, Harden includes the hidden curriculum in his model, within the learned curriculum (Dent & Harden 2013). The hidden curriculum is the effect of ‘organisational structure and culture’ on the learning of the students (Hafferty 1998 p.404); subliminal messages about attitudes, opinions and professionalism that penetrate through to the students. The hidden curriculum is not addressed separately in the framework of analysis used for this study, as that was deemed beyond the scope of the research question. However, the effects of the hidden curriculum were indirectly recorded within the ‘learnt curriculum’ data.

This study has not directly considered the effect of assessment on clinical reasoning development (Fuentealba 2011). It was clear from student focus groups that students want to improve their reasoning skills in order to become a competent veterinary surgeon, not because they see it as necessary to pass exams; they were intrinsically, rather than extrinsically, motivated. Consequently, assessment was not explored further. It would be beneficial, if this study were to be expanded, to understand why examinations are not motivating students to improve their clinical reasoning. It is possible that students do not feel that the skill itself *is* examined, or that their internal motivators are simply stronger.

This study did not take into the consideration the opinions of employers when evaluating the clinical reasoning ability of graduates, due to the focus being on the curriculum. As shown in work by Doucet & Vrins (2010), graduates and employers frequently disagree in their evaluation of performance. Including the opinions of employers would allow triangulation of the graduate’s self-assessment and would increase the reliability of any findings.

When asking staff to review their own curriculum, particularly in a focus group environment, it is possible that they will be either overly critical or defensive. They also may not want to comment on an area of the curriculum designed by a peer – particularly if that person is also taking part in the focus group. Institutional hierarchy and culture will also have affected the disclosure of participants. Similarly, students may feel an affinity to the school that affects their perspectives. Alternatively, they may have performed poorly in a particular area and thus resent it. These factors, along with the fact that participants are 'self-reporting' on their clinical reasoning ability, should be considered when interpreting the results of this study.

Braun & Clarke (2013) advise researchers to be reflexive - to identify factors that will affect their analysis of the data - when a qualitative methodology is used. In this case, the researcher was a postgraduate student at the institution under investigation during the research period. Furthermore, the researcher had extensive prior knowledge of the SVMS curriculum from studying at the institution as an undergraduate and consequently had experienced the curriculum from the 'student perspective'. This may have affected the interpretation of the qualitative data.

4.4 Chapter summary

This study has provided an understanding of clinical reasoning development within the current SVMS curriculum. It has highlighted several areas of the curriculum that could be improved to help students become competent in clinical decision-making. The next two chapters of this thesis will expand and develop two of the suggestions for improvement that emerged from this study:

1. The potential for standardised client simulation to provide students with a contextualised learning experience that replicates the decision responsibility currently missing from the curriculum (chapter five).
2. The development of a strategy to improve the student experience on CEMS such that clinical reasoning exposure and discussion becomes a priority (chapter six)

Chapter 5 The use of standardised client simulation to develop clinical reasoning

The study presented in the previous chapter suggested the potential for simulation involving standardised clients (SCs) to improve clinical reasoning ability in SVMS students. This was the starting point for the second study, which aimed to investigate the use of SCs for clinical reasoning development in veterinary students.

SCs are currently used widely in veterinary education to develop communication skills in students (Gray et al. 2006). Actors recreate the experience of conversing with a client so that students may practice techniques of effective history taking, dealing with conflict and breaking bad news. The actors are trained to portray the clients in an identical way each time, allowing the scenario to be replicated and used as an examination scenario. The actors are given information about the client they are portraying – including their personality and circumstances. Although effective at improving communication skills in veterinary students (Latham and Morris 2007), SCs are not widely used for the development of decision-making ability in veterinary education. Certainly, at the SVMS, moving beyond purely communicatory factors is not within the session learning objectives.

At the SVMS, students are taught using SCs in years one, two, three and four. Their communication skills are examined using SC scenarios as part of OSCE examinations in year three. The fidelity of the SC sessions at the SVMS is low. Each session takes place in a small group teaching room within the school. There are between 8-10 students and a facilitator observing each scenario from within the room, all of which feedback to the participant on their performance. Although the actors 'dress-up' for their role, students will often encounter the same actors in different characters throughout the course and do recognise their faces. Students are permitted to call for 'time-out' during the scenario if they are unsure how to proceed – at which point the situation will be discussed as a group. The difficulty of the SC sessions increases as the course progresses, moving from the data gathering task of history taking towards more emotionally challenging communicatory tasks.

This study aimed to investigate whether standardised clients could be used to develop clinical reasoning in veterinary students. This was done by creating a new SC simulation focusing on clinical decision-making. The effect of this simulation on the clinical reasoning of fifth year SVMS students was then investigated.

The first section of this chapter describes the current relevant literature surrounding the investigation. Then the methodology, methods and results are described in turn. Finally, the discussion section considers the implications of the study.

5.1 Literature Review

5.1.1 An introduction to medical simulation

Simulation is defined in the Oxford English Dictionary as:

> 'The technique of imitating the behaviour of some situation (whether economic, military, mechanical, etc.) by means of a suitably analogous situation or apparatus, esp. for the purpose of study of personnel training.' (Oxford University Press 2015)

In medicine, simulation is used to provide repetitive practice of clinical and communicatory skills. Healthcare students can be considered adult learners, which have specific educational requirements as described by Knowles (1970). These include the need for learning to be problem-centred and immediately applicable to their lives. Incorporating problem solving in the form of case simulations can provide the necessary link between the classroom and reality to motivate adults to learn (Forrest et al. 2013). It also gives them the opportunity to identify past experiences that shape their approach to learning, another feature of andragogy, by understanding how they frame simulated situations (Rudolph et al. 2007). Fanning & Gaba (2007) claim adults 'learn best when they are actively engaged in the process, participate, play a role…' which has clear overlaps with simulation. Simulation can be used to develop cognitive, technical, behavioural and decision-making skills (Forrest et al. 2013).

The term ' medical simulation' covers a wide variety of educational activities, involving online avatars, trained actors, low-fidelity models, haptic feedback, high-fidelity manikins and complete simulated environments. For this reason, simulators are often classified into several categories, which can vary by author (Decker et al. 2008, Rosen 2008, Forrest et al. 2013). The name, description and common usage of the major classifications of simulation are shown in table 5.1.

Type of simulation	Description	Common usage
Part-task trainer	Low to medium fidelity anatomical models, usually of only part of the body, used to practice a single clinical skill	Deliberate practice of a specific skill e.g. venepuncture
Electronic patient or Human Patient Simulator	Complex full body simulators that can display physiological responses to practitioners actions	High-fidelity replication of situations requiring a combination of clinical reasoning, communication and stress management
Standardised (or simulated) patient	Actors trained to portray patients so that they can engage in role-play with learners in a replicable way	Communication training, often combined with other clinical skills such as decision making
Virtual patient	Patients and clinical cases shown on a computer, in 2D or 3D, via software or online virtual worlds.	Clinical reasoning and case management, clinical skill development e.g. cardiac auscultation
Simulated environment	Replication of a whole clinical environment, including surroundings, equipment and personnel	Patient safety team training, often combined with clinical assessment and decision making

Table 5.1 The classification of simulation methods, adapted from Decker et al. (2008), Forrest et al. (2013), Rosen (2008) and Bradley (2006)

Several types of simulation can be combined to increase the learning potential of any given session. For example, part-task trainers can be attached to standardised patients, and electronic patients are commonly used within simulated environments. This is known as hybrid simulation (Forrest et al. 2013). It can be used to increase the fidelity of a simulation or to combine multiple learning objectives into one session.

A meta-analysis of simulation based medical education versus traditional clinical education was performed by McGaghie et al. (2011). They found 'clear and unequivocal' (p.4) evidence that simulation is more effective at teaching clinical skills than lecture-based education, despite the small number of studies that fit the inclusion criteria (n=14). Another meta-analysis within the field of nursing found that simulation increases the self-efficacy of nursing students more than traditional teaching methods (Franklin and Lee 2014). Cook et al. (2012) compared the effectiveness of technology-enhanced simulation to other instructional methods in another meta-analysis, concluding that there is a moderate improvement in skill and behaviour outcomes when using simulation (including standardised patients). There is, therefore, robust evidence that simulation provides an effective method for teaching a range of skill and attributes.

This literature review will provide an overview of simulation use in education. This field is extremely wide, with thousands of published journal articles addressing it. For that reason this review with be succinct, making use of systematic reviews where possible, and discuss only aspects relevant to the study presented within this chapter. Papers will be drawn from all aspects of healthcare, but predominantly medicine and nursing. This is due to the absence of research in the veterinary field. Virtual patients and computerised simulations will only be covered briefly within this literature review, as it was felt their use and application is considerably different to practical simulations, and not wholly relevant to the current study. This review begins by considering the development of simulation, and then focuses on the use of simulation to develop clinical reasoning, the debriefing process, assessment in simulation and finally simulation in veterinary education.

5.1.2 The history of simulation

The use of simulation to aid human advancement has a long history, stretching further back than medicine itself. Bradley (2006) suggests jousting was an early form of simulation – allowing knights to practice fighting on horseback so they were prepared when going into battle. Certainly, in the 1600s, a birthing simulator made of cloth and sponge was used to teach midwives the process of parturition in medieval France

(Gardner and Raemer 2008). The benefits of simulation have been self-evident for centuries.

The aviation industry was the forerunner in the development of modern simulation – beginning in 1929 with development of the first flight simulator (Rosen 2008). The benefits of this 'Link trainer' was so evidential that within five years the US Army had implemented their use during training, and by 1955 all commercial pilots were required to undertake simulation to renew their licenses (Rosen 2008). The use of simulation then expanded from aviation; to include space travel, nuclear reactor and submarine simulators (Bradley 2006, Rosen 2008).

In 1960, 'Resusci-Anne' was created, bringing simulation to medicine. She was a human manikin used to teach the newly-discovered resuscitation methods to health professionals and marked the first part-task trainer to be developed (Bradley 2006, Rosen 2008). 'Harvey', a cardiorespiratory examination part-task manikin followed shortly after, and is still used in some institutions today (Forrest et al. 2013). Innovation in this area then became dormant for several decades until, in the 1990's, a surge of interest led to the development of a huge array of simulators designed to mimic surgical techniques. These then expanded outside of the surgical theatre, to include more routine practical skills such as ultrasonography (Rosen 2008). Currently, advanced part-task trainers are available for anything from placing a urinary catheter to performing laparoscopic surgery.

The use of standardised patients for medical training began in 1963, when actors were used to portray various neurological presentations to medical students at the University of Southern California (Barrows and Abrahamson 1964). However, the scientific community rejected the method as 'unscientific' (Rosen 2008, p. 159) and 'demeaning to medical education' (Forrest et al. 2013, p. 14). This remained the situation until the field of obstetrics and gynaecology championed the use of standardised patients - this time to practice interviewing mothers and pelvic examination (Rosen 2008, Forrest et al. 2013). Their use increased and diversified over time, leading to the incorporation of standardised patients within undergraduate medical examinations to assess interviewing technique. In 2004, standardised patients were introduced into the US medical licensing program examinations (Rosen 2008).

In 1969, the first electronic full-body simulator was created by Abrahamson et al. (1969); complete with heartbeat, pulses, respiratory movement and blood pressure. Again, the innovation was ignored – regarded as expensive and unnecessary, and only one was ever built (Forrest et al. 2013). The use of complex simulators in medical education was not taken seriously until the late 1980's, when Stanford University and The University of Florida developed their own high-fidelity anaesthesia simulators (Bradley 2006). These were expensive, but effective. They also incorporated team-training, allowing human factors to be considered alongside clinical scenarios. Birthing simulators re-appeared in the 1990's, as did human-patient simulators in many other fields of medicine. Currently, these high-fidelity electronic manikins are widely used in undergraduate and postgraduate medical education.

The final chapter in the development of medical simulation was virtual reality. Very basic on-screen modelling began in the late 1980s. Then, a public-domain bank of 3D anatomy images – The Visible Human Project - was released (Ackerman 1999). This large resource simplified the development of computerised simulations of surgical techniques. Haptic feedback was being incorporated into these simulations by 1997, increasing the fidelity. Second Life, an online virtual world, has been used in medical education since 2007 (Boulos et al. 2007, Forrest et al. 2013) as a platform for simulation. Resources can be accessed by students from any internet-connected device, including lectures, clinical training (e.g. cardiac auscultation) and discussions (Boulos et al. 2007). The virtual patient technology continues to develop, and more complex and immersive on-screen simulations are continually invented.

Medical simulation has developed hugely in the last 50 years, and continues to expand. Dedicated simulation education centres are now widespread, where simulated sessions are run commercially (Forrest et al. 2013). Simulation performance is increasingly being used as an assessment for accreditation and licensing purposes. However, Rosen (2008) cites issues with validity, fidelity and expense as 'major barriers to its use in health care education.' (P.162). It is clear there is still research to be done to maximise the potential of medical simulation.

5.1.3 Simulation and clinical reasoning

Simulation has been used for a large variety of learning objectives, including communication (Aspegren 1999, Chown et al. 2015), team training (Daniels et al. 2008, Falcone et al. 2008, Merien et al. 2010) and surgical skill development (Good 2003, Grantcharov et al. 2004, Griswold-Theodorson et al. 2015). Simulation is also used for development of clinical reasoning in students, although there is less research in this area. The research that is available tends to examine only the lower two levels of Kirkpatrick's training evaluation model – reaction and learning – and not the behavioural changes or impact on patient safety that are represented by the higher levels (Kirkpatrick 1994, Swanwick 2013).

The majority of research investigating clinical reasoning development during simulation (of any type) comes from human nursing. A systematic review of quantitative research published between 1999 and 2009 (Cant and Cooper 2010) found that only five out of eleven studies assessing clinical reasoning development during nursing simulation reported statistically significant post-simulation scores. However there was great variation in the reliability and validity of each of the included studies – with sample sizes ranging from 23 to 798 and large differences in time spent participating in the simulation. One study included in the review – a randomised control trial of 74 graduate nurses – reported that participants that were exposed to electronic patient simulation scored significantly higher on a post-intervention patient assessment exam than their computer-based learning counterparts (Shepherd et al. 2007, Cant and Cooper 2010). The experimental design of this study increases the reliability of the findings and suggests that simulation can be used effectively to train clinical reasoning ability. However, the authors note that the faculty scoring the post-intervention exam may have known to which test group the participants belonged.

Powell-Laney et al. (2012) provided further evidence that electronic patient simulation can improve clinical reasoning ability. Nursing students (n=133) were randomly assigned to either written-case or simulation based teaching sessions on myocardial infarction. They were subjected to a pre/post intervention knowledge test, and all asked to complete a final simulated scenario where their response times were measured. The simulation-based training group performed significantly better in both the examination and the time taken to initiate cardiopulmonary resuscitation (CPR) to an electronic patient suffering cardiac arrest. However, the test simulation was identical to the training simulation, so the written-case group may have had a disadvantage. Despite this, the knowledge examination improvement indicates that simulation can be used to develop some degree of clinical reasoning in students, possibly more successfully than written cases.

There are several other studies within nursing education that claim to validate the use of various forms of simulation to teach decision-making. For example, Yuan et al. (2014) noted an increase in clinical judgment ability from repeated simulation exposure, but did not include a control group in their study design. Gibbs et al. (2014) reported the success of electronic patient simulation to teach reasoning skills, but used tools with clear biases to evaluate impact. Lasater (2007) presents an interesting qualitative investigation on student simulation experience, but conclusions are limited as the data is all self-reported perception. It is clear from the literature that well-designed studies into clinical reasoning development during simulation are rare.

Steadman et al. (2006) conducted a randomised control trial on 31 undergraduate medical students. Each student was assigned to either an electronic patient simulation or problem-based learning training group. The students' clinical decision-making was then tested using another simulation scenario and graded using a checklist. Two factors increase the reliability of this study: 1) the examination simulation scenario was different to the one practiced by the simulation group during training and 2) the control group underwent simulation training on a different topic, so the total simulator-exposure time of both groups were equal. The researchers found that the simulation group performed significantly better (P=<0.0001) and their individual improvement from the pre-test simulation scenario was greater. This study provides the most convincing evidence that simulation can assist clinical judgement development.

Functional magnetic resonance imaging (fMRI) was used by one research group to understand the impact of simulation on clinical reasoning at the level of the brain (Goon et al. 2014). Twelve undergraduate medical students were randomly assigned to a 30-minute training session involving either simulation or online tasks before being scanned by an fMRI machine. The findings suggested that simulation-based training reduces stress felt during action-based MCQ examination relating to their training, as these students exhibited less activity in the corresponding areas of the brain. The sample size of this study is small, however, as it is a pilot, so the results need to be interpreted accordingly.

Only one study was found that compared the use of standardised patient (SP) simulation to any other form of learning. Turner et al. (2010) found no significant difference in clinical diagnosis ability between medical students trained using SPs or a web-based session. However, students did prefer the SP teaching method to the web-based session.

Overall, the lack of rigorous experimental data makes it difficult to conclude whether simulation can be used to develop successfully clinical reasoning. There are research papers that are suggestive of the efficacy of simulation. However, there is a lack of concrete evidence on the subject – despite the widespread adoption of simulation into nursing and medical curricula.

5.1.4 Assessment using simulation

Assessment has been called a ‘powerful learning tool’ (Fuentealba 2011, p. 157), driving students to master the material being examined. In order to align assessment methods with outcome-based learning objectives, simulation is often used as an examination technique (De Galan et al. 2007, Forrest et al. 2013).

Simulation is used as part of Objective Structured Clinical Examinations (OSCEs) at many medical schools. OSCEs involve the use of simulated patients, part-task models and cases to examine clinical skills such as history taking or patient examination. They take the format of multiple small ‘stations’, each with an individual task, that students rotate around every five or six minutes (Harden and Gleeson 1979). Simulation is valuable as an examination technique, as it allows students to demonstrate the ‘Shows how’ level of Millers hierarchy of clinical assessment (Miller 1990, Forrest et al. 2013), rather than just demonstrating knowledge of a clinical task (figure 5.1). OSCEs now form an integral part of medical curricula across the globe and the amount of research available is so large that Swanson & van der Vleuten (2013) consider it impossible to conduct a ‘reasonably thorough review’ (P.S17). For that reason, this section of the literature review will focus the aspects of assessment most relevant to this study – simulation scoring methods and self-assessment.

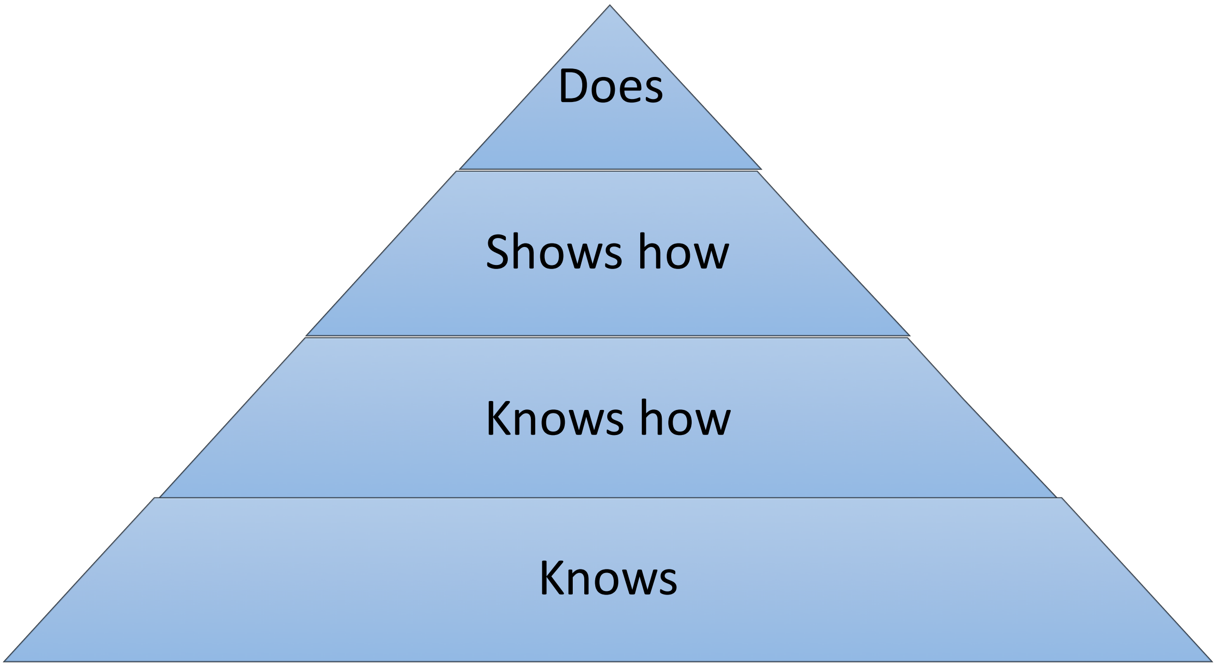

Figure 5.1 Millers framework for clinical assessment. Each level represents increasing ability to perform a clinical skill. OSCEs are able to examine the 'shows how' level, by asking the student to demonstrate their skill. The level above this, 'does' can only be demonstrated by functioning independently in context e.g. clinical practice. Adapted from (Miller 1990).

Simulation scoring methods – checklists versus global rating scales

There is ongoing debate on the best method for OSCE scoring (Ilgen et al. 2015). Both Global rating scales (GRS) and checklists systems have been advocated. The features, advantages and disadvantages of each method are shown in table 5.2.

Scoring method	Description	Advantages	Disadvantages	Example
Checklists	A list of observable tasks that should be performed to demonstrate proficiency. Assessor responses are binary: yes or no.	Reduces subjectivity Detailed, precise feedback on errors for participants Less rater training required	Do not differentiate between levels of performance Hard to include the impact of sequence, timing and unnecessary tasks Unique checklist required for each scenario tested	Rescuing a patient in deteriorating situations evaluation tool (Liaw et al. 2011)
Global rating scales	A Likert-style rating scale that grades the performance of tasks or behaviours. Assessors decide the level of performance.	Can use one scale across many scenarios Can incorporate nuanced errors Can include detailed description for each level	Prone to subjectivity Vague feedback provided to learners Extensive rater training needed	Non-technical skills for surgeons rating scale (Yule et al. 2006)

Table 5.2 Comparison of two methods of scoring simulated assessments (adapted from Regehr et al. 1998, Forrest et al. 2013, Swanson and van der Vleuten 2013).

During a systematic review of the literature, Ilgen et al. (2015) found 45 studies that compared the use of GRS and checklists to grade simulation performance. They reported similar inter-rater reliability for both methods, which disputes the commonly claimed weakness of subjectivity when using GRS (Forrest et al. 2013). GRS showed higher inter-item and inter-station reliability. The authors noted, however, that this might be due to greater familiarisation with the scoring method when using GRS, as the same one is used in all OSCE stations. This is compared to the use of a different checklist for each task when using that method. The review also focused on technical skills, so the findings may not apply to professional skills such as communication.

In veterinary education, GRS scores have been shown to be more reliable than checklist scores when grading OSCEs via video recording (Read et al. 2015). However, within this study, the number of raters was low (12). Additionally, every rater scored each video twice – firstly with a checklist and secondly with a GRS. This may have significantly affected the results, with scoring likely biased by increased familiarisation with the examination points when using the GRS.

Occasionally, the two metrics are combined within a mark-scheme. This is demonstrated by the Objective Structured Assessment Of Technical Skills (OSATS) tool, developed by Martin et al. (1997). Although this combines the advantages of both methods, it also increases the time needed for development and rater training. Overall, both methods of grading simulation have advantages and disadvantages. The most important contributor to reliability and validity is the process used to create the mark-scheme, and the training of the assessors using it.

Self-assessment

Self–assessment in simulated environments can be a practical way to assess large numbers of students with small numbers of staff – although not suitable for summative assessments. There is controversy, however, on the accuracy of self-assessment. Some studies investigating self-assessment during simulation have shown that participants can judge their own performance in line with that of an examiner (MacDonald et al. 2003, Weller et al. 2005, Sadosty et al. 2011). However, two of these studies indicated that students that were rated lowest by the external examiner were not accurate at self-assessment, frequently overestimating their skill. Further studies have suggested that practitioners can accurately grade their own technical skills, but not behavioural skills such as communication (Moorthy et al. 2006, Arora et al. 2011).

A systematic review of physician self-assessment performed by Davis et al. (2006) concluded that self-assessment abilities were low, as 13 out of 20 studies analysed demonstrated no (or inverse) correlation between self-ratings and external ratings. They also reiterated that those with the least skill were worst at accurate self-assessment, but noted those with the most confidence tended to follow the same trend. Colthart et al. (2008) also performed a systematic review on self-assessment, and found there was not sufficient evidence to confirm or refute the effectiveness of self-assessment. However, they did find that self-assessment is improved by feedback and by providing defined criteria for grading. The lack of rigorously designed research was cited as the cause for lack of evidence.

Generally, caution needs to be taken when using self-assessment scores. Although they can be accurate, particularly when using skilled participants, they should not be relied on alone for evaluation of ability. Instead, combination with another assessment method is recommended (Baxter and Norman 2011).

5.1.5 Debriefing

Experiential learning can be defined as 'the process whereby knowledge is created through the transformation of experience' (Kolb 1984, p. 41). This has a critical role in simulation, where the student learns by participating in an artificial situation. Kolb (1984) described a cycle of development that occurs when a student engages in experiential learning (figure 5.2). A crucial step of this cycle is reflection. Reflection allows the student to evaluate their performance, identify the influences on their actions and the session outcomes and decipher their emotional response. Without this step in the cycle, the student would not be able to construct ideas for improvement to be implemented at the next opportunity, thus their skill level would remain constant (Hoover 1974, Kolb 1984).

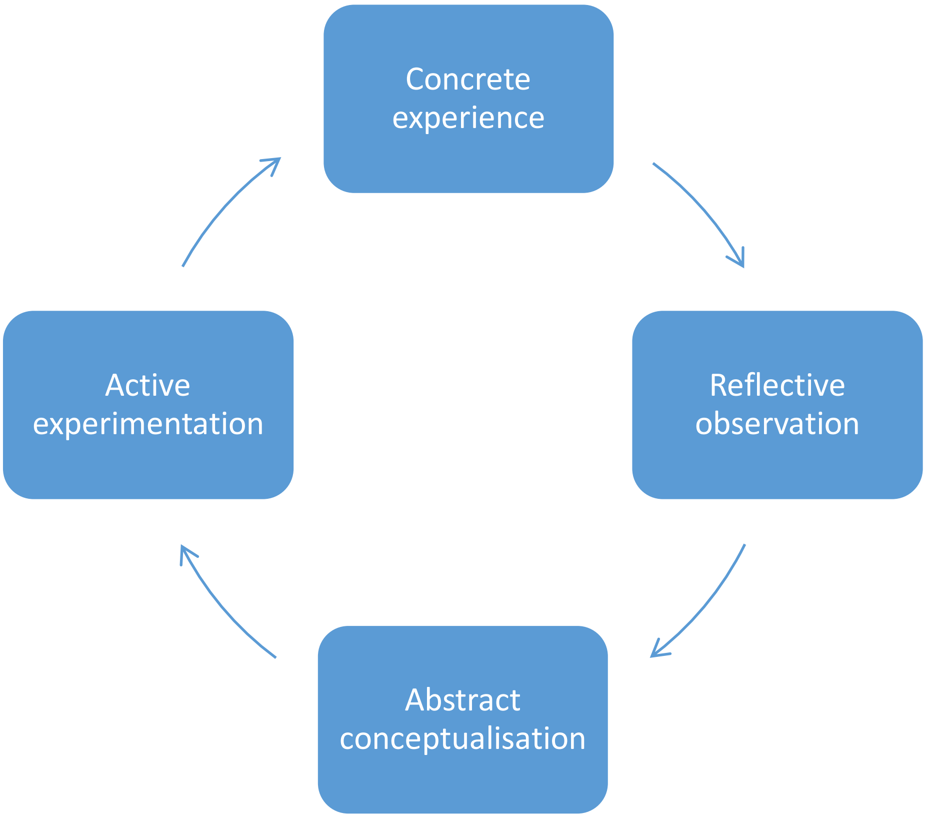

Figure 5.2 Kolb's experiential learning cycle (Kolb 1984)

Students can conduct the reflective stage of Kolb's experiential learning cycle by themselves, but it has been found that helping them in this process by facilitating a debriefing increases the learning potential of a simulation (Issenberg et al. 2005). Without a debriefing, reflection may be unsystematic and rushed (Fanning and Gaba 2007).

The aim of debriefing has been described as improving 'learning, future performance and ultimately patient outcomes (Levett-Jones and Lapkin 2014, p. 58). A systematic review found that feedback was the most important feature of high-fidelity simulation when maximising effective learning – reported in 51 research papers (Issenberg et al. 2005).

Kelly et al. (2014) asked nursing students to rate the importance of 11 aspects of a simulation experience to clinical judgement development on a five point Likert scale. The highest rated components selected by the students were 1) facilitated debriefing (mean average 4.02) 2) post-simulation reflection (3.98) and 3) guidance by the academic (3.78) – signalling that a significant amount of learning occurs within the debrief. Debriefing is now considered an critical part of simulation (Levett-Jones and Lapkin 2014), and several different methods of debriefing have been published (Rudolph et al. 2007, Kuiper et al. 2008, Dreifuerst 2012). A clear answer to the question 'Which method is best?' is unavailable – and many institutions develop their own styles of debriefing (Neill and Wotton 2011). The structure of the various models of debriefing vary, but most include the following three elements (Fanning and Gaba 2007):

1. Introduction – emotional reactions to the simulation; initial impression gathering
2. Personalisation – reflection focusing on the actions and motivations of the participant; identifying areas for improvement
3. Generalisation – discussing the 'big picture' implications of the session; application of experiences to real life

The expertise of the facilitator is key to the effectiveness of a debriefing (Fanning and Gaba 2007, Neill and Wotton 2011, Boese et al. 2013). The role of the facilitator includes helping participants 'explore the case and their thought processes used in decision making' and 'understand and achieve the objectives' of the session (Boese et al. 2013, p. S23). Faculty members require training to provide effective debriefing (Cockerham 2015), which can include continuing education, mentoring and coursework (Boese et al. 2013, Forrest et al. 2013). Some studies advocate the use of video-recording the participants' performance to aid debriefing (Grant et al. 2010, Chronister and Brown 2012), however Levett-Jones & Lapkin (2013) found no clear consensus within the literature as to whether this increased feedback effectiveness.

Debriefing can be either structured or unstructured. A structured debriefing requires the use of a precise method e.g. debriefing with good judgment (Rudolph et al. 2007), whereas in an unstructured debriefing the facilitator improvises the procedure as they deem fit. Decker et al. (2013) claim a structured framework for debriefing is essential for effectivity. However, Neill & Wotton (2011) found conflicting evidence for this point when reviewing the relevant literature and concluded that further research is needed in this area. Three commonly cited methods for structured debriefing are described in table 5.3.

Method	**Author(s)**	**Description**
Debriefing with good judgement	Rudolph et al. (2007)	This model operates on three principles: 1) Participants approach a simulation with preformed cognitive frames that determine their actions and responses. These need to be identified and analysed to improve performance. 2) Facilitators will always form judgements on student performance. Both hiding these opinions and presenting them as hard-fact will alienate participants. 3) An advocacy-inquiry approach to questioning – where the facilitator explains their judgment as a hypothesis and explores it further with participants – is most effective.
Debriefing for meaningful learning	Dreifuerst (2010)	The facilitator guides the participant through six stages: engage, evaluate, explore, explain, elaborate and extend. This structures the process and allows reflection-in-action, reflection-on-action and reflection-beyond-action.

SHARP	Ahmed et al. (2013)	A 5-step process (and mnemonic) for debriefing, where facilitator completes the following: 1) Set learning objectives – before the case 2) How did it go? – What went well? 3) Address concerns – what did not go well? 4) Review learning points – were the learning objectives met? 5) Plan ahead – what can you do to improve your future performance?

Table 5.3 Three methods of structured debriefing

5.1.6 Simulation in veterinary education

The use of simulation in veterinary education has grown in the last 10 years. This has been mainly driven by the increasing importance placed on communication training (Gray et al. 2006) and clinical skills teaching, coupled with the overwhelming acceptance of the pedagogical value of simulation within the field of human medicine. Additionally, the increasing numbers of veterinary students makes time practicing clinical skills (e.g. surgery) competitive and limited (Kneebone and Baillie 2008, Byron et al. 2014). However, simulation use within veterinary schools is minor compared to other health professions; still within the infant stages of development and implementation.

Two main uses for simulation in veterinary education have surfaced in recent years: 1) deliberate practice of clinical skills e.g. venepuncture and 2) development of communication skills (Radford et al. 2003).

The use of standardised clients to teach communication skills was first described by Radford et al. (2003) at The University of Liverpool. They developed an integrated communication curriculum that involved the use of professional actors as standardised clients. The session was reviewed positively by students, although no attempt to measure communication skill improvement was made. Shortly afterwards, Ontario

Veterinary College published details of their own curriculum in communication skills, including standardised clients (Adams and Ladner 2004). This study again reported high student satisfaction with the sessions. Participants also showed a statistically significant increase in their perception of their own knowledge of communication ($P=<0.001$). However, once again no objective measurement was made of student improvement, despite the use of a rubric within the simulation.

In 2006, the National Unit for the Advancement of Veterinary Communication Skills (NUVACS) reported the use of standardised clients in all UK veterinary schools for communication training. In 2007, a study experimentally demonstrating the validity of simulation use for veterinary communication development was published (Latham and Morris 2007). The authors found that students trained using standardised clients outperformed two control groups when communicating with genuine clients at a local veterinary practice. The control groups were 1) students with no communication training and 2) students that had taken part in one three-hour small group seminar on communication skills, not involving simulation. The blinding of the assessors and the use of clients to provide additional communicatory scores to students makes the findings the best veterinary-specific evidence for the use of standardised clients.

Part-task simulations were introduced to veterinary education by Smeak et al. (1991), who developed and tested a haemostatic technique simulator on 20 veterinary students. Blinded scoring showed the simulation group were better able to perform haemostasis in a live animal. This was followed up by a study examining the effect of a hollow organ closure model on student ability to execute a gastrotomy in a live animal (Smeak et al. 1994). The second study concluded that the model did not affect student performance.

Baillie et al. (2005a) validated the use of a haptic feedback simulator to train veterinary students to locate the uterus during bovine rectal palpation. This experimental study randomly selected and assigned 16 undergraduate students to either a simulator or traditional group. All students experienced the lecture-based training already within the curriculum and the simulator group received additional training on the palpation model.

Both groups were tested on their ability to identify the uterus in a live cow – verified using an ultrasound probe attached to the students hand. The results demonstrated that the simulator group participants were statistically more likely to identify the uterus than the control group (although the statistical test used to determine this is not detailed). This provides strong evidence of the efficacy of the bovine simulator, the main limitation being the small sample size.

Baillie et al. (2005b) then integrated the rectal palpation simulator into the veterinary curriculum at the University of Glasgow Veterinary School and surveyed students' responses. Acting on student suggestion, the part-task trainer was combined with a standardised client (played by the teacher) to create a hybrid simulation. Feedback was positive from the students, and a similar learning session was integrated into the curriculum at the Royal Veterinary College (RVC)(Baillie et al. 2010). At the RVC, students were also asked to decide an appropriate treatment plan and dispense medication - extending the simulation to cover clinical reasoning. Student response was overwhelmingly positive and 80% of participants felt their ability to diagnose bovine fertility was improved. However, no attempt was made in any of the studies to quantify or objectively assess any improvement in clinical reasoning, and the latter two studies did not measure improvement in palpation ability.

In recent years, several part-task trainers have been developed and validated for veterinary use. These include an equine jugular injection model (Eichel et al. 2013), a canine gastrointestinal endoscopy trainer (Usón-Gargallo et al. 2014), a small-animal thoracentesis simulator (Williamson 2014) and a haemostasis simulator (Giusto et al. 2015). Further research papers have described new part-task trainers, but only evaluated their use through participant survey (Capilé et al. 2015, Langebæk et al. 2015). Simulators are now frequently being incorporated into clinical skill laboratories, where students can practice in their spare time, with or without instructor assistance. The need for cost effective models is pushing veterinary educators to create their own simulators, however the vast majority are not published in journals. For example, the

SVMS uses several simulators within their own clinical skills centre, all created by staff and many validated by local studies, but none have been published.

The most technologically advanced use of simulation was the development of a high-fidelity canine patient simulator from components of a human electronic patient by Fletcher et al. (2012). After completing cardio-pulmonary arrest scenarios using the simulation, 70 veterinary students completed a feedback survey - 98.5% of these students felt the simulator provided an engaging learning experience, and 73% reported emotions similar to a genuine clinical situation. However, once again, only self-reported outcomes were measured thus the implications are limited.

In summary, there have been some significant developments in the use of simulation to develop professional and clinical skills in veterinary education. Several simulation activities now form core elements of veterinary curricula. Despite this, direct evidence of impact is frequently absent from validation studies. It seems that veterinary schools are generally happy to accept research from medical education as proof of simulation efficacy, rather than re-validating the methods within their own field.

This chapter will now move on to describe a study conducted to investigate the use of SC simulation to develop clinical reasoning in veterinary students.

5.2 Methodology and methods

5.2.1 Methodology

This study aimed to answer the question 'Can SC simulation be used to develop clinical reasoning in veterinary students'? The question was deliberately broad to allow for multiple interpretations of the word 'develop' – including quantifiable skill, understanding and confidence. These aspects were all considered important due to the complicated nature of the skill and the lack of consensus within the literature of the process of clinical reasoning development.

Generally, in educational research, an intervention is validated by a before-after comparison of the ability to perform the task in question (Grantcharov et al. 2004, Dreifuerst 2012, Powell-Laney et al. 2012, Treadwell et al. 2014). In this study, measuring clinical reasoning ability prior to and post SC simulation would give an accurate view of the effect of the session – provided scientific rigour was maintained. However, there is no proven method to examine clinical reasoning ability. Various authors claim that certain techniques are accurate and validated, but all have limitations and flaws (described in Chapter Two).

The lack of satisfactory methods of quantifying clinical reasoning ability led the author to triangulation as a method to increase the reliability of any data gathered. Triangulation involves collecting multiple 'perspectives' of a phenomenon (Kam et al. 2011). All of these perspectives may contain unreliable information, but by combining them to form an overall data set, the effect of the erroneous information on the reliability of the study is reduced (Pope and Mays 2006). When performing triangulation, the different methods of data collection should be chosen to best address the research questions (Silverman 2013) – encompassing quantitative and qualitative methods as needed. This study employs four different methods to investigate the impact of the SC simulation in order to increase the reliability of the results via triangulation. This was important as each of the four chosen methods have limited generalisability when considered alone, but together form a detailed, comprehensive, investigation.

A mixed methods approach developed as the data collection methods were decided. Quantitative methods were used to measure any subjective or objective performance changes during the session, whilst qualitative methods were used to investigate the experience of the participants. The mixed method approach is discussed at length in Chapter Three.

5.2.2 Methods

Simulation session design

As SCs were not used for clinical reasoning development in the SVMS curriculum prior to the study, a new simulation session was developed. This process began by identifying the intended learning objectives (ILO's) of the session (Figure 5.3). The ILOs focussed on clinical reasoning development – broken down into component skills and confidence.

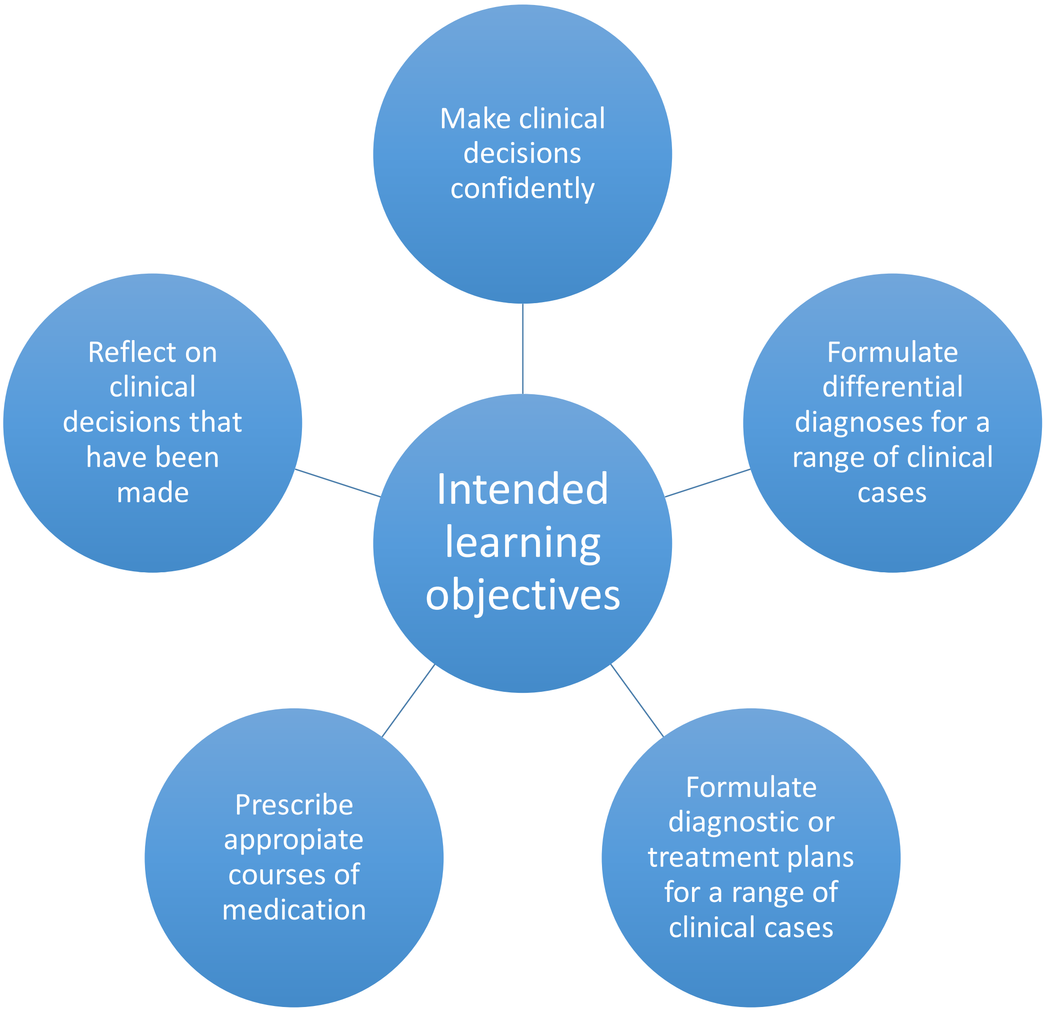

Figure 5.3 The ILOs developed for the standardised client simulation

A fully contextualised high fidelity first opinion consultation format was chosen for the simulation. This allowed all ILOs to be met whilst maintaining high fidelity and reproducibility. Due to the practicalities of having live animals present, a small animal focus was selected. The SC simulation was designed for fifth year students as they were expected to have the knowledge and confidence to be able to make successful clinical decisions alone.

Literature relating to simulation design was then reviewed. A systematic review performed by Issenberg et al. (2005) was used to determine key features to include within the simulation design to promote effective learning. These were incorporated where possible (table 5.4).

Feature	**Description**	**Implications for the design of this study**
Feedback	Providing a form of feedback to the learners regarding their performance	Detailed personal feedback was given to each student after every simulated consultation by the facilitator
Repetitive practice	Multiple opportunities for students to practice tasks - must be with the aim of improvement	Each student took part in three simulated consultations to allow them to practice decision-making multiple times and implement feedback given
Capture clinical variation	Portraying a variety of clinical cases to maximise case exposure	The three consultations the student took part in all simulated different clinical cases
Controlled environment	An environment where mistakes can be made safely and the facilitator can focus on the student, not the patient	The simulation was completely controlled – errors could be made without patient consequences
Individualised learning	Students should be active participants in a simulation experience that is individualised to each students needs	For this reason, students took part in the simulation alone and did not passively observe other students completing the simulation
Simulator validity	The simulation must have a high fidelity and be comparable to a genuine experience	The simulation was designed to be as high fidelity as possible – including the absence of peers/facilitators in the consultation area

Table 5.4 The components identified by Issenberg et al. (2005) in a systematic review that were incorporated into the SC simulation design to promote effective learning

The standardised client simulation

The simulation was designed to recreate a first opinion small animal consultation as closely as possible. The clients were played by trained actors, each accompanied by an animal in the role of their pet. To allow opportunity for repetitive practice, each student took part in three consecutive simulated consultations, each involving a different clinical case. Participation was individual to allowed focused feedback. A diagrammatic representation of the simulation process is shown in figure 5.4, presented at the end of this section.

Pride Veterinary Centre, a small animal first opinion practice and referral hospital, was used as the simulation location. Fifth year SVMS students undertake four weeks of intramural WBL at the practice, in two fortnight-long blocks. Students were asked to take part in the simulation on the first day of their WBL at Pride Veterinary Centre, which equated to five students per fortnight participating.

Prior to the simulation, students were emailed information about the structure of the upcoming session, including a two-word summary of each case, similar to that recorded by receptionists when booking a consultation in practice (appendix 6). Each session began by familiarising the student with the simulation environment and process, after which they were required to sign a participant consent form (appendix 1). Students were then presented with a written clinical history pertaining to their first case. When ready, the student collected the SC and their pet from the waiting room. The structure of the consultation was controlled by the student, ending with the SC exiting the room. The students were instructed to respond to the concerns of the client in an appropriate way, including discussing possible diagnoses and treatment options, and prescribing any necessary medication. After the consultation finished, a 15-minute debriefing took place with the facilitator, before continuing onto the next consultation. Three consultations and associated debriefings took place in total. After the third debriefing, the student was asked to complete the data-gathering documentation (described later in this section).

Several features were incorporated into the simulation to ensure a high fidelity:

1. The simulation took place within a veterinary practice – making use of a genuine consultation room and waiting area
2. Live animals were used
3. Students did not have prior contact with the SC actors – their first encounter was in the waiting room and different actors were used for each filmed consultation
4. A full consultation was conducted, without the student being able to request help
5. All normal tasks involved in small animal consultation were required – including history taking, clinical examination (with the exclusion of rectal temperature for welfare reasons), diagnosis and treatment where appropriate.
6. The researcher observed the student's performance from outside the consultation room using a live video feed

The simulation was scheduled to run from January to September 2015. In May, the final year students graduated – meaning that a new cohort were partaking from that point forward. As one cohort took part from May to September, they completed the session towards the start of their final year (Group A). The other cohort - January to May - completed the simulation towards the end of their final year (Group B). This provided opportunity to compare the effect of the simulation at different points in the curriculum.

Case design

To maintain high fidelity, live animals were used as the patients within the simulated consultations. This limited the possible case pathologies to those where a clinically normal animal was a reasonable presentation. Additionally, the case needed to involve several clinical decisions at an appropriate difficulty. The final requirement was that any breed/sex of dog could be used to play the patient. Cats and other small animals were not used in the simulation, as they would have had to be caged when not in use, which would have compromised their welfare.

Three cases were developed, summarised in Table 5.5. Each case was based on a genuine veterinary patient encountered by the author in the two weeks preceding case generation. Details of the health problem, history and clinical plan remained the same. The financial situation and personality of the owners involved was changed to meet the aims of the simulation and provide additional decision-making opportunities, but these were kept consistent with each case.

Case	**Most likely diagnosis**	**Appropriate treatment plan**	**Owner considerations**
Acute diarrhoea	Dietary indiscretion	Advise the owner to feed a bland diet (e.g. chicken breast) and administer digestive support paste twice daily according to weight	Usually seen by the senior vet, who always prescribes antibiotics for diarrhoea.
Seizure	Idiopathic epilepsy	Offer the owner a blood test (biochemistry, haematology minimum) and advise monitoring at home for further seizure activity	Has no insurance and can spend a maximum of £75 during this visit
Weight loss and polydipsia	Diabetes mellitus/ Chronic kidney disease	Advise the owner to submit a urine sample for dipstick/specific gravity testing and recommend a blood test (biochemistry and haematology minimum)	Mother recently died from cancer so is extremely sensitive to the possibility of tumours

Table 5.5: Summary of the three cases developed for the standardised client simulation. Detailed case descriptions can be found in appendix 7.

A template was created to record details of each case for the actors playing the standardised clients. This informed the actors of each animals' history and each owner's financial situation and personality. It also explained when to reveal certain information during the consultation. A completed template for each case is provided in appendix 7.

Once created, the case information was sent to three small animal veterinary surgeons to review. All agreed the cases were authentic and clinically accurate, thus no further modifications were made.

During the simulation, the order of the three cases was randomised for each student. The reason for this was twofold: 1) to minimise the effect of any variation in case difficulty 2) to prevent the researchers grading the student performances via video-recording knowing which order the cases were attempted.

Actor recruitment and training

Professional medical actors were not used during the simulation, due to their expense. Instead, postgraduate students from within the SVMS were recruited via email to act as the standardised clients. Six postgraduates volunteered to assist with the simulation. All took part in a three-hour training session, during which the cases were discussed in detail. The postgraduates then took turns to play the role of each client in a simulated consultation, with the author playing the role of the veterinary surgeon and replicating possible student actions and responses. This continued until all volunteers were confident in the three character roles. Information packs were given to the volunteers containing case information, which they could then continue to study after the training was complete. A rota was provided, scheduling two actors per session – meaning all volunteers took part a minimum of every six weeks. Actors were compensated for their time with the standard SVMS casual labour wage.

Quantitative measurement of simulation impact

The Lasater clinical judgement rubric (LCJR) was developed by Lasater (2007) to grade clinical reasoning ability in nursing students during high fidelity simulation (Lasater 2007b, Adamson et al. 2012, Jensen 2013, Shin et al. 2015). The rubric was created using the model of clinical judgement in nursing (Tanner 2006), which itself was developed from observing nursing students. The LCJR was chosen to grade clinical reasoning ability in this study for the following reasons:

1. It is specific for use within high fidelity simulation, allowing grading of physical actions and conduct rather than written answers. This was important as the simulation aimed to develop a contextualised and holistic form of decision-making; therefore, a practical examination method would best test these aspects.
2. It could be modified to give a quantitative score of clinical reasoning skill.
3. The reliability and validity of the LCJR has been proven in several studies (Lasater 2007b, Adamson et al. 2012, Jensen 2013, Lasater et al. 2015, Shin et al. 2015). Although both would need to be demonstrated within the context of this study, previous studies provided evidence that this would be possible.

The LCJR is based around clinical judgement in human nursing, rather than veterinary medicine. This was unavoidable, as there has been no research into this particular area in veterinary students. There are many similarities in clinical reasoning between medical and veterinary disciplines (Everitt 2011, May 2013) and thus the majority of the LCJR could be used unedited for the SC simulation. There were, however, the following modifications made:

- The language and phrasing was edited to make appropriate for veterinary medicine (e.g. 'client' instead of 'patient')
- The component 'Being skilful' was removed, as students were not required to demonstrate any skills during the SC simulation (except clinical examination which is graded within a different category)

- The grading of reflective skills was removed as this would be conducted with the help of a facilitator during the SC simulation
- The descriptive classifications of each level of ability were quantised

There were also three changes made to increase simplicity of use:

- The LCJR was reorganised so the category order mirrored the normal structure of a consultation
- The language was edited to include less jargon
- Specific examples were given for each criteria that related to the three cases being used within the simulation

The modified Lasater Clinical Judgement Rubric (mLCJR) is shown in table 5.6. It was tested using a pilot simulation, held at the SVMS. One experienced veterinary surgeon was video-recorded completing the three simulated consultation cases. The rubric was then used to assess the performance of the participant. No changes were necessary to the format of the mLCJR following the pilot study.

The mLCJR was used in two ways during the simulation. Firstly, students were asked to score their own clinical reasoning ability pre and post simulation using the rubric. This was performed immediately before the first SC consultation, and after the debriefing period of the last consultation. Secondly, the participant's clinical reasoning was scored by a researcher using the rubric. The first and third SC consultations each student conducted were video recorded. After completion of data collection, these videos were blinded, randomised and scored by the author. The scoring process was aided by a mark sheet (appendix 8) listing the appropriate history questions, examination and treatment plan for each case. Ten percent of the video recordings were also scored by a second researcher, allowing the interrater reliability to be calculated. This was done by calculating the Intraclass Correlation Coefficient using SPSS statistics 22 (IBM).

Component	Score			
	1	2	3	4
History taking	Is ineffective at taking a history. Obtains very limited information from the owner. *E.g. Only asks one or two of the mark sheet history questions.*	Asks SOME required questions, but misses a few important ones out. Seems unsure what information to ask for and may ask irrelevant questions. *e.g. Does not ask about water intake when faced with the weight loss case*	Asks MOST required questions, but occasionally does not follow up or clarify important leads. May miss one minor point, but asks all vital questions. *e.g. Does not ask about in-contact animals when faced with the D+ case*	Asks ALL relevant questions when taking a history. *e.g. Asks all questions on the mark sheet*
Examination	Examination is very limited, only one or two components are checked. *e.g. Only auscultates chest*	Performs a LIMITED clinical examination. Important aspects of the exam are missed out. *e.g. Does not perform any neurological examination when faced with the seizing case*	Performs a THOROUGH clinical examination; a few minor components are missed. *e.g. Does not check lymph nodes on any case*	Performs a COMPLETE clinical examination, does not miss any components relevant to the case. *e.g. Completes all points on the mark scheme*
Identifying abnormalities	Misses the importance of clinical findings – unjustly dismisses them. *e.g. Not appreciating significant weight loss that requires investigation in the weight loss case*	Recognises SOME abnormalities, but overlooks some important findings from the history/exam. *e.g. Not noting polydipsia when faced with the weight loss case*	Recognises MOST abnormalities that need to be considered, missing only minor aspects. *e.g. Not noting lethargy in the diarrhoea case*	Recognises ALL problems that need to be addressed. *e.g. Identifies all relevant abnormalities*

Prioritising data	Does not know which findings to concentrate on, prioritises an unimportant problem over the relevant issue – may not attend to the main problem. *e.g. Focusing on lack of flea treatment at length during the weight loss case*	Attempts to focus on the main problem, but gets distracted. Alternatively, does not prioritise relevant findings as important. *e.g. Does not prioritise polydipsia as a problem when discovered in history of the weight loss case*	Generally concentrates on the most important findings, but does talk about irrelevant aspects of the exam/history BRIEFLY. *e.g. Recommending worming when faced with the acute D+ case (except as general recommendation to worm regularly)*	Just discusses and forms a treatment plan for the relevant findings. *e.g. Only discusses aspects directly related to the current problem*
Making sense of data	Struggles to interpret history and exam findings. Is unsure how to proceed. Does not determine a feasible way to proceed with the case. *e.g. Sends owner of weight loss case home with view to monitor weight over coming months*	Attempts to interpret the clinical findings, but misses an IMPORTANT differential diagnoses or includes irrelevant ones. *e.g. Does not consider toxin ingestion when facing seizing case*	Is able to interpret the history and clinical exam to form several differential diagnoses, but may miss a MINOR differential or include a differential that is very low in likelihood. *e.g. Considers worm infestation a differential for acute D+*	Is able to interpret the history and clinical exam to form a set of accurate differential diagnoses. *e.g. Clearly has considered all relevant differential diagnoses when deciding how to proceed with case*
Well planned intervention	Treatment plan is not acceptable treatment for the case. *e.g. Prescribing antibiotics when facing acute D+ case*	Treatment/investigation is not the most appropriate for the case, but some aspects are correct and will aid diagnosis/treatment. *e.g. Not conducting urinalysis on patient with PUPD but performing blood test*	Treatment/investigation plan is correct for the case, but there may be minor, aspects missed or incorrectly included. *e.g. Not advising Prokolin for acute D+ case*	Treatment choice ideal for case (considering animal and owner factors). *e.g. Follows treatment plan on mark sheet*

Calm, confident manner	Is visibly stressed/anxious and lacks confidence. Relies on client to make decisions and direct consultation. *e.g. Long silences and obvious uncertainty when deciding on treatment plan*	Is tentative in the leader role; redirects some responsibility for decision making to the client. Moments of self-doubt, not 100% sure of treatment plan. *e.g. Offers treatment options but does not direct client/make recommendation – client decides how to proceed*	Is calm and confident in MOST situations. Directs the consultation but occasionally is unsure. *e.g. Changes mind about recommendations mid-consultation but otherwise confident and assumes responsibility for decision making*	Assumes responsibility; is confident with diagnosis/treatment plan. *e.g. Decides a treatment plan and relays this confidently to client*
Clear Explanation	Explanations are confusing and directions are unclear or contradictory. Owners are confused. *e.g. Owner cannot make sense of instructions given*	Explanations are mostly clear, though one element may cause confusion for the owner and need to be clarified. *E.g. Does not explain opinions clearly, owner has to ask questions to clarify*	Explains carefully to clients and gives clear directions. The pace/tone may be inappropriate or may not check for owner understanding. *e.g. Explains plan well but speaks too quickly*	Communicates at good pace; explains interventions clearly; checks for understanding. *e.g. Explains plan at appropriate speed, clearly and checks for owner comprehension*

Table 5.6 The modified Lasater Clinical Judgement Rubric (mLCJR) used for clinical reasoning grading during the simulation

Quantitative analysis of simulation impact

The data from both the student self-assessment (SA) and the researcher-assessment (RA) were input into SPSS statistics 22 (IBM) for management and analysis. A P-value ≤ 0.05 was considered statistically significant.

To determine whether the data from groups A and B could be amalgamated the difference between the pre and post simulation scores of each student were calculated for both the SA and RA. These were input into SPSS statistics 22 (IBM) and A Mann-Whitney U test comparing the improvement of each group was performed on each mLCJR component separately. There was a statistically significant difference in the score-change between the two groups on the SA, so the data sets were not merged. There was not a significant difference for the RA, so the data for groups A and B were combined.

The following methods were performed separately on groups A and B when evaluating the SA and once on the combined data from both groups when analysing the RA.

The pre and post simulation scores were compared using a Wilcoxon Signed Ranks statistical test. Each component of the mLCJR was analysed individually. Then, the median and mean averages were calculated for each component, both pre and post simulation.

To determine whether the components could be summed to create an overall pre/post total for each group, Cronbach's alpha value of internal consistency was calculated. As all alpha-values fell above 0.7, the consistency was accepted within all four categories (Group A SA/RA, Group B SA/RA) and the components summed (Bland & Altman 1997). A Wilcoxon signed ranks test was then performed on the totalled data.

In order to determine whether the three cases used within the simulation were of equal difficulty, the scores from the RA were input into SPSS statistics 22 (IBM) alongside the case they related to. A Kruskal-Wallis test was performed to asses any variation in median average score between the cases. As one case was found to be significantly ($p<0.05$) harder than the rest, the data resulting from that case was removed from the RA scores and the Wilcoxon signed ranks test, described above, was repeated.

Construct validation

To determine whether the mLCJR was accurate at measuring clinical reasoning ability, a cohort of experienced veterinary surgeons were tested using the rubric. If the experts performed significantly better than the students this would suggest the mLCJR had acceptable construct validity. A purposive sample of seven SVMS staff that had over three years' experience as a first-opinion small animal veterinary surgeon and had worked in practice within the last 12 months were selected. All took part in one simulated consultation and were video recorded. For simplicity, the same case was used for all expert participants – acute diarrhoea. The simulation was held within a clinical skills laboratory at the SVMS, arranged to resemble a consultation room. The simulation location was changed to prevent the staff needing to travel to Pride Veterinary Centre, thus reducing the time sacrifice to take part. All other aspects of the simulation were identical to the student experience.

The expert participants' recordings were graded by the author. Blinding was not performed as, due to the age of the experts compared to the students, the identity of the staff was unavoidably clear. Once graded, the median and mean average total score was calculated.

To compare the expert and student performances, all student total scores from the acute diarrhoea case were added to the expert total score data set. A Mann-Whitney U test was used to identify any significant ability differences between the two groups.

Survey analysis of simulation impact

A Likert-scale survey was designed to collect student opinions about the simulation (appendix 9). This method was used to give a statistical overview of participant perceptions. Fifteen statements were presented to the students, focussing on the experience of the simulation and the skills developed. Five of the statements were reversed (i.e. negative). Participants signalled their agreement level with the series of statements (Strongly disagree, Disagree, Slightly disagree, Slightly agree, Agree or Strongly agree). Students were asked to answer the survey on paper immediately after completing their final consultation and debrief.

Likert-scale survey responses were converted to numerical data for analysis, where Strongly disagree = 1 and Strongly agree = 6. This was input to SPSS 22 (IBM). A Mann-Whitney U test was performed on the combined data from both cohorts to determine if their data could be merged. As nine questions were answered statistically differently between groups, the data were analysed separately.

To determine if the questions could be summed to a total, Cronbach's alpha was performed. To do this, the answers to the reversed questions were inverted – i.e. the score one became a six. As both groups alpha values returned above 0.7 (Bland and Altman 1997) the total score for each student was calculated. For both cohorts, the median and mean averages were determined for each question. The total percentage agreement was then calculated, where answers of 1, 2 or 3 represented disagreement, and 4, 5 or 6 showed agreement.

5.2.3 Qualitative analysis of simulation experience

The use of SC simulation to improve clinical reasoning was suggested by the results of the previous study (presented in Chapter Four). It was discussed that simulation may be able to provide the contextualised learning and case responsibility currently lacking from the SVMS curriculum. To investigate whether the session did successfully incorporate those aspects, a deeper, qualitative analysis of the students' experiences was required. This was achieved by conducting focus groups with participants. Focus groups were chosen as they stimulate conversation between occupants, exposing opinions and insights that might not be voiced in an interview setting.

A convenience sample of participants was used for the focus groups, due to the busy schedule of the students whilst on WBL. Thirty students were asked to partake – 15 from both groups A and B. Six focus groups were held, each with five participants that took part in the SC simulation together. Each focus group was held two days after the participants completed the simulation.

The focus groups followed a semi-structured format and lasted between 30 to 60 minutes. Questions focused on the experience of the students during the simulation; how the experience differed from other experiences of decision-making during the BVM BVS course and how participants felt they reasoned through the cases. A full list of questions, structured into a facilitator prompt sheet, is provided in appendix 10. All focus groups were audio recorded, transferred electronically to a computer and then transcribed, by either an external source or the researcher. Where transcription was done by an external source, the document was checked by the author for accuracy.

The transcriptions for all focus groups were merged into one data set for thematic analysis. Thematic analysis was performed using guidelines developed by Braun & Clarke (Braun and Clarke 2006). Complete inductive code generation was performed, managed through NVIVO (QSR, version 10). Codes were then interpreted and grouped together to form subthemes and themes. These themes were iteratively revised and edited. One focus group transcript was coded by a second researcher and agreement reached in order to ensure a consistent approach. Once coding was complete, all themes were defined and explained.

Pilot studies

Due to the nature of the investigation, pilot studies of the simulation and survey could only be held with the student cohort involved in data collection, after they had completed the simulation. For this reason, the first four students participating in the simulation were considered the pilot group. However, as there were no changes required to any of the simulation elements, the data from these participants was ultimately included in the analysis.

The focus group was piloted with five students that had participated in the simulation two days previously. Again, there was no change necessary to the focus group format or questions so their data was included in the analysis.

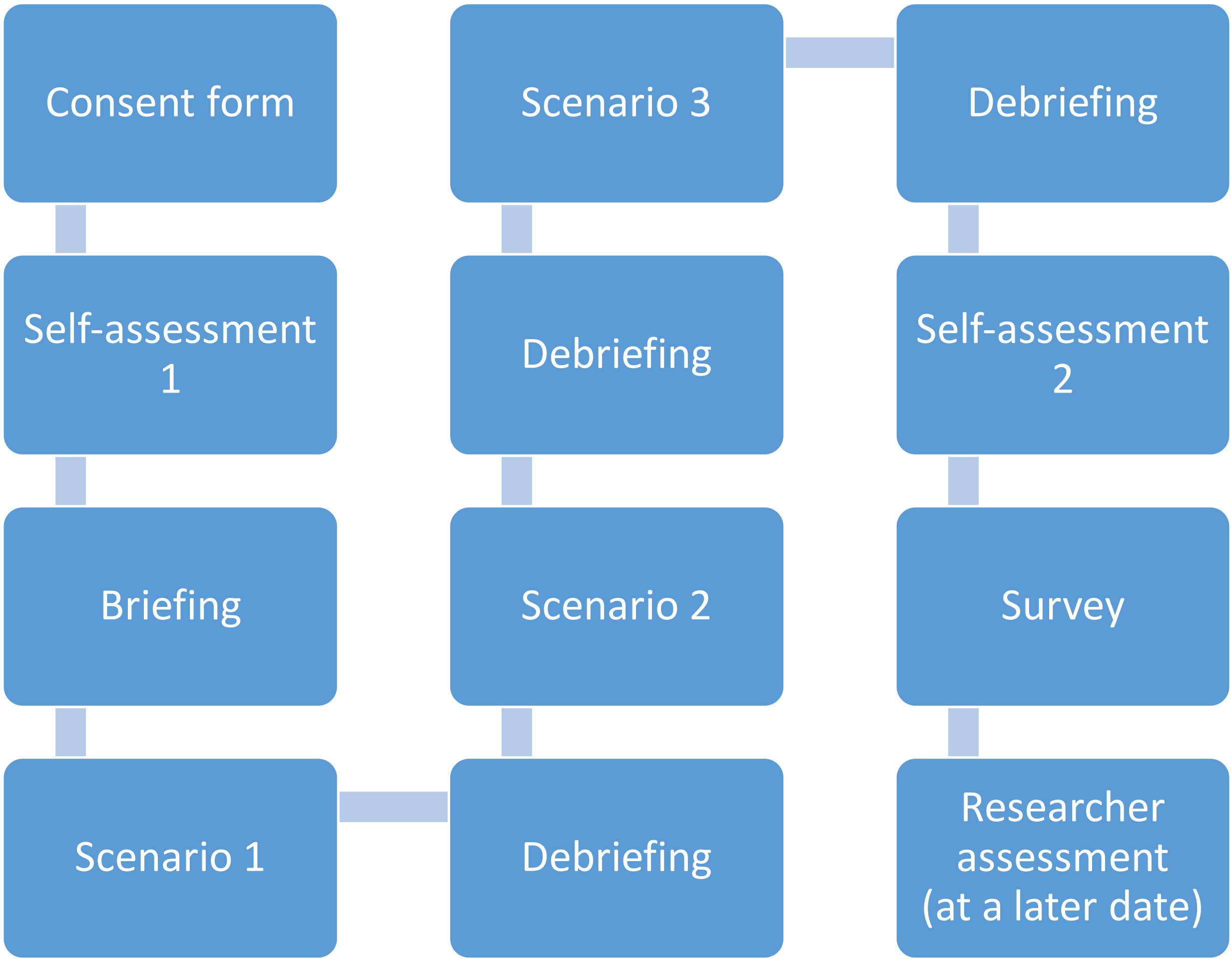

Figure 5.4 The overall simulation session process; repeated for each student

5.3 Results

This section will present the results from the student self-assessment, the researcher-assessment, the participant survey and finally the focus groups.

5.3.1 Student self-assessment

68 students took part in the simulation – 32 in group A and 36 in group B. All 68 students that participated in the simulation completed their full SA. The results of the Mann-Whitney U test to determine whether the datasets from groups A and B could be combined are shown in table 5.7. As there was a significant difference in SA improvement between the two groups on four of the mLCJR components, the cohort data was analysed separately. The mean and median values calculated for each group's improvement pre and post simulation (table 5.7) indicate that group A (early) reported a greater level of clinical reasoning improvement.

mLCJR Component	Median (mean) improvement Group A n=32	Median (mean) improvement Group B n=36	Mann-Whitney U test statistic	P Value
History taking	1.00 (0.66)	0.00 (0.29)	378.50	0.010*
Examination	1.00 (0.72)	0.00 (0.17)	314.00	0.000*
Identifying abnormalities	1.00 (0.72)	0.00 (0.43)	440.00	0.094
Prioritising data	0.00 (0.25)	0.00 (0.14)	504.50	0.415
Making sense of data	0.00 (0.34)	0.00 (0.23)	521.00	0.581
Well planned intervention	0.00 (0.59)	0.00 (0.46)	517.50	0.550
Calm, confident manner	0.00 (0.44)	0.00 (0.09)	394.00	0.016*
Clear explanations	1.00 (0.69)	0.00 (0.14)	387.50	0.013*
Total	4.00 (4.38)	2.00 (2.09)	340.50	0.006*

*Table 5.7: Median and mean improvement in self-assessment score, with results of the Mann-Whitney U test comparing the change in self-assessment score pre/post simulation between groups A and B. *P value less than 0.05 indicating statistical significance*

The next stage of analysis – identifying any statistically significant improvement in SA scores post-simulation – is shown in tables 5.8 and 5.9. Group A reported significant improvement in all components of the mLCJR ($P \leq 0.05$). Group B showed significant improvement in four out of eight components: History-taking, Identifying abnormalities, Making sense of data and Well planned intervention.

mLCJR Component	Median (mean) pre-sim score	Median (mean) post-sim score	Wilcoxon signed-ranks test statistic (Z score)	P-value
History taking	2.00 (2.47)	3.00 (3.13)	-4.36	<0.001*
Examination	2.00 (2.16)	3.00 (2.81)	-4.38	<0.001*
Identifying abnormalities	2.00 (2.03)	3.00 (2.75)	-4.23	<0.001*
Prioritising data	2.50 (2.53)	3.00 (2.78)	-2.14	0.033*
Making sense of data	2.00 (2.38)	3.00 (2.72)	-2.40	0.016*
Well planned intervention	2.00 (2.19)	3.00 (2.78)	-3.34	0.001*
Calm, confident manner	3.00 (2.59)	3.00 (3.03)	-3.13	0.002*
Clear explanations	3.00 (2.75)	3.00 (3.22)	-4.61	0.001*

*Table 5.8 Group A pre and post simulation self-assessment scores, with results of the Wilcoxon signed-ranks test to determine if the difference between pre/post-simulation self-assessment scores is statistically significant. *P-value shows a statistically signficant differnece (≤0.05)*

mLCJR Component	Median (mean) pre-sim score	Median (mean) post-sim score	Wilcoxon signed-ranks test statistic (Z score)	P-value
History taking	3.00 (2.83)	3.00 (3.11)	-2.50	<0.001*
Examination	3.00 (2.60)	3.00 (2.77)	-1.90	<0.001*
Identifying abnormalities	2.00 (2.31)	3.00 (2.74)	-3.27	<0.001*
Prioritising data	3.00 (2.63)	3.00 (2.77)	-1.51	0.033*
Making sense of data	3.00 (2.49)	3.00 (2.71)	-2.14	0.016*
Well planned intervention	2.00 (2.23)	3.00 (2.69)	-3.77	0.001*
Calm, confident manner	3.00 (2.89)	3.00 (3.97)	-1.00	0.002*
Clear explanations	3.00 (2.97)	3.00 (3.11)	-1.67	0.001*

*Table 5.9 Group B pre and post simulation self-assessment scores. Results of the Wilcoxon signed ranks test to determine if the difference between pre/post-simulation self-assessment scores is statistically significant. *P-value shows a statistically signficant differnece (≤0.05)*

Cronbach's alpha was calculated for pre and post simulation mLCJR components – shown in table 5.10. An alpha value >0.7 for both groups meant the components from the 'before' SA could be summed to a total, as could the components from the 'after' SA of each group. A Wilcoxon signed ranks test performed on these new figures determined there was a significant improvement in total score for both groups (table 5.11).

Group	Cronbach’s alpha for pre-simulation components	Cronbach’s alpha for post-simulation components
A	0.846	0.824
B	0.800	0.833

Table 5.10 Cronbach's alpha values for summing the mLCJR components to form 'before' and 'after' totals for each group

Group	Median (mean) total pre-sim score	Median (mean) total post-sim score	Wilcoxon signed-ranks test statistic (Z score)	P-value
A n=32	20.50 (21.53)	25.00 (25.91)	-4.61	<0.001*
B n=36	23.00 (23.57)	26.00 (25.66)	-3.44	0.001*

*Table 5.11 Result of Wilcoxon signed-ranks test on pre/post simulation totals for each group. *P-value shows a statistically signficant difference (≤0.05)*

The Mann-Whitney U test used to identify any significant difference in the total improvement between groups returned a test statistic of 340.00 and a significant P-value of 0.006. The corresponding median and mean averages are shown in table 5.12.

Group	Median improvement	Mean improvement
A n=32	1.00	1.88
B n=36	1.00	1.26

Table 5.12 Median and mean average improvement between pre/post-simulation total scores

5.3.2 Researcher assessment

All 136 video-recordings were suitable for researcher analysis. The two assessors reached an ICC of 0.894 after marking 10% of the video recordings, indicating 'almost perfect' inter-rater reliability (Royal and Hecker 2015, p. 3)

The result of the Mann-Whitney U test to determine if the datasets from groups A and B could be merged are shown in table 5.13. As there was no significant difference in the grading between the two groups (P≤0.05) the datasets were combined for further analysis.

mLCJR Component	Median (mean) improvement Group A n=32	Median (mean) improvement Group B n=36	Mann-Whitney U test statistic	P Value
History taking	0.00 (0.25)	0.00 (0.31)	505.50	0.365
Examination	0.00 (0.03)	0.00 (0.12)	507.00	0.351
Identifying abnormalities	0.00 (-0.06)	0.00 (-0.08)	486.00	0.210
Prioritising data	0.00 (0.16)	0.00 (0.11)	574.00	0.979
Making sense of data	0.00 (0.41)	0.00 (0.42)	557.00	0.810
Well planned intervention	0.00 (0.06)	0.00 (-0.06)	543.50	0.683
Calm, confident manner	0.00 (0.06)	0.00 (0.03)	506.00	0.370
Clear explanations	0.00 (-0.19)	0.00 (-0.17)	558.00	0.814
Total	-0.5 (-0.31)	1.5 (0.69)	503.00	0.369

Table 5.13 Median and mean improvement in researcher-assessment scores of each group, with results of the Mann-Whitney U test comparing the change in researcher-assessment score between the first and third simulations between groups A and B.

The researcher scoring of groups A and B combined are shown in table 5.14. The Wilcoxon signed-rank test results (table 5.14) show there was a statistically significant improvement in two mLCJR components: History taking and Making sense of data.

Cronbach's alpha was calculated for the first and third simulated consultation scores. The alpha value for the 'first' mLCJR components was 0.67, and the 'third' components 0.75, indicating the internal reliability was sufficient to total (table 5.14). The Wilcoxon signed ranks test showed no significant difference between total scores (table 5.14).

mLCJR Component	First consultation median (mean) score	Third consultation median (mean) score	Wilcoxon signed ranks test statistic (Z score)	P-value
History taking	2.00 (2.50)	3.00 (2.93)	-3.00	0.003*
Examination	4.00 (3.50)	4.00 (3.51)	-0.01	0.992
Identifying abnormalities	4.00 (3.75)	4.00 (3.55)	-1.57	0.116
Prioritising data	4.00 (3.60)	4.00 (3.61)	-0.12	0.906
Making sense of data	2.00 (2.75)	3.50 (3.13)	-2.16	0.031*
Well planned intervention	3.00 (2.85)	2.00 (2.84)	-0.49	0.625
Calm, confident manner	3.00 (3.13)	3.00 (3.09)	-0.41	0.684
Clear explanations	3.50 (3.38)	3.00 (3.18)	-1.90	0.058
Total	25.50 (25.47)	26.00 (25.84)	-0.50	0.619

*Table 5.14: First/third simulated consultation scores according to the researcher-assessment, with results of the Wilcoxon signed ranks test to determine if the difference between first/third consultation researcher-assessment scores is statistically significant ($P \leq 0.05$). *P-value shows a statistically signficant difference (≤ 0.05)*

To determine if any of the three cases randomly assigned to each student were significantly harder, a Kruskal-Wallis test was performed (table 5.15). The results showed the weight-loss case was statistically easier than the other two cases.

Case	Median score	Mean score	Kruskal-Wallis test P-value
Weight loss	23.00	24.21	0.012*
Diarrhoea	27.00	26.59	
Seizure	26.00	26.06	

*Table 5.15: Results of Kruskal-Wallis test comparing scores in all three cases, with the mean and the median value for each case. *P-value shows a statistically signficant difference (≤0.05)*

Table 5.16 shows the average scores and results of the Wilcoxon signed ranks test when all weight-loss case data was removed. No statistically significant improvement in student performance was found.

mLCJR Component	First consultation median (mean) score	Third consultation median (mean) score	Wilcoxon signed ranks test statistic (Z score)	P-value
History taking	2.00 (2.52)	3.00 (2.86)	-1.65	0.100
Examination	4.00 (3.62)	4.00 (3.19)	-1.39	0.17
Identifying abnormalities	4.00 (3.81)	4.00 (3.95)	-1.13	0.257
Prioritising data	4.00 (3.57)	4.00 (3.86)	-1.29	0.20
Making sense of data	2.00 (2.86)	3.00 (3.14)	-0.80	0.422
Well planned intervention	3.00 (3.00)	3.00 (2.86)	-0.49	0.624
Calm, confident manner	3.00 (3.24)	3.00 (3.00)	-0.98	0.325
Clear explanations	4.00 (3.48)	3.00 (3.10)	-1.42	0.156
Total	27.00 (26.01)	26.00 (25.95)	-0.09	0.925

*Table 5.16: First/third simulated consultation scores according to the researcher-assessment, with results of the Wilcoxon signed ranks test to determine if the difference between first/third consultation researcher-assessment scores is statistically significant ($P \leq 0.05$). *P-value shows a statistically signficant difference (≤ 0.05*

5.3.3 Construct validation

Seven expert participants took part in the validation simulation. The expert and student total average scores were compared (table 5.17). A Mann-Whitney U test showed a statistically significant difference between the expert and student performance, suggesting the mLCJR has an acceptable construct validity.

Group	Median score	Mean score	Mann-Whitney U test statistic	P-value
Student n = 41	27.00	26.59	43.00	0.003*
Expert n = 7	31.00	30.71		

*Table 5.17 Median and mean total average scores of the student and expert groups within for the acute diarrhoea case, with the results of the Mann-Whitney U test to determine if there was a significant difference between the two. *P-value shows a statistically signficant differnece (≤0.05)*

5.3.4 Survey results

All 68 simulation participants completed the survey. One participant did not answer all questions and was excluded, leaving 67 completed surveys for analysis. The results of the Mann-Whitney U test to determine if the datasets from groups A and B could be merged are shown in table 5.18. As the two groups answered nine questions significantly differently, the data from groups A and B were analysed separately. The median and mean averages (table 5.18) show group A answered all questions with a higher level of agreement than group B.

Question	Group A median (mean) score N=32	Group B median (mean) score N=35	Mann-Whitney U test statistic	P-value
The session was enjoyable	6.00 (5.53)	5.00 (5.17)	378.00	0.010*
The session was a good use of my time	6.00 (5.72)	6.00 (5.54)	463.50	0.144
I would like to participate in a session like this again	6.00 (5.69)	5.00 (5.17)	323.00	0.001*
My knowledge improved during the session	6.00 (5.53)	5.00 (4.97)	333.50	0.002*
My practical skills improved during the session	5.00 (4.72)	4.00 (4.29)	411.00	0.043*
My overall confidence in making decisions improved during the session	5.50 (5.41)	5.00 (5.03)	392.50	0.021*
My overall ability to reach a diagnosis has improved as a result of the session	5.00 (5.09)	5.00 (4.77)	420.00	0.049*
My overall ability to form a treatment plan has improved as a result of the session	5.00 (5.00)	5.00 (4.83)	491.00	0.341
I feel more prepared to undertake small animal consultations now	5.50 (5.41)	5.00 (5.20)	460.00	0.164
I found the session challenging	5.00 (5.03)	5.00 (4.61)	415.00	0.051

I found the session demoralising	1.00 (1.42)	2.00 (1.74)	405.00	0.030*
I found the session and scenarios unrealistic	1.00 (1.44)	2.00 (1.65)	429.00	0.060
I felt embarrassed participating in the session	1.00 (1.78)	2.00 (2.14)	435.50	0.092
The feedback sessions were informative	6.00 (5.87)	5.00 (5.31)	276.00	<0.001*
The feedback sessions were demoralising	1.00 (1.06)	1.00 (1.06)	338.00	<0.001*

*Table 5.18 Median and mean average ratings for each survey question, with results of Mann-Whiney U test to determine if groups A and B answered the survey differently. *P-value shows a statistically signficant difference (≤0.05)*

The percentage agreement with each question is shown in table 5.19. Both groups responded positively to the majority of statements.

Question	Group A percentage agreement	Group B percentage agreement
The session was enjoyable	100.00	100.00
The session was a good use of my time	100.00	100.00
I would like to participate in a session like this again	100.00	97.10
My knowledge improved during the session	100.00	94.30
My practical skills improved during the session	96.90	88.60

My overall confidence in making decisions improved during the session	100.00	100.00
My overall ability to reach a diagnosis has improved as a result of the session	100.00	100.00
My overall ability to form a treatment plan has improved as a result of the session	100.00	100.00
I feel more prepared to undertake small animal consultations now	100.00	100.00
I found the session challenging	96.90	97.10
I found the session demoralising	0.00	0.00
I found the session and scenarios unrealistic	6.20	2.90
I felt embarrassed participating in the session	15.60	20.00
The feedback sessions were informative	100.00	97.10
The feedback sessions were demoralising	0.00	0.00

Table 5.19 The percentage of participants that agreed (answered 4/5/6) with each survey question

Cronbach's alpha was calculated to determine if the questions of the survey could be totalled for each group. The alpha value for group A was 0.84 and for group B was 0.86 – making the internal consistency sufficient to sum to a total. The median total score for group A was 82.00 (mean 81.25) and for group B was 77.00 (mean 75.88). The Mann-Whitney U test showed a significant difference in the total agreement level between the two groups (test statistic =284.50, P=0.001).

5.3.5 Focus groups

Six overarching themes emerged from the focus group data - shown in figure 5.5. Each theme is described below, with quotes from the transcripts shown in italics to support them. Each focus group has been assigned a code; codes FG1, FG2 and FG3 represent group B participants, and FG4, FG5 and FG6 represent group A participants.

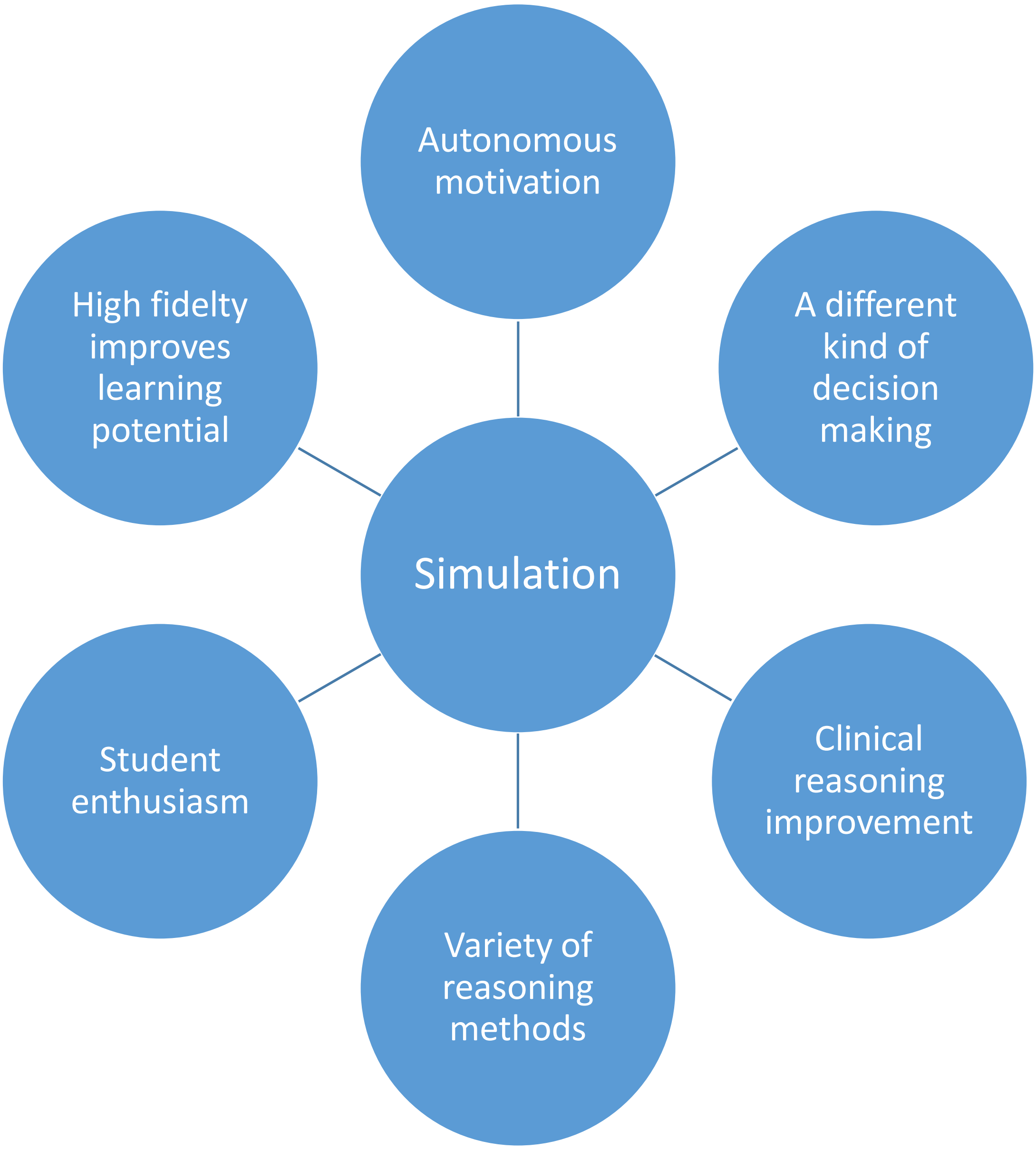

Figure 5.5 Themes that emerged from thematic analysis of the focus group data

<u>Theme one: Autonomous motivation</u>

This theme developed from the finding that students seem to be autonomously motivated to perform well during the simulation. Students were not motivated to perform well by examinations, but instead by personal goals. The first of these was the desire to perform well simply because they are used to being high achievers.

> *'I think it's all in our nature to try and want to be good at everything.' FG1*

> *'I felt like I wanted to do well because I always want to do well.' FG4*

> *'Whether it's an assessment or not, even if it doesn't reflect on my feedback, I want to do well anyway.' FG3*

Students were also very aware that the simulation represented tasks they would be performing on a daily basis once graduated, and wanted to perform well to prove to themselves they would be able to cope once in practice. They appreciated receiving positive feedback from the simulation as it reassured the students that they had the skills necessary to work as a veterinary surgeon.

> *'I'm going to be doing a lot of consulting for the next few years so I would like to try and be good at it (during the simulation).' FG1*

> *'It makes you feel good about yourself if you have been in (the simulation) and coped as we are hopefully going to be doing (the same tasks) when we are working properly in practice.' FG2*

> *'(Consultations) are what we are going to be doing all day every day in practice so I think the main driver for me (to perform well in the simulation) is that this is the career that I want, I do want to be a small animal vet, so I do want to be able to deal with these consults. So I suppose my main driver to do well was to come out of it thinking Ok I've only got a few months until I graduate and I can manage this.' FG2*

> *'If you want to be a small animal vet, which I do, this is something you're going to have to do every day…' FG5*

Thirdly, a subtheme emerged titled 'Fear of looking stupid'. Students did not want their supervising clinicians, facilitator or the actors to see them performing badly. This did not seem to relate to fear of receiving criticism or judgement, but instead was a matter of pride and self-confidence. This was suggested by the fact that students did not associate this fear with bad feedback or concern from staff but instead with embarrassment and shame.

'I suppose I didn't want to look silly in-front of (the actors)' FG2

'Unfortunately I think that (not looking stupid) was my main motivator (to perform well).' FG3

'I guess I was a bit nervous, a bit worried, about being watched.' FG2

Facilitator: 'What motivated you to perform well in the simulation?'
Student: '…not wanting to look stupid. You never want to look stupid in front of anyone. And especially being a fifth year, and now we are only a few months from graduating and consulting is one of the core skills... if it was a complete disaster, even in front of a complete lay person, it would be really embarrassing…' FG1

This fear of embarrassing themselves made students anxious about being filmed, as they felt it would create a permanent record of any mistakes made.

'I also felt quite nervous… (about) making a bit of a fool of yourself on camera' FG2

'(There would be) videographic evidence that you're rubbish!' FG3

'I was just thinking 'Oh My God they're going to film me, what if I do rubbishly? What if I can't diagnose it? What if I can't treat it?'' FG3

These three aspects – self-reassurance, avoiding embarrassment and the habit of always wanting to 'do well' were the only motivators mentioned by the students. No external motivators – such as examinations, or outside expectations – were discussed. These external factors seem to have limited effect on student desire to complete the simulation to the best of their abilities.

<u>Theme two: A different kind of reasoning</u>

During the analysis, it became clear that the clinical reasoning taking place within the simulation had many differences from other decision-making experiences students had

had in the curriculum. Three key factors were described as being novel. Firstly, the students described the simulation as being their first experience of making clinical decisions alone. They spoke of using the clinician usually present in practice consultations as a 'safety-net'; ensuring that any mistakes they make are corrected before they have consequences. Thus, they felt their decisions were always 'checked' and approved.

> *'We have never really been left to completely just make a (clinical) decision ourselves.' FG1*

> *'(In other consultations) you have got that safety net behind you… if you say 'I'm thinking about this' and they say 'Well maybe, but think about...' you have always got someone there pointing you in the right direction.' FG1*

> *'I think I was more thorough (making decisions) in the simulation because I didn't have (a clinician) looking over my shoulder who would have been like 'You have forgotten this or that'. (Having a clinician present in other consultations) was subconsciously reassuring, like a safety blanket and I didn't really feel under pressure to make any decisions and…I wasn't as thorough. But when I was on my own (in the simulation) I was like 'Right I cannot miss anything, I need to make sure I gather all the information because I'm the one making the decision', so I think it was more realistic.' FG1*

> *'(In the simulation) all the responsibility is on you – it's the first time we have properly had it all on us in a way… because you have always got a clinician as a back-up in every other case we've been doing.' FG2*

> *'I think the decision-making was what I got out of (the simulation) the most… you have to rely on your own decision, you have to put more trust in yourself.' FG3*

> *'This actually was probably like the first time I've had to like diagnose or decide on a treatment plan…' FG4*

This meant students felt responsibility for the decision they had made within the simulation. Again, they thought having a clinician present in other consultations has removed their sense of case responsibility. Being alone in the simulation helped to create the experience of having sole charge over decision-making – despite the fact the clients and patients were not real.

> *'It is completely different (in the simulation) having that responsibility over a client and a patient, saying 'Do this and I will see in you in a week or so…'.' FG1*

'(In the simulation) all the responsibility is on you – it's the first time we have properly had it all on us…' FG2

'I felt responsible (during the simulation).' FG3

'I just found it quite generally daunting taking on the consult and prime responsibility…where you did not have anyone to rely upon for the first time.' FG6

Secondly, the students were not used to being under pressure to make clinical decisions. They felt that having a client in the consultation room forced them to make decisions faster. It emerged that clinical reasoning examinations and consulting with an SVMS clinician are done at a more leisurely pace and thus the skill of thinking under pressure is not practiced.

'You have to make quite a quick decision (in the simulation)... Where I think with (clinicians) you can have a nice chat and discuss your different options and then decide which ones are sensible to go with.' FG1

'I knew what I wanted to do I just didn't have the mental space to do it in the (simulated) consult.' FG2

'(In the simulation) you have got to make the decision there and then, you haven't got time to go away and think about it…' FG3

'When you're in a consult room you've obviously got the pressure of someone else being there and you feel like, well I felt like, I didn't like any silences...' FG5

Students also commented on the different processes they use for clinical reasoning on paper (e.g. CBL, examinations) compared to within the simulation. It was suggested that thinking 'in your head' is harder than other types of clinical reasoning and thus the opportunity to practice it was valuable.

'When you are writing on paper you can write down all the different treatment options and decide from there what one you're going to pick. You haven't got time to be doing that in an actual consult you need to know what you should be doing there and then, not messing around with all the other options that might be available.' FG3

'It's a different way of thinking though, isn't it, because when you've, when you write it on paper you're working through in stages, whereas if you're in conversation you have to skip half of that stuff' FG5

'It is one thing being able to write on a piece of paper what you are thinking and sit there and look at what you have put down, but it is another thing processing it

all in your brain and your head and thinking about what you need to ask and then thinking of what other possible things it could be.' FG6

The integration of situational factors was the third aspect of clinical reasoning within the simulation that students found novel. This involved combining their decision-making skills with communication, considering the owners needs and administrative tasks.

'You are multi-tasking in the simulation because you are also thinking what am I projecting to the client? How am I going to explain it to the client? Am I being clear?' FG1

'I've never done a consent form, I've never priced up before, so that was really good to practice.' FG2

'(In the simulation) it all just clicks like 'I need to do the drugs, I need to treat it, I've only got 15 minutes, I need to get all the history and the clients still talking!' FG3

'We've never, ever had to deal with money before, we've never had to think about prices, or trade names…' FG4

'Obviously there's an ideal route but the owner isn't always going to want to, or be able to afford, the ideal route, so (the simulation) was a balancing act between those bits for me.' FG2

'On paper you could be like 'Go home on a bland diet, whatever' – but (in the simulation) there is a client, waiting, stood there, probably expecting antibiotics or something… so that's different because you have to manage client expectations.' FG3

The theme 'A different kind of decision making' identifies the fact that students are processing information differently to draw conclusions within the simulation compared to CBL, examinations and clinician consultations. They are learning to think in different way to cope with the time pressures and multi-tasking required during a consultation.

Theme three: Clinical reasoning improvement

This theme arose from the comments of students that felt their clinical reasoning skills had improved during the simulation.

'…and the improvement you saw in just three (simulated) consults. You were like 'Oh hold on if I was a new grad, in my first day I would have improved massively from my first consult'. That was quite reassuring.' FG2

'We all felt like we had massively improved, like the difference between the first and last (simulated) consult...' FG2

'I feel that (the simulation) has prepared me and I've improved.' FG5

'I felt like I improved as the consults went on.' FG2

This was evident not only in outright claims, but also in discussion about what had been learnt. Students demonstrated insight into the clinical reasoning process and their own strength and weakness.

'I don't know necessarily how important it was to get a diagnosis just from those consults. If (diarrhoea) resolves after bland feeding or giving a bit of Prokolin, did the diagnosis really actually matter that much?' FG1

'(the simulation) highlighted that I need to be more decisive and get my point across. In my head I know what I want to say but then I didn't want to force my opinion on the client too much, but I guess part of the job is having to do that in some cases.' FG2

'I know that it's really important that we get to the right answer and we go down the right diagnostic route but in a situation like that it's important to take into consideration what the client is hoping to get out of it. And it doesn't mean you should necessarily give them whatever they want but you do have to react to them.' FG2

Many students reported their confidence in clinical decision-making and overall ability to work as a veterinary surgeon increased due to the simulation.

'I think (the simulation) improved my confidence because I walked in thinking I'm not going to know what to do... and I walked out thinking I did know what to do.' FG1

'I think what I got out of (the simulation) mostly was that I worked out that I am capable (consulting). Whereas before I had done (the simulation) I was fairly certain that I was not good enough to do it.' FG6

'I do not think you will ever feel confident (making clinical decisions) in real life unless you have practiced it like we did.' FG6

'(The simulation) gives you the confidence to realise that you are not rubbish…' FG6

Overall, it appears that the simulation had a positive impact in the clinical reasoning development of the students. Additionally, their confidence in using the skill in practice has increased.

Theme four: Variety of reasoning methods

When questioned about how they made decisions during the simulation, students described a variety of methods. This included using hypotheticodeductive and pattern-recognition strategies. Extending their description of the system two reasoning used, students discussed copying decisions they had seen being made during CEMS when a similar case presented.

> *'I felt like I always had some idea right from the start right from seeing the patient.' FG2*
>
> *'Sometimes I find it hard to explain how I came up with the solution, sometimes it does just ping there like 'Oh I think this is what I should do'.' FG3*
>
> *'My brain doesn't just go like (Snap) 'Yeah Cushing's' or whatever… it always takes me a longer time for some reason.' FG4*
>
> *'I think a lot of (my clinical reasoning) is what I've seen on EMS.' FG1*
>
> *'When you are under pressure to make a decision I just think about what I've seen other people do.' FG1*

It was also clear from the data that there was a degree of case specificity affecting the ability to make clinical decisions. Students disagreed on which case was most complicated, and their opinions generally reflected their level of knowledge about each pathology.

> *'I felt that the one consult that I did better in was the one that I knew more about and you felt more comfortable with.' FG5*
>
> *'If you've got the knowledge, I think (clinical reasoning) is so much easier.' FG5*

These findings increase our understanding of how novice veterinary surgeons make clinical decisions, and the role of knowledge in that process.

Theme five: Student enthusiasm

All of the focus group participants were incredibly positive about the simulation session. Despite initial nerves, the students unanimously enjoyed taking part, as well recognising the benefits of the session.

> *'(The simulation) is genuinely a really positive experience.' FG3*
>
> *'I really loved (the simulation), it was really good to do…' FG4*
>
> *'I really enjoyed (the simulation).' FG4*

Students also recommended using the simulation to examine clinical reasoning ability, as they felt it was a more accurate representation of their skill level than a written exam.

> *'I think (the simulation) is a better way of testing clinical reasoning than written exams.' FG3*
>
> *'I would rather do (the simulation) than do my (written) clinical reasoning exam at the end of the year.' FG1*

The students were very keen for more opportunities to take part in the simulation session. They felt that completing the simulation at both the start and end of the final year of the SVMS course would allow them to track their progress in clinical decision-making.

> *'More opportunity to do (the simulation), whenever it was available, would be good.' FG2*
>
> *'If we could have the opportunity to do (a simulated consultation) once a module or something… it's a shame it's just those three (consultations) because it's actually a really good way to learn, I think.' FG5*
>
> *'To be able to do (a simulated consultation) well and to get feedback on that is probably more important than other things that we've had (in the SVMS curriculum).' FG5*
>
> *'I think we should have more than one (simulation session), so you could see the improvement. Say one at the beginning of the year and one towards the end of the year. You could see how much you have improved throughout the year and if your decision making has improved.' FG3*

Overall, the simulation appears to have the complete support of the students. It is educational, but also enjoyable and the direct relevance of the session is clear to students.

Theme six: High fidelity improves learning potential

The last theme emerged from the comments of students regarding the fidelity of the simulation. There were unique aspects of the simulation design that students felt improved the realism of the consultation and decisions made. These included being in a genuine veterinary practice, not being directly observed and the case design.

> *'You're in the setting and you're going to get a client from the waiting room which makes it all very real.' FG5*
>
> *'It was better to be filmed than to have someone watching (the simulated consultation).' FG4*
>
> *'I think these (simulated cases) were good because you were making decisions whether you were sending the animal home or not and that is something you are really going to be faced with (in practice)…' FG1*

However, students also noticed lapses in fidelity, which affected their performance within the consultations. Their main concern was that the animals used did not have a genuine pathology, which they felt reminded them the consultation was not real. A few students, who knew the postgraduate actors from personal circumstances outside the SVMS, commented on the realism lost when the client is recognised as false.

> *'I feel like if it had been a real dog with a real problem, my clinical exam would have been a bit more thorough. But I was like 'I know this dog has not got diarrhoea, I know this dog is not seizing' FG3*
>
> *'So it's all going well until you do the clinical examination and then it's like 'It's not real, is it?'… You are like 'This dog's fine, but let's just keep on pretending'.' FG6*
>
> *'I found the simulation with the second actor more realistic just because I recognised (the first actor)… It just felt less real because I recognised her.' FG1*

This theme demonstrates the value of a high fidelity environment during a simulation, particularly when aiming to develop clinical reasoning ability. Students appear to become fully immersed in the realism of the SC simulation, but this can be broken by anything slightly fraudulent.

5.4 Discussion

This study has investigated the use of standardised clients for the development of clinical reasoning in veterinary students. It was found that SC simulation can significantly increase student self-assessed clinical reasoning ability and confidence. However, researcher-assessed parameters only improved in two areas – history taking and making sense of data – showing objective measurement does not correlate with student impressions. The instrument used for scoring – the mLCJR – was shown to have acceptable construct validity and inter-rater reliability. Students responded very positively to the simulation in their survey feedback and found the debriefing particularly beneficial to their learning. Focus group analysis showed that motivation to perform well in simulated consultations was autonomous, and the way that students make decisions in stressful circumstances may be different to the processes used when they feel less pressured. The focus group findings also supported the student-reported improvement and enjoyment of the SC simulation.

This section will discuss the most important findings from the study, attempting to integrate them with the current literature.

5.4.1 The modified Lasater Clinical Judgement Rubric as a tool for evaluating clinical reasoning during simulation

The LCJR has been validated in many studies previously (Lasater 2007b, Blum et al. 2010, Adamson et al. 2012, Jensen 2013, Shin et al. 2015). As modifications were made to the LCJR to make it suitable for a veterinary context, the rubric needed to be reassessed for validity and reliability. There was a lack of clear guidance in the literature on how to conduct this analysis, so the methods were adapted from other studies examining the use of a grading rubric (Morgan 2004, Adamson et al. 2012). Intraclass correlation (ICC) was chosen to assess interrater reliability (IRR) as it is accounts for the two-direction disagreement possible in ordinal data (Petrie and Sabin 2009). The IRR of the mLCJR was very high (0.894). This corresponds with the findings of other studies; for example Adamson et al. (2012) found an ICC of 0.889 when six video-recorded nursing simulations were scored by 29 raters using the LCJR.

Construct validity was measured by testing the ability of the mLCJR to differentiate between novice and expert. As a significant difference was found between students and veterinary surgeons in this study (P=0.003) it appears that the mLCJR has sufficient validity. Again, this mirrors the findings of two separate researchers assessing the LCJR previously (Adamson et al. 2012). Due to time constraints of both the project and SVMS staff, only seven experts (10% of the student sample number) took part in a simulation. In addition, as there was such a clear physical difference between the student and staff participant, the videos were unable to be blinded. This may limit the strength of conclusions drawn from the validity calculations. If repeated a larger sample of expert clinicians would be used and, if possible, a researcher from outside of the SVMS would grade the videos.

In summary, the mLCJR showed excellent reliability and acceptable validity when used to grade SC simulations via video recording.

5.4.2 The effect of standardised client simulation on clinical reasoning development

The results are from this study are somewhat incongruous. Whilst students report an increase in skill level and confidence, the objectively measured RA only partially supports this. However, overall it appears that SC simulation is effective at developing clinical reasoning confidence and, to a lesser extent, skill.

On the SA, group A showed a statistically significant improvement in all component of the mLCJR and group B showed improvement in four out of eight components. Those that group B marked as improved included key aspects of decision-making: Identifying abnormalities, Making sense of data and formulating a Well-planned intervention. The totalised pre/post-simulation SA scores were also significantly improved for both groups. The results of the survey triangulate the SA findings, with 100% students believing the session improved their decision-making confidence, ability to reach a diagnosis and ability to form a treatment plan. In further support of these findings are the themes of 'Clinical reasoning improvement' and 'Student enthusiasm' identified during the focus group analysis. These three methods of data collection all reinforce the conclusion that SC simulation can be used to teach clinical reasoning. However, they all involve self-reported data. As discussed in the literature review within this chapter, there is debate on the validity of student self-assessment. Using triangulation within this study aimed to minimise the effect of subjectivity, however it is unknown to what degree this occurred.

The RA showed improvement in only two of the components of the mLCJR – history taking and making sense of data. The latter of these focuses on the formation of differential diagnoses, arguably a key aspect of clinical reasoning and one the session aimed to improve. The former, history taking, is a skill that students practice at the SVMS from year one. For this reason, the fifth year students involved in the simulation were already expected to be proficient in it. One explanation for the noticeable improvement in history taking may be that the task actually requires the formation of differential diagnosis in order to ask the necessary question to rule each in/out. Although students have practiced the communicatory tasks of history taking previously, they have had limited opportunities to combine this with a diagnostic task. This theory is supported by the work of Nendaz et al. (2000). They found that the diagnostic accuracy of students, residents and practitioners all decreased when only a 'chief complaint' was provided and further data collection was required, opposed to a full clinical vignette. The authors discovered the reason behind poor performance with chief complaint scenarios was the failure to gather sufficient information during the history taking process, despite being given (when asked) more information than the vignettes provided. The authors conclude that the teaching of history taking should be integrated with reasoning tasks, so that students practice using the two in conjunction and thus are able to apply this model when in practice. If extrapolated to veterinary medicine, this theory could explain the improvement in history taking, despite it not being a focus of the simulation; i.e. by reviewing the formation of differential diagnoses during the debriefing, the ability to structure data gathering also improved. In an investigation of the structure of veterinary consultations, Everitt (2011) found that the history taking process was interweaved with the physical examination – suggesting that the former is used to inform the latter and vice versa. This theory further supports the increase in history taking ability being an indicator of clinical reasoning improvement.

The SA and RA do not appear to agree on the level of development during the simulation. One possibility is that students have over-estimated their improvement, or simply gained confidence but not measurable skill. A second possibility is that case specificity affected the student's objective skill level between cases. Case specificity was first noted by Elstein et al. (1978) when they observed that the diagnostic ability of a physician varied – scoring well on one case examination was not an indicator of future performance. The implication of this was that knowledge plays a role in clinical reasoning; it is not simply a generalisable skill as previously thought (Wimmers and Fung 2008). Further research has shown that actually a combination of knowledge and general problem-solving ability is needed for successful reasoning (Norman et al. 2006, Wimmers and Fung 2008, Dory et al. 2010), however no studies exclude the need for domain specific knowledge. If this theory is applied to this study, a student that had greater knowledge about idiopathic epilepsy would be more likely to perform well during that case simulation, regardless whether it was their first or last consultation. If their knowledge of acute diarrhoea and weight loss causes was significantly lower, any reasoning skill development might become negligible. The focus group theme 'Variety of reasoning methods' highlights several comments made by students that imply their case knowledge affected their performance in the simulation, supporting the theory of case specificity.

As the students in this study were provided with a case list several days prior to the simulation it was expected they would research the topics, thus reducing the effect of subject-specific knowledge. However, whether or not the students did partake in revision was not measured and so it is difficult to estimate the influence of case specificity. As this study used four methods to evaluate the simulation, and all but the RA strongly suggest the simulation was successful, it is likely that case specificity has influenced the objective measurement of clinical reasoning development. If this study were to be repeated, providing reading material or a lecture on the topics to be addressed in the forthcoming consultations would help to reduce case specificity. There would always be, however, the effect of personal experience on knowledge and decision-making that would case some degree of bias.

One further factor may have contributed to the difference between the RA and SA score improvement. Three components of the mLCJR – Examination, Identifying abnormalities and Prioritising data – had a RA 'first consultation' median score of four; the highest possible mark. This means that it was not possible for students to improve in those areas (in a way that was recognisable on the mLCJR). It is likely that this arose due to a mismatch between student ability and simulated consultation difficulty. In future work, increasing the difficulty of the cases could reduce this effect. As it may not be possible to manipulate the physical examination task, this component might need to be removed from the mLCJR.

5.4.3 Differences between the research groups

Group A (early) reported a significantly larger degree of improvement than group B (late) during the SA within four categories: History taking, examination, calm confident manner and clear explanation. It can be argued that these four components of the mLCJR are covered well in the SVMS curriculum – particularly in the final year of the course, when students are required to interact with clients and examine animals regularly. The fact that group B did not improve as much in these four categories as group A suggests that teaching and repetitive practice in fifth year improves their ability in these areas to a level at which they are proficient by the time the simulation was conducted. The remaining components - identifying abnormalities, prioritising data, making sense of data and forming a well-planned intervention – represent key mental tasks during clinical decision-making. These components showed the same increase within both group A and B, suggesting that there is little improvement in ability during fifth year. Overall, this demonstrates that some components of clinical reasoning are being developed by the SVMS curriculum, but essential mental processes are remaining unchanged throughout.

This difference is not mirrored in the RA results, in which both groups of students performed equally. There are several possible explanations for this. Firstly, group B students might be overestimating their communication and examination ability in the SA. However, we know from previous research that overestimation and lower levels of skill are correlated (Colthart et al. 2008) – which would imply that group A should be more likely to overrate their scores. This makes the second possibility, that group A underrated themselves less likely also. Thirdly, the RA results may be inaccurate due to case specificity – as discussed above.

There was a significant difference between the median response of groups A and B on nine out of fifteen survey questions. There appears to be no pattern to this distribution, except that group A have a higher mean rating (or inverse mean rating) on all questions.

This difference in opinion in the survey was not replicated in the focus group investigation – where the opinions of all students were remarkably cohesive. The total agreement level of group A was also significantly higher than group B. It appears that group A both enjoyed the simulation more and felt a greater benefit than group B.

Combined, these results suggest that that a SC simulation is most beneficial for students at the start of a WBL course, rather than towards the end. However, clinical reasoning is still improved if students partake in the simulation later in the course. In fact, the majority of the effect is retained, with communication and examination technique development being the main difference.

5.4.4 Implications for clinical reasoning

Several themes emerged from the focus group analysis that have implications for the understanding of clinical reasoning. The first of these is 'A different kind of decision making'. Students claimed their clinical reasoning process was different when in a simulation, compared to consultations with clinicians, CBL or exams. This has important consequences for how clinical reasoning is taught, as the simulation closely resembles the day-to-day work of a veterinary surgeon. Students described the pressure of making decisions quickly within the simulation as something new that they have not experienced elsewhere; a way of reasoning that required different thought processes than they were used to. It is known that stress affects human decision-making – increasing the amount of risk-taking behaviour observed (Starcke and Brand 2012). In these circumstances, subjects use heuristics more frequently (Keinan 1987). Studies of veterinary surgeons have shown that they suffer greater levels of stress than the general population, especially those recently graduated (Gardner and Hini 2006, Bartram et al. 2009). The combination of these two factors – high stress in veterinary surgeons and the impact of stress on decision-making – suggests educators need to be giving students opportunity to practice clinical reasoning under pressure. If the process of reasoning is different when time is not limited, then efforts to develop clinical reasoning in relaxed settings will not prepare students for making decisions in the real world. Simulation is known for causing stress in students – generally perceived as a negative consequence (Lasater 2007a, DeCarlo et al. 2008). However, this 'side-effect' of simulation-based education could be utilized for the students benefit. The timing of such an intervention would be critical – subjecting a student to decision-making under pressure before they are capable would only damage their confidence. But, for a student already competent at clinical reasoning in the classroom and clinic, simulation may provide the last key situation in which to master their skill.

Another major finding of this theme is that the simulation experience was the first time students had felt fully responsible for their own clinical decisions. Even when they are given opportunities to make decisions within WBL consultations, the students report a sense of security from the clinician present that prevents them from emotionally investing in their decision. The same problem has been reported in medicine, where the 'simplistic' approach to teaching clinical reasoning generates a 'sterile academic environment which avoids feelings of responsibility for any morbidity or mortality experienced by the patient as a consequence of making an inappropriate diagnosis' (Patel et al. 2014, p. 213). Again, the effect of diminished responsibility is that students practice a cosseted form of clinical reasoning that is not fully representative of the skill they will need to use in practice. Thus, when they graduate, they are underprepared. This is supported by the findings of Tomlin et al. (2010) who investigated UK veterinary students' understanding of and concerns regarding their future career. One of the biggest fears about entering practice reported was 'being responsible for clinical decisions'. As the researchers noted the same worry in both entry and exit levels students, they concluded that 'the undergraduate course has done nothing to alleviate (the concern)' (P.784). The authors do not provide recommendations for overcoming this, but this study implies that simulation could be used to provide practice of 'feeling responsible'.

Student participants found situated decision-making another new challenge. They found incorporating owner factors particularly novel, alongside the need for multi-tasking. This probably results from the isolated nature of other clinical reasoning experiences - normally students make clinical decisions in an artificial environment where their only task is to get the correct answer. This allows them to focus all their concentration on the decision-making process, which is not often possible in reality. On top of this, students rarely complete clinical notes, prescribe and dispense drugs or calculate costs when participating in real consultations during WBL. These are all routinely carried out by veterinary surgeons and form 'distractors' that interfere with clinical reasoning, however students rarely practice incorporating them into decision-making. Several studies have shown that contextual factors impact clinical decision-making (Durning et al. 2011, 2012, Sibbald et al. 2011), meaning teaching students to recognize and respond to these distractors is important. Again, students cited the SC simulation as an effective way to develop multi-tasking ability.

Another theme to arise from the focus groups was 'Variety of reasoning methods'. This developed from discussing with the students how they made decisions within the simulation. There were various methods described, including system one, system two and dual process reasoning. This is not surprising, as Coderre et al. (2003) not only showed that both hypotheticodeductive and pattern recognition methods were used by students, but also that diagnostic accuracy was significantly higher when using pattern-recognition. A later study by Ark et al. (2006) found that students using dual process reasoning were most diagnostically successful. This has implication for veterinary education, as it indicated that system one reasoning should not be discouraged and that students should be aware of dual process reasoning so that they may utilise it correctly.

All the components of clinical reasoning development discussed here are elements within situativity theory. Situativity theory actually encompasses several other learning theories that are grouped to form a perspective on learning. The overall premise is that thinking and learning reside within experiences (Durning and Artino 2011). It emphasises the importance of the physical environment, the social environment and the cultural environment in which learning takes places. In opposition to information processing theory (IPT), situativity theory argues that separating knowledge and situation is impossible – that one is routed in the other. For that reason, all learning should occur in context. Durning & Artino (2011) compare the conceptualisation of IPT as 'the world inside the head' to the situativity theory view of 'the head inside the world' (P.189).

Situativity theory was used by Patel et al. (2014) to develop recommendations for teaching decision-making to medical students. They place importance on creating a genuine experience of clinical reasoning that replicates the tasks required in practice. Key elements of this include fostering patient responsibility, promoting dual process reasoning, preserving the complexity of 'real-world' clinical problems and encouraging metacognition. Also important is giving students opportunity to practice managing uncertainty, information overload, anxiety and stress. Patel et al. (2014) propose use of this model, alongside traditional teaching techniques, to develop a holistic decision-making ability in medical students. This has clear implications for veterinary education – as the clinical reasoning process is extremely similar to that used by physicians. The negatives of de-contextualised decision-making, discussed above in the context of this study, are almost identical to the 'limitations of current approaches' (p.213) Patel et al. (2014) identify in medical clinical reasoning education. This suggests that not only should veterinary educators be incorporating situativity theory into their teaching, but that SC simulation is an effective way of doing that.

It is clear from this study that the clinical reasoning process varies depending on context and is inseparable from the situation in which it occurs. Therefore, educators should be aiming to recreate the situational factors that occur in the 'real-world' when teaching clinical decision-making.

5.4.5 Implications for standardised client simulation

The focus group analysis provided insight into the motivation for students to perform well during a SC simulation. The three key motivators reported by students were self-reassurance, fear of embarrassment and the desire to always perform well. Notably, the common educational motivator of examinations was not discussed (Mann 1999) – despite the fact that SVMS students take part in a 'clinical reasoning examination' at the end of the final year of study. The reason for this this may be that students do not consider the simulation practice for these examinations, either because the simulation does not teach decision-making or the examination does not test it. The challenges associated with examining clinical reasoning were discussed in Chapter Two.

The motivators described by the students fall mostly within the autonomous category of motivation. Williams et al. (1999, p.993) defines autonomous motivation as 'personally endorsed and reflects what people find interesting or important'. This means students are forming their motivation internally, rather than being pressured from an external source e.g. examinations. Ryan & Deci (2000) use Self-Determination Theory to describe how the 'perceived locus of causality' (PLOC) affects the autonomy associated with a motivation and thus the students approach to learning. To transfer a PLOC from an external to internal source, the process of internalization must occur. The 'always want to do well' and 'motivated by job' subthemes highlight the fact that these high-achieving students have internalized their PLOC and integrated their motivation into other aspects of their self; so it becomes an element of their personality (Ryan and Deci 2000b). The participants' fear of embarrassment also shows a degree of internalization, although there may still be some external drive originating from the judgment of others. Ryan & Deci (2000) use the term 'identification regulation' to describe motivators causing partial internalization and thus semi-autonomous motivation.

Autonomous motivation has been shown to have beneficial outcomes in many fields, including medical education. Williams et al. (1999) quote a large bank of literature demonstrating the advantages of autonomous motivation, but all research was focused on children and thus the implication for higher education are unclear. However, two studies have been performed on medical students – firstly, Roth et al. (2007) investigated the effect of autonomy supportiveness of instruction on medical students when learning to interview patients. They found that students who were taught in this way felt more competent at interviewing and developed a deeper consideration of the psychosocial needs of the patient. A second study performed on 297 medical students found a positive correlation between degree of autonomous motivation and both academic achievement in examinations and level of metacognition (Sobral 2004). Clearly, this source of motivation is a valuable one, and the fact that SC simulation can trigger this suggests an effective teaching model. Several authors encourage the use of autonomy supportive teaching methods within medical curricula (Williams et al. 1999, Sobral 2004, Roth et al. 2007) – simulation may be an effective way to ingrate this at the SVMS and other veterinary schools.

5.4.6 Limitations

This study aimed to increase the reliability of the results by using four methods of data collection to triangulate results. This proved largely successful, as the majority of the data correlated. However, the RA results do not align completely with the SA, survey and focus group results. As discussed, this is most likely a result of case specificity – however this still presents the biggest limitation of this study. If the study were repeated or extended, the case specificity could be reduced by increasing the number of cases each student completes, therefore compensating for inter-case variance.

Another concern within this study is the consistency of the clinical cases used. When comparing the difficulty of the three cases, the weight loss scenario appeared to be disproportionately hard. As the order of the three cases was randomised (and therefore some students were not graded on their performance on the weight-loss case) the effect of the bias on the RA was evaluated. This suggested that there was no improvement in any of the mLCJR components or total score during the simulation. However, this finding is also limited as the removal of weight-loss case data reduced the sample size to 21 students. This is too small to draw any firm conclusions. The effect of the case bias, coupled with the problem of case specificity, make it difficult to make recommendations based on the RA data.

An objective scoring of student clinical reasoning improvement was performed to compensate for the limitations of self-reported data. As highlighted, the validity of the RA data is reduced, meaning the limitations of self-reported data need to be considered. These relate to the confines of introspection, and the ability to understand one's own subconscious decision-making process. Again, the use of triangulation minimizes the effect of any inaccuracy, but does not eliminate it.

Disagreement within the literature regarding the best way to measure clinical reasoning ability led to the selection of the LCJR to grade the simulation. Concerns about the use of an instrument designed for a different profession were reduced by the measurement of IRR and construct validity. The positive results of these tests are limited by the small sample sizes used – both representing 10% of the student sample size. Increasing this number would make the reliability and validity findings more robust. Additionally, it was not possible to blind the marking of the expert group for validation purposes, which reduces the accuracy of the claim of validity. Further work could include an in-depth investigation of the mLCJR as a method of evaluating clinical reasoning ability in veterinary simulation, even assessing its potential as an examination rubric. This was not within the aims of the current study, but may prove beneficial to the field of veterinary education.

5.5 Chapter summary

This study has shown that standardised client simulation can be used to increase student confidence in clinical reasoning ability. It also provides opportunity for situated learning; allowing practice of multi-tasking, coping with stress and being responsible for clinical outcomes. There is some evidence that simulation objectively improves some aspects of clinical reasoning, including differential diagnosis formation. However, further work needs to be done to clarify this. Importantly, this study highlights the differences between the decision-making students practice during their time in education, and the decision-making they will use once working in practice. This has implications for veterinary education both nationally and internationally.

The next chapter in this thesis will present the final study, which aimed to improve the visibility of the clinical reasoning process used by clinicians during CEMS.

Chapter 6 'Decision Diaries' – stimulating conversation about clinical reasoning during extramural studies

Chapter Four (An investigation into the development of clinical reasoning) identified a discrepancy in opinion regarding clinical extramural studies (CEMS). Whilst some participants cited CEMS as one of the key areas of clinical reasoning development within the SVMS curriculum, others disagreed. Several students, staff and graduates felt that CEMS was not achieving its potential. The study discussion proposed that the implicit nature of clinical reasoning within the CEMS learning objectives, and the inaccessibility of the supervising clinicians' thought process when making clinical decisions, were responsible for this.

The study presented within this chapter aimed to address these problems. It did so by creating a tool to stimulate conversation between students and veterinary surgeons about the decision-making process. It was hoped that by providing students with a clinical reasoning focussed communication task, it would also raise their awareness of clinical reasoning during CEMS and encourage reflection on the decision-making processes used.

The chapter begins with a review of the relevant literature, followed by a description of the study methods and results. Lastly, the research findings are interpreted and future research questions are posed.

6.1 Literature review

The section will review research examining work-based learning, extramural studies and reflection. These three topics play important roles in the design and implementation of the current study.

6.1.1 Work-based learning

Work-based learning (WBL) is a term applied to a multiplicity of ways to learn within a working environment, normally involving a placement within a workplace (Raelin 1997). Work-based learning takes two forms at UK veterinary schools: intramural and extramural. Intramural studies are based within the university or associated veterinary practices, extramural studies are external to these. These two variations provide very different learning experiences, demonstrated in table 6.1, but have been found to complement each other as learning methods (Magnier et al. 2011).

	Intramural studies	Extramural studies
Location	Within University or associated practices	External to the university
Organised by	University	Student
Most common case type	Referral	First-opinion
Student case responsibility	High	Low
Case volume	Medium	High
Teaching experience of staff	High	Low
Number of students competing for clinical task/cases	High	Low

Table 6.1 Comparison of Intramural and extramural studies (Hubbell 2008, Bell et al. 2010)

Learning during work-based learning

Educational theories can be used to understand the process of learning within WBL. Experiential Learning is a cognitivist educational theory that provides an outline for effectively learning from practical experience – the aim of students' during WBL (Kolb 1984). Experiential Learning theory was discussed in Chapter Five; it is relevant to both the contexts of simulation and WBL as the former is trying to replicate the latter. In contrast to this cognitive conception of learning, are socio-cultural theories of learning. It has been argued that socio-cultural perspectives are more suited to understand situations where students are learning in complex social environments, such as WBL (Swanwick 2013). This group of learning theories include Social Cognitive Theory and Social Constructivism. However, Situated Learning Theory has the most direct application to WBL, due to the focus on skill development as part of a community. The next subsection will address this theory in detail.

6.1.2 Situated Learning Theory

Situated Learning Theory, developed by Lave and Wenger (Lave and Wenger 1991), attempts to frame learning in sociocultural terms. The main premise is that learning is contextually bound, and that the people within that context provide a key role in development. Lave and Wenger named these populated contexts 'Communities of practice'. A community of practice forms around the tasks that make up the 'practice' – with all members sharing common aims and resources. The social hierarchy is based on skill level – with those in charge usually the most experienced. A veterinary surgery can be used as an example of a community of practice: everyone that works within the surgery (the community members) are practicing veterinary medicine to some degree using the same resources. At the centre of the community is the Senior Partner – a vet with considerable experience that takes the role of leader. Radiating out from the senior partner may be the veterinary assistants, then veterinary nurses, animal care assistants and finally receptionists. Trainees, in this case veterinary students, reside at the periphery of the community – shown in figure 6.1.

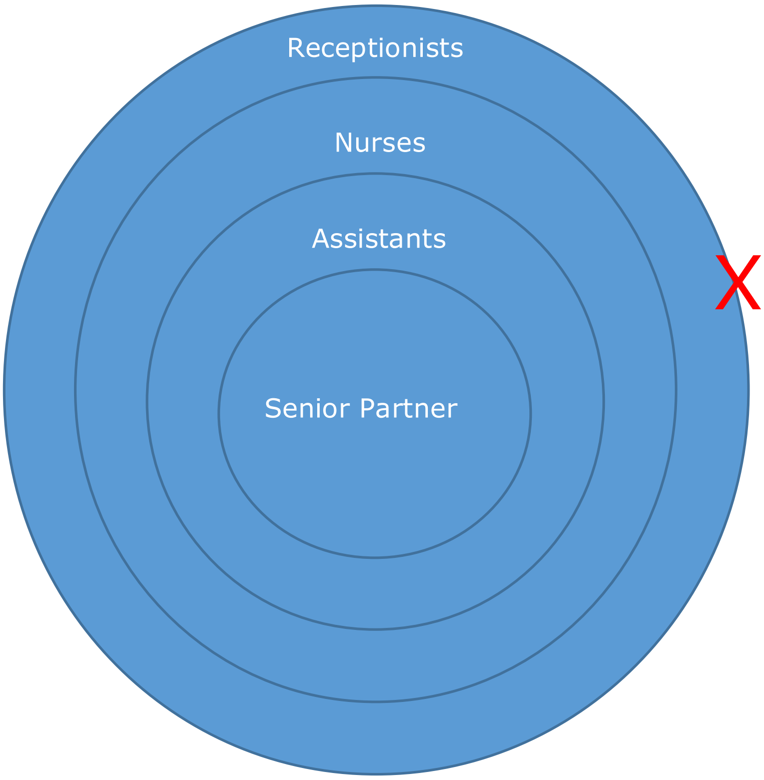

Figure 6.1 A diagram of the veterinary surgery as a community of practice. The senior partner is at the centre of the community, followed by assistant veterinary surgeons, veterinary nurses and finally receptionists. The X represents the position of veterinary students at the periphery of the community. The student will progress towards the centre with increasing experience.

Lave and Wenger use the term 'Legitimate peripheral participation' to describe the learning of students within a community of practice. The word 'legitimate' refers to the purposeful nature of the activities they engage in, but it is termed 'peripheral' as the work performed by the student is generally not essential to the community of practice (Lave and Wenger 1991, Scholz et al. 2013). Students gradually work their way to the centre of the community through development and interaction with members over varying lengths of time. The aim of those tasked with teaching is to provide students with opportunities to participate in activities and maximise their involvement in the community. However, informal learning is critical to learning within communities of practice and it has been found that the 'teachers' are not necessarily those designated for that role e.g. supervisors (Boud and Middleton 2003).

There have been criticisms of Situated Learning Theory. These include the oversimplification of relationships between participants – particularly those on the periphery with those in the centre. Also, the authors oscillation between describing the theory as the 'actual' and an 'ideal' learning structure causes confusion (as it can only be one or the other) (Hughes et al. 2013). Billett (2002) argues that the variable accessibility of learning opportunities within the workplace are not considered by Situated Learning Theory; thus, the inconsistency of student experience is overlooked. Anderson et al. (2011) dispute the totalitarian nature of the claims – instead suggesting that *some* learning is optimised when situated, but not all. In practice, there have been very few studies that investigate the validity of concepts within Situated Learning Theory (Swanwick 2013), except of those of Lave and Wenger themselves.

The implication of Situated Learning Theory is that communication and participation are key elements of the learning process – meaning a CEMS placement lacking these features may result in limited development. It also suggests that the role of teacher within these contexts is diverse (Scholz et al. 2013) – practitioner, mentor, facilitator, evaluator – which provides a formidable challenge to CEMS providers with minimal, if any, educational practice.

6.1.3 Reflective practice

Sandars (2009) defines reflection as 'a metacognitive process that creates a greater understanding of both the self and situation so that future action can be informed by this understanding' (p.685). It involves looking inwards and evaluating situations and performance in order to learn from actions. Reflective ability has become a requirement of both medical (Sandars 2009) and veterinary curricula (RCVS 2014a) and is used within this study to encourage students to evaluate the clinical reasoning of practitioners.

Originally described by Dewey (1933) the process of reflection has now been investigated by several authors. Summaries of three key theories of reflection are shown in table 6.2. Common factors exist between the majority of models of reflection – these include the process being iterative, the trigger being a disruption to usual activities, a self-directed critical analysis taking place and the integration into previous knowledge being vital (Atkins and Murphy 1993, Mann et al. 2009, Swanwick 2013).

Type	**Model**	**Description**
Explains the process of reflection	Schon 1987	Most clinicians reside within a knowledge 'comfort zone'. When they are surprised by a problem they cannot answer they engage in reflection-in-action, experimentation and reflection-on-action
	Boud 1985	After the 'experience' stage, subjects return to the experience and re-evaluate it whilst considering their feelings about the situation. Finally, through this reflection, outcomes are generated that may lead to change in behaviour.
Explains the hierarchy of reflection	Boud 1985	The return-to-experience phase is split into four stages, each of increasing difficulty: 1. Association – linking new information to that already know 2. Integration – searching for relationships between the data 3. Validation – assessing the authenticity of the insights gained 4. Appropriation – making the knowledge part of the self
	Moon 1999	Reflection changes surface learning to deep learning. The ascending levels of reflection are defined as 1) Noticing 2) Making sense 3) Making meaning 4) Working with meaning and 5) Transformative learning

Table 6.2 Summary of theories of the reflective process and reflective hierarchy

A systematic review on reflection in the health professions found that none of the 29 studies included attempted to measure any outcomes of engaging in reflection (Mann et al. 2009). Despite this, the authors conclude that reflection can aid experiential learning. Their review suggested that higher levels of reflection are harder to achieve and thus achieved less frequently; that reflection appears to increase deep learning; that professional identity is formed via reflection and that a clinician can improve their own reflective ability via activities such a diary-keeping. However, the claims of this systematic review are restricted by the lack of quantitative studies to triangulate the qualitative data.

Reflection has become an essential component of veterinary education in recent years, particularly in relation to professional development (Mossop 2012, Mossop and Cobb 2013). Several studies have found that reflective ability is considered very important in veterinary graduates (Rhind et al. 2011, Bok et al. 2014), and it has been shown that SVMS gradates feel well prepared for reflective practice in their first job (Cobb et al. 2015). Recently, a 'Professional Development Phase' has been introduced by the RCVS – requiring all new graduate veterinary surgeons to reflect on their development during the first year of practice (RCVS 2012). However, evidence for the effectiveness of reflection in veterinary education is entirely qualitative. This is mostly due to the nature of reflection – a higher order cognitive skill that is more appropriately investigated using qualitative methods.

6.1.4 Veterinary extramural studies

Introduced by the RCVS in 1932, extramural studies (EMS) are a significant component of the undergraduate veterinary curriculum (May 2008). All British veterinary students are required to complete 12 weeks of animal husbandry based EMS (AHEMS) and 26 weeks of clinical practice based (CEMS) to achieve professional recognition in the UK (RCVS 2009).

CEMS is considered important as it familiarises students with first-opinion practice – the most common destination for new graduates (Robinson and Buzzeo 2013). Teaching in intramural veterinary hospitals is generally focused on referral cases, meaning students would gain limited experience of first-opinion work without CEMS (Hubbell 2008). It also allows students to undertake placements at non-clinical establishments, e.g. research laboratories, to illustrate the possible career paths after graduation (RCVS 2009). The majority of students organize their CEMS placements themselves (RCVS 2014c), mostly choosing private veterinary practices to work in. The average placement length is two weeks, with a range between one and 19 weeks (RCVS 2014c). Students have the option to concentrate their focus on their species of interest – for example, spending a large portion of their CEMS at an equine practice. At the SVMS, there is no requirement for species variety in placements – although it is advised.

In 2014, the RCVS published the results of their survey investigating EMS during undergraduate courses (RCVS 2014c). They found that 95.6% of recent graduates surveyed considered EMS an essential part of the veterinary curriculum, and only 4.8% thought it could be completely replaced by intramural studies. The greatest benefits of CEMS were reported to include experience of medical/surgical procedures not seen at university (particularly small animal neutering operations); development of communication skills; and appreciation of the need for reflective clinical practice. Additionally, 83.5% of recent graduates felt CEMS provided experience of 'real-world' constraints, such a consultation length and client finances. The survey report discusses the lack of consistency in placement quality - with different practices providing variable amounts of practical experience and case involvement, and the increasing financial burden EMS places on students. The investigation provides a good insight into the current state of EMS, however the response rate was low (18.6%) and those that did complete it may have a reason for doing so – i.e. either very positive or negative views on EMS. It must also be remembered that the work has not been peer-reviewed and thus the methods and the conclusions should be interpreted accordingly.

Several studies investigating the student transition to practice have given triangulating information about the nature of CEMS. Rhind et al. (2011) conducted focus groups with recent graduate and final year veterinary students, who also commented on the inconsistency of EMS placements being a problem. At the SVMS, it is recognized that students build significantly on their surgical skills through CEMS placements (Cobb et al. 2015), thus the variability could have a significant impact on the surgical skills of new graduates. Routly et al. (2002) found that both new graduates and their employers felt EMS required improvement, particularly in the provision of first-opinion case exposure and surgical skill development. These findings are further strengthened by similar graduate opinions reported by Jaarsma et al. (2008).

The literature suggests that EMS is a highly valued aspect of the veterinary curriculum, but one that needs some degree of standardization and increased focus.

Extramural studies and clinical reasoning

Clinical reasoning development, problem-solving practice and case responsibility are not included within the RCVS EMS advisory documentation (RCVS 2009, p. 2), implying that they are not within the remit of CEMS. The British Veterinary Association (BVA) also provides CEMS guides for both students and practitioners – neither of which reference decision-making as a skill for development (BVA 2011, 2013). The student handbook provided for students at the SVMS prior to staring CEMS expands the RCVS aims to include problem solving ability in relation to 'welfare, diagnosis, prognosis and treatment including appropriate use of therapeutics' (University of Nottingham 2012, p. 41). This indicates that clinical decision-making is an intended learning outcome of SVMS CEMS. It appears that there is inconsistency and confusion in the resources available to students on the importance of developing this skill whilst on placements.

6.2 Methodology and methods

6.2.1 Methodology

The aim of this study was to create a tool to stimulate conversation about clinical reasoning between the student and veterinary surgeon during CEMS. The tool was envisioned as a 'Decision Diary', where a questionnaire would prompt students to enquire about the decision-making process of the accompanying veterinary surgeon.

A mixed methods approach was utilised for data collection and analysis. A quantitative methodology was chosen to analyse the content recorded within the diaries, as this would provide a reliable and replicable assessment of student exposure to clinical reasoning. To determine the impact of the diary on the students understanding of clinical reasoning, a qualitative approach was selected. It was hoped the use of mixed methods would create a comprehensive view of the Decision Diary as a learning aid.

6.2.2 Data collection methods

Decision Diary design

The first step in the Decision Diary design was to devise the intended learning objectives (ILOs) of the tool. These are shown in figure 6.2.

It was decided the diary should be produced on size A5 paper to make it portable. The diary needed to contain space for multiple case recordings. A 'case questionnaire' was created to structure the conversation between student and clinician; this could then be repeated as necessary to control the size of the diary.

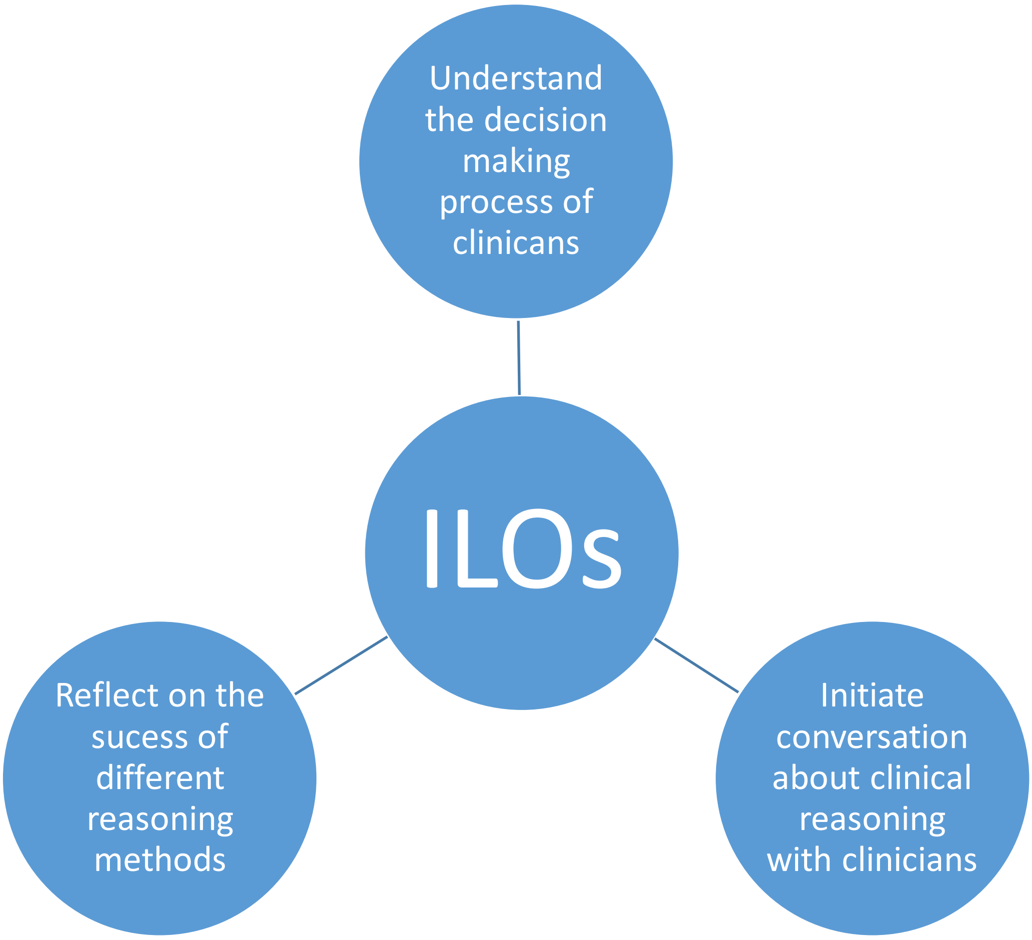

Figure 6.2 The intended learning objectives (ILOs) of the Decision Diary

The content of the case questionnaire was based on work by Nielsen et al. (2007). They used Tanners' (2006) Clinical Judgement Model to develop a reflective template for nursing students. This template contains 17 questions for students to answer when reflecting on their clinical judgement within a specific situation. These questions formed the original case questionnaire.

The case questionnaire was then reduced to five investigative questions and two reflective questions. This was done to decrease the time needed to complete one entry, for both the student and veterinary surgeon. To achieve this, questions were merged, made broader or removed. An 'Instructions' page was inserted at the start of the

Decision Diary, and a blank 'Notes' page was added to the end of each case questionnaire.

The first draft of the Decision Diary was piloted with two fifth year SVMS students. The students were instructed to complete two entries within the diary whilst on CEMS. They then returned the diary and gave written feedback on the ease of use. The students reported confusion over the wording of the questions, misunderstanding their meaning. As a result of this, the questions were rephrased to make their intention clearer. The order of the questions was also changed to make the flow more logical. This format was then piloted with two further fifth year SVMS students, given the same instructions as previously. This time the students reported no problems with the Decision Diary. The data was not included in the final analysis.

The final version of the case questionnaire was then printed and bound into 30 identical Decision Diaries – each with space for 10 cases. The final decision diary is presented in appendix 11, with one case questionnaire for example.

Survey design

A 6 point Likert-scale survey (appendix 12) was created to collect participant opinions on the Decision Diary. Ten statements were presented and participants were asked to indicate their agreement, the options being Strongly disagree, Disagree, Slightly disagree, Slightly agree, Agree and Strongly agree. Questions focussed on the ease of use of the diary, and the effect it had on clinical conversation and clinical reasoning understanding. Both paper and online versions of the survey were made available for students.

The survey was piloted with two fifth year SVMS students that had previously participated in the pilot study of the Decision Diary. No edits were necessary to the survey as a result of pilot feedback. Again, the data was not included in the final analysis.

Student recruitment

All students in years three and four of the SVMS course were invited via email to participate in the study. The only requirement was that the student had already arranged a CEMS placement over the Christmas (year four) or Easter (year three) holiday period. Nine third year students and 20 fourth year students replied to the email and all were accepted onto the study.

Two meetings were held with volunteers - one for each year group - where each participant signed a consent form (appendix 1), recorded the type and dates of their CEMS placement and received a Decision Diary. Students were asked to complete two case questionnaires per week of placement. No information about the nature or process of clinical reasoning was given.

Students were all reminded about the use of their diaries during their first week of placement via email, and it was made clear that the researcher was available to answer questions that arose whilst there. Following CEMS placement completion, students were asked to return their Decision Diaries and complete the survey.

Focus group design

Two focus groups were held with student participants to gain a deeper understanding of the effect of the Decision Diary on student learning. All study participants were invited to attend the focus group held for their specific year group. As summative examinations take place immediately after the Christmas and Easter holidays, the focus groups were postponed until the second week of the new term. The first focus group was considered the pilot study for the questioning structure, as it was necessary to include students that had experienced the Decision Diary in any pilot study undertaken. However, no questions were changed following the first group and the data was included in the analysis.

A semi-structured format was used for questioning, supported by a prompt sheet used by the facilitator (appendix 13). Questions focussed on the impact the Decision Diary had on clinical conversation, how the diaries were used and the effect on student understanding of clinical reasoning. Both focus groups were audio recorded, stored on a computer and transcribed by the researcher.

6.2.3 Data analysis methods

Content analysis

The content of each Decision Diary returned was analysed for evidence of clinical discussion and reflection. The method was adapted from Cohen et al. (2011) and was also used in Study one.

Selective deductive coding was performed on all content within the returned diaries, on a case-by-case basis. Two codes were generated to use within the content analysis – shown in table 6.3. The unit of analysis was set as one comment – not necessarily a whole sentence or question answer, as the students often did not write in sentences or made multiple points in one answer. Coding was performed systematically, repeated to ensure accuracy, and discussed with two additional researchers. The number of each code per case was then totalled, and the mean average frequency of each code per case entry was calculated.

Code	Inclusion criteria	Exclusion criteria
Observation	Description of a clinical interpretation or decision made by a veterinary surgeon AND the reasoning behind it	Description of a clinical interpretation or decision WITHOUT accompanying reasoning
Reflection	Reflective comments on the method of clinical reasoning used by the veterinary surgeon and/or comparison between veterinary surgeons	Description of clinical reasoning without analysis of pro/cons or implications for own practice

Table 6.3 The codes created for use within the content analysis on completed Decision Diaries

During the coding process, the number of cases was counted, and the mean number of cases completed per placement and per week by each student were calculated. The cases were then classified according to student gender, species involved (small animals/farm animals/equines) and case type (routine/emergency/medical/surgical – table 6.4). The percentage of cases that fell within each individual category was calculated.

Case type category	Description
Routine	Condition is very prevalent within the general population
Emergency	Condition is acute and severe, requiring emergency attention
Medical	Condition is not prevalent in the general population and required medical intervention
Surgical	Condition is not prevalent in the general population and required surgical intervention

Table 6.4 Criteria for categorisation of diary entry case type

The Observation code frequency, Reflection code frequency and entry number per student per week were then systematically compared to each of the classification variables (gender, year group, species and case type). This was done using a Mann-Whitney U test for gender and year group comparisons, and a Kruskal-Wallis test for species and case type comparisons. As there was a statistically significant difference in the frequency of both codes between males and females, the mean averages were then calculated for each gender to allow comparison. Lastly, the case type was tested for statistically significant variation by author gender, species involved or year group using a Fishers Exact test. Due to a statistically significant difference in the number of each case type recorded by male and female students, the percentage of total cases classified as routine/emergency/medical/surgical for each gender was calculated.

Survey

To determine if the results of the survey could be merged into one data set, a Mann-Whitney U test was performed on both year groups' responses to each individual question. As there were no significant difference between the answers given by years three and four, the data were amalgamated.

The mean average rating, standard deviation, median average rating and inter-quartile range were calculated for the each survey question. The percentage agreement with each statement was also calculated, where an answer of one, two or three indicated disagreement and four, five or six indicated agreement.

Finally, a Kruskal-Wallis test and a Mann-Whitney U test were used to determine the effect on survey responses of placement type and gender respectively.

Focus Groups

The transcriptions from both focus groups were combined into one data set for analysis. Thematic analysis was then performed on the data, using the same process described in Study one. This method is based on guidelines by Braun & Clarke (2006). NVIVO software (QSR, version 10) was used to manage the complete inductive coding process. These codes were then interpreted and grouped to form themes and subthemes. One focus group transcript was coded by a second researcher and agreement reached to ensure consistency. Finally, the resulting themes were defined.

6.3 Results

The following section will present the results of the survey, content analysis, and finally the thematic analysis. In all of the statistical tests, a P-value ≤ 0.05 was considered significant.

6.3.1 Recruitment

Table 6.5 shows the number of students recruited and how many of these completed each phase of the study. More fourth year students were recruited than third year students, however, 100% of the year three volunteers took part in the focus group, compared to only 40% of year four participants.

Year group	Number of students recruited	Number (%) of diaries completed	Number (%) of surveys returned	Number (%) of focus group participants
3	9	9 (100)	9 (100)	9 (100)
4	20	12 (60)	18 (90)	8 (40)

Table 6.5 The number (and percentage) of students that were recruited and completed each stage of the study

6.3.2 Survey

The results of the Mann-Whitney U test to determine if the two groups' data could be combined are shown in table 6.6. There were no significant difference in responses between years 3 and 4 so that data was merged for analysis.

Question	Year 3 median (mean) score	Year 4 median (mean) score	Mann-Whitney U Test Statistic	P value
The Decision Diary was easy and practical to use	5.00 (4.55)	5.00 (4.53)	70.50	0.722
It was easy to find the time to complete the Decision Diary	3.00 (3.11)	4.00 (3.35)	65.50	0.542
Most vets were co-operative when asked to discuss their cases	5.00 (5.00)	4.00 (4.18)	48.00	0.106
The Decision Diary facilitated clinical conversation between the vet and myself	4.00 (4.56)	5.00 (4.59)	71.50	0.782
The Decision Diary helped me understand how the vets I worked with made clinical decisions	5.00 (4.67)	4.00 (4.24)	57.00	0.266
After using the Decision Diary, I feel better equipped to make my own clinical decisions	4.00 (3.78)	4.00 (3.65)	72.00	0.791
I would recommend using the decision diary to other students wanting to improve their clinical decision making skills	4.00 (4.33)	4.00 (4.00)	62.50	0.430
Using the diary was a waste of my time on CEMS	2.00 (2.22)	3.00 (2.41)	76.00	1.000
I found vets did not have the time to discuss their cases with me	2.00 (2.89)	2.00 (3.12)	70.00	0.712
Using the Decision Diary has not affected my clinical decision making ability	3.00 (2.67)	3.00 (2.76)	68.50	0.651

Table 6.6 Median and mean average survey responses for years 3 and 4, with the results of the Mann-Whitney U test to identify any differences in the survey responses between year groups.

Students were positive about the use of the Decision Diary, agreeing that it increased both clinical reasoning discussion and their own understanding of Decision-making.

However, students did find it difficult to find a convenient time to discuss the diary questions with the busy veterinary surgeons. Percentage agreement and median and mean averages for each question are shown in table 6.7.

Question	Percentage agreement	Median average	Mean average
The Decision Diary was easy and practical to use	88.50	5.00	4.54
It was easy to find the time to complete the Decision Diary	42.30	3.00	3.27
Most vets were co-operative when asked to discuss their cases	84.60	5.00	4.46
The Decision Diary facilitated clinical conversation between the vet and myself	84.60	5.00	4.58
The Decision Diary helped me understand how the vets I worked with made clinical decisions	84.60	4.00	4.38
After using the Decision Diary, I feel better equipped to make my own clinical decisions	69.20	4.00	3.69
I would recommend using the decision diary to other students wanting to improve their clinical decision making skills	76.90	4.00	4.08
Using the diary was a waste of my time on CEMS	15.40	2.00	2.35
I found vets did not have the time to discuss their cases with me	42.30	2.50	3.04
Using the Decision Diary has not affected my clinical decision making ability	23.10	3.00	2.81

Table 6.7 The percentage agreement, mean and median average for each survey question.

Mann Whitney-U and Kruskal Wallis tests to determine the effect of placement type and participant gender on survey responses showed no significant differences between any of the categories (table 6.8).

Question	Placement type		Participant gender	
	Test statistic	P- value	Test statistic	P-value
1	1.886	0.60	55.000	0.74
2	1.185	0.76	47.000	0.42
3	4.543	0.21	36.500	0.13
4	1.218	0.75	40.000	0.21
5	2.678	0.44	31.500	0.07
6	1.969	0.56	58.000	0.89
7	0.815	0.85	50.500	0.55
8	2.408	0.49	44.000	0.31
9	4.715	0.19	53.500	0.68
10	1.507	0.68	50.500	0.54

Table 6.8 The results of the Kruskal-Wallis test to determine the effect of placement type on survey responses, and the Mann-Whitney U test to determine the effect of participant gender on survey responses.

6.3.3 Content analysis

In total, 21 Decision Diaries were returned for analysis. The demographics of the participants that returned their diaries are shown in table 6.9. The mean average number of cases completed by each student per week was 1.42, and the mean average number completed by each student per placement was 3.2. Each individual decision diary entry was classified by author gender, species involved and case type. The majority of cases involved small animals and were routine consultations (table 6.10).

Gender	**Year group**	**Placement type**
Female	3	Equine
Female	3	Small animal
Female	3	Small animal
Female	3	Small animal
Female	3	Small animal
Female	3	Small animal
Female	3	Small animal
Female	3	Farm
Male	3	Farm
Female	4	Mixed
Female	4	Mixed
Female	4	Equine
Female	4	Equine
Female	4	Small animal
Female	4	Small animal
Female	4	Small animal
Female	4	Farm
Male	4	Mixed
Male	4	Farm
Male	4	Small animal
Male	4	Small animal

Table 6.9 Demographics of the participants that returned their Decision Diary for analysis

feature		Percentage of entries
Author gender	Female author	73.5
	Male author	26.5
Species involved	Small animals	54.4
	Equines	13.2
	Farm animals	32.4
Case type	Routine	45.6
	Emergency	22.1
	Medical	26.5
	Surgical	4.6

Table 6.10 The classification of each Decision Diary entry and the percentage of entries that fall within each category

A mean average of 5.35 observation codes and 2.93 reflective codes were identified per case.

Table 6.11 shows the results from a series of statistical tests used to identify any significant differences in diary entries resulting from a number of variables. Female students' diary entries were found to contain a higher frequency of both the Observation and Reflection codes per case (figure 6.4). Additionally, there appears to be variation in the type of cases recorded depending on the gender of the author. A greater percentage of the total number of cases recorded by females were categorised as routine, whereas males recorded a higher percentage of emergency and surgical cases (figure 6.5).

Test variable	Grouping variable	Statistical Test	Test statistic	P-value
Observation code frequency per case	Gender	Mann-Whitney U	211.00	0.001*
	Year group	Mann-Whitney U	472.00	0.551
	Species	Kruskal-Wallis	3.11	0.211
	Case type	Kruskal-Wallis	5.26	0.154
Reflection code frequency per case	Gender	Mann-Whitney U	199.00	0.000*
	Year group	Mann-Whitney U	425.50	0.227
	Species	Kruskal-Wallis	3.30	0.192
	Case type	Kruskal-Wallis	4.27	0.234
Case type	Gender	Fishers Exact Test	7.42	0.047*
	Year group	Fishers Exact Test	3.89	0.281
	Species	Fishers Exact Test	3.28	0.797
Entry number per student per week	Gender	Mann-Whitney U	23.00	0.179
	Year group	Mann-Whitney U	44.50	0.508
	Species	Kruskal-Wallis	6.02	0.111

*Table 6.11 The test variable, grouping categories, statistical test utilized and resulting test statistic and P-value for a series of analyses assessing factors influencing entry writing. *P-Value indicated statistically significant difference ($P \leq 0.05$)*

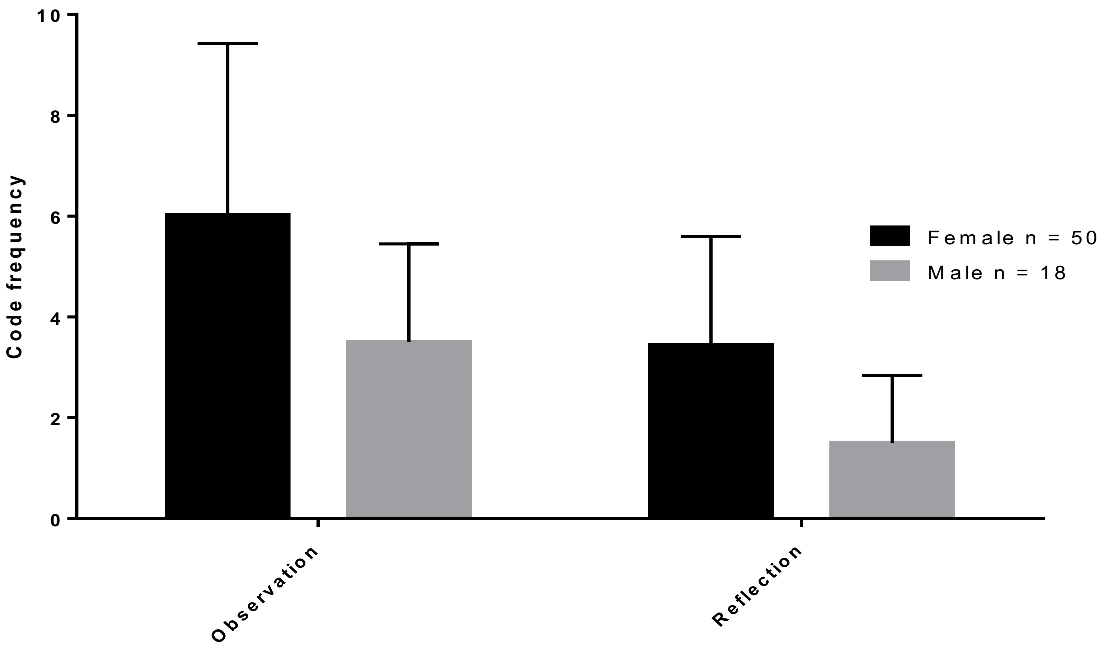

Figure 6.4 The mean average frequency of Observation and Reflection codes per case according to author gender

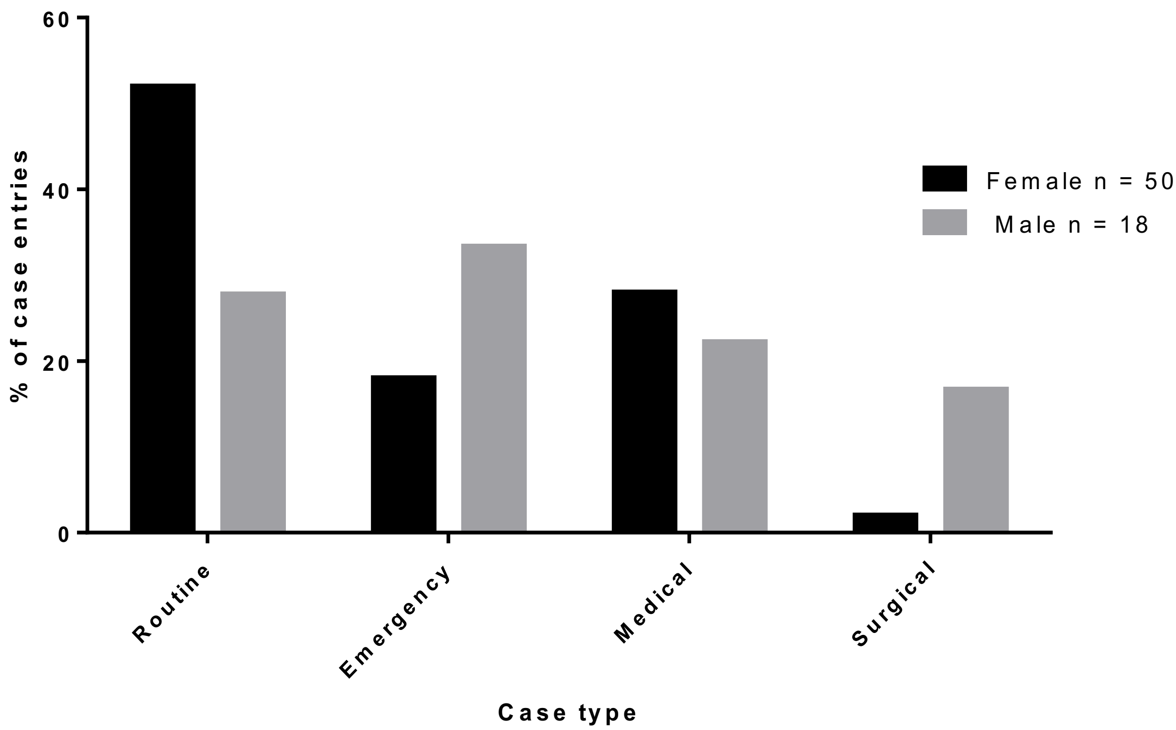

Figure 6.5 The percentage of total cases recorded by each gender that fall within each case type category

6.3.4 Focus groups

Three themes and five subthemes emerged from the thematic analysis of focus group data – shown in figure 6.6. Each theme will be discussed below, with excerpts from the focus group transcripts to demonstrate the concept. The quotes are labelled F3 for third year participants and F4 for fourth year participants. The third year focus group lasted 39 minutes, and the fourth year focus group lasted 51 minutes.

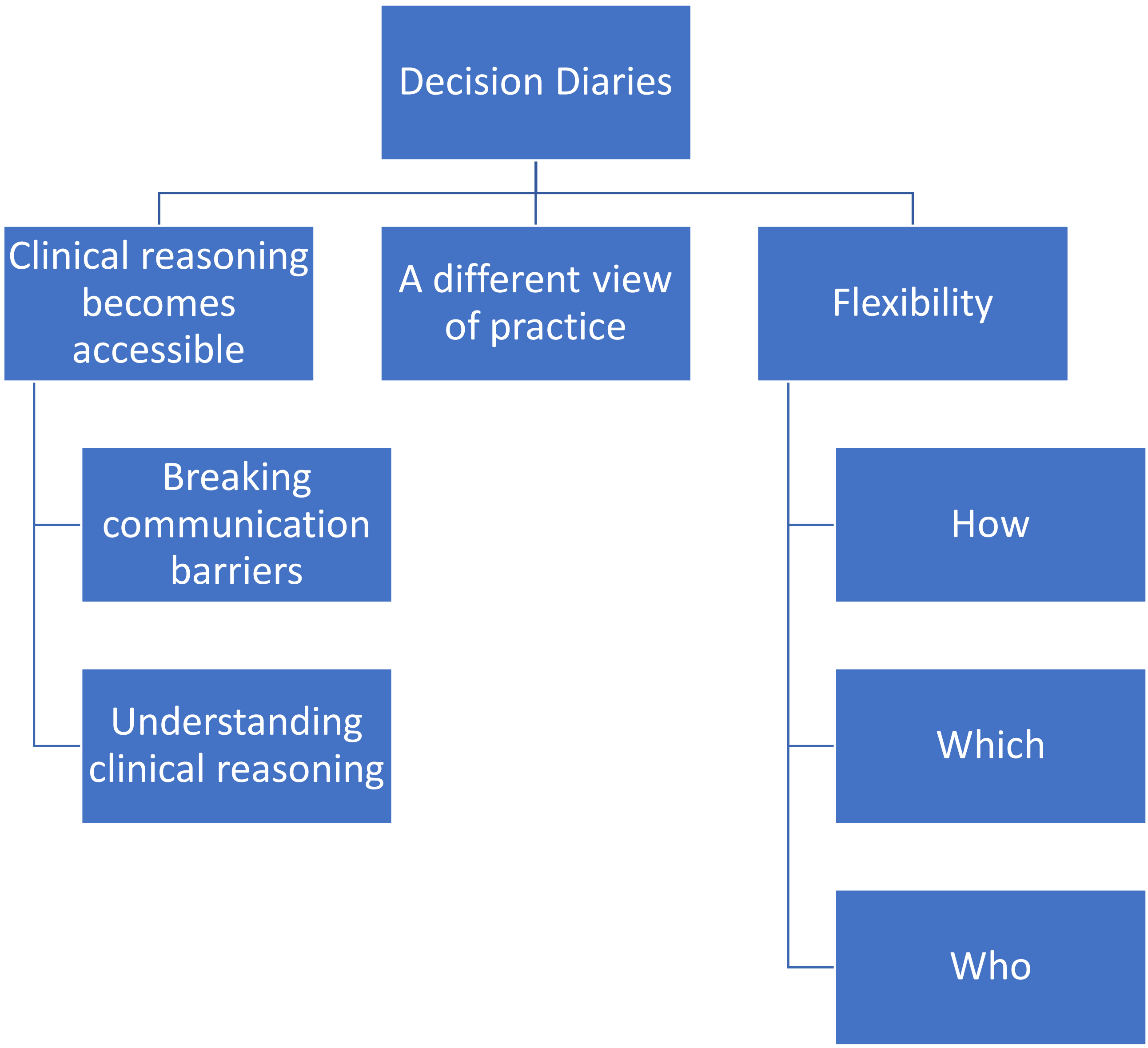

Figure 6.6 The themes and subthemes developed during the thematic analysis

Theme one: Clinical reasoning becomes accessible

This theme developed from comments made by participants suggesting that the Decision Diary was successful in raising student awareness of clinical reasoning during CEMS. Two sub-themes were identified. The first, Breaking communication barriers, arose from student reports that they discussed the process of decision-making with veterinary surgeons more when using the diary. They also felt it prompted them to ask more questions pertaining to the reasoning behind clinical case diagnosis and treatment.

> *'I also found that actually having asked (the vets) the (Decision Diary) questions, they actually started in consult explaining things to me like in the way that they would do for the Decision Diary.' F4*

> *'I did… definitely more questioning than I would normally have done on a placement, because in my mind I was thinking if I had (the Decision Diary) with me right now, what would I be asking? So it really stimulated more conversation.' F4*

> *'(The Decision Diary) made you ask the vet, 'Oh so I've seen this drug being used before for that condition. How come you're choosing this one instead?' F4*

> *'(The Decision Diary) made you think about the questions and made you think, 'Oh actually why are they giving those antibiotics?' F4*

The second subtheme emerged as the students discussed what they had learnt by using the diary during placement. They produced insights into the clinical reasoning process, and the development of decision-making ability - demonstrating that their knowledge of the topic had increased. Interestingly, even students who did not think the Decision Diary was useful made comments that indicated they had reflected on the nature of clinical reasoning.

> *'(I noticed) very different approaches - an older vet and a newer vet. So it was really interesting to see how (the older vet) would go, he knows what he normally sees, he knows those are the clinical signs for that, and he knows what he's doing before he gets to the farm. Whereas the younger guy was more systematic and thinking of what he would test and how he would look at things because obviously he is newer to the field.' F3*

'I had one (vet) who was a new grad and she's been working there like twelve weeks or something. So everything she did was, 'Oh I don't actually have a massive load of experience. So I used other vets' experience and just my formal knowledge', and that was interesting to reflect back on that. But then I had older vets who'd been practicing for twenty years doing this and they were like, 'Well actually it's because I know that kennel cough and lungworm are the most common things that are going to cause a cough rather than…' So there were like 'I didn't have to ask my colleague or I didn't have a massive list of differentials. I had the top three and then if that didn't work, I was just going to go and read up in a book what else.' F4

Overall, this topic provides qualitative evidence that the Decision Diary does increase student understanding of clinical reasoning, whether they are aware or it or not.

Theme two: A different view of practice

During the focus groups, students compared the use of the Decision Diary to the use of 'case studies'. These are clinical and reflective pieces of writing that students are required to complete for their summative portfolio, focussing on medical, surgical, ethical and personal perspectives. Participants felt that the Decision Diary differed from the typical case study because it focussed on 'every-day' cases, rather than interesting and unusual ones. Students found this useful, as it caused them to realise they often pay little attention to routine consultations. They felt that case studies and Decision Diary entries complement each other, providing a more complete clinical perspective.

'I found that (the Decision Diary) was a different type of case to what I look for when I look for a (case study), like different entirely.' F3

'I think (with case studies) you want an interesting case and one that you find exciting, whereas (with the Decision Diary) you want one where you can see the vet's made a decision that you can follow.' F4

Students also felt that using the Decision Diary highlighted the 'real-life' aspects of clinical decision-making. Although they would have been exposed to non-clinical factors that influence clinical reasoning in previous consultations, it seems the Decision Diary concentrated their attention on the clinical reasoning process and thus emphasised this dimension. Students made reflective comments about the nature of decision-making in 'real life' during the course of focus group discussion

> *'(the vet) was like, 'Well I thought of lungworm because we live in a lungworm endemic area', and that was one of her things. So I know that just in our area that was why she decided to do that. Whereas if she'd been somewhere else, that wouldn't have been necessarily one of her top differentials.' F4*

> *'A rabbit came into us and it was skin and bone and I was chatting to the vet about it afterwards … it was a real-life view on (the case) because (the vet) was completely angry about the fact that she couldn't get the rabbit (hospitalised) and… give it the best level of care, but then equally she was like, ''There's no point me telling the owners they've got to pay for an overnight stay for this rabbit, when if that one dies, they can just go down the pet shop and get another one.''' F4*

> *'(We) had this sick cow that had mastitis and it wasn't just E. coli mastitis. It was complicated stuff. So the vet was thinking of what antibiotic to give and he was formulating it in his mind and he was like, 'Well what do you want from this? Do you want her back into milk or are you just going to get rid of her?' And (the farmers) were like, 'Well she's thirteen and we want her well so she can go for meat. We don't want her back in for milk anyway. She's not giving any.' … and so because of that it completely changed what (the vet) was going to do… it was completely different and that influenced his decision more than anything else. F4*

It appears that using the Decision Diary focused student attention onto the clinical judgement required for routine cases, including any non-clinical considerations.

<u>Theme three: Flexibility</u>

It became clear during the focus group discussions that students require flexibility to be able to make the most of the Decision Diary. This was broken down into three components. Firstly, students required the flexibility to decide which veterinary surgeons to approach when using the diary (*who*). This was because some students reported defensiveness on behalf of the veterinary surgeon when questioning about their reasoning process.

> *'If you ask about a choice (the vet had) made… they were like, 'Well I don't know why I've chosen that drug', and they just didn't really enjoy the fact that you were even asking.' F4*

> *'Some of (the vets) were using Convenia a lot in cats and they got really defensive if you asked them why and they couldn't explain it.' F4*

'The vet I was with was quite interested in the (Decision Diary) and was really happy to help.' F3

(The vet) came up to ME… and was like 'I've got a spare 20 minutes do you want to sit down and go through (yesterday's case)?' F4

Other veterinary surgeons were unhelpful when shown the Decision Diary – either not engaging in reflection on their own decision process, or refusing to help altogether. This led students to conclude that the personality of the veterinary surgeon involved heavily influenced the extent to which they could use the diary.

'I found that if (the case) was a quite simple thing that they see most days they wouldn't give detailed answers. They would just say 'It's this... because it is. I do it every day, that's how it works.' F3

'(The vet) who had been qualified 45 years, his answer for the question 'what made you make this decisions?' his answer was 45 years of experience and I couldn't get much more out of him.' F3

'Trying to get (the vets) to explain things like… it's like, 'We just know', and it's that's not so great when you're writing things out.' F4

These factors, combined, suggested that student need to be able to 'pick and choose' which veterinary surgeon they discussion decision-making with. For that reason, limiting the completion of the diary to one placement may not be appropriate, as it limits the choice.

The second component of the Flexibility theme was *Which*. This arose from the feeling that the Decision Diary was more useful for some clinical cases than others, due to the limited amount of clinical reasoning required. This implies that students require the ability to select the most appropriate cases to use as a diary entry – which, again, is limited by a restricted time period.

'If there's a bacterial infection, (you can ask) why did (the vet) use that particular antibiotic? Is it because that's what (the bacteria is) sensitive to? You're going to get much more out of that case than a case where they're just treating something just a little bit under the weather.' F4

'I picked out a mixture (of cases for diary entries) because I thought it would be interesting to see how vets coped with the straight-forward things they see all the time or what they did when it came to something a bit more complex.' F3

Finally, students needed flexibility in *How* they completed the Decision Diary. This subtheme arose from the different ways in which participants chose to utilise the diary.

> *'I just discussed it with (the vet) and asked the questions that I could remember were in the decision dairy then I could go back and fill in certain sections of it myself.' F3*
>
> *'I filled (my Decision Diary) in after each case.' F3*
>
> *'I just asked some questions and discussed the case afterwards or the next day and then would write it down myself at home.' F4*
>
> *'I was doing farm placement so I could (fill in the diary) whilst I was in the car, chatting to the vet.' F3*
>
> *'I gave (the vets) the questions to read whilst I was writing (the answers)...'F4*

They also disagreed on the format the diary should take – electronic or paper.

> *'I think if it was something physical given to me... like a book... I would be much more likely to do it, rather than (online).' F3*
>
> *'I would be much more likely to (complete the diary) it if it was a template (online).' F3*
>
> *'I guess you could have an online option of (the Decision Diary) and a hard copy option of it for those who would rather write it down and those who would rather do it online.' F3*

This subtheme highlighted the need to appeal to all learning preferences to maximise the appeal and utility of the Decision Diary.

In conclusion, the more flexibility that can be given to students in the form of *Who*, *Which* and *How*, the more likely they are to learn from using the Decision Diary.

6.4 Discussion

This study has designed and tested the 'Decision Diary' for the purpose of stimulating discussion about clinical reasoning during CEMS. Survey responses showed the students found the diary improved communication about decision-making. They also reported an increased understanding of how veterinary surgeons make decisions, and felt better equipped to make their own decisions. These assertions were triangulated by the content analysis, which showed a mean average of 5.35 observations and 2.93 reflections per case – demonstrating that students were writing down their insights into clinical reasoning within the Decision Diary. Focus group investigations again reiterated this finding with the theme 'Clinical reasoning becomes accessible', where students both claim and demonstrate their improved understanding of decision-making in practice. The focus groups also found that the Decision Diary highlighted the routine aspects of veterinary medicine, particularly in contrast to traditional case studies. However, it was noted that a much larger degree of flexibility with the format and timing of the diary is needed to make it successful.

6.4.1 The Decision Diary as a learning tool

Although the increased workload brought by the Decision Diary was resented by students, overall they considered the tool beneficial when on CEMS. The diary improved clinical reasoning understanding by stimulating conversation between veterinary students and clinicians. This allowed students to question the method of clinical decision-making used for each particular case. The new information was then subject to reflection, as the students integrated it with their own previous knowledge. Based on these findings, the Decision Diary has achieved the original study aims, although further work is necessary now to perfect the tool for student use.

The content analysis of the Decision Diaries demonstrated that female students were recording clinical observations and reflections more frequently per case. This is not surprising, as previous research has shown that female medical students are more effective at reflective tasks than males (Boenink et al. 2004, Hulsman et al. 2009). In this study, 73.5% of case entries were written by female authors, so the number of male comparators is low. This percentage reflects the gender distribution within the study sample (76.2% female) and within the SVMS – where 76.5% of year three and 70.0% of year four are female. Across both genders, more observations were recorded than reflections – most likely because only two out of seven questions within each case questionnaire required reflection. Female students were also found to record more routine case presentations in the Decision Diary than male students, who recorded more emergency and surgical cases. The reason for this discrepancy is unclear, as all students received the same instruction.

During the analysis phase, the data from both cohorts was shown to have sufficient internal consistency to be merged. This was surprising, as the majority of third year students had not completed a CEMS placement previously, but all fourth year participants had. This difference in experience was expected to affect the usefulness of the Decision Diary, but it did not. The implication is that fourth year students do not learn to communicate about decision-making during their placements, and thus find the Decision Diary as helpful as those students starting CEMS for the first time. The lack of this skill, even within those familiar with a CEMS environment, emphases the need for a clinical reasoning resource. It also suggests that the diary could be utilised throughout CEMS rather than being targeted just at 'first-timers'.

Veterinary surgeon defensiveness was a problem for students using the diary, and led to the need for greater flexibility when choosing which veterinary surgeons to target. The unwillingness of some veterinary surgeons to discuss their clinical reasoning may be due to a misunderstanding of the purpose of the diary. If practitioners saw the diary as a judgment of their clinical decisions, rather than a communication tool, then defensiveness is a reasonable response. A way to minimise this problem is to give students preparatory information before using the Decision Diary. As the reaction of certain veterinary surgeons was not pre-empted, no warning or advice was given to students regarding dealing with veterinary surgeons during this study. Now the problem has been highlighted, resources could be created to help students present and use the Decision Diary. Pre-CEMS resources have already been shown to improve the student CEMS experience. The EMS Driving Licence, created and tested by Bell et al. (2010) is a preparatory guide available to all students for use before CEMS. The resource was created to address key issues raised by placement practices and students as part of a mixed methods research project. When tested, 100% of veterinary students claimed they would recommend the resource to others, thus demonstrating the value of instruction prior to CEMS. A similar project could be undertaken to determine veterinary surgeons' concerns about the Decision Diary and formulate advice for students dealing with these problems. This information could then be included within the diary instructions.

Flexibility was requested in the format of the Decision Diary, with student preference split between digital and paper diaries. This is not surprising, as the use of computers within veterinary education has increased exponentially in the last 50 years (Greenhill et al. 2015), making it logical to create a digital form of the Decision Diary. However, as noted by Bell et al. (2010), CEMS providers may not be as comfortable with modern technology. Since we are asking student and veterinary surgeons to collaborate, the needs of all parties must considered.

6.4.2 Implications for veterinary education

One of the main factors limiting the use of the decision diary was the inability or reluctance of veterinary surgeons to reflect on their own clinical reasoning. By telling students 'That's what I always do…' clinicians limit access to and understanding of the clinical situation. This appears to contradict the findings of the RCVS EMS report, which cites increased understanding of the importance of reflective practice as one of the key benefits of CEMS (RCVS 2014). However, this report was not peer reviewed before publication. The reason for the lack of reflection may reside in the progression of veterinary education in the last few decades (Fletcher et al. 2015). Professional skills such as communication and reflection have only relatively recently become an important part of veterinary curricula – meaning older generations of veterinary surgeons may not have the same level of reflective skills that is now considered normal within students. The inability (or reluctance) of CEMS providers to engage in reflection has wider implications than simply incomplete Decision Diaries; because students role-model the clinicians they learn from (Reuler and Nardone 1994, Maudsley 2001, Paice 2002). Wright et al. (1997) found that 90% of participating medical students identified one or more clinical role models during their training. Role models affect the professional development of students, contributing the hidden curriculum of an institution (Irby 1986, Paice 2002). Students that witness clinical acumen with seemingly no reflective practice involved may not realize the necessity of the skill for continued professional development. They may also pick up bad habits, or misunderstand the purpose and process of reflection. It has been claimed that clinical role models require 'the ability to articulate the mental process that led to the successful completion of a diagnosis or clinical procedure' (Irby 1986, p. 39). If students are emulating role models without that skill, are educators prepared for what they might be learning about clinical decision-making?

Delany & Golding (2014) used action research methods to help clinical educators reflect on their own clinical reasoning process, in order to make it accessible to students. Faculty were asked to identify areas that students often struggled to reason through, and then formulate a 'thinking routine' from their own approach to the problem. The authors reported that this method was successful at increasing the reflective ability of clinical teachers, resulting in increased transparency of their thought processes. A similar method could be implemented to assist CEMS providers that wanted enhance their reflective skills, run as a continuing professional development session at the SVMS. It would not be possible to make attendance compulsory; however, providers that had been on the training course could be recommended to students struggling with clinical reasoning.

The ability to examine and reflect on routine cases was one of the benefits of the Decision Diary reported by students. They felt that the emphasis within traditional case studies, completed as part of a reflective portfolio, is on more unusual or exciting cases and they appreciated the chance to redirect their focus. This was triangulated by the content analysis data, which showed that the majority (45.6%) of diary entries concerned routine cases. However, students are not *required* to pick complicated cases for their portfolio case studies – they *choose* to. This habit of students was commented on by CEMS providers during an investigation by Bell et al. (2010), who found it 'annoying when students only pick interesting cases to follow' (p.193). It appears that students are paying limited attention to routine cases, although further research needs to be done to confirm this. As the majority of clinical cases faced in practice are (by definition) routine, veterinary educators' need to ensure students are dedicating an appropriate amount of time to them whilst on CEMS. This is particularly important in veterinary schools where intramural studies revolve around referral hospitals, and first-opinion cases are rare. In these schools, almost all routine-case exposure occurs during CEMS. Halliwell (2006) criticizes this delegation of teaching to practitioners untrained and unprepared for educating students. Further, he states that institutions claiming to provide consistency in placement standard are 'deluding themselves' (p.312), implying that CEMS is not the appropriate platform for this crucial element of the curriculum. At the SVMS, first-opinion placements in small animal, equine and farm medicine are included within intramural rotations. However, SVMS students still appreciate the opportunity the Decision Diary gave them to focus on routine cases. Overall, this leaves the researcher with three unanswered questions for veterinary schools to consider:

1. How thoroughly are routine clinical presentations covered in the curriculum, and how much is left to placement providers?
2. How effective is CEMS at teaching students how to manage routine cases?
3. What should the ratio of first- and second-opinion case exposure be within a veterinary curriculum?

6.4.3 Limitations

This study was limited by the small number of participants that volunteer to take part. This number was further reduced when several diaries were not returned. It is not surprising that students did not readily volunteer for the study, as no incentive was given, except the opportunity to improve their clinical reasoning skills. In a course with a high work burden, any additions to that are often received negatively. Furthermore, students that did volunteer for the study are likely to have felt the need to improve their clinical reasoning, which may have biased their experience with the Decision Diary. Despite these limitations, this study has shown that the Decision Diary can be effective at improving decision-making discourse and thus a larger-scale research project is warranted. Repeating the project would also give opportunity to evaluate the changes suggested to the diary – i.e. format and time constraints.

This study did not use observational data collection methods to evaluate the effect of the Decision Diary on clinical conversation. Although this method may have provided stronger evidence of discourse change, it would have been impossible to predict or account for the change in behaviour caused by the presence of the researcher or a video camera. If behaviours did change, this would have influenced the findings of the content analysis also, reducing the reliability of those findings. In this case, all methods had certain unavoidable limitations and those chosen were deemed to have the most minimal limitation effects.

As with all focus groups, the opinions of the participants can be affected by the presence of the researcher. In this case, students may not have verbalised critiques of the diary so as not to cause offence. This is unlikely, however, as it was made clear to students that all feedback was welcome. To reduce this effect in any follow-up studies, a facilitator not involved in the Decision Diary design could be used.

6.5 Chapter summary

This study has developed and tested a new resource for stimulating conversation about clinical reasoning during CEMS. Students responded positively to the Decision Diary, and these opinions were triangulated through content analysis to show that insight into the clinical decision-making process was gained through use of the diary. However, the response of veterinary surgeons was mixed – leading students to request more flexibility, allowing them to 'pick and choose' the most helpful practitioners.

The final chapter of this thesis shall now revisit the results of all three research studies in order to form recommendations for clinical reasoning optimisation within veterinary curricula.

Chapter 7 Discussion

Three separate studies have been conducted within this thesis to investigate the development of clinical reasoning in veterinary students. The following chapter will attempt to integrate the findings of these studies into five recommendations to improve the current state of clinical reasoning development within veterinary curricula. First, however, the results of each study are summarised to reiterate the key findings.

7.1 Summary of findings

7.1.1 Study one: An investigation into the development of clinical reasoning

The first study of this thesis sought out the perceptions of staff, students and graduates on the development of clinical reasoning within veterinary students at the SVMS. The results indicated that a basic level of reasoning skill was being achieved by students before graduation, but that considerable improvement was needed once in practice to meet the requirements of the job. A lack of responsibility for clinical decisions as a student was described as one of the key factors leading to difficulty reasoning in practice. In addition, the absence of contextual features when developing reasoning skills meant that graduates found it difficult to incorporate financial and client factors into their clinical decisions. It became clear during the analysis that the need to develop clinical reasoning skills is not made explicitly clear to students, resulting in them being unaware of the concept and its importance. Finally, barriers to clinical reasoning development – including ineffective CEMS and negative participant attitude towards the topic – were identified.

7.1.2 Study two: The use of standardised client simulation to develop clinical reasoning

Study two involved the creation of a standardised client simulation session with the aim of improving the clinical reasoning ability and confidence of final year students. Sixty-eight participants completed three simulated consultations, with the role of the client being played by a trained actor. Survey data collected showed that participants were incredibly positive about the experience, with 100% agreeing that the session improved their ability to make clinical decisions. Self-assessment data triangulated this finding – showing a significant improvement in student perception of their overall clinical reasoning skill level before and after the simulation. However, blinded researcher analysis of the consultation video-recordings found that only the ‘History-taking’ and ‘Making sense of data’ components of the assessment rubric showed a significant increase in ability. Focus groups conducted with simulation participants uncovered the autonomous motivation students felt to perform well in the simulation, as well as confirming their increase in confidence following the session. Student discussion also described the use of ‘A different kind of reasoning’ – suggesting that the processes of decision-making students learn during the SVMS curriculum is not the same methods used when faced with the time and client pressures of a real (or simulated) consultation.

7.1.3 Study three: 'Decision Diaries' – stimulating conversation about clinical reasoning during extramural studies

Within the third study of the thesis, a Decision Diary was created to stimulate conversation between student and practitioner during CEMS; designed to expose the decision-making process of the veterinary surgeon. Twenty-one third and fourth year students trialled the Decision Diary whilst on CEMS. Content analysis of the returned diaries demonstrated that clinical reasoning methods were being discussed with students, who were then able to reflect on their relative success. This was triangulated by survey and focus group results, both of which confirming that clinical decision-making discussion increased as a result of Decision Diary use. Furthermore, focus group results suggested that the Decision Diary emphasised the importance of routine clinical cases, rather than 'interesting' or 'exciting' cases. It also prompted students to reflect on the impact of contextual factors, such as finances, on decision-making.

7.2 Recommended modifications to veterinary curricula

In this section, four recommendations will be made for curriculum design in veterinary education. Although based on data gathered regarding the SVMS, the recommendations are applicable to all veterinary schools as they address the 'bigger picture' of clinical reasoning development, rather than specific teaching methods. The author is aware that veterinary schools function within the tight constraints of the RCVS, EAEVE and their parent university, but wishes to put these considerations aside temporarily in order to deliver a fresh perspective on veterinary education based on the findings of this research.

7.2.1 Align the curriculum to the career

A recurring theme within the results of this research is that students are struggling when in practice, as their decision-making skills are not 'fit for purpose'. This is exemplified by the lack of confidence found in graduates during study one, and the period of decision-making adaptation they describe. However, as detailed within the introductory chapter, the SVMS dedicates both lectures and practical sessions to the development of clinical reasoning, alongside extensive exposure to CBL, and even attempts to examine clinical reasoning. This means that whatever is being learnt within directed sessions is not transferred to practice; leading to the question – is the clinical reasoning process being taught to students the same process that they will use once in practice? Put another way, is the clinical reasoning curriculum aligned to the career needs of graduates? The findings from the studies conducted within this thesis suggest not.

Study one highlighted a number of key elements needed for clinical reasoning development, including responsibility for decisions and the implications of real clinical consequences. This was reinforced by the findings of the second study, which again raised the issues of responsibility and the ability to make decisions without a 'safety net' – both of which the students did not feel they had experienced prior to the simulation. Additionally, students appreciated the chance to make decisions under stress when taking part in the simulation, as time and client pressures had not been a part of previous reasoning opportunities. Participants clarified the importance of responsibility, pressure and stress on decision-making by describing a different cognitive approach to clinical reasoning when facing these challenges. In fact, these comments were reiterated in all focus groups held as part of study two – leading to the development of the theme 'A different kind of reasoning'.

Previous research has also hinted at the misalignment of the veterinary curriculum and the veterinary profession. Everitt (2011) found, when conducting focus groups with members of the profession, that veterinary surgeons did not feel they had been taught the same methods of clinical decision-making that they now used in practice. This applied even to recent graduates exposed to the more modern curricula structure. In addition, as part of her doctoral thesis, Cobb (2015) found that good examination performance was not a positive predictor of preparedness for practice in SVMS students, reinforcing the theory of career misalignment.

It seems as though the reasoning process is different when acting under stress. If this is so, then students need to be taught how to cope under this pressure so they can manage it when in practice. Stress is rife within the veterinary profession, particularly amongst new graduates (Gardner and Hini 2006, Bartram et al. 2009), therefore graduates need to be able to function well under these conditions. If all the clinical reasoning experience a student has is from completing 30-minute consultations, they will not be prepared for the time pressures faced in practice. If they have always had a clinician behind them for reassurance in consultations, how will they cope with the fear of making a mistake and harming an animal unintentionally when they graduate? If a student has never practiced incorporating client factors into their decision-making process, they will not be able to resolve the financial or practicality issues faced in practice. The author acknowledges the need to introduce students to the topic of clinical reasoning in stages suited to their experience level. However, by the time students' graduate, they need to have been trained to do the 'real' job, not a 'watered-down' version. It is important to align the clinical reasoning curriculum to the true nature of clinical reasoning in practice.

One possible method to train students to manage stress during the decision-making process is disaster simulation. This involves a team of students put under pressure to respond quickly and safely to an emergency (Bissett et al. 2013). As the main aim of this simulation is to teach students to cope with thinking under pressure, the context and content of the simulation does not need to veterinary related. As an example, students could be required to respond to a traffic collision they have witnessed. The Texas A&M University College of Veterinary Medicine have already implemented a rotation dedicated to emergency planning and response (Bissett et al. 2013). Part of this course involves the simulation of an impending natural disaster, with the students required to prepare an emergency evacuation protocol. The disaster is then enacted using Second Life™ – an online virtual platform, during which a number of animals are injured, requiring the students to decide, *quickly*, how to proceed with each case. In the authors' opinion, a similar opportunity would be invaluable for British veterinary students.

7.2.2 Contextualise learning

The benefits of situating the learning of clinical reasoning in reality have been discussed several times within this thesis. It has become clear that, currently, students are not exposed to the complicating factors of decision-making that play a substantial role in clinical practice. This includes incorporating financial issues, client expectations and demands, contextual distractions, producing estimates, producing accurate clinical notes and communicating clearly and with empathy. Although the curriculum may cover all of these aspects independently, they are not combined with the cognitive demands of clinical reasoning. Thus, when graduates start their first job, they must quickly learn to adapt their decision-making methods to integrate these additional factors. If educators can give students practice of this ‘multi-tasking’ challenge before graduation, the need to adapt is reduced.

All three studies within this thesis have demonstrated the need for contextual integration of clinical reasoning. In study one, interviewed graduates described the difficulties they felt when faced with ‘real-world’ decision-making for the first time. For that reason, they recommended the extension of the simulation program at the SVMS to include clinical reasoning *in situ*. In study two, where the idea of contextualising clinical reasoning development was trialled, students appreciated the integration of decision-making with communication, financial factors and client needs – although they did find it challenging. Overall, the session was very popular, and students even felt it would be more appropriate to examine clinical reasoning using simulated consultations than written exams. They particularly appreciated the high fidelity of the session – indicating that contextualised learning is important to them. Lastly, in study three, students described the exposure and insight into the non-clinical factors that affect decision-making as one of the key benefits of using the Decision Diaries. They felt they had not before appreciated the range of considerations that influence clinical reasoning in practice.

Situation of learning in reality is a key premise of andragogy, as adults learn more effectively when they can see an immediate ‘real-life’ application of skills (Knowles 1970, Kassirer 2010). As discussed previously, the need to contextualise learning has grown in prominence in both medical (Durning and Artino 2011) and veterinary (Scholz et al. 2013) education literature. This is in line with the focus of education shifting towards outcome-based curricula (Harden 1999, Davis 2003). More emphasis is being placed on producing graduates that can *perform* the job for which they have been trained. In veterinary education, the outcomes required are derived from the RCVS Day One Competencies – which include the 'understanding of and competence in… clinical reasoning' (RCVS 2014a, p. 12). However, if veterinary students can only make clinical-decisions in certain straightforward circumstances, it can be argued that they are not competent in clinical reasoning in respect to both the list of competencies and the requirements of the job.

The author proposes that the level of contextualisation of clinical skills within the veterinary curriculum should be increased. The term 'clinical skills' is intended to cover both clinical reasoning and other associated practical skills, for example, communication and physical examination. These are grouped together to mirror their use in reality – if students need to use these skills together when in practice, why not teach them together? It is the exception, not the norm, that clinical reasoning is used in isolation when in practice. Teaching component skills separately requires graduates to assimilate them during the transition period. The author believes this could be avoided by integrating the subjects appropriately.

Once again, the need to start with 'the basics' is acknowledged, and classroom-based activities, such as CBL and small-group work, are ideal for this. However, students should be progressing into contextualised learning sessions by the time clinical knowledge is introduced, so that these two aspects may be effectively integrated. Based on the success of the simulated consultations conducted in study two, high-fidelity simulation seems an effective way of providing this style of learning, particularly when increasing student presence at teaching hospitals/clinical associates is not feasible. These simulated scenarios should be expanded to cover a broad range of clinical situations – for example: emergency care, euthanasia, co-morbidities – and species.

7.2.3 Increase the profile of clinical reasoning within the curriculum

The third recommendation stems mainly from study one – where clinical reasoning was found to be an unknown concept to most student participants. The following quote demonstrates the significance of clinical reasoning to a fourth year student:

> *'I remember in third year not having a clue what clinical reasoning was, just thinking it's these scary exams that were on the horizon... And I don't think I necessarily even associated the name of the exam with the process to start with. It was just a name that the exams had…'*

Staff also felt that clinical reasoning was not made explicit to students. To compound this, staff claimed that clinical reasoning is not written in learning objectives – even when it was an intended outcome of a session. Instead, students are expected to *assume* sessions such as CBL are aiming to improve their decision-making ability.

The problems with this can be explained by comparing clinical reasoning to another higher-order cognitive skill: reflection. Within the SVMS curriculum, reflective development is highlighted to students through learning objectives, ongoing summative coursework and dedicated small group sessions. If their reflective abilities are not satisfactory, this is discovered through coursework submission and can be remediated before graduation. As a result, graduates have a good level of competency in reflective practice (Cobb et al. 2015). Contrast this to clinical reasoning, where students are not even aware they should be developing their skill level, let alone tested and given feedback on their ability. They have no way of tracking their progress, or requesting extra help if needed. The SVMS has limited understanding of the clinical reasoning ability of their graduates and whether the RCVS Day One Competency is being achieved.

Fundamentally, clinical reasoning needs to become as overt within the curriculum as other professional or practical skills. The theory behind the reasoning process should be explained, so students understand what they are aiming for and how their own skill level may progress through different stages. They should be able to evaluate the clinical reasoning of the clinicians they learn from, so they can select the most effective methods to integrate into their own practice. They should have direct feedback on their own reasoning ability and given help to improve where needed. These provisions are given to every other dimension of veterinary education, and now need to be part of clinical reasoning development. Higgs (2008) contends that to create a curriculum of this nature:

> *'The team of educators must be committed to this approach, rather than simply including reasoning as a listed goal or isolated learning activity in their programme.' (p.383)*

For this reason, staff training in the literature surrounding clinical reasoning would be necessary – to ensure faculty embody the philosophy of the curriculum.

The Decision Diaries created within study three succeeded in making clinical reasoning visible to students during CEMS placements. As a result, participants felt that their own decision-making skills improved, despite this not being an aim of the project. This indicates that being aware of clinical reasoning does have the potential to improve student ability. This theory is supported by Anderson (2006) in her doctoral thesis, who combined case studies with quantitative measurement of medical student clinical reasoning development. She found that awareness of clinical reasoning was a positive predictor of their clinical reasoning ability. In addition, students that recognised the role modelling of staff regarding decision-making were found to learn from their example and perform at a higher level than those students oblivious to the role modelling. Anderson recommends that 'clinical reasoning needs to be carefully articulated in program design, teaching and assessment' (Anderson 2006, p. 184), to emphasise the importance of this skill within clinical practice in the hope of encouraging students 'to personally focus on developing their clinical reasoning' (p.184). However, this study only examined the development of clinical reasoning during the first two years of medical school and thus the implications for the advanced stages of the course are unknown. Additionally, some of the methods used to quantify clinical reasoning and critical thinking had questionable psychometric rigour. Nonetheless, the study provides triangulation of the need for explicit clinical reasoning exposure within medical/veterinary curricula.

The author believes that dual process reasoning should be the basis for any curriculum redesign. It has been shown that clinicians cannot predict the diagnostic mistakes of others – demonstrating that clinical reasoning is a very individual process (Norman 1989, Norman and Brooks 1997). It is therefore unrealistic to think teachers can predict the clinical reasoning strategies of their students, and instead must simply provide all of the available 'tools' for the students' to select from. Teaching dual process theory would allow students to switch between system one and two reasoning when necessary. In this way, students could progress from hypotheticodeductive techniques to pattern-recognition when their personal illness scripts were sufficient to enable this. In essence, students should be empowered to develop their own clinical reasoning ability with the feedback and support needed to achieve this.

7.2.4 Focus on common cases

The final recommendation is that the focus of the veterinary curriculum is shifted towards common pathologies and case presentations, and away from those considered rare. This aims to improve the ability of new graduates to cope with routine cases, as previous studies have shown that they can struggle with these when first entering practice (Routly et al. 2002, Gilling and Parkinson 2009).

It appears as though graduates' reasoning ability is uniform across the continuum of disease prevalence – instead of being focussed on the common conditions and weaker on the rare conditions. The results presented in this thesis support this, with staff participants in study one expressing concern about the ability of students to form realistic differential diagnosis lists. Instead of prioritising common conditions, staff found that students recall long lists of unusual disorders, even when in the final year of the course. In the authors' opinion, this results from underexposure to routine cases and overexposure to pathologies that are not often encountered in first opinion practice. This theory is supported by the results of study three, which investigated the use of Decision Diaries on CEMS. When questioned, students contrasted the Decision Diary to the current SVMS case study template that, unwittingly, leads students to focus on exciting or unusual cases. They claimed the diary concentrated their attention on the 'everyday cases', which they would not normally consider important. This is reflected in the content analysis, which showed that 46.5% of the cases recorded by students were classified as 'routine'. However, only third and fourth year students took part in study three, so how their perspective changes in the practice-based final year of the course is unknown.

The development of clinical reasoning expertise relies on repeated exposure to clinical cases. To form an illness script, a student must encounter a particular condition several times, in order to understand the possible presentation variations and treatment options. Once formed, this script will allow system one reasoning to be implemented when next encountering the same condition, reducing the cognitive demand and time consumed. Forming illness scripts is an important part of reasoning development – one that should not be postponed until after graduation. Studies have shown that incorporating system one methods into the reasoning process improve diagnostic ability in students (Ark et al. 2006, 2007, Norman et al. 2014), and multiple authors have advised its integration into medical curricula (Coderre et al. 2003, Ark et al. 2006, Norman et al. 2007). It would be impossible for students to have a full repertoire of illness scripts by the time they graduate – so priority must be given to those that will be of most use; those of frequently encountered cases.

In the authors' opinion, within the current curriculum, students do not get the opportunity to form illness scripts. This is the result of two factors. Firstly, students do not gain enough experience dealing with common conditions in practice. Although this is improved in curricula where WBL is not concentrated within teaching hospitals, a greater first-opinion exposure is still desirable. Without repeated exposure to routine cases, illness scripts cannot develop. Secondly, when students are within first opinion practice, they admit to losing concentration during routine cases - as demonstrated in study three of this thesis. Thus, they are not engaged in the reasoning process and potentially do not form illness scripts. Due to these combined reasons for lack of script formation, graduates are forced to use system two reasoning for all consultations, which takes excessive time and cognitive resources. Everitt (2011) found an increase in system one reasoning when veterinary surgeons were attempting to work within the time constraints of clinical practice. If graduates cannot use system one methods due to a lack of illness scripts, instead relying on slow hypotheticodeductive reasoning, they are likely to fall behind and become stressed as a consequence.

In order to address this, the author suggests CBL sessions focus only on the common conditions encountered in first-opinion practice. In addition, the same condition should be covered several times, with variations in clinical presentation and treatment considerations, to allow students to develop illness scripts. To focus student attention on routine cases during CEMS, the use of the Decision Diary is recommended. A quota of diary entries should be required per year. If possible, these entries should be categorised and retained throughout the course. In this way, students can create a log to be referred back to – akin to a 'physical illness script' within which comparisons of diagnostic methods and treatment plans for similar presentations can be compared. Within the clinical years of the course, both lectures and WBL should concentrate as much as possible on routine cases, particularly in relation to the reasoning involved and the variations seen. Finally, it should be ensured that 'the basics' of first-opinion consultations are covered within the curriculum. Currently, students are expected to learn how to conduct post-operative checks, repeat prescription consultations and preventative medicine evaluations during WBL. As these form such staple components of primary care, they should be addressed within lectures, practical classes or simulations.

7.3 Suggested curriculum structure

An example curriculum structure is presented in this section (table 7.1), to demonstrate how the author envisions the recommendations above being implemented. The example curriculum is based on the structure of the current SVMS curriculum – i.e. involving body systems modules, a longitudinal professional skills module, a dissertation project in year three and a final year spent solely on WBL placement rotations. The suggested curriculum is ambitious, and differs dramatically from the current structure. It aims to provide 'food for thought' on the direction in which veterinary education should be progressing.

In this imagined scenario, a dedicated area for simulation would be developed with areas for small animal, equine and farm animal simulation. Technology should be incorporated where possible. A team of two FTE staff members would be responsible for designing, co-ordinating and running the simulated sessions across all year groups. A 'Sim Log Book' would be implemented, for students to record their action plans, feedback and reflection for each simulation. This could be online, but should be maintained throughout the course so students and tutors can track development. The simulation scenario repertoire should be increased so that common tasks such as euthanasia or herd health work can be incorporated. Instructions for developing these are outside the scope of this thesis – but are definitely achievable with creativity, staff time and investment.

The proposed curriculum utilises the theory of *scaffolding* described by Vygotsky (1962). With each progressive year, the students are pushed slightly out of their 'comfort zone' or, as named by Vygotsky, *zone of proximal development*. From here, students can reach the next stage of their development, without being stretched beyond their capabilities and losing confidence. In this way, the clinical reasoning acumen of the students is improved year-by-year, in much the same way as most UK veterinary schools deliver communication training currently (Mossop and Gray 2008).

In order to incorporate the new features of the curriculum, aspects of the old curriculum would need to be removed. The authors' suggestion is that research is conducted into the information from the current curriculum actually utilised (directly or indirectly) by graduates in practice, and anything not moderately represented be removed or reduced. Alternatively, topics best suited to postgraduate education could be identified – for example, advanced orthopaedic surgery – and removed.

Year	Simulation	Case-based learning	Workplace-based learning	Other learning sessions	Formative examination	Summative Examination
One	Each student should engage in two simulation sessions per year. These should focus on the basics of communication skills.	Focussed on simple cases often presented in first-opinion practice. These cases should be related to the current system module, but not in a predictable or obvious way. Ideally, some very prevalent pathologies should be repeated throughout the year.	Not applicable as non-clinical at this stage.	The professional skills module should contain small group teaching sessions on clinical reasoning theory, development and uses. Additionally, practice cases on very common conditions should be provided for the groups to work through with a facilitator.	The last of the two simulation sessions should act as a formative examination, conducted under exam conditions. Feedback should be given in the form of a debriefing.	Theory of clinical reasoning examined during the Multiple Choice Questions (MCQ) summative exam for the Professional Skills module.
Two	Each student should take-part in three sessions per year. These should now incorporate history taking, communication skills and the physical examination of an animal. Clinical reasoning should be necessary to direct the history taking and examination. Cases should be basic – e.g. gastrointestinal parasites	Continuation of module-based cases used in year one.	Students should be introduced to the Decision Diary. The aims of the diary should be explained and the importance of 'routine' decision-making highlighted. As a small group, students should discuss appropriate use of the diary and approaching veterinary surgeons for input. The diary should be used during CEMS.	No special requirements.	The last of the three simulation sessions should act as a formative examination, conducted under exam conditions. Feedback should be given in the form of a debriefing	A summative OSPE station should examine communication skills combined with other tasks – e.g. recording clinical notes.

Three	Students should take part in three sessions per year. Within these, advanced communication skills – e.g. angry clients – should be combined with physical examination and basic clinical reasoning. Ideally, cases should correspond to topics studied in third year – e.g. anaesthesia	Continuation of module-based cases used in years one and two.	Students should continue to use the Decision Diary on CEMS placements. Once annually, the diary should be discussed between the student and their tutor.	No special requirements.	The last of the three simulation sessions should act as a formative examination, conducted under exam conditions. Feedback should be given in the form of a debriefing The Decision Diary should be formatively graded when by the student tutors.	Simulated scenarios involving communication skills, physical examination and basic clinical reasoning should be included in the examination methods.
Four	One simulation session should be held per clinical module. The simulations should fully integrate history taking, physical exam, diagnosis and treatment planning with communication skills and knowledge gained from the specific module.	Sessions should be unstructured, without questions. Case information should be released in stages. Co-morbidities should be included in some sessions. Cases should relate to the current module but this may be less obvious– e.g. not the presenting complaint. Situational factors including owner finances and abilities should play a key role in all cases.	Students should continue to use the Decision Diary on CEMS placements. Once annually, the diary should be discussed between the student and their tutor.	The professional skills module should contain sessions instructing students on the use of the SOAP acronym, alongside a 'recap' of clinical reasoning theory and development.	All simulations should be conducted under exam conditions. Each simulation session should be followed by formative feedback as part of a debriefing. Student performance would be expected to improve throughout the year, as they grew accustomed to the simulation format.	Simulated scenarios encompassing clinical reasoning, communication, practical skills and knowledge should be included in the examination methods. The Decision Diary should be given a summative grade.

Five	One simulation session should be held per month. These should be a random assortment of common clinical presentations. Communication, clinical reasoning, practical skills and knowledge should all be integrated. Situational factors such as finances, client expectations and distractions should be heavily involved. Additionally, all WBL groups should take part in one 'disaster scenario' simulation.	Small group CBL does not occur in the final year of the SVMS course. However, a library of virtual patient cases should be available for students to access for revision.	No special requirements.	Seminars should be held with SVMS clinicians once fortnightly, where students can work through the clinical reasoning process of cases they have observed during the rotation. In addition, a checklist of common clinical presentations or problems related to the particular rotation should be created. This should be used to ensure students have at least discussed the approach to all routine problems.	All simulations should be conducted under exam conditions. Each simulation session should be followed by formative feedback as part of a debriefing.	'Finals' should involve simulated scenarios and MCQ examinations. In addition to the components included in the fourth year summative simulations – situational distractions, financial considerations and client expectation should be incorporated.

Table 7.1 An example curriculum structure for optimising clinical reasoning development, based on the current structure of the SVMS curriculum

7.4 Future work

A great deal of research is still required within the field of veterinary clinical reasoning before institutions are likely to have enough evidence or confidence to implement a curriculum like that detailed above.

To address this, an extensive study into the clinical reasoning ability of graduates should be conducted. This should involve multiple data collection methods, including focus groups and interviews with graduates and employers, direct observation of clinical practice, liaison with the RCVS/Veterinary Defence Society regarding complaints against graduates and a large-scale survey. The aim of this research should be to identify the strengths and weaknesses of new graduates when starting work. Additionally, ethnographical investigations may be conducted to understand, on a personal and professional level, how well graduates are coping with the transition to practice.

Another important area for further research is the use of simulation for examination purposes. The example curriculum presented in table 7.1 includes the use of simulation as both a formative and summative examination method. Precise details of the summative examinations are not included, due to the absence of information regarding the psychometric properties of the method – for example, how many cases each student should undertake to produce an acceptably reliable result. Clearly, these properties need to be confirmed before any summative examination can be implemented. Research into the effect of simulation as a formative examination would allow the impact on learning behaviours to be investigated, revealing whether the simulation influences student actions beyond the consultation room.

Finally, if a curriculum was implemented that followed the recommendations provided within this thesis, a longitudinal study assess the impact of the change would be advised.

7.5 Conclusion

Becoming a veterinary surgeon is a difficult journey, and practicing as a veterinary surgeon is a challenging profession. Every year, recent graduates leave the profession because of stress, unhappiness and disillusion. The transition into practice may be the toughest point of their career, but it is the period within which veterinary educators must 'let go' of their students with the hope that they can now make it alone. Graduates need to be confident in their abilities when starting their first job because it will be challenging, it will be exhausting and, at times, it will be demoralising. Veterinary educators have the responsibility to ensure that students are capable of weathering this transition; but the research presented within this thesis indicates that they are falling short. In order to provide students with the best possible start to their career the development of clinical reasoning within veterinary curricula needs to be improved. Educators need to ask themselves whether they are training students to do the job at hand, under the circumstances that graduates will find themselves in. Currently, clinical reasoning - one of the key skills of clinical practice - is being neglected within the curriculum and graduates are struggling as a result. This thesis has several ways of addressing this problem, including the use of standardised client consultations and reflective diaries. Veterinary schools must now look at how best to integrate these into their curricula and improve the clinical reasoning abilities of new graduates, with the hope of easing the transition to practice and providing a positive start to a long and successful career.

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Appendices

Appendix 1 – Consent form

Title of the study: Understanding and developing clinical reasoning Related Skills in veterinary students
Researchers:
Claire Vinten – svxcev@nottingham.ac.uk
Liz Mossop – liz.mossop@nottingham.ac.uk

Purpose of the study:
My research is focussed on the teaching and learning of clinical reasoning skills. Clinical reasoning is the process of making decisions and solving problems in clinical practice. It is an essential skill for veterinary surgeons; therefore research into how it develops in students is important for advancing veterinary education. I am starting by mapping how students at the SVMS develop clinical reasoning skills, and then aim to investigate and trial ways to enhance this process.

Consent:
This consent form is a formal way of indicating that you agree to participate in this study and that you understand that any information collected by the researchers:

- will be used for a research study
- may be written in a report for publication
- may be presented at research conferences or meetings
- will be anonymised and treated confidentially
- will only be accessed by research colleagues or examiners
- that you can request to see a copy/summary of the completed study
- that you can request to see any information written down/kept during the process of data collection.
- The researchers have explained that any comments you make will be anonymous so that in the final study write up, it will not be possible to identify you

	please tick
I understand that participation in this study is voluntary and that I may leave the study at any time (without needing to provide reasons for doing so)	
I agree that information I give during the study can be used in a report, a published paper or a conference or meeting presentation.	
I understand that the study is being conducted for the purposes of research.	
I understand that I can request to see a summary of the findings, and I can also request to see any notes made during the process of my data collection.	

If you have any queries regarding this study, please speak to the researcher directly or contact them via e-mail.

Participant
Name:.. Signature:.....................................

Researcher
Name:.. Signature:......................................

Date:..................................

Thank you very much for participating in this study.

Appendix 2 – Staff focus group questions

1. Housekeeping
    a. Please sign consent form
    b. Please help yourself to food at any point
2. My research
    a. Mixed methods study with two main areas
        i. How do SVMS undergrads develop clinical reasoning skills?
        ii. How can this be improved? Involves trialling new methods.
3. Definition of clinical reasoning
    a. The thought process involved in making a clinical decision about a patient or population; including diagnoses, prognoses, testing and treatment regimes
    b. Is everybody happy with that?
    c. Please note teaching doesn't necessarily mean directly, can refer to skill development in any way, directly or indirectly
4. Structure
    a. Short warm up question
    b. Three research questions – are very similar so may overlap and I may cut them out as I go along
    c. Finally we will discuss the results of my content analysis of curriculum documents so far
    d. Question one will be nominal – meaning you will write down answers individually first then discuss them
    e. Will be butting in and asking questions, or bring you back to task, due to time constraints. May come back to it later.
5. Ground rules
    a. Please contribute to group discussion, share your own opinions – it is these I am interested in.
    b. Please allow others to speak and have their say
    c. After leaving the session, please do not discuss anything that was said today to ensure confidentiality to all participants.
6. Questions?
7. Warm up question
    a. How and when did you learn to make decisions within your field?
    b. Can be vet or non-clinical research
8. Question one – NOMINAL - Where in the curriculum are clinical reasoning skills developed? Anything from whole modules to individual sessions.
    a. What session types?
    b. What years?
    c. What modules?
    d. Any stand out or one off teaching events?
    e. What is the role of EMS? And rotations?
    f. What year do they start to learn CLINICAL REASONING skills?
9. Question two – How effective is current clinical reasoning teaching and learning?
    a. What do we do well?
    b. What do we do poorly?
    c. How good are the reasoning skills of the fifth years/new grads?
    d. Is there a need for improvement?
    e. Do we start at the right time/early enough?
10. Question three – How might we improve the teaching/learning of clinical reasoning skills here at the SVMS?
    a. Is there anything you would add to the curriculum?
    b. Anything you would remove from the curriculum?
    c. What would help students learn reasoning skills? Why?

    d. Should students be taught about the CLINICAL REASONING process?
    e. Have you seen/heard any methods used elsewhere?
11. Results discussion – these are the results I have had so far. I did a content analysis on all the documents I could find about the curriculum. I would like your opinions on my findings – they are not set in stone just what is shown by the official documents. What do you think?
    a. Lectures are the timetabled session most often associated with clinical reasoning (or associated skill) learning objectives.
    b. Very limited clinical reasoning development occurs in the first two years of the five year course.
    c. There is limited reference to clinical reasoning skill development in AHEMS/CEMS documents.
        i. Do you agree with these findings?
        ii. Why is each session type important?
        iii. How do each session type improve CLINICAL REASONING skills?
        iv. If you agree with 2, why?
        v. Should it occur in the first two years?
        vi. Is EMS important? Why?
        vii. Why is there limited references in EMS?
        viii. Why have I found these results?
12. Anything further to add?
13. Thank you very much for participating.

Appendix 3 – Student focus group questions

1. Housekeeping
    a. Please sign consent form
    b. Please help yourself to pizza at any point
2. My research
    a. Mixed methods study with two main areas
        i. How do SVMS undergrads develop clinical reasoning skills?
        ii. How can this be improved? Involves trialling new methods.
3. Definition of clinical reasoning
    a. The thought process involved in making a clinical decision about a patient or population; including diagnoses, prognoses, testing and treatment regimes
    b. Give example for them of clinical reasoning
    c. Please note teaching doesn't necessarily mean directly, can refer to skill development in any way, directly or indirectly
4. Structure
    a. Short warm up question
    b. Four research questions – are very similar so may overlap and I may cut them out as I go along
    c. Question two will be nominal – meaning you will write down answers individually first then discuss them
    d. Will be butting in and asking questions, or bring you back to task, due to time constraints. May come back to it later.
5. Ground rules
    a. Please contribute to group discussion, share your own opinions – it is these I am interested in. Please also remember that you are all at different stages of your course so will have different skill levels and probably different opinions. That is fine.
    b. Please allow others to speak and have their say
    c. After leaving the session, please do not discuss anything that was said today to ensure confidentiality to all participants.
6. Questions?
7. Warm up question
    a. How important are clinical reasoning skills in veterinary practice?
8. Question one – How confident do you currently feel in your clinical reasoning abilities
    a. How would you feel if you had to consult right now?
    b. How would you feel deciding a diagnosis?
    c. How would you feel choosing a treatment option?
    d. When do you expect to be confident at clinical reasoning?
    e. How well do you think you are taught clinical reasoning?
    f. Are you aware of your own clinical reasoning skills and their development?
9. Question two – What do you find helps improve your clinical reasoning skills?
    a. How useful is seeing practice? Why?
    b. What makes this more or less useful?
    c. How does peer interaction affect them?
    d. How useful are clinical relevance sessions? Why?
    e. How useful are lectures? Why?
    f. How useful are SDLs? Why?
    g. How useful are practical's? Why?
    h. Anything outside vet school?
    i. How do you feel about the results of my work so far that say that lectures are the main way that you are taught clinical reasoning skills?

10. Question three – Can you identify any specific areas of the curriculum that have helped to improve your clinical reasoning skills?
    a. Any specific session types?
    b. Any specific teaching events?
    c. Any specific modules or whole year?
    d. EMS?
    e. Do actor sessions help?
    f. Do interactive lectures help?
    g. Does clinical relevance sessions help?
    h. Does PPS help?
    i. Do wrap up sessions help?
    j. Do rotations help? Which ones? Does consulting on rotations help? Anything else on rotations that has helped?
11. Question Four - What would you like to see implemented to help you improve your clinical reasoning skills?
    a. Is there anything you would add to the curriculum?
    b. Anything you would remove from the curriculum?
    c. Are there any sessions you would like more frequently?
    d. Are there any sessions you would like further developing?
    e. At what stage in the course would you like to be made aware of clinical reasoning?
    f. What would help you learn reasoning skills? Why?
    g. Should you be taught about the CLINICAL REASONING process?
    h. How would you improve any of the sessions or teaching events mentioned earlier?
12. Anything further to add?
13. Thank you very much for participating.

Appendix 4 – Graduate interview questions

1. What was your first veterinary position after leaving university?
    a. Clarify time spent there, species, FT/PT
2. Thinking back to your first few months in practice, how competent did you feel at making diagnoses?
    a. Was there anything you found challenging when diagnosing?
    b. How well did the SVMS prepare you for this for this task? (knowledge and process)
3. How competent did you feel at making treatment decisions?
    a. Was there anything you found challenging about choosing a treatment regime?
    b. Is the anything SVMS could have done to prepare you better for this task?
4. Where in the SVMS curriculum do you feel you learnt how to make clinical decisions?
5. What would you suggest to improve clinical decision making skills in new graduates?

Appendix 5 – Content analysis results

Document	Chapter/section title	Code	frequency
Programme Specification	Curriculum development	Clinical Reasoning	1
	Programme learning outcomes	Related Skills	2
		Clinical Reasoning	2
	Personal and professional skills 1	Clinical Reasoning	1
	Personal and professional skills 3	Related Skills	2
	Neuroscience 2	Related Skills	9
	Haematology and immunology 2	Related Skills	5
	Musculoskeletal system 2	Related Skills	5
	Reproductive system 2	Related Skills	5
	Cardiovascular system 2	Related Skills	5
	Respiratory system 2	Related Skills	6
	Gastrointestinal system 2	Related Skills	7
	Skin, hoof and horn 2	Related Skills	6
	Urinary system 2	Related Skills	5
	Endocrine 2	Related Skills	5
	Clinical practice modules	Related Skills	4
		Clinical Reasoning	1
	BVMedSci transferable skills	Related Skills	1
	BVM BVS intellectual skills	Related Skills	1
		Clinical Reasoning	1
Teaching, learning and assessment handbook	Veterinary personal and professional skills module 1	Clinical Reasoning	1
Self-assessment report one	Factual information (curriculum development)	Related Skills	2
		Clinical Reasoning	1
	Status of subjects and types of training (teaching formats)	Clinical Reasoning	1

	Undergraduate curriculum followed by all students (specific details of modules) (D13PPS)	Clinical Reasoning	1
		Related Skills	1
	Undergraduate curriculum followed by all students (specific details of modules) (D14LCB)	Related Skills	3
		Clinical Reasoning	1
	Undergraduate curriculum followed by all students (specific details of modules) (D14URI)	Related Skills	1
	Undergraduate curriculum followed by all students (specific details of modules) (D14ECN)	Related Skills	5
	Undergraduate curriculum followed by all students (specific details of modules) (D14SHH)	Related Skills	3
	Undergraduate curriculum followed by all students (specific details of modules) (D14GIL)	Related Skills	3
	Undergraduate curriculum followed by all students (specific details of modules) (D14CRS)	Related Skills	2
	Undergraduate curriculum followed by all students (specific details of modules) (D14REP)	Related Skills	1
	Undergraduate curriculum followed by all students (year 5 clinical practice rotations)(Dovecote)(transferred to Scarsdale)	Related Skills	3
	Undergraduate curriculum followed by all students (year 5 clinical practice rotations)(Oakham Small animal)	Clinical Reasoning	1
	Undergraduate curriculum followed by all students (year 5 clinical practice rotations)(PDSA)	Clinical Reasoning	3
	Undergraduate curriculum followed by all students (year 5 clinical practice rotations)(Scarsdale equine)	Related Skills	2
	Undergraduate curriculum followed by all students (year 5 clinical practice rotations)(Farm skills)	Related Skills	1
	Undergraduate curriculum followed by all students (year 5 clinical practice rotations)(Scarsdale farm animal)	Related Skills	1
	Undergraduate curriculum followed by all students (year 5 clinical practice rotations)(Twycross)	Related Skills	2
	Further information (clinical practice and clinical elective specialist practice modules)	Related Skills	3
		Clinical Reasoning	1

	Comments (The veterinary curriculum as preparation for a professional career)	Related Skills	2
	The teaching programme (General learning objectives underlying the curriculum)	Related Skills	1
	Factual information (clinical EMS)	Related Skills	1
Clinical extramural studies handbook	Clinical extramural studies – an overview (aims)	Clinical Reasoning	1
	Appendix A – detailed breakdown of aims	Clinical Reasoning	1
Learning objectives	D11CRS	Related Skills	1
	D11NEU	Related Skills	1
	D12ENI	Related Skills	12
	D13PPS	Clinical Reasoning Related Skills	5 2
	D13PVS	Clinical Reasoning	2
		Related Skills	2
	D14CRS	Clinical Reasoning	1
		Related Skills	62
	D14ENI	Related Skills	95
	D14GIL	Related Skills	73
	D14LCB	Related Skills	22
	D14NEU	Related Skills	22
	D14REP	Related Skills	75
		Clinical Reasoning	3
	D14URI	Related Skills	93
Self-assessment report two	5 (development and publication of learning outcomes)	Related Skills Clinical Reasoning	2 1
Year five handbook	Introduction (by Professor England)	Clinical Reasoning	1
	Evidence based veterinary medicine	Clinical Reasoning	1
	3End of year examinations	Clinical Reasoning	4

	Additional information for your referral medicine rotation at pride VC	Related Skills	4
Learning objectives (rotations)	DWR	Clinical Reasoning	5
	OVHmed	Clinical Reasoning	15
		Related Skills	5
	OVHrot	Clinical Reasoning	5
		Related Skills	3
	OVHeq	Clinical Reasoning	5
		Related Skills	2
	PATH	Clinical Reasoning	2
	SCARsur	Clinical Reasoning	5
	SCAReq	Clinical Reasoning	9
		Related Skills	2
	SCARmed	Clinical Reasoning	13
		Related Skills	2
	TwyZoo worries	Clinical Reasoning	2
		Related Skills	1
	TwyZoo exotics	Clinical Reasoning	4
		Related Skills	1
	VetsNow	Clinical Reasoning	16
		Related Skills	10
	PDSA	Clinical Reasoning	4
		Related Skills	3

Table 3 location of codes identified during the content analysis completed as part of study one

Appendix 6 - Email sent to students before the simulation session

Dear students,

On the first day of your rotation at Pride Veterinary Centre (first opinion) you will be taking part in a simulated consultation exercise.

This simulation session has been developed as a way for you to experience conducting a full consultation by yourself – history, physical exam, diagnosis and treatment. You will each take part in the session individually, while the rest of your group continue with the rotation as normal

The session takes place in the consult room to the right of the Blue Cross room, along the main corridor of consult rooms. When you arrive please knock on the door and wait outside. Each student will run three consultations, with a debrief in-between, lasting about 1.5 hours in total. The clients will be played by actors but they will have real animals with them.

The timetable is as follows:

Student 1 – 9:30
Student 2 – 11.:10
Student 3 – 12:50
Student 4 – 14:30
Student 5 – 16:10

Mike Davies will tell you which number you are in the morning. Please be prompt to your session slot as the schedule is very tight! Make sure you bring your PPE, stethoscopes, pen and calculator. You may wish to bring a notebook too.

It should be a fun day and a great learning experience, so please come with an open mind.
For now, here is your consult list for the morning:

Monday	Smith, Biscuit	D++
	Taylor, Gypsy	seizure??
	King, Jazz	lost weight

See you on Monday,

Claire

Appendix 7 – Case summaries

<u>Case one</u>

Summary of case:	Diarrhoea
Name:	Biscuit Smith
Species	Canine
Ideal Breed:	Any
Age:	5
Ideal Sex:	Any neutered
Reason you brought your pet to the vets:	Biscuit has a bit of Diarrhoea and you think she needs some antibiotics to clear it up VOLUNTEER THIS INFORMATION TO THE VET WHEN ASKED WHY YOU HAVE BROUGHT BISCUIT IN
Additional information about the problem:	Yesterday morning you let Biscuit into the garden and she urinated as usual, but Also passed some diarrhoea. It seemed very watery, but was the usual brown colour and there was no blood or mucus present. She seemed fine in herself and ate her breakfast quickly. You then went out to work for 3 hours, during which time Biscuit normally just sleeps. However, when you got home there were two puddles of brown coloured liquid in the kitchen, with virtually no formed material at all. You assumed this was further diarrhoea and cleaned it up. At this point Biscuit seemed a bit 'run-down' and not her usual excited self. You gave her a dog treat to cheer her up and she ate it quickly. You stayed home with Biscuit for the rest of the day, letting her out regularly to go to the toilet. You estimate she probably opened her bowels 4 more times that day. While you were at home she mostly slept, but she was very keen for her walk at 4pm and was very lively throughout it. You fed her at 6pm and again she ate it all. She did, however, ask to be let out half an hour after eating, but you couldn't see her going to the toilet as it was dark, so you don't know if there was more diarrhoea. After this she seemed to fall asleep, and was fine until you went to bed yourself. This morning, you were pleased to find there had been no accidents overnight – however Biscuit still did not seem right; she didn't bark as she usually does in the morning when she hears you coming down the stairs. You also think she looks sad. She had another bout of diarrhoea when you let her into the garden, it did not look as watery today but there did seem to be some green mucus in it. Biscuit ate her breakfast much more slowly this

	morning, and twenty minutes afterwards she defecated in the kitchen. Again, it was thicker than yesterday with some mucus. At this point you rang the vet as you decided she might need some antibiotics. ONLY TELL THIS INFORMATION TO THE VET WHEN DIRECTLY QUESTIONED ABOUT IT – E.G. 'WHAT COLOUR WAS THE DIARRHOEA? HOW IS SHE IN HERSELF?' YOU CAN START BY GIVING BASIC INFORMATION AND ADDING IN MORE DETAIL WHEN QUESTIONED FURTHER. YOU CAN BE VAGUE WITH ANSWERS – FOR EXAMPLE SAYING FLOWER JUST LOOKS 'SAD' OR 'NOT HERSELF'.
Other information about the animal:	Biscuit is vaccinated every year – but not at this practice – you take her to a Vets4Pets where the vaccinations are cheaper (but you don't think the vets are as good). You are not sure what they vaccinate her against. You worm her occasionally with a tablet you get from the pet shop (Bob someone?) but you don't use a flea treatment on her unless you see her itching as you don't like the thought of all those chemicals on her fur. The last time you wormed her was about 6 months ago. She has never had any problems before and has only been to this practice to be neutered. ONLY GIVE THIS INFORMATION TO THE VET IF THEY DIRECTLY ASK ABOUT IT – E.G. IS BISCUIT VACCINATED? WHEN DID YOU LAST WORM HER? HAS SHE HAD ANY PROBLEMS IN THE PAST?
Other information about owner:	You have owned several dogs before, so you are quite confident about looking after them. You think you have a very good 'understanding' of Biscuit and her personality. One of your previous dogs used to be given antibiotics from the vet when he had diarrhoea and vomiting, so you are sure that if they are prescribed for Biscuit she will clear up in no time. That vet was Mr Baker, one of the practice partners, so you are hoping to be seen by him today. You are a person that speaks your mind very clearly and will do so at the vets today if you are not happy about anything. You are not overly worried about the diarrhoea but you are getting a bit irritated at having to clean the mess up. You run your own business from home as a life coach, but occasionally do home-visits to clients. Your husband works away from home 5 days a week as a banker in London. You have one son, 13, who is away at boarding school at the moment. THIS IS PRIVATE INFORMATION. THE VET MAY NOT ASK DIRECT QUESTIONS ABOUT IT, BUT YOU MAY REFER TO IT IN ANSWERS

	TO OTHER QUESTIONS. FOR EXAMPLE, 'HOW CAN I HELP YOU TODAY?' 'OH, AREN'T I SEEING MR BAKER, I USUALLY SEE HIM'.
In the consult:	You are very keen to be given antibiotics for Biscuit, and will argue with the vet if they don't prescribe them. You don't think a young vet knows better than the experienced Mr Baker did and you might make that clear! If the vet does give you medication, make sure you know how to use it when you get home – you may need to question the vet if they do not tell you themselves. You can be a pain in the neck to the vet in this consult, and just generally disagree and question the vet's recommendations until they give you clear reasons.
History for student:	13/4/2011 – admit for spay, exam NAD, last season 4 months ago. 13/4/2011 – routine bitch spay, premed ACP and vetergesic, knock down with propofol, ligated with cat gut, closed with PDS, skin closed with intradermals. No bleeding. 13/4/2011 – Discharged, given buster collar and sensitivity diet, 5 days metacam. 15/4/2011 – post op check, wound healing well, all fine on exam. O reports bright after op and eating now. 20/4/2011 – post-op check. Healed nicely, Biscuit v comfortable in abdo. Back to normal self at home. Metacam finished.

Case two

Summary of case:	Idiopathic epilepsy – first seizure
Name:	Gypsy Taylor
Species:	Canine
Ideal Breed:	Labrador
Age:	3 years
Ideal Sex:	Either
Reason you brought your pet to the vets:	Gypsy had a fit last night. You rang the emergency vets and they told you to bring him to your normal practice in the morning. VOLUNTEER THIS INFORMATION TO THE VET WHEN ASKED WHY YOU HAVE BROUGHT GYPSY IN

Additional information about the problem:	You were woken up last night at 1am by strange noises and banging coming from the bottom of the bed. You got up and saw Gypsy lying on his side on the floor; his eyes were open and fixed on something in the distance. He seemed very stiff and all four legs were moving, as if he was running. You called his name but he didn't respond. At this point you got very worried, but were too scared to touch him. You noticed he had urinated and defecated. You ran for the phone and called the vet practice, but their answer machine kicked in and asked you to call their 'out of hours' vet on a different number. You write it down and call it straight away, but while the phone was ringing Gypsy seemed to calm down a bit – his movements stopped and he relaxed and started panting. The whole thing seemed to last 2-3 minutes. You stroked him as you spoke to the vet on the phone and described the incident. The vet said it sounded like he was having a seizure, and since he is now OK it was best to wait until the morning and then take him to your usual vets. You were quite shocked by this, thinking that Gypsy needed to be seen straight away. The vet on the phone explained that Gypsy should be fine now, but if he has another seizure to call back. He then said he had to go as another emergency had arrived and said goodbye. You were very worried about Gypsy and stayed up for an hour or so with him, before letting him on the bed to fall asleep. During this time he seemed spaced out and disorientated and he fell to sleep quickly. This morning you didn't feed him and were too worried to take him for a walk, in case it triggered another fit. You rang your practice as soon as they opened and booked the first available appointment. Gypsy has seemed completely back to normal. ONLY TELL THIS INFORMATION TO THE VET WHEN DIRECTLY QUESTIONED ABOUT IT – E.G. 'CAN YOU TELL ME WHAT HAPPENED'. DO NOT INCLUDE ALL THE DETAIL, JUST TELL THE VET THE BASIC INFORMATION. YOU CAN THEN ADD MORE DETAIL AS AND WHEN YOU ARE QUESTIONED ABOUT IT. REFER TO THE SEIZURE AS A 'FIT' AND DO NOT DESCRIBE IT UNLESS ASKED ABOUT SPECIFIC FEATURES (E.G. HOW LONG DID IT LAST? WAS HE AWAKE?). YOU CAN VOLUNTEER INFORMATION ABOUT THE CALL TO THE EMERGENCY VET, WHICH YOU ARE UNHAPPY WITH. YOU CAN TELL/SHOW THE VET HOW WORRIED YOU ARE ABOUT GYPSY FROM THE START.

Other information about the animal:	Gypsy is vaccinated every year, and you flea treat him every couple of months when you can afford it, using Frontline that you get from a chemist. You last wormed Gypsy about a year ago but you can't remember what with. Gypsy has a good appetite and goes for an hour long walk every day. He has never had any medical problems, except once breaking a claw on his back leg (you can't remember which). It was hanging off and bleeding so you brought him to the vets where it was clipped off and the bleeding stopped. It hasn't bothered him since. Gypsy is not insured. ONLY GIVE THIS INFORMATION TO THE VET IF THEY DIRECTLY ASK ABOUT IT – E.G. IS GYPSY VACCINATED? WHEN DID YOU LAST WORM HIM? HAS HE HAD ANY PROBLEMS IN THE PAST?
Other information about owner:	Gypsy is the first dog you have owned, and you have no other pets. You work during the day (as a Teaching assistant), and Gypsy is left alone in the house. At 1pm your retired neighbour comes round and takes Gypsy for an hour long walk. You have very limited understanding of medical terms. Your financial situation is tight – you will always pay for necessary veterinary treatment for Gypsy, but it puts a strain on your wallet and for sums over £75 you may have to borrow money from your sister. You are not married and have no children, so Gypsy means a lot to you. THIS IS PRIVATE INFORMATION. THE VET WILL PROBABLY NOT ASK DIRECT QUESTIONS ABOUT IT, BUT YOU MAY REFER TO IT IN ANSWERS TO OTHER QUESTIONS. FOR EXAMPLE, 'COULD GYPSY HAVE HAD OTHER SEIZURES THAT YOU HAVE NOT NOTICED?' 'YES, I AM OUT MOST OF THE DAY AT WORK, HE COULD HAVE HAD ONE THEN.'
In the consult:	You are very worried about Gypsy and should show this. You should get upset when talking about the topic. You should not be rude, but you can be abrupt if the vet is not making complete sense to you. You are also concerned about finances, and are hoping that sorting this out won't cost more than £75, which you have brought in cash today. When you discuss cost, be frank about what you can afford and how challenging it will be you to get large sums of money together. You can agree to diagnostics or treatment up to the value or £150, but no more. Whilst you are at the vet, you should complain about the 'out of hours' service – you think Gypsy should have been seen as an emergency last night. If the vet explains the situation, likely cause and investigation/treatment options clearly to you then you should relax a bit and take their advice.
History for student:	2/09/13 – O new to practice. Fully vaccinated until now, no previous history other than vaccinations and castration. Vaccs today – DHPPI, L and KC. Exam NAD.

	14/05/14 – O brought in as claw on fifth digit RH is broken almost in half – loosely attached. Trimmed claw off, minimal bleeding, stopped with silver nitrate pencil. 4/09/14 – Vacc with PI, L and KC. Exam NAD.

Case three

Summary of case:	Weight loss
Name:	Jazz Brown
Species	Canine
Ideal Breed:	Any
Age:	9
Ideal Sex:	Any neutered
Reason you brought your pet to the vets:	You brought Jazz in to have her claws clipped, as you do every two months. In the consultation the nurse seemed worried because Jazz has lost weight since she was here last time. The nurse asked you to wait and see the vet, explaining that you will have to pay a £30 consultation fee. VOLUNTEER THIS INFORMATION TO THE VET WHEN ASKED WHY YOU HAVE BROUGHT JAZZ IN
Additional information about the problem:	Jazz has been coming to have her claws clipped at the practice every two months. You have a 3 year old daughter so you want to make sure Jazz won't accidentally scratch her. The last time you had her claws clipped the nurse mentioned she had lost a bit of weight. This didn't particularly worry you, although you haven't changed her feeding or exercise regimes. Today, when the nurse weighed Jazz, she said she had lost 1kg in the last 2 months, which the nurse said was a lot. You thought hard, but cannot think of anything you are doing differently with Jazz that might have caused her to lose weight. She seems to have a normal appetite. You do agree, however, that she looks a bit thinner than usual. The nurse said you should talk to the vet about it, but then mentioned that it would cost £30 for the consultation. You agreed. ONLY TELL THIS INFORMATION TO THE VET WHEN DIRECTLY QUESTIONED ABOUT IT – E.G. 'HAVE YOU CHANGED HER EXERCISE REGIME LATELY?'
	Jazz is registered for the pet health plan at the practice. This means she gets regular vaccinations, flea treatment and worming

Other information about the animal:	– although you are not sure when each is due next as you rely on your calendar for that. You also get a discount on claw clipping with the plan. Jazz goes for a half-an-hour walk every morning – your husband takes her before he goes to work. You feed her a bowlful of Bakers Complete in the morning and half a bowlful at night – she normally eats it all. You did not feed her this morning however, as you were in a rush. She isn't really interested in human food, so doesn't get may 'tid-bits' or treats. She has always been in good health, apart from the odd bout of diarrhea or sickness. She is quite lively, thought has calmed down as she has gotten older. You haven't noticed anything wrong with her at the moment, though you think she might be drinking a bit more than usual. You haven't measured her water intake, but you think you may be finding the bowl empty more often than usual. You have kept the same exercise and feeding routine for several years, since you moved to the area. ONLY GIVE THIS INFORMATION TO THE VET IF THEY DIRECTLY ASK ABOUT IT – E.G. IS JAZZ VACCINATED? WHEN DID YOU LAST WORM HER? HAS SHE HAD ANY PROBLEMS IN THE PAST? YO CAN START WITH THE BASIC INFORMATION AND ADD MORE DETAIL IF PROMPTED.
Other information about owner:	You are a nursery nurse, and live at home with your husband and 3 year old daughter. You are fairly comfortable financially, and Jazz is insured with pet plan (your excess is £150). Last month your mother died from pancreatic cancer, and you are still very sensitive about the subject. You have no other pets. THIS IS PRIVATE INFORMATION. THE VET MAY NOT ASK DIRECT QUESTIONS ABOUT IT, BUT YOU MAY REFER TO IT IN ANSWERS TO OTHER QUESTIONS. FOR EXAMPLE, 'A BLOOD TEST WILL COST £100' 'THAT IS OK, JAZZ IS INSURED'.
In the consult:	You are willing to spend money to help Jazz, but only if you sure that the procedures/treatment are necessary, so make sure the vet justifies them to you adequately. You have no idea what is going on, and don't really know what type of problems would cause Jazz to lose weight. If the vet does not tell you the possible causes, you will ask him. If the vet mentions cancer, it will bring back memories of you mother and you will become agitated. You are not sure what information is helpful for the vet, so only divulge information when asked. You do, however, ask a lot of questions.
History for student:	(weight loss to work out as 10% of normal weight of canine actor – examples given here) 1/11/14 – claws clipped, no problems. Weight (+1kg) – has decreased but O not sure why. Pls weigh again at next clip

	5/10/14 – Advocate and Droncit 6 month supply dispensed 1/9/14 – Routine claw clip. Weight (+1kg) 1/7/14 – Claw clipped, digit 2 on RF bled slightly – stopped with SN pencil. Weight (+0.5kg) 1/5/14 – Claw trim, front claws all long. Rear claws didn't need clipping. weight (+0.0kg). Joined Pet Health Club. Vacc DHPPI, L, KC. Advocate and Droncit 6 months supply dispensed. 1/3/14 – O would like to have claws clipped regularly as worried about daughter getting scratched. They are quite long today so adv trying every two months and increase/decrease as necessary. Trimmed with no problems. (+0.0kg) NEW CLIENT

Appendix 8 – Simulation mark points

Case	History	Clinical Exam	Treatment plan
Diarrhoea	• Onset/duration? • Description including blood/mucus presence? • Frequency? • Eating/drinking? • Vomiting? • Lethargy? • Dietary indiscretion possibility? • Previous occurrence?	• Eyes, mm colour • Mouth, CRT, MM feel • Chest auscultation • Abdominal palpation • LN palp	• Starve/bland diet/sensitivity diet • Prokolin/kaolin/other
Seizure	• Description of episode? • Clarify points to confirm neurological cause • Eating/drinking? • Behaviour/health before episode? • Behaviour/health after episode? • Possibility of toxin ingestion?	• Eyes, mm colour • Mouth, CRT, MM feel • Chest auscultation • Abdominal palpation • PLR, observe walking and balance, knuckling reflex – quick parts of neuro exam!	• Offer blood test • Do not have to insist on this, just recommend to the owner as a precaution.
Weight Loss	• Change in diet? • Change in exercise? • Eating normally? • Urination frequency/drinking frequency? • Vomiting/Diarrhoea? • Worming status • Behaving normally (lethargy etc)?	• Eyes, mm colour • Mouth, CRT, MM feel • Chest auscultation • Abdominal palpation • LN palp	• Advise blood test • Advise urinalysis – dipstick and SG

Table 4 checklist of points that should be included in the history, physical exam and treatment plan of each simulation case

Appendix 9 – Simulation survey

	Strongly Disagree	**Disagree**	**Somewhat Disagree**	**Somewhat Agree**	**Agree**	**Strongly Agree**
Question	**1**	**2**	**3**	**4**	**5**	**6**
The session was enjoyable						
The session was a good use of my time						
I would like to participate in a session like this again						
My knowledge improved during the session						
My practical skills improved during the session						
My overall confidence in making decisions improved during the session						
My overall ability to reach a diagnosis has improved as a result of the session						
My overall ability to form a treatment plan has improved as a result of the session						
I feel more prepared to undertake small animal consultations now						
I found the session challenging						
I found the session demoralising						
I found the session and scenarios unrealistic						
I felt embarrassed participating in the session						
The feedback sessions were informative						
The feedback sessions were demoralising						

Appendix 10 – Simulation focus group questions

1. How did you feel prior to the simulation?
    a. Did you research the consultation topics?
    b. Did you feel motivated to perform well? Why?

2. Describe how you made you clinical decisions during the simulation?
    a. What influenced them?

3. How has the session made you feel more prepared for practice? (as marked on feedback forms)
    a. Decision making
    b. Coping with uncertainty

4. How does the session differ from:
    a. Completing similar cases on paper?
    b. Consulting with a clinician on rotations?

5. How would you improve the simulation session?
    a. When in the rotation year would it be most beneficial?
    b. What would you like more practice doing?

Appendix 11 – The Decision Diary

The University of Nottingham

UNITED KINGDOM · CHINA · MALAYSIA

School of Veterinary Medicine and Science

Decision Diary

Name:

Year:

This diary is intended to help you understand and reflect on how veterinary surgeons make clinical decisions in consultations. Clinical decisions include diagnosis, management, therapeutics and owner factors.

Choose a consultation where a vet made clinical decisions that you would like to know more about (e.g. how did they know reach that diagnosis?), then complete the following form with the vet. You can add your own questions when necessary.

Please complete sections one and five (highlighted red) by yourself. Complete as many as possible during your placement, with a variety of cases, so that you may be exposed to different methods of decision making. These diary entries can then be put into your portfolio.

Date: Location:

1. Background

Give a brief outline of the scenario

2. Noticing

What were the vets initial ideas about the case - from the history, reason for visit and first impressions?

Did these change as the consultation progressed? Explain why

3. Interpreting

What experiences has the vet had that influenced their diagnosis in this case? For example formal knowledge, previous experience with a similar problem and/or personal experiences. How did they help the vet reach a decision?

4. Responding

What treatment/management decisions did the vet make? Why? What factors influenced them?

5. Reflection

What are the pros/cons about making clinical decisions the way this vet did?

What have you learnt that might help you when you come to make your own clinical decisions in the future?

Appendix 12 – Decision Diary survey

Type of placement: small animal / equine / farm / exotics / other (circle all that apply)

	Strongly disagree	**Disagree**	**Somewhat Disagree**	**Somewhat Agree**	**Agree**	**Strongly Agree**
The Decision Diary was easy and practical to use						
It was easy to find time to complete the Decision Diary						
Most vets were co-operative when asked to discuss their cases						
The Decision Diary facilitated clinical conversation between the vet and myself						
The Decision Diary helped me understand how the vets I worked with made their clinical decisions						
After using the Decision Diary, I feel better equipped to make my own clinical decisions						
I would recommend using the Decision Diary to other students wanting to improve their clinical decision making skills						
Using the diary was a waste of my time on CEMS						
I found vets did not have the time to discuss their cases with me						
Using the Decision Diary has not affected my clinical decision making ability						

Appendix 13 – Decision Diary focus group questions

1. How easy was it to use the Decision Diary
   - Practicality
   - Size
   - Interacting with vets
2. How did you use the Decision Diary
   - What situations?
   - What type of cases?
   - How soon after you saw the case did you fill it in?
   - Did you add your own notes/do anything differently?
3. How useful was completing the Decision Diary?
   - Did it help you start conversations with the vet about their decisions?
   - Did it help you understand how they had reached the decision they made?
4. Would you make any changes to the Decision Diary or the way it is used?
5. Would you recommend the use of the Decision Diary to other students?
   - Why/why not