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Training for uncertainty in Veterinary education

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Submitted in fulfilment of the requirements for the degree of Doctor of Health Professions
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Abstract

This thesis addresses the question of how veterinary students learn to cope with uncertainty in professional practice. There is currently a lack of clarity in discussion of what constitutes effective coping with uncertainty in veterinary practice and indeed how this might be taught or assessed as part of the veterinary education process. This is despite wide recognition that managing uncertainty is central to practice in the health professions, reflected in the fact that the ability to cope with uncertainty is considered a “day one competency” for veterinary surgeons.

This research adopted both extensive and intensive perspectives to address the central research question. Orienting concepts were developed from the literature on workplace learning, approaches to clinical uncertainty and individual differences in tolerance of uncertainty and ambiguity.

The extensive perspective used a survey study to describe tolerance of ambiguity among veterinary students at a UK veterinary school. On average, ambiguity tolerance did not change during the classroom based part of veterinary training. Individual trajectories were often more erratic and some students moved between the highest and lowest categories during the course of training. Previous education and status as a mature student were both associated with greater tolerance of ambiguity, suggesting that educational and life experiences can produce changes in this disposition.

The intensive perspective comprised a qualitative case study, using clinical case discussion recordings and semi-structured interviews to develop an understanding of the mechanisms which influence learning to cope with uncertainty in the context of an international elective placement. Using the language of situated learning theory, learning to cope with uncertainty was described as legitimate peripheral participation in the uncertainty work of a community of practice. Uncertainty work is a novel concept used to describe navigating ambiguity, complexity and risk in professional practice.

Using this theoretical framework to draw together findings from both intensive and extensive perspectives suggested the central role of gaining access to uncertainty work in professional learning. Generative mechanisms have been proposed to explain the empirical findings. Access to uncertainty work was negotiated between students and staff in the context of clinical and educational practice. Trust was central to gaining access to uncertainty work, and this was reflected in increasing clinical responsibility. Ambiguity tolerance was described in this context as a disposition of individuals which can influence their engagement with and access to uncertainty work.



Through an exploration of the significance of these mechanisms in the context of Veterinary education, implications for curriculum and policy have been highlighted. Although the use of measures of ambiguity tolerance in selection are considered problematic, there can be clear scope to support students in accessing uncertainty work and to highlight encounters with uncertainty work as integral to the professional role, providing opportunities to promote personal and professional development through reflective practice.

(458 words)

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Author's declaration

I declare that, except where explicit reference is made to the contribution of others, that this dissertation is the result of my own work and has not been submitted for any other degree at the University of Glasgow or any other institution.

Definitions and abbreviations

Activity system: A key concept in Activity Theory (Vygotskiĭ & Cole 1978); a way of understanding collective human activity through consideration of the relationships between individuals, their actions and culture over time.

Ambiguity tolerance (AT): The orientation of individuals to ambiguous stimuli or events (see also Intolerance of ambiguity below)

Case discussion: A conversation about a patient and their clinical condition. In the context of my research, the term is used to describe a specific conversation between staff and student regarding an animal patient.

Cognitive bias: tendency to adopt a certain mental perspective

Cognitive load: impact on working memory

Community of Practice (COP): A key concept in Situated Learning Theory (Lave & Wenger 1991) which denotes a social group with shared purpose through which learning opportunities can be accessed.

Day 1 competencies: A statement of the knowledge, skills and attributes expected of new veterinary graduates

EMS (Extra mural studies): training opportunities provided outside of Vet School and typically including placements on farms and in private veterinary practices

EPA (Entrustable Professional Activity): a form of assessment recently introduced into post-graduate medical training and based on the premise that trainees are deemed competent with a new task when a supervising physician elects to trust them to perform this independently.

Intercalation: Completing an additional 1-2 years of study part way through a professional degree which allows graduation with an additional degree (e.g. Bachelor's degree, Master's degree)

Intolerance of ambiguity (IA): Essentially the same as AT (see above) but presented in a different way i.e. the tendency to perceive ambiguous situations as a source of threat.

Intolerance of uncertainty (IU): A cognitive bias that affects how a person perceives, interprets, and responds to uncertain situations.

Iterative: Moving back and forth in analysis in an attempt to find an optimal solution

Naturalistic decision making: An approach to studying decision making which involves observing and analysing decisions in a real-world context, rather than in controlled experimental settings.

Need for cognitive closure (NCC): Wanting a firm answer to a question and therefore showing an aversion toward ambiguity

Royal College of Veterinary Surgeons (RCVS): The professional body responsible for regulation of the UK veterinary profession with responsibilities for accreditation of programmes of veterinary education



Rotation: A clinical placement (typically less than 8 weeks long) undertaken by students in the later stages of professional training

Rounds discussion: A formal opportunity for the clinical team to discuss the management and condition of patients in a clinical setting. In the context of my research, rounds discussion refers to an educational meeting which incorporates a number of separate case discussions (see above).

Tacit knowledge: Knowledge of which we are consciously unaware because it is so integral to familiar activities.

Uncertainty avoidance (UA): The extent to which a society attempts to minimise uncertainty, closely related to uncertainty orientation.

Uncertainty orientation (UO): A characteristic of cultures which describes how uncertainty is framed within cultural norms and expectations – closely related to uncertainty avoidance.

Uncertainty work: A phrase I have coined to describe ‘that which must be done to cope with uncertainty in clinical practice’. This developed through the research process towards a final definition of ‘handling uncertainty in practice’.

Unit of analysis: The way in which a case study researcher elects to partition their data – a unit of analysis might be an interview, a collection of documents or an individual participant, for example.

Working equids: Donkeys, mules and horses used to assist in physical work such as carrying loads and traction.

Zoonotic: Disease which can be passed from animals to humans.

1 Introduction to the thesis

1.1 Introduction

This thesis describes a research study exploring how veterinary students learn to cope with uncertainty in professional practice. The context of the study is a UK Veterinary School and associated clinical facilities where students learn. The thesis describes two complementary research projects designed to illuminate different aspects of learning to cope with uncertainty. The first focuses on individual differences in ambiguity tolerance in a population of veterinary undergraduates, and how these differences relate to professional training. The second is a case study exploring the experiences of students and staff participating in an international elective placement based at a charity clinic for working equids.

In this first chapter, I introduce the structure of the thesis, the area of study and the specific context of the research.

1.2 Structure of the thesis

The thesis is structured in four parts. The first part (Chapters 1-3) provides an overview of the subject area a review of literature relating to the orienting concepts for this research and an explanation of the philosophical perspective that informs the methodology. The second part (chapters 4 & 5) describes the first study: a survey of ambiguity tolerance in undergraduate veterinary students; chapter 4 describes the background and methods, chapter 5 focuses on the results of the study and includes a short specific discussion. The third part (chapters 6-9) describes the qualitative case study: chapter 6 explains the background and methods, chapter 7 presents the results of a descriptive analysis of the uncertainty work of study participants and in chapter 8 I examine the value of situated learning theory as the basis for understanding how students learn to cope with uncertainty in this context. In chapter 9 I discuss the findings of the case study. The final part draws together the findings from the two related studies in a general discussion, suggesting implications for practice and drawing conclusions (chapter 10).

1.3 Uncertainty in professional practice

The ability to cope with ambiguity and feelings of uncertainty is central to professional practice. Professionals must deal with situations which are complex and unpredictable and where they must balance conflicting interests and needs (Fook, Ryan & Hawkins, 2000). Donald Schon describes these as the indeterminate zones or 'swampy lowlands' (1995, p.28) of professional practice.

Professions have their origins in societies where the possession of a unique base of knowledge and skills conferred both trust of the public and the ability to charge for

services (Evetts 2003). The protection of this status is seen to be critical for the continued existence of the professions. In the past there has been recognition that expressions of uncertainty could risk this privileged status and it is proposed that processes of professional socialisation have developed to frame this uncertainty in acceptable ways (Light 1979; Lingard, Garwood & Schryer 2003; Vaidyanathan & Brandon 2015).

As society changes and the claim to mastery of a unique body of propositional knowledge is eroded by increasing availability of information and wider education (Haug 1976), the professions have had to redefine their roles (Timmermans & Oh 2010). For example, an increasing focus on evidence-based medicine aims to define best-practice for physicians and creates a new scope for professional mastery in the interpretation and appraisal of a growing body of available information (Timmermans & Angell 2001).

In the health professions, the uncertainty which is central to professional practice may relate to complexity of medical cases, indeterminate outcomes and ambiguous or missing data (Han, Klein & Arora 2011). Many factors can contribute to uncertainty in the clinical context including the inherent variability in patients and disease processes, interpretation of ambiguous clinical and diagnostic findings, and difficulty differentiating between individual knowledge deficits (“what I don’t know”) and areas which are truly unknown or unknowable (“what we don’t know”) (Hall 2002; Ghosh 2004; Beresford 1991).

1.4 Uncertainty in Veterinary practice

The role of the veterinary profession is to promote animal health and welfare, public health and to protect the environment (Economides 2007). The veterinary profession has much in common with human-health professions. A large proportion of veterinary surgeons currently work in clinical practice roles (Robinson, Williams & Buzzeo 2014). In these roles they are responsible for communication with clients, advising on animal health and welfare, investigation of disease, making a diagnosis, and undertaking medical and surgical treatments.

The Royal College of Veterinary Surgeons stipulate in their “Day-1 competencies” that new Veterinary graduates should be able to cope with uncertainty including that related to incomplete information or rapidly changing environments (RCVS 2014). The ability to cope with uncertainty is acknowledged to be an important attribute facilitating the transition from student to practitioner in the Veterinary profession (Rhind, Baillie, Kinnison & others 2011) yet there is limited understanding of what constitutes effective coping with uncertainty and how undergraduate vet students and qualified practitioners actually manage uncertainty in professional practice.

A small but growing literature looking at communication and clinical decision making in veterinary practice recognises the complexity of the situations in which veterinary surgeons practice (for example, Kleen, Atkinson & Noordhuizen 2011; Vandeweerd & Kirschvink 2012). The process of clinical consultation in veterinary companion animal practice is a complex one and is frequently non-linear in structure (Everitt 2011; Vandeweerd & Kirschvink 2012). Veterinary surgeons adopt an iterative approach to collection of information through speaking to clients and physical examination of their animal patients; simultaneously evaluating this information and adjusting their approach based on developing hypotheses about diagnosis and incorporating clients' priorities and patient-related constraints (Everitt 2011). Uncertainties in the context of clinical consultation relate not only to biomedical aspects of practice but also social and contextual influences.

There is recognition that veterinarians use both analytical and non-analytical approaches to decision making in practice (Vandeweerd. 2012; Canfield, Whitehead & Johnson. 2016a; Canfield, Whitehead & Johnson. 2016b; Whitehead, Canfield & Johnson. 2016). Analytical approaches are systematic, structured and typically produce a higher cognitive load than non-analytical approaches which tend to rely on cognitive shortcuts (heuristics), pattern matching and intuition (Eva 2005). Evidence from medical contexts suggests that in situations which are time limited and which are uncertain, complex or ambiguous, non-analytical strategies are frequently adopted by decision makers (Hall 2002; Gorini & Pravettoni 2011). Although these non-analytical decision processes are considered particularly vulnerable to cognitive bias and hence error, there is a growing recognition of their value in expert decision-making (Eva & Norman 2005; Hicks & Kluemper 2011) and decisions made in real-world complex situations (Gigerenzer & Goldstein 1996).

The Veterinary profession has a number of differences in practice that may lead vets to experience different or greater uncertainty than their medical colleagues. Training or limited licensure in veterinary education is uncommon, meaning that veterinary graduates train to treat multiple species, often across very different paradigms of clinical practice (Klosterman, Kass & Walsh. 2009; Crowther, Hughes & Handel 2014). This requires a broad knowledge, and the ability to adapt and transfer knowledge from one species to another, as well as a certain flexibility in outlook, which may require veterinarians to move between adopting an economically efficient herd-based approach in production animal practice, to the individual companion animal care provided for a family pet. Although many veterinary surgeons choose to limit their area of practice after graduation, genuine specialisation in veterinary practice is still much less common than in medical practice, with only 8% of practicing vets in the UK working in referral or specialist practice contexts (Robinson, Williams & Buzzeo 2014). The 'broad church' of the veterinary profession also

produces ethical dilemmas for veterinary professionals who must balance their responsibility for animal welfare with the wishes of paying clients, economic limitations and very different approaches across different practice areas (Donaldson, Fistein & Dunn 2010; Batchelor , Creed & McKeegan. 2015; Batchelor & McKeegan 2012).

The frequency of working in primary care roles (Robinson et al. 2014) where resource limitations and co-morbidity can produce complex and challenging caseloads (Robinson, Brennan, Cobb & Dean 2015), is compounded by the limited evidence base in veterinary practice (Vandeweerd, Kirschvink & Clegg 2012). Although the field of evidence based veterinary medicine is growing, with initiatives to develop good practice guidelines and evidence summaries (Hardin & Robertson 2006) , there are few of the large scale clinical research studies which inform practice in the medical professions, and skills required to adopt an evidence based approach are seen as lacking (Vandeweerd et al. 2012). This means that veterinary surgeons are often working with incomplete information about, for example, the relative efficacy of different patient-management options (Schmidt 2007).

1.5 Uncertainty and professional education

The process of accreditation for professional programmes of education typically requires that institutions demonstrate that their programme prepares students to meet specific learning outcomes, which are closely aligned to professional competency frameworks. The adoption of outcome-based education as a dominant paradigm in health professional education (Harden 2015) focuses curriculum design closely on professional competency (Harden 2015; Harden 1999; Frank , Snell & O.Cate 2010; Hodgson, Pelzer & Inzana 2013). Hence, what might constitute appropriate teaching, learning and assessment in 'coping with uncertainty' has been the subject of some debate and training for uncertainty is described as a neglected, yet critically important, element of medical curricula (Luther & Crandall 2011; Hall 2002; Geller, Faden & Levine 1990).

One of the challenges in addressing how coping with uncertainty, ambiguity and complexity should feature in the curricula of the Health professions is that we lack a clear consensus about the desired outcome. In contrast to areas such as surgical skills training, where there is some clarity about what constitutes competent performance, we have yet to develop a framework to describe what constitutes effective coping with uncertainty in professional practice. For example, although the CANMEDS framework (Frank JR, Snell L, Sherbino J 2015), one of the most detailed used in medical education, states that newly qualified physicians need to: "*Recognize and respond to the complexity, uncertainty, and ambiguity inherent in medical practice*" there is little detail regarding what responding might entail.

It may be that coping with uncertainty entails primarily tacit knowledge and cannot be verbalised, or that formal professional discourse tends to minimise rather than share uncertainty and risk taking (Eraut 2000). However, there are also limitations of competency as a concept. Adoption of a capability approach in professional training is one alternative (Fraser & Greenhalgh 2001). Professional capabilities are considered to go beyond competence; whereas competence is described as what individuals know or are able to do in terms of knowledge, skills, and attitude, capability is the “*extent to which individuals can adapt to change, generate new knowledge, and continue to improve their performance*” (Fraser & Greenhalgh 2001). The GMC (General Medical Council) in the UK has recently completed a consultation on capabilities of medical professionals, which includes a series of statements relating to “*recognition and response to the complexity, uncertainty, and ambiguity inherent in medical practice*” (General Medical Council 2016). It seems likely that a capability approach will also be of relevance to veterinary practice.

As well as facilitating learning, programmes of professional education are charged with making high stakes assessment decisions based on competency and performance. There is a growing recognition that common approaches to assessment are inadequate for capturing what are effectively capabilities rather than competencies, and therefore alternative approaches and different expectations may be needed (Engebretsen et al. 2016; S W Fraser & Greenhalgh 2001; Frank et al. 2010)

Assessment techniques where students are asked to make decisions, such as script concordance tests (Charlin, Gagnon & Pelletier 2006; Charlin & Van Der Vleuten 2004) or situational judgement tests (Patterson, Zibarras & Ashworth 2015), include reasoning under well-defined conditions of uncertainty. It is also significant that the adoption of entrustable professional activities (EPAs) as a method of competency assessment in postgraduate education (Ten Cate 2013), provides scope for tacit aspects of performance to influence assessment decisions as much as those which can be captured on a formal checklist or structured exam question.

Coping with uncertainty is not just important for the clinical practice of professionals, it may also be important for their own wellbeing. Individual differences in attitudes to ambiguity and uncertainty can influence emotional responses to uncertainty and have been highlighted in discussions of selection to professional training (Geller 2013; Geller et al. 1990; Wayne, Dellmore & Serna 2011). Despite recent suggestions that uncertainty is reframed as a constructive element of clinical practice (Engebretsen et al. 2016), clinical uncertainty is generally seen as a negative aspect of clinical practice and there is evidence that uncertainty in diagnosis and case management in the medical context can cause stress in patients and physicians (Ghosh 2004). Anxiety related to uncertainty has



been cautiously associated with stress and burnout in groups of medical professionals (Kuhn, Goldberg & Compton 2009; Cooke, Doust & Steele 2013). This potential association has not yet been explored in the Veterinary profession, which has a high incidence of mental health morbidity and a suicide rate over double that of the medical profession (Bartram & Baldwin 2010; Cardwell, Lewis & Smith 2013).

1.6 The specific professional context for this study

The context for this research is a UK veterinary school which offers a 5 year Bachelor of Veterinary Medicine and Surgery (BVMS degree programme). The school has recently undergone a significant curriculum change, which was ongoing during the period of data collection and analysis (see Appendix I). The new curriculum adopts an integrated systems-based approach built around clinical case examples. There are three phases in the programme:

- Foundation phase (years 1 & 2): integrated systems and case-based modules focused on developing understanding of the principles of practice and the structure and function of animal species.
- Clinical phase (years 3 & 4): clinically-focussed modules covering important veterinary species and taking a problem-focused approach to developing student understanding of health, disease, diagnosis and management in individuals and populations.
- Professional phase (year 5): core clinical rotations, each a month long and with the aim of meeting “Day 1 Competencies”. Students also chose two elective rotations.

A vertical theme of clinical and professional skills training runs through years 1-4, culminating in clinical rotations in the final year of the programme. In addition, and in common with other UK veterinary schools, all students are required to complete 12 weeks of preclinical and 26 weeks of clinical extramural studies in a variety of animal management, farm and veterinary practice placements over the course of the programme.

As well as being accredited by the UK and European veterinary institutions, the programme is also accredited by the American Veterinary Medical Association. As a result of this, there is a relatively high proportion of international students studying on the programme, many of whom are from North America or Asia.

One important characteristic of the programme is that students typically begin to spend time in professional practice environments (inside and outside the veterinary school) from the end of their second year. The clinical facilities of the school include a busy small animal referral hospital (seeing primarily canine and feline patients), an equine referral hospital and a production animal practice which provides ambulatory and hospitalisation

services. The school also has contractual arrangements with several local practices and a number of charitable organisations and shelters, where students also spend time during their core training in final year.

The survey study (Chapters 4 & 5), was conducted with undergraduate students across all phases of the programme. The focus of the case study (Chapters 6-9) is on one of the final year placements, a working equid clinic in Africa.

1.7 Positioning myself within the study

At this point, it is important to outline my own perspective and role in the research context. My background is as a veterinary surgeon working in small animal primary care practice. I have worked for the university for over 10 years. After a year working in the teaching hospital, the majority of my time has been based at a charity clinic in the city centre, where I supervised and supported small groups of final year students caring for patients whose owners were on a low income. In 2011 I was seconded from this role to work on development of a new curriculum. The main drive for this curriculum renewal had been the outcomes of the previous accreditation inspections which had identified curriculum development as a priority, particularly in response to the concomitant publication of the “Day 1 competencies” by the RCVS in the UK. My role was to consult widely on the strengths and limitations of the then current curriculum and to work with colleagues from across the school to design, plan and implement the new curriculum. Through this process, my professional role changed from practitioner to educationalist and I now have a role within the school as associate course leader for final year and Portfolio Co-ordinator.

My own experiences of learning to cope with uncertainty as a vet and as a teacher inform my educational approach; I found that the early months and years in practice were full of uncertainty and navigating a way through this was an important formative experience for me. When supporting student learning in the charity clinic, I was able to see how others experienced and coped with complex, ambiguous and uncertain situations. I observed individual differences in coping strategies and reflected on how best to support students experiencing uncertainty. When my focus moved to considering the design and development of a veterinary curriculum, I recognised the importance of developing skills for primary care practice, and noticed that some of the outcomes required by our accrediting bodies were easier than others, to plan for, to teach and to assess. I was particularly interested in the stipulation that the curriculum should nurture new veterinary graduates who would be able to cope with uncertainty and adapt to change and found myself wondering whether a curriculum could indeed do this and how this outcome might be ‘taught’ and ‘assessed’.



This research has been a part time project for me over the last 7 years. During this time I have been closely involved with student teaching and assessment across the programme – this provides ready access to learning and to participants, but comes with challenges relating to potential conflicts of interest and the need to maintain an ethical and professional approach to my research and my work.

I have chosen to position myself in this research as an interested and informed observer, yet it is clear that my professional role in this research context makes me an ‘insider’ in many elements of this work. The advantages and challenges of insider research are well recognised (Merriam, Johnson-Bailey & Lee 2001; Mercer 2007) and I provide reflexive statements in chapters 6 & 9 which specifically address a number of these issues.

1.8 The Professional issue

Despite the recognition of the importance of coping with uncertainty for veterinary professionals, there is a lack of evidence characterising how uncertainty is encountered in veterinary practice, how decisions are made in situations characterised by complexity, ambiguity and uncertainty, or indeed how veterinary professionals can cope (or fail to cope) with this uncertainty. Without this understanding, it becomes difficult to develop or evaluate outcome-based undergraduate curricula to address this capability effectively. In my own context, this has been evident when considering the design of the new curriculum, and also through involvement in assessment processes. My aim in developing this research focus was to help address practical questions which I encountered in my role in veterinary education – for example, is it better to provide more or less support to students in clinical practice situations? What is the impact of assessment processes where questions must be designed to have unambiguously ‘right answers’? How important is reflective practice for enabling students to engage with uncertainties? What features of learning environments help students learn to cope with uncertainty? Why are students and staff reluctant to discuss their uncertainties? These practical questions focused my interest on the topic of uncertainty, and engagement with the literature led to the subsequent development of primary research questions, which are further developed in chapter 3, section 3.1.:

- (1) *To what extent do veterinary students tolerate ambiguity, and*
- (2) *How do they learn to cope with uncertainty in veterinary professional practice?.*



2 Literature review

This chapter reviews the orienting concepts which inform my research approach.

2.1 Key terms and concepts

2.1.1 Uncertainty

2.1.1.1 Definitions

Although a number of definitions of uncertainty have been proposed, I will use a definition based on that developed by Lipshitz and Strauss (Lipshitz & Strauss 1997, p.2), who describe uncertainty in the context of action as: ‘a sense of doubt which blocks or delays action’; a subjective perception of doubt. Defining uncertainty in subjective terms implies that it will result from different events or experiences for different individuals. For example, encountering a patient with clinical signs typical of Rabies is likely to result in greater uncertainty for a newly qualified vet trained in a Rabies-free country than an experienced practitioner working in an area where Rabies is common.

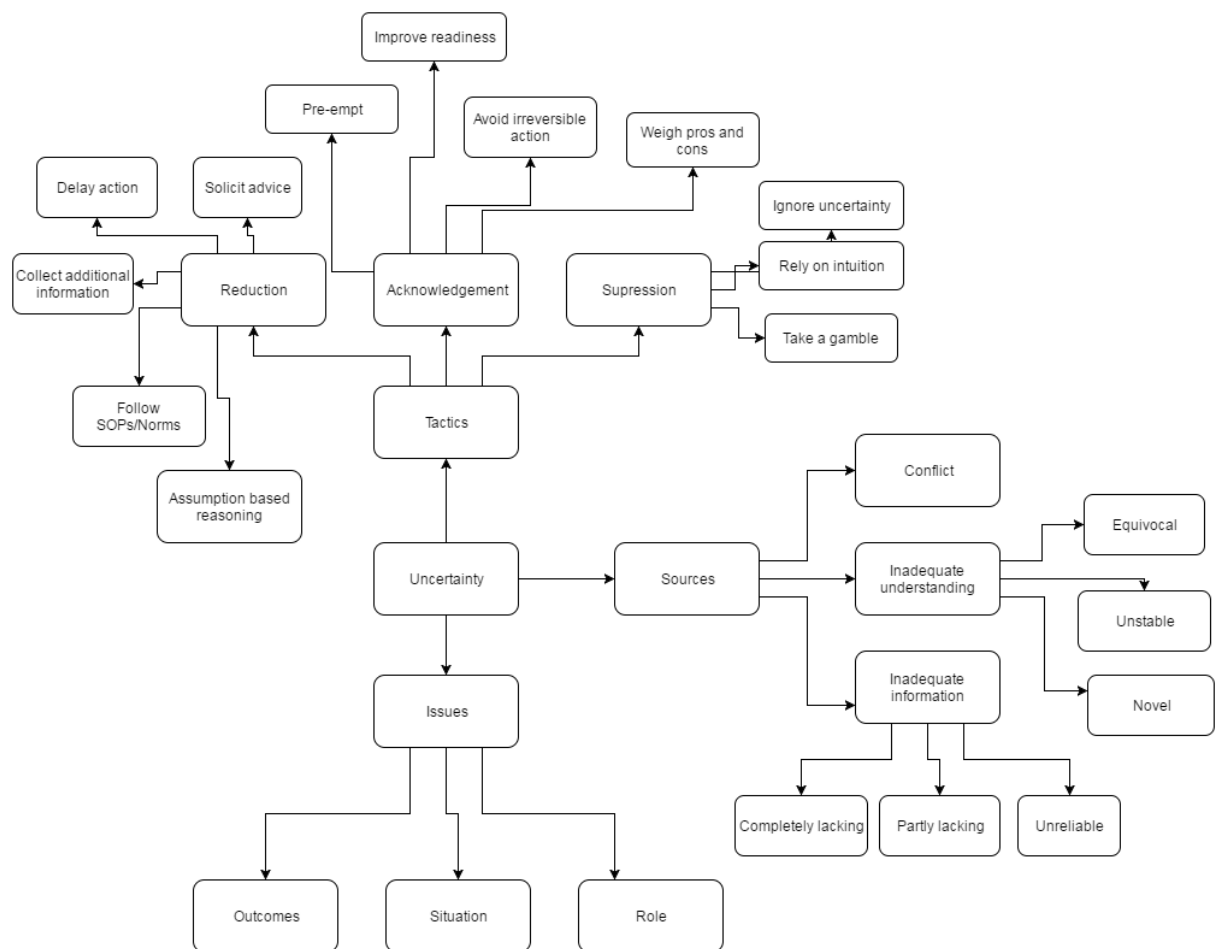
Han et al. (2011) argue that doubt is itself a term which needs to be defined, and propose an alternative definition of uncertainty, describing it as the ‘subjective perception of ignorance’. However, as ignorance implies incomplete information or incomplete understanding, there is a risk that using this term excludes situations where uncertainty instead relates to complexity or conflict (Rowe 1994).

2.1.1.2 Frameworks and taxonomies

In order to provide clarity and a shared language around uncertainty, a number of frameworks and taxonomies have been developed. Approaches vary from classifying uncertainty in mathematical terms (Yannakakis & Togelius 2015), to more subjective frameworks, which may be developed for specific disciplines or contexts (Refsgaard, van der Sluijs, Højberg, & Vanrolleghem, 2007; Regan, Colyvan, & Burgman, 2002; Smithson, 1989). In the health professions, Han and others (2011) propose a simple taxonomy which classifies sources of uncertainty into three categories: Complexity (multiplicity of causal factors and interpretive cues), Ambiguity (imprecision, contradiction, lack of information) and Probability (indeterminacy of future outcome, similar to risk). Although this classification is simple and comprehensive, it can be difficult to use in practice as part of a qualitative research approach: when one is ‘in the moment’ it is not always clear whether one’s sense of doubt results from complexity, ambiguity or probability and the meaning of these terms is not immediately clear to some research participants. Although the framework used is similar, the language used in the case study component of this research is based on the classification developed by Lipschitz and Strauss (1997) as part of a research tradition described as naturalistic decision-making (Klein 2008) and

subsequently applied to a health professions context by (Cristancho, Apramian, Vanstone, Lingard, Ott, & Novick, 2013). The framework was developed and refined through studies of individual descriptions of real life decision-making under conditions of uncertainty and as a consequence uses a language of uncertainty which relates more closely to informal or everyday descriptions of events. Figure 2-1 provides a visual representation of the framework, describing uncertainty in terms of sources (features which produce uncertainty), issues (what issue the uncertainty relates to) and tactics (types of response to uncertainty):

Figure 2-1: Classification of uncertainty, adapted from Lipschitz & Strauss, 1987



2.1.2 Coping

2.1.2.1 Definition of coping

Coping is defined as 'efforts to prevent or diminish threat, harm, and loss, or to reduce associated distress' (Carver & Connor-Smith 2010). The term is commonly used to describe a response to stressful situations and can encompass both behavioural and cognitive strategies.

Coping has been dichotomised in a number of different dimensions, which taken together provide ways in which a given coping strategy can be described. For example, coping strategies can be described as adaptive or maladaptive (Zeidner & Saklofske 1996).

Adaptive coping is the adoption of strategies which minimise stress or anxiety.

Maladaptive coping implies a negative outcome for the individual, in terms of increased stress or poor long-term outcomes. The distinction between adaptive and maladaptive coping has proved difficult to operationalise in practice, where the identification of what constitutes a successful outcome is not always easy to achieve (Tunks & Bellissimo 1988; Zeidner & Saklofske 1996; Brown, Westbrook & Challagalla 2005; Thwaites & Freeston 2005). For example, when adopting a strategy of seeking emotional support, an individual seeking support may find this reassurance helps them to focus on solving the problem. On the other hand, seeking support may take the form of venting of emotions, which can be maladaptive if it results in an unacceptable burden to the supporter, who may seek to distance themselves further (Carver, Scheier & Weintraub, 1989). Similarly, there is no clear understanding of what constitutes adaptive or 'good' coping with uncertainty.

Other distinctions include whether coping is focused on the problem or on the emotion it produces, (Lazarus & Folkman 1984), whether the problem is appraised as a threat or a challenge (Tomaka, Blascovich, Kibler, Ernst & Met 1997) and whether the strategy adopted is one of engagement, through support-seeking or cognitive restructuring for example, or disengagement, through avoiding or denying the problem (Skinner, Edge, Altman & Sherwood, 2003).

The tactics described in coping with uncertainty (Lipshitz & Strauss 1997) relate best to this last approach and there are areas of productive overlap between classifications of engagement or disengagement strategies of coping (Skinner et al. 2003) and tactics for coping with uncertainty (Lipshitz & Strauss 1997).

2.1.3 Learning

2.1.3.1 Definitions

Definitions of learning depend on the theoretical framework which is used. In common use, learning is defined in the Oxford English Dictionary as:

■■■■■

'The action of receiving instruction or acquiring knowledge ... a process which leads to the modification of behaviour or the acquisition of new abilities or responses, and which is additional to natural development by growth or maturation' (Pearsall 2004)

This behaviourist approach conceptualises learning as primarily knowledge acquisition, yet there are other perspectives on learning which rest on different theoretical approaches.

2.1.3.2 Approaches to theorising learning

The process of using theory to improve understanding of our experiences and observation of real life is sometimes described as looking at the world through a theoretical lens (Reeves et al. 2008). Depending on which theory of learning is used, different elements, ideas and concepts are brought into focus.

There are a number of theories of learning which are potentially relevant to understanding how professionals learn to cope with uncertainty. I have chosen to divide these into theories which see learning as a change in the individual, and theories which see learning as a social process.

2.1.3.3 Learning as a change in the individual

Adopting a cognitive view of learning emphasises the importance of processes which happen in the brain of the individual. Learning, in this approach, is viewed as a physical and functional transformation in cognitive structures (Conole, Dyke, Oliver & Seale, 2004). This is consistent with behaviourist theories of learning (Skinner 1974) which adopt a position which considers learning as a linear process: an individual is exposed to an educational intervention which produces a change in behaviour (Conole 2004).

Experiential learning approaches, which view learning as grounded in experiences (Kolb 1984), describe a cycle of construction and revision of understanding, emphasising the importance of deliberative processes such as reflective practice (Schön 1983) which make sense of those experiences. Reflective practice is considered to be an important element of life-long learning, required to maintain professional competency (Schön 1983; Ryan 2013; Adams, Nestel & Woods. 2006).

Transformative learning theory (Mezirow 1997) emphasises the capacity of learning to change individual perspectives on the world. The stimulus for this transformation is described as a 'disorientating dilemma' which may manifest as an acute crisis situation (Roberts 2006) or a more gradual change of awareness (Prout Lin, Nattabi & Green, 2014).



2.1.3.4 *Learning as a social process*

Social cognitive learning theory (Bandura 2001) recognises the importance of social interaction in learning and brings together the social and the cognitive elements of learning, leading to some important insights, such as the importance of observing role models and developing self-efficacy in learning. Self-efficacy is similar to confidence and represents an “individual’s judgement about [their] ability to carry out a specific task or activity” (Bandura 2001, p.3). This is important in the context of learning in clinical situations because self-efficacy will influence students’ readiness to engage in workplace learning opportunities (Zimmerman, Bandura & Martinez-Pons, 1992) and role modelling by clinical supervisors is an important educational strategy (Rabow, Remen, Parmelee, Dean & Inui, 2010).

Theories of situated learning (Lave & Wenger 1991) and expansive learning (Engeström & Sannino 2010) consider learning in the context of social communities (Roth & Lee 2007). Learning is seen as participation in the practice of the community (Lave & Wenger 1991) or described through analysis of contradictions present within and between multiple activity systems capable of transforming activity (Engeström 1995; Engeström & Sannino 2010). Engeström’s third generation expression of Cultural Historical Activity Theory (CHAT) focuses on networks of interactive activity systems and provides a framework to describe the complexity relating to their multiple perspectives and different interactions (Engeström 2000; Engeström 2001). This is important because it suggests that situations where multiple activity systems overlap will be particularly relevant to encountering complexity and learning to cope with uncertainty. Later in this chapter (section 2.3.1) I will go on to consider how situated learning theory and its’ communities of practice conceptualisation, relates to learning in the professional workplace.

2.2 Psychological constructs

2.2.1 Definitions

A construct is an ‘intangible collection[s] of abstract concepts and principles which are inferred from behaviour and explained by educational or psychological theory’(Downing 2003, p.2)

One example of a construct is that of individual differences in personality. Individual differences are “enduring dispositions that cause characteristic patterns of interaction with the environment” (Parks & Guay 2009). Personality is considered to be substantially influenced by genetic factors and a dominant model has emerged which describes personality in terms of the big five personality traits: extroversion, openness, agreeableness, conscientiousness and neuroticism (Pervin 1994).

Individual differences are associated with emotional and behavioural forms of coping (Lee-Baggley, Preece & DeLongis, 2005; Malkoç 2011; O'Brien & DeLongis 1996), and a number of approaches have considered specifically the question of whether individual differences may influence how individuals respond to uncertainty or react to encountering complex, ambiguous or risky situations (Berenbaum, Bredemeier & Thompson. 2008; Lauriola & Levin 2001).

2.2.2 The psychology of uncertainty

While there is no described psychological construct which specifically captures 'coping with uncertainty', there is a significant literature originating from studies of human psychology, which focuses on description and evaluation of individual differences in attitudes to uncertainty and its antecedents. These include ambiguity tolerance (Budner 1962), intolerance of uncertainty (Berenbaum et al. 2008; Birrell et al. 2011), uncertainty orientation (Klemola & Norros 1997), need for cognitive closure (Webster & Kruglanski 1994) and uncertainty avoidance (Hofstede 1984). Table 2-1 outlines hypothesised similarities and differences between four of these constructs.

Table 2-1: Summary of hypothesized similarities and differences between uncertainty constructs (adapted from Rosen et al 2013)

Construct	Definition	Comments
Intolerance of uncertainty (IU)	A dispositional characteristic that arises from a set of negative beliefs about uncertainty and its connotations and consequences	<p>People with higher IU feel threatened by future situation; higher IA feel threatened by current situation</p> <p>IU more highly correlated with worry (which typically centres on anticipation of future consequences) than IA</p>
Intolerance of ambiguity (IA)	An individual's tendency to interpret ambiguous situations as a source of threat or discomfort	<p>Cognitive interpretation of uncertain or ambiguous environment as source of threat</p> <p>Tendency to respond with pattern of negative cognitive, affective, and behavioural reactions to threat</p> <p>Measures assess general tendency to prefer predictability</p>
Uncertainty orientation (UO)	Categorisation of people into those who are (a) uncertainty-oriented (find uncertainty desirable and are motivated to resolve it) and (b) certainty-oriented (avoid uncertainty and prefer to maintain clarity)	<p>Reflects individual preferences regarding uncertainty</p> <p>Reactions to uncertainty depend on the situational context (degree of uncertainty)</p> <p>IU is dimensional; UO is dichotomous</p> <p>IU focuses on psychological effects of uncertainty;</p> <p>UO focuses on desire to resolve or avoid uncertainty</p> <p>In IU, affect is a product of the uncertainty;</p> <p>In UO, affect is a product of one's motivation to resolve or avoid uncertainty</p>
Need for cognitive closure (NCC)	An individual's desire for a firm answer to a question and an aversion toward ambiguity	<p>Like IA, measures have subscales of "desire for predictability"</p> <p>IA is unilateral in that people report more or less IA; NCC can reverse according to benefits/costs of the situation</p>

Although these constructs tend to be closely associated with each other, it is ambiguity tolerance which has been a particular focus of research in the health professions (DeForge & Sobal 1989; Caulfield, Andolsek, Grbic, Roskovensky 2014; Luther & Crandall 2011) and other educational settings (Elias 1999; DeRoma, Martin, Kessler & Lynne. 2003).

2.2.3 Ambiguity tolerance

2.2.3.1 Defining the construct

Intolerance of Ambiguity is defined as “the tendency to perceive ambiguous situations as a source of threat” (Budner 1962).

Low ambiguity tolerance (AT) has been associated with other psychological constructs such as dogmatism, authoritarianism and rigidity (Furnham & Ribchester 1995). Individuals who have greater tolerance of ambiguity typically score highly on measures of openness, although there are areas of difference between the two constructs (Bardi et al. 2009a).

Although AT is often conceptualised as a stable biologically-based personality trait, there is a lack of research demonstrating the heritability of AT and there is some support for an alternative social psychological conception which considers AT as a set of attitudes (Furnham & Marks 2013; Furnham & Ribchester 1995). This is important because the status of AT as a ‘state’ or a ‘trait’ has implications for the extent to which it can change through educational or other experiences.

2.2.3.2 Measures of ambiguity tolerance

A variety of measures have been developed to assess AT. Although some cognitive tests have been described, most of these measures are self-assessed written scales containing a series of statements designed to represent ambiguous situations, with which participants are asked to agree/disagree, using a Likert-type rating (Furnham & Ribchester 1995). These scales have been criticised due to poor psychometric properties of some of the early versions (Furnham & Marks 2013; Herman, Stevens, Bird, Mendenhall & Oddou, 2010) and also because of the well-recognised limitations of self-assessment scales in measuring attitudes (Podsakoff & Organ 1986) due to their reliance on self-perception. Although a number of measures have subsequently been developed which have good psychometric properties, the concept of AT is still considered to lack conceptual clarity, or indeed a basis in theory which might provide a clearer rationale for the inclusion of items in measurement scales (Furnham & Marks 2013).

It has been argued that AT is likely to be affected by the context in which it is expressed (Durrheim & Foster 1997; Herman et al. 2010). Individuals may tolerate ambiguity

differently in work contexts, for example, compared with social or personal contexts. Context-specific instruments have been developed and validated with groups of health professionals and in educational contexts (Hancock , Roberts, Monrouxe & Mattick. 2014; McLain 2009). A dichotomy seems to have emerged, as some measures are designed to be independent of context and, as a result, use items which are very generic; other measures are designed to capture more context-specific elements of ambiguity tolerance; these use scale items which are firmly embedded in the specific context and, as a consequence, these lack transferability between different contexts (Furnham & Marks 2013; Hancock et al. 2014).

The measure used in the survey component of this research is the Tolerance of Ambiguity in Veterinary students (TAVS) scale (Hammond , Hancock, Martin, Mellor, Jamieson,. 2016) which was developed as part of the current research programme from a similar scale used with medical students (see Appendix II).

2.2.3.3 Stability of ambiguity tolerance

The extent to which ambiguity tolerance can change over time is unclear. Although AT seems to be fairly stable in repeated measures for individuals, the results of correlational research suggest that there is a degree of plasticity during early childhood and that ambiguity tolerance increases with age (Furnham & Ribchester 1995; Caulfield et al. 2014; Geller et al. 1990). Changes in AT over the course of medical training have been reported in some studies (Han et al. 2015), but not all (Hancock et al. 2014; Geller et al. 1990; Weissenstein et al. 2014).

2.2.3.4 Proposed mechanisms for changes in ambiguity tolerance

Linking the concept of AT to theories of coping; one approach to conceptualising AT is to view it as a form of appraisal of situations. In this approach AT is related to how an ambiguous situation is appraised, which in turn influences the emotional and behavioural responses which are adopted, for example engagement or disengagement (Bardi et al. 2009a; Tomaka et al. 1997). This is important because it suggests a potential mechanism to explain how AT might influence coping with uncertainty. Furthermore, changes in AT may indicate learned changes in coping strategies representing ‘learning to cope with uncertainty’.

An alternative mechanism frames AT not as an outcome but as an enabling factor influencing student engagement in ambiguous learning situations. Geller (2013) proposes a divergent relationship, suggesting that students who begin training with a relatively intolerant attitude to ambiguity will subsequently become less tolerant as they avoid engagement in activities which may expose them to ambiguity during training. The converse is proposed for students who begin training with greater tolerance for ambiguity,

on the basis that they will actively engage with ambiguous situations and as a consequence will become even more tolerant of these. In practice however, this may be limited by the extent to which individuals are free to make these choices.

2.3 Approaches to conceptualising learning to cope with uncertainty

2.3.1 Socio-cultural approaches to educational research

Significant insights into uncertainty and complexity are developed through the application of social theories of learning to professional education contexts. Notable examples focusing on learning as professional socialisation include the seminal work of Renee Fox, who described ‘training for uncertainty’ in medical students in the latter part of the last century (Fox 1980), as well as the more recent studies of uncertainty in the ‘signature pedagogy’ of medical student’s case presentations (Lingard, Garwood, Schryer & Spafford. 2003).

Both of these studies develop insights, which would not be identified by considering learning only in terms of individual knowledge acquisition. Viewing training for uncertainty as a social process, enables Fox to describe the management of uncertainty as one of the key elements of professional training, in particular the central problem of recognising ‘What we don’t know’, compared with ‘What I don’t know’, and the importance of being able to recognise the difference between these two forms of ignorance (Fox 1980; Light 1979). The role of uncertainty in professional discourse is also highlighted in studies of clinical rounds discussions, where the rhetorical features of certainty and uncertainty in novice case presentations illuminate learning to ‘think as a doctor’ (Lingard et al. 2003). Diversifying the perspectives used in educational research to embrace socio-cultural approaches to learning is considered key to understanding uncertainties and complexities in different educational contexts (Cleland, Walker, Gale & Nicol, 2016).

2.3.2 Situated learning

Situated learning (Lave & Wenger 1991) has been proposed as a productive framework for exploring workplace learning in veterinary education (Scholz, Trede, & Raidal. 2013). By describing learning in veterinary education as legitimate peripheral participation, we can move our focus away from a content and process model (with a focus on what is to be learned and how it is to be taught) towards understanding the features of practice of the community and the factors which influence legitimate peripheral participation in that practice (Fuller, Hodkinson, Hodkinson & Unwin, 2005). This is particularly useful in the context of learning to cope with uncertainty, where the outcomes of ‘what is to be learned’ are far from clear. One example of this might be to consider the importance of access to practice. In order to learn through legitimate peripheral participation one must first gain access to the community of practice. Lave describes access as being “always

problematic” (Lave & Wenger 1991, p.100) as there are inevitable tensions between the needs of the newcomers to access practice for learning and the needs of the community to limit or restrict that access, for reasons of practicality or policy. In the context of professional education for example, we might describe access in terms of selection onto professional programmes, which in turn confers the legitimacy to attend EMS placements and clinical rotations, where peripheral participation in practice is possible. By using the conceptual lens of situated learning through which to view student learning, we are able to focus on the social and cultural influences on learning, rather than on trying to map out the content of what there is to be learned (Scholz et al. 2013). Situated learning evolves through a learning curriculum which is derived from the learners developing understanding of *‘what there is to learn and how it is to be learned in the context of the community of practice’* (Lave & Wenger 1991, p.97).

There are several criticisms of situated learning theory that are particularly relevant to this research. First, the idea that individuals interact with a single, stable community of practice is inconsistent with observations from empirical research into modern professional learning, which suggest that learners encounter multiple different communities over the course of their training and that many of these interactions are short-term and more fluid than the stable communities described by Lave and Wenger (Eraut 2004). Secondly, characterisation of learning entirely as participation or socialisation fails to acknowledge the role of personal knowledge in learning (Eraut 2004; Fuller et al. 2005; Roberts 2006); which means that the individual approach is missing when we adopt the perspective of situated learning. This is important because it is individual-centred frameworks of professional competency that drive professional curricular development and describe expected educational outcomes.

2.3.3 Professional learning

2.3.3.1 The importance of the workplace

Comparing types of knowledge acquired in formal education settings with those developed in the workplace suggests that learning to cope with uncertainty is particularly likely to occur in the course of clinical rotations and EMS placements, during which veterinary students learn through immersion in authentic clinical workplaces.

Empirical studies of professional and vocational workplace- learning reveal differences between the type of learning prioritised in formal education, and that which occurs in the workplace. Educational contexts tend to focus on theoretical and methodological knowledge, practical skills and techniques, generic skills and general knowledge about the occupation itself (Eraut 2004). In contrast, knowledge acquired in the workplace goes beyond the codified knowledge (e.g. that acquired during initial training and through formal

continuing professional development courses) to include work-specific skills (technical, interpersonal, thinking and learning), knowledge resources (e.g. professional networks), understanding, decision-making and judgement (ibid). This is important because these latter forms of knowledge incorporate learning to manage complex situations using judgement, and are characterised by increasing responsibility and understanding of the significance of how local contexts and situations influence practice.

In this approach, learning is defined in terms of knowledge acquisition rather than legitimate peripheral participation and may be implicit (independent of conscious attempts to learn) as well as deliberative, requiring the skilled combination of situational knowledge, professional experience and judgement (Eraut 2000).

The process of transfer of knowledge between contexts is critical for successful performance. Learning to use previously acquired knowledge in a new situation is particularly challenging in complex situations, requiring situational understanding in order to recognise what knowledge is relevant, before transforming this knowledge to fit the new situation and integrating it ready for use in the new situation (Eraut 2016).

Coping with transformation of knowledge between contexts may itself produce uncertainty. For example, differences have been described between the espoused theories which represent an idealised view of practice taught through formal education, and theories in action which reflect what actually happens in practice (Argyris 1995; Eraut 2004). Contradictions between espoused theories and theories in use become evident when moving between formal vocational education and the professional workplace. It is proposed that these contradictions may produce uncertainty and can result in scepticism or frustration when practitioners find themselves continually falling short of the standards they have learned in the formal education process (Eraut 1994).

2.3.3.2 *Tacit knowledge*

The lack of formal frameworks and descriptions for what constitutes effective coping with uncertainty in practice, suggests that this may involve primarily tacit personal knowledge. Definitions of tacit knowledge include 'that which has yet to be abstracted from practice' (Spender 1996) and "that which we know but cannot tell" (Fingesten 1968). If coping with uncertainty is largely tacit, then accessing this knowledge as part of a research process is problematic. The extent to which tacit knowledge can be made explicit in the context of workplace research is debated (Eraut 2000). Essentially, it is hard to know whether a failure to elicit descriptions of knowledge represents a lack of appropriate questioning, or whether it is indeed tacit knowledge, which is impossible to verbalise.

Eraut's conclusion has much in common with the concept of the 'learning curriculum' in situated learning – he proposes that 'thick' versions of tacit knowledge will be used in actual professional practice and 'thin' versions of that which can be made explicit will be used in explaining, research and training (Eraut 2000). Hence, when trying to access experiences of learning to cope with uncertainty, the challenge of accessing the tacit dimension of knowledge must be recognised.

2.3.3.3 *The indeterminate zone of professional practice*

Donald Schon (1983) describes tacit knowledge as the indeterminate zone of professional practice. The indeterminate zone is where the practitioner experiences uncertainty and encounters complexity and conflict. Schon adopts a slightly different perspective however, considering the indeterminate zone to be not just 'indescribable' but irrational. The value of the indeterminate zone as a concept is that it recognises the areas of practice where even defining the problem is difficult. Schon, however, argues that it is only through reflection that we can begin to make sense of our experiences and it is these indeterminate zones for which reflective practice is particularly critical.

2.3.4 *Reframing coping with uncertainty*

There are two substantial challenges associated with understanding learning to cope with uncertainty. The first, as outlined above, is that tacit knowledge important in coping with uncertainty is difficult to access through the research process. The second relates to the limitations in conceptualisation of coping, which incorporate judgements of what constitutes an adaptive outcome. In simple terms, this means that it is difficult to be confident that any description of coping with uncertainty based on empirical research is complete, and even harder to establish whether described emotional and behavioural coping strategies are, in fact, adaptive.

One way to address these challenges is to reframe 'coping with uncertainty' using a social-centred definition. Social-centred definitions effectively turn the question around: rather than asking what constitutes effective coping with uncertainty, instead we consider what is required in order to cope with uncertainty. This is analogous to descriptions of clinical competency which define competency as "skills needed to do the job" (Eraut 1994) and concepts such as emotional labour which is defined as "the process by which workers are expected to manage their feelings in accordance with organizationally-defined rules and guidelines" (Wharton 2009, p.2). In order to focus on learning, without having to define all of the features and facets of effective coping with uncertainty, we can describe coping with uncertainty in terms of meeting other peoples' expectations. Borrowing from the analogous concept of emotional labour; I have coined the term "uncertainty work"



which I have initially defined as ‘that which must happen in order to cope with uncertainty in practice’.

2.4 Conclusions

Drawing together the above discussion provides a statement of the theoretical framework for this study.

Uncertainty, defined as the subjective perception of doubt, is typically experienced in situations characterised by ambiguity, complexity and probability. An individual may experience uncertainty as incomplete information, inadequate understanding or conflict (Lipshitz & Strauss 1997); this uncertainty may relate to the situation itself, possible outcomes or the individual’s own role.

Tactics such as acknowledgement, suppression and reduction are adopted in order to cope with uncertainty. These tactics are analogous with engagement or disengagement strategies of coping. Although coping may be described as adaptive or maladaptive, the identification of what constitutes ‘good’ coping with uncertainty is challenging.

It is unclear to what extent individual differences in orientation to ambiguous or risky situations and perceptions of uncertainty represent stable or malleable states and there is currently limited evidence to support suggested mechanisms by which educational experiences might influence these states.

Both social and individual approaches to learning are of value when considering how veterinary students learn to cope with uncertainty. Social learning theories characterise learning as professional socialisation and learning is described as legitimate peripheral participation in a community of practice. In this framework, access to practice is necessary but not sufficient for learning.

Individual-centred frameworks of professional competency describe expected educational outcomes and are therefore important for professional curricular development.

Comparing types of knowledge acquired by individuals in formal education settings with those developed in the workplace suggests that learning to cope with uncertainty is particularly likely to occur in the course of clinical rotations and extra mural studies placements during which veterinary students can learn through immersion in authentic clinical workplaces. It is unclear the extent to which formal education which typically precedes in-clinic learning can equip students to take advantage of these opportunities and whether pre-clinical education can have a role in learning to cope with uncertainty.

The tacit elements of professional knowledge that are utilised when managing uncertainty in practice are difficult to access, articulate and therefore evaluate; although even an



incomplete understanding is useful in helping us to understand learning. Reframing 'coping with uncertainty' as 'uncertainty work', initially using a socialcentred definition: "that which must happen in order to cope with uncertainty in practice", provides an opportunity describe elements of uncertainty work and to use this concept as a starting point for understanding veterinary student' experiences of learning.

3 Research Framework

In this chapter I describe my research questions and outline how my approach to this research study draws on an underpinning philosophical framework. The aim of identifying a philosophical framework is to explain the claims I make for my findings in terms of their relationship with an objective reality and how they can be generalised or applied in other contexts.

3.1 Research questions

The primary research questions are:

- (1) To what extent do veterinary students tolerate ambiguity, and*
- (2) How do they learn to cope with uncertainty in veterinary professional practice?*

In the first component of this research, the focus is on exploring and describing individual differences in tolerance of ambiguity. The survey study is designed to address three secondary research questions in the context of a veterinary student population:

- 1a) How are individual differences in ambiguity tolerance related to demographic variables?*
- 1b) Does ambiguity tolerance change over the course of training? and*
- 1c) How does ambiguity tolerance relate to elective and career choices?*

The aim of the second component of the research is an explanatory case study, focusing on:

- 2a) How do veterinary students learn to cope with uncertainty in the context of an international elective rotation in a resource-limited environment?*
- 2b) What is it about the international elective rotation that facilitates students' learning to cope with uncertainty?*

The general discussion in chapter 10 draws on the two components of the research to further develop both description and explanation as a way of addressing the primary research questions:

3.2 Ontology & epistemology

Ontology is concerned with understanding the nature of reality and epistemology with the nature of knowledge. The realist approach that underpins my research provides an ontological middle ground between positivist and interpretivist approaches. The realist approach accepts that there is a reality and that it can be known to some extent, but does not assume that all elements of reality can be known or indeed that everything which can be known is a complete representation of reality (Bhaskar 2008).



Realism differs from a positivist approach, which latter is built on the expectation that reality can be accessed directly through human observation; and that what we can measure, and therefore know, about the world is indeed real and only that which is measurable exists (Krauss & Putra 2005). This is described by critics as the ‘epistemic fallacy’ (Sayer 1992). The realist approach treats empirical regularities in a different way. They are seen as “*pieces of the jigsaw puzzle of searching for mechanisms, not arbiters*” (Danermark 2002).

Realist research typically focuses not on documenting direct causation or correlation, but on identification of causal mechanisms and developing an understanding of their actions in specific contexts.

One example where this approach is employed is the use of realist evaluation in healthcare. Instead of focusing only on whether a given healthcare intervention works (traditional evaluation), a realist approach asks “what works, for whom, in what contexts and how” (Wong et al. 2016; Clarke et al. 1998). The aim is to identify likely causal mechanisms which may explain observed outcomes and which may help us to understand why the intervention will work (or not work) in another context (Dobson 1999).

The constructivist and relativist approaches propose that it is meaningless to claim that any one statement about reality is any more truthful than another statement, because all knowledge is mediated through individuals (Krauss & Putra 2005). We bring different perspectives and we influence both the passage and process of research (Melles & Gavin 2005). At its extreme, this approach to research proposes that we can only ever see or know a specific interpretation of the world and that reality is only constructed from our own perceptions and does not exist independently of these (Krauss & Putra 2005). It is argued that the concept of multiple possible realities limits the ability of research findings to be applied to practical situations or used to inform policy (Searle 2003; Sharar 2016). The realist approach recognises the fact that our knowledge is contingent and depends upon our historical experiences, but argues that some explanations and theories of the world are better than others and that the convincing force of a theory can be judged based on rational criteria such as its ability to explain our observations (Danermark 2002).

3.3 Conducting educational research

Although it is possible to adopt a positivist approach to research in education, there are some significant limitations to doing this. Education does not take place in a closed system where it is possible to control for or remove the impact of external variables (Sharar 2016; Jones et al. 2006; Cleland et al. 2016). Rather it is a complex intervention



occurring in an open system (Wong et al. 2012). Although educational experiments can be attempted and studies designed to compare interventions (Torgerson 2002), the reality is that education does take place in a unique context; influenced by many contextual factors. The impact of a given educational intervention for example, is highly related to this context and the two cannot easily or usefully be separated (Norman 2003; Bates & Ellaway 2016).

Moreover, education is a social process. Society can be viewed in terms of structure and agency and the interplay between these: 'Society is both the ever present condition (material cause) and the continually reproduced outcomes of human agency' (Bhaskar 2005, p.43)

This means that when studying a social process such as education, a research approach needs to consider both agency (individual students, staff and their actions) as well as social structure (the institution and culture in which education occurs) (Sharar 2016).

Education is also a practice; those designing and delivering a programme of education have to make decisions about how the curriculum will be designed, which activities will be prioritised and which policies should be developed and implemented. Although the ideal of evidence-based education policy may be misdirected (Greenhalgh et al. 2009), using research evidence to inform decisions is at least partly contingent upon the transferability of these research findings.

The advantage of a realist approach for educational research is that it allows recognition of contextual factors in educational systems, yet also provides a way for us to think about transfer of findings between different contexts. The focus on identification of causal mechanisms, which may be relevant for many different contexts, provides scope for educational researchers to relate their findings to an objective reality. It also allows for us to recognise that we often have to make policy decisions with an imperfect knowledge of this objective reality, for example being uncertain about how a postulated mechanism may interact with our own specific context.

3.4 Intensive and Extensive approaches

As the aim of research from a realist perspective is to identify causal mechanisms at work, the research must be adaptable and prepared to draw on many different types of data as part of a process of investigation. This eclectic methodology recognises that conducting research is an investigative process and that a choice of research methods will become clearer as the research progresses. Consequently, a "critical methodological pluralism" is advocated (Danermark 2002, p.151), suggesting that choice of research method will depend on the observations and theoretical conceptualisations which develop in the early

stages of the research. In the case of the studies described in this thesis, the research design developed over time, as potential causative mechanisms were identified. An initial research proposal designed around three separate studies was simplified and refined as the scope of different elements became clearer. For example, through early observations of different clinical placements I was able to identify a placement where students seemed to experience uncertainty frequently, and the case study component of this research was designed to focus on this placement. Realising that this placement was working with an underserved community, I considered that this may be an important mechanism and adjusted the design of the survey part of my research to collect data on elective choice in order to see whether there was a relationship at population level between ambiguity tolerance and choice of this placement. As the scope of the case study grew to encompass concepts of 'uncertainty work' and communities of practice I had to prioritise areas for study in greater depth and reduce the number of studies in order to accommodate the expanding scope of this element.

The use of a combination of qualitative and quantitative methods in research, so called 'mixed methods', is particularly useful in trying to understand different aspects of a phenomenon. In the case of learning to cope with uncertainty, quantitative methods are most useful for investigating questions of how responses to statements about uncertainty change over time and vary across a population. Qualitative methods are more suited for providing detailed descriptions of students' experiences of learning and their personal responses to real-life uncertainty. The term triangulation is used to describe the way in which qualitative and quantitative data are combined to help confirm a theory to a greater degree than either method can on its own (Risjord, Dunbar & Moloney 2002). Using a realist perspective for mixed methods research provides a coherent theoretical perspective from which to view the study outcomes, which may avoid many of the problems that are associated with working from two different research paradigms (McEvoy & Richards 2006).

Realist research designs accommodate the distinction between qualitative and quantitative methods within the concept of extensive or intensive research dimensions (Danermark 2002; Sayer 1992). Extensive research is focused on the contexts in which causal mechanisms work whereas intensive research is focused on the discovery and description of these mechanisms (Edwards et al. 2014). The two strategies are described by Sayer (Sayer 1992) and summarised in Table 3-1.



Table 3-1: Intensive and Extensive approaches to research reproduced from Sayer (1992, p.243).

	Extensive	Intensive
Typical format of research question	What are the regularities, common patterns, distinguishing features of a population? How widely are certain characteristics or processes distributed or represented?	How does a process work in a particular case or small number of cases? What produces a certain change? What did the agents actually do?
Relations	Formal relations of similarity	Substantial relations of connection
Type of groups studied	Taxonomic groups	Causal groups
Type of account produced	Descriptive 'representative' generalisations, lacking in explanatory penetration	Causal explanation of the production of certain objects or events, though not necessarily representative ones
Typical methods	Large-scale survey of population or representative sample, formal questionnaires, standardised interviews, statistical analysis	Study of individual agents in their causal contexts, interactive interviews, ethnography. Qualitative analysis.
Limitations	Although representative of a whole population, they are unlikely to be generalisable to other populations at different times and places. Problems of ecological fallacy in making inferences about individuals. Limited explanatory power.	Actual concrete patterns and contingent relations are unlikely to be 'representative', 'average' or 'generalizable'. Necessary relations discovered will exist wherever their components are present e.g. causal powers or objects are generalisable to other contexts as they are necessary features of these objects,
Appropriate tests	Replication	Corroboration

The two studies described in this thesis exemplify this distinction.

The survey of ambiguity tolerance described in the first section adopts an extensive approach, aiming to describe individual differences in tolerance of one source of uncertainty (ambiguity) in a population of veterinary students. Although the extensive approach cannot answer questions of causation on its own, it can provide useful descriptive information which may support this discussion and may also help to generate questions of causality (Danermark 2002). The case study takes an intensive approach, trying to understand the mechanism(s) by which students may learn to cope with uncertainty, by focusing on the specific case of a small group of veterinary students on an international elective.

The two specific methodologies used in this research are survey research and case study research, respectively to represent the extensive and intensive strategies. Case study methodology is particularly well suited to intensive research from a critical realist perspective (Dobson 1999; Easton 2010; Wynn & Williams 2012). This is primarily because it is flexible and enables in-depth, detailed investigation of a case or small number of cases, with the aim of elucidating mechanisms of relevance to the research question.

The use of survey research and associated statistical analyses as part of the extensive research process requires some further explanation. From a realist perspective, the use of measurement scales and statistical probabilities in the study of social phenomena has been criticised for leading to reductionist theories which fail to represent the complexity of reality (Archer et al. 2013; Bhaskar 2008; Sayer 1992). Certainly, arguing that a score on a self-assessed ambiguity tolerance scale represents the reality and the entirety of an individual's attitude to ambiguous situations is a naïve and reductionist approach. Similarly, finding a strong and statistically significant correlation between scores for ambiguity tolerance between 1st and 3rd year of training could be the result of a number of different causative mechanisms, many of which may be context-specific. However, Edwards and others argue that quantitative methods should be considered in terms of models rather than empiricism. These models may be in the form of approximations or as statistical summaries and the focus is on practical adequacy and description, rather than on prediction or generalisation (Edwards et al. 2014).

3.5 Explanatory research: the analytic process

Danermark and others (2002, pp.109–110) outline six stages in explanatory research from a realist perspective. Theory is central to this process and is described by the authors as: 'a certain way of viewing reality, a generally valid set of concepts that can be used when



formulating interesting and relevant questions in concrete investigations' (Danermark 2002, p.140).

In my research these six stages have not happened in chronological order. The reality of the research process is that it is iterative and convoluted; here, I outline where each stage is represented in the chapters that follow.

The first stage is **description** of the concrete event or situation. In the first study I describe patterns of responses to a measure of ambiguity tolerance in a population of veterinary students. In the second study I describe the uncertainty work of veterinary students on an international elective placement, through descriptions of clinical rounds discussions and the interpretations of these events by participants.

The second stage requires **analytical resolution**, a process of separating events into components, aspects or dimensions. In the first study, this analysis uses statistical techniques and categorisation of data in order to identify relationships between different variables. In the second study, I use an existing analytical framework to categorise sources and issues of uncertainty and the coping tactics adopted by students and staff. This is complemented by thematic analysis of interviews, using an inductive approach to identify key features of learning to cope with uncertainty in this context.

The third stage involves **theoretical re-description (abduction)**. Alternative theoretical interpretations are considered in relation to the developing research findings and the events are interpreted and re-described using the conceptual frameworks of one or more of these theories. The ideas and objects of study are further developed through consideration in the context of this theoretical framework. In chapters 2 & 6 I outline the different theoretical approaches which were considered and summarise the situated learning theory which is used to underpin the second study. In chapter 8 a middle range theory is described based on the concepts of situated learning theory, and this is used to re-describe events in terms of communities of practice and their management of uncertainty work. A middle range theory (Stone & Merton 1958) aims to propose causal mechanisms which are not so specific that they will only ever apply to a single occurrence, in a single context at a single time; but are not so general that they aim to explain every occurrence, across all contexts, and at all times. The middle range theory here acts as a contextualised articulation of the general theory, a template against which observations can be assessed and through which the theory can be evaluated (Smith 2010).

The fourth stage involves **retroduction**, which is closely related to the abductive inference of the third stage. Retroduction is defined as: 'a thought operation involving a reconstruction of the ...properties required for a phenomenon to exist' (Danermark 2002,

p.206). Chapter 9 describes a specific retroductive step where the causative mechanisms are described in relation to the international elective experience.

Chapter 10 brings together the two research studies in order to address the primary research questions (see 3.1). This process is partly retroductive as it draws on the findings of both studies to consider the retroductive question:

“What is it about veterinary education which enables or constrains students’ learning to cope with uncertainty?”

The fifth stage is a **comparison** between different theories and mechanisms in terms of their relative explanatory power. This stage is incorporated at several different points in the research process. In Chapter 9 a focus group of participants and stakeholders is invited to consider the causative mechanisms which emerged from the case study part of the research and to consider which mechanism(s) offer(s) the greatest explanatory power. In chapter 10, as part of the general discussion, the outcomes of the two studies are considered in tandem, in order to compare the relative importance of individual differences in ambiguity tolerance and the social structural mechanisms described in the case study.

The final stage is **concretisation and contextualisation** which effectively completes the cycle of the research by looking at how different structures and mechanisms are manifest in concrete situations and aims to contribute to explanations of concrete events and processes. As many of the concrete events will already have been described in chapters 4-7 in relation to the middle range theory, to avoid repetition, the conclusions of the thesis presented in chapter 11 provides a summary of how the proposed mechanisms play out in the context of the veterinary school where the research is conducted.

3.6 Quality in research

Judgements about the quality of research must consider both the rigour of the constituent parts and ascertain whether the outcomes of these studies are combined in a way which is sensitive to the ontological and epistemological underpinnings of the realist approach (Wong et al. 2016; Healy & Perry 2000). Six criteria (Healy & Perry 2000) have been developed to judge the reliability and validity of qualitative research in the realist paradigm, which draw on established frameworks from both qualitative (Miles & Huberman 1994; Lincoln & Guba 1985; Yin 2003) and quantitative (Neuman 1997) traditions in social research.

The first two of these criteria relate to ontology: **ontological appropriateness** and **contingent validity**.



Realist research deals with “complex social science phenomena involving reflective people” (Healy & Perry 2000, p.6). In the case of the current research the selection of a ‘how’ problem (how veterinary students learn to cope with uncertainty in veterinary professional practice) provides an ontologically appropriate topic for realist research. Similarly, the decision to study the phenomenon of learning to cope with uncertainty in a real-world “fuzzy boundary” system, and the focus on in-depth investigation, description of research context and identifying causal mechanisms, rather than direct cause-effect relationships, meets the second criterion of contingent validity. This is similar to the concepts of credibility or authenticity used in the evaluation of qualitative research.

The third criterion relates to epistemology and whether **multiple perceptions** of participants and of peer researchers have been incorporated in the research process. In this research, perspectives include interviews with staff and student participants, allowing discussion of the clinical rounds recordings that are the primary source of data, as well as a stakeholder focus group to review potential causal mechanisms. Interim findings from the data analysis were presented to research supervisors and a critical friend at regular intervals during the research process, providing an opportunity for peer review and discussion of emerging interpretations.

The remaining three criteria concern the methodology: trustworthiness, analytic generalisation and construct validity.

Trustworthiness involves maintaining an audit trail and transparency in the research process. The use of research notes and analytic memos provides a record of the evolving focus of the research and analytic decisions. For the qualitative case study, verbatim quotes from interviews and recordings presented in relevant appendices enable the reader to evaluate analytic interpretations. Similarly, for the quantitative survey analysis, tables and figures are provided.

Analytic generalisation and **construct validity** are both related to the role of theory in the research process. The literature review in chapter 2 explains the conceptual framework which informs the studies. The case for the validity of key constructs such as ambiguity tolerance and uncertainty work is built and refined through demonstration of links between relevant theory and the research findings, as well as using triangulation between different sources of evidence. The case for transferability of the findings of this research is made on the basis of development of theory (though identification of causative mechanisms) which may then be applied, refined and tested in different contexts (Yin 2003). This is different to statistical generalisation where the focus is on theory testing and where findings in a subset of a population are generalised to the wider population on the basis of statistical probability. Statistical analysis performed as part of the first study is

used to test for differences between groups and to explore whether differences observed in the study sample are more or less likely to hold true at the whole population level.

3.7 Conclusions

In this chapter I have described the research questions and the underpinning philosophical framework which guided my approach to the two different components of this research. The research has evolved through over the course of study, moving from three to two components, and become more focussed, which has allowed more in-depth analysis of the case study element in particular. I argue that adoption of realist analytical approaches provides a framework to bring the two components together and to justify the transferability and application of this research in an educational setting.

4 Ambiguity tolerance in Veterinary students: study design and methods

4.1 Analysis of ambiguity tolerance in a veterinary student population

4.1.1 Research questions

The extensive component of this research is designed to address three secondary research questions in the context of a single veterinary school student population:

1a. How are individual differences in ambiguity tolerance related to demographic variables?

- Age
- Gender
- Ethnicity
- Nationality
- Previous education

1b. Does ambiguity tolerance change over the course of training?

- Using a cross sectional approach
- Using a longitudinal approach
- For individual students

1c. How does ambiguity tolerance relate to elective and career choices?

- Preferred area of practice
- Preferred species focus
- Elective study choices

4.1.2 Research Hypotheses

Based on review of the literature, hypotheses were generated to guide the research study. These are included in Appendix III and subsequently referred to sections 5.1 & 5.2.

4.1.3 Study context

The study took place between 2013 and 2016 in a UK school of Veterinary medicine. The programme outline is provided in chapter 1.

The criteria for admission to the programme are exacting and prospective students are required to demonstrate academic achievement (Excellence in A Level or Scottish Highers and/or a previous degrees or equivalent qualification) as well as practical experience in working with animals. The admissions process includes review of written statements and a structured panel interview. In the last 2 years of the study period a computer based assessment of ethical reasoning was also introduced.

A summary of changes to the programme during the study period is provided in Appendix I.

There are typically 120-140 students in each year of the Programme. Small numbers of students (fewer than 5 each year) move between years of the programme due to intercalation (usually between 3rd and 4th year) or failure to meet requirements for progression. On graduation from the programme employment rates are close to 100% (Unistats (UK) 2017).

4.1.4 Survey design

Appendix II comprises a copy of the paper (the researcher is first author) describing development of the Tolerance of Ambiguity in Veterinary students (TAVS) scale used in this survey, which was in press at the time of preparation of the thesis. Due to limitation of space, full details of the development of the scale and the validity argument made for its use with Veterinary students are included in this appendix..

The final survey form is included in Appendix IV. Questions 1-6 on age, gender, ethnicity, nationality and previous education used categories described by the UK Government Office of National Statistics (Office for National Statistics 2013), adjusted for expected study population at the Veterinary school. Two questions asking about career aspirations used categories based on those from the RCVS survey of the veterinary profession (Buzzeo et al. 2014). The remaining questions were scale items where participants were asked to self-assess their responses to statements relating to ambiguity. Items were scored on a 5-point Likert scale (1 = strongly disagree and 5 = strongly agree). Both positively and negatively worded items were included in the scale and negatively worded items were reverse scored before analysis (see also Appendix V)

The survey form was piloted and minor revisions of item wordings for demographic questions were made prior to use.

An initial short version of the form contained 31 items and this was subsequently revised to include an additional 10 items. Of the 31 items in the short version, 22 of the TAVS specific items were included. For the long version, all 27 of the TAVS specific items were included. The decision to use a short form in the first instance was made on the basis that it would take less time for participants to complete, however, following analysis of the first data set it became clear that the reliability of the short version was suboptimal and therefore a longer version was used in subsequent data collection. The long version was used as the basis for the TAVS scale development and validation which is explained in detail in the original paper included in Appendix II.

4.1.5 Study sample & participant recruitment

All students enrolled on the BVMS Programme were invited to participate in the study. Ethical approval for the study was granted by the College ethics committee (see Appendix VI). Permission to survey students was granted by the Associate Head of School for Learning and Teaching and approved by the student association.

Table 4-1 shows the survey points for each year group:

Table 4-1: Survey points for each year group

Year group	Timing	Context
BVMS1	Start of semester 2	After a clinical skills practical session
BVMS2	Start of semester 2	After a clinical skills practical session
BVMS3	Middle of semester 2	During an assessment sequestration
BVMS 5	Pre-Semester 1	After an Induction week lecture

4.1.6 Data Collection

A participant information sheet and consent form were attached to a paper version of the survey (see Appendix VI for copies of these forms) and participants were invited to complete the consent form and survey and leave them in a box provided for collection. A link was made available via the course virtual learning environment for those students who preferred to complete an electronic version of the survey. The majority of participants completed the paper version.

Participants were invited to provide their student ID number as a way of tracking individual participants through the study. Consent forms were detached from surveys following collection and stored separately in order to maintain participant anonymity.

During year 1 of the study, participant responses were entered manually into an electronic form and results downloaded to an Excel spreadsheet. During years 2 & 3 of the study, a scanner-readable version of the survey was used which enabled all paper surveys to be scanned using the Cardiff Teleform system (Hewlett Packard). Responses were checked and validated by a member of administrative staff. Online responses were downloaded directly from the survey website.

4.1.7 Data analysis

Data were analysed using SPSS V20 statistical analysis software (IBM). In the sections which follow I describe the initial data preparation and the analysis completed for each of the research questions in turn.

4.1.7.1 Data preparation

1) Reverse coding and scale calculation

Appendix V details the psychometric features of the 41 scale items. In order to optimise the parsimony and reliability of the scale while minimising the time taken to complete, a subset of the 27 TAVS items (which include 12 reverse-coded items) were created and used in the subsequent analysis. The rationale for the scale development and item selection is explained in the original paper (see Appendix II). A TAVS score (out of 100) was calculated for each student using the linear transformation formula: $\text{Final TAVS} = 25 * (\text{mean TAVS} - 1)$, where mean TAVS is the mean of the participants scores on the 27 TAVS items.

4.1.7.2 Data validation

The following criteria were determined for inclusion of survey response data in the subsequent analysis:

1) No more than 25% missing response data



- 2) No previous response set for that cohort and year (i.e. participant who has completed the survey twice at the same time point, based on student ID number).

Descriptive statistics were generated to identify responses which did not meet the inclusion criteria and these were removed from subsequent analysis.

For responses which met the inclusion criteria, missing data were handled in subsequent analysis using list-wise deletion for demographic and career related variables and using mean substitution for TAVS scale item variables.

The use of mean substitution for scale item variables was chosen because in around a third of the survey responses (298/929) an administrative error meant that a short version of the survey form was used which included only 22 of the 27 total scale items for the TAVS scale. Rather than excluding these responses from the analysis, the mean value for each of the five missing scale items was used to enable a TAVS score to be calculated for these participants. Although mean substitution is expected to reduce the variance of TAVS scores for the study sample, it was considered more appropriate than multiple imputations based on other responses which could artificially accentuate differences in TAVS scores (Rubin, Witkiewitz, St Andre & Reilly 2007). The impact of mean substitution on the variance of TAVS scores is described in the results section. The test cohort was selected for the longitudinal analysis on the basis that all survey completions used the long form and therefore mean substitution was not required for missing items.

Response rates were calculated for each year-group and for each cycle of the survey. The numbers of participants who had provided an ID number and had completed the survey on more than one occasion (11-14 months apart) were also identified.

4.1.7.3 Relationship between AT and demographic variables

Descriptive statistics were generated for each of the 5 demographic variables:

- Age
- Gender
- Ethnicity
- Nationality
- Previous education

A Pearson correlation was conducted to evaluate the relationship between an individual's age and TAVS score. Differences in mean TAVS scores between different age groups were assessed using a one-way analysis of variance (ANOVA). Difference in mean TAVS scores between mature students (30 years and over) and non-mature students (under the age of 30 years) was assessed using an independent samples t-test. The decision to

identify those in the 31-35 and over 35 groups as mature students (defined as ‘those over the age of 21 who didn't go to university after school or college’ (UCAS 2017)) is based on a recognition that North American students typically complete an undergraduate degree (4 years) before they embark on a professional degree (5 years), so a proportion of students in the 26-30 age category may not be considered mature students.

A one-way analysis of variance (ANOVA) was used to assess whether there were significant differences between the mean TAVS scores based on gender, ethnicity and nationality. Levene's test (Levene 1960) was conducted prior to completion of ANOVA to assess whether there was homogeneity of variance. Where homogeneity of variance was confirmed, a Tukey *post-hoc* test was completed (Kim 2015). Where variance was not homogenous, a Welch ANOVA was used with a Games-Howell *post-hoc* test (ibid). Because age could be a confounding variable for both nationality, and previous education (younger students less likely to have completed a prior degree for example), an analysis of covariance (ANCOVA) was used to assess whether there were significant differences between the mean TAVS scores based on differences in nationality and previous education, controlling for the effect of age. Similarly, an ANCOVA was used to assess whether there were significant differences between the mean TAVS scores based on differences in nationality controlling for the effect of previous education.

To compare the TAVS scores for international and non-international students, the results for nationality were recoded into two groups (British vs All other nationalities) and an independent samples t-test was used to compare the mean TAVS scores for the two groups.

Demographic variables were subsequently included as part of the multiple regression analysis as described in a later section.

4.1.7.4 Does ambiguity tolerance change over the course of training?

The first stage of this analysis used a cross sectional design. A one-way ANOVA was used to compare mean TAVS scores, with stage of training. As age increases during training, an analysis of covariance (ANCOVA) was used to determine whether there were significant differences between mean TAVS scores based on differences in stage of training, controlling for the effect of age.

The second stage of this analysis adopted a longitudinal approach using data from a single year-cohort (referred to as “test cohort”), who were surveyed annually for 3 years. Responses from the test cohort were classified by year of study and stage of training. A Pearson correlation analysis was used to assess whether there was a significant correlation between participant TAVS scores between each of the three years of the



longitudinal study. A repeated-measures ANOVA with Greenhouse-Geisser correction (Abdi 2010) was used to assess whether mean TAVS score differed significantly between time points.

There are different descriptions in the literature of how participants may be grouped based on scores for ambiguity tolerance (Chiang 2016; Weissenstein et al. 2014; Norton 1975; El-Koumy 2003). Classification of participants into three groups (High, Low and Moderate) can be based on norm-referencing (Norton 1975; El-Koumy 2003) or criterion referencing (Chiang 2016). Classifications for TAVS scores were norm-referenced based on an analysis of the entire study data set, by splitting responses into three equal groups and identifying cut-scores which represented the boundaries of each of these groups.

Test-cohort TAVS scores were classified by TAVS group (High, Moderate or Low). For each participant in the test group (those with 3 survey responses) the pattern of movement between test groups was identified and illustrated using graphs and tables. The pattern of movement between test groups was calculated as follows:

Test-moves = (Number of test positions moved between T1 and T2) + (Number of test positions moved between T2 and T3)

Where T1 is 2013/14 survey, T2 is 2014/15 survey and T3 is 2015/16 survey.

For example, a participant who was in group 3 (High) at all three time points would have a calculation as follows:

Test-moves = (0) + (0) = 0

Whereas a participant who was in group 3 (High) at T1, group 1 (Low) at T2 and group 2 (Moderate) at T3 would have a calculation as follows:

Test-moves = (2) + (1) = 3

Test-cohort TAVS scores were classified according to this group system and movement between TAVS groups was compared between each of the three years during which the test-cohort participated in the study. A descriptive summary of test-moves for the test-group of the test-cohort was produced and a Pearson correlation was used to ascertain whether there was a correlation between numbers of test-moves and mean TAVS scores for the test-group. A Welch one-way ANOVA with Games-Howell post-hoc test was used to determine whether there was a statistically significant difference in number of group-moves between groups (based on TAVS group in year 1 of training).



4.1.7.5 *How does ambiguity tolerance relate to elective and career choices?*

The first part of this analysis used data from the full set of participant responses. Participants were asked two questions about their career plans. The first related to their expected career path (e.g. clinical practice or further speciality training), the second related to which type of practice they expect to work in (e.g. small animal or equine practice). For brevity, these are referred to as career path and species area respectively.

Descriptive statistics were generated comparing TAVS scores between different groups based on expected career path and species area. A one-way ANOVA was used to assess whether there were significant differences between the mean TAVS scores for each group.

The second part of this analysis focused on the test-cohort only. Using ID numbers provided voluntarily by study participants in the test cohort, participants were matched to their choice of final year elective. Final year electives are chosen in the second semester of 3rd year. Students are asked to provide a first and a second choice of elective. Matching elective choices data with TAVS scores during the first three years of training enabled further analysis to consider the relationship between TAVS scores and choices of electives. Although some elective choices may be popular, and not all students will get their first choice of elective, capturing the data at the point of choice submission ensures that the elective recorded represents the students' first choice. A specific request was made to the ethics committee to ensure that these data (which are in the public realm) could be used in this way. This request was granted.

Elective choices are split into Tier 1 and Tier 2. There are 5 options for Tier 1 electives and 17 options for Tier 2 electives. Of the 17 options for Tier 2 electives, 2 are based in clinical facilities which work with underserved populations (Working equids and Shelter medicine). Two are specifically international opportunities (both based in areas of Africa) and 1 has an international option (Dairy in the USA).

Descriptive statistics were generated comparing TAVS scores between different groups in the test-cohort only, based on choices of Tier 1 and Tier 2 elective.

To test the hypotheses that students with higher ambiguity tolerance would be more likely to choose an international elective opportunity and more likely to choose to work with underserved populations, a t-test was used to compare the mean TAVS scores for students who had chosen an international elective (Africa or US Dairy) and those who had not and between those who chose to work with an underserved populations (Working equids or Shelter medicine) and those who had not. Responses from participants who had chosen Tier 2 Dairy (which has international and non-international options, N=18) were



included in the international group on the basis that most of these placements are in the USA (typically fewer than 25% of students opt to stay in the UK).

4.1.7.6 Can we predict ambiguity tolerance based on demographic and career-related parameters?

A multiple regression analysis was run to predict TAVS score from demographic variables which preliminary analyses suggested may be significant. Checks were run to ensure that data met the assumptions required for multiple regression analysis (P-P plots, Q-Q plots, Durbin Watson statistic calculation)(Osborne & Waters 2002).

5 Ambiguity tolerance in veterinary students: Results and Discussion

5.1 Results

5.1.1 Responses and overall distribution of ambiguity tolerance

A total of 932 survey responses were collected across the three years of the study. Four responses failed to meet the inclusion criteria for the study (>25% missing data, N=3; duplicate response N=1) and these were excluded from subsequent analysis. For the remaining responses (N=928), Table 5-1 shows the patterns of response between the different year groups and cohorts.

Response rates per year group range from 31%-93% over the course of the study. Response rates in the cohort followed as part of the longitudinal study range from 52%-93%. In general, better response rates were achieved where the survey completion opportunity was associated with a structured activity (e.g. a clinical skills practical session).

The majority of responses (N=878) included a student ID number which could allow survey responses to be tracked from year to year. A minority (N=50) declined to provide an ID number.

Table 5-2 shows the number of occasions on which participants completed the survey. Depending on the stage of training, occasions were between 11-16 months apart.

Because response rates in some years of the study were low, individual responses were pooled for the cross sectional analysis. For significant findings, analyses were repeated for each study year independently.

Table 5-2: Survey completion by participants (*assuming those who did not give ID number only completed survey once)

How many times survey completed	Number of participants	Number of responses
Missing ID number	<=50	50
1	453	453
2	154	308
3	39	117
Total	696*	928

Figure 5-1 and Figure 5-2 show the distribution of TAVS scores for the study population before (Figure 5-1) and after (Figure 5-2) use of mean substitution.

The 21-25 year age category was most commonly chosen. 76.3% of participants were female. The characteristics of the student participants were comparable to the characteristics of the general veterinary student population in the UK , as 76% of all veterinary students admitted to UK veterinary schools in 2012/13 were female (RCVS 2013). However, a higher proportion of our students (36%) had a previous degree qualification than the average for UK Veterinary school admissions (21%) (RCVS 2013).

Figure 5-1: Distribution of TAVS scores prior to use of mean substitution for missing values

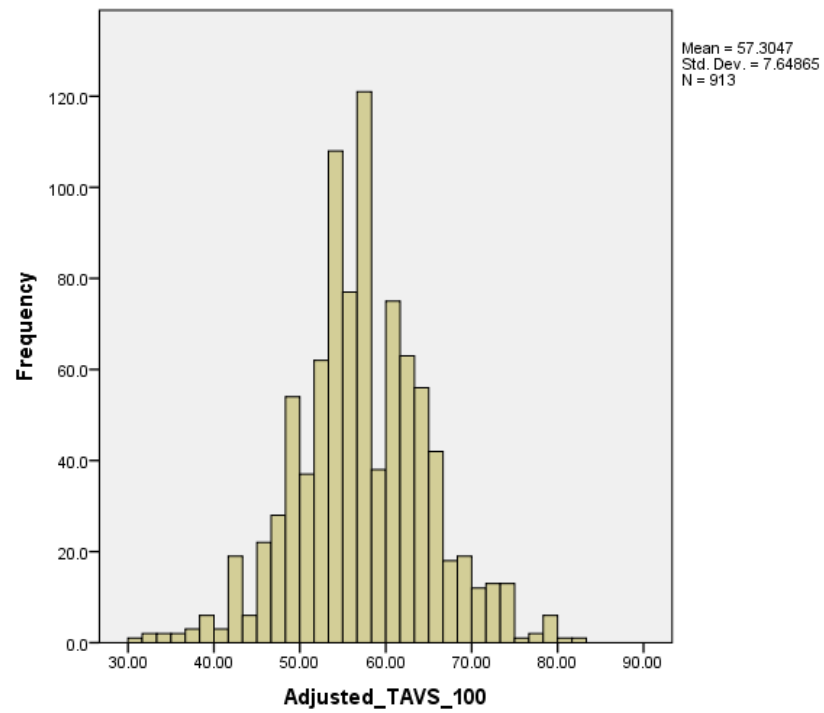
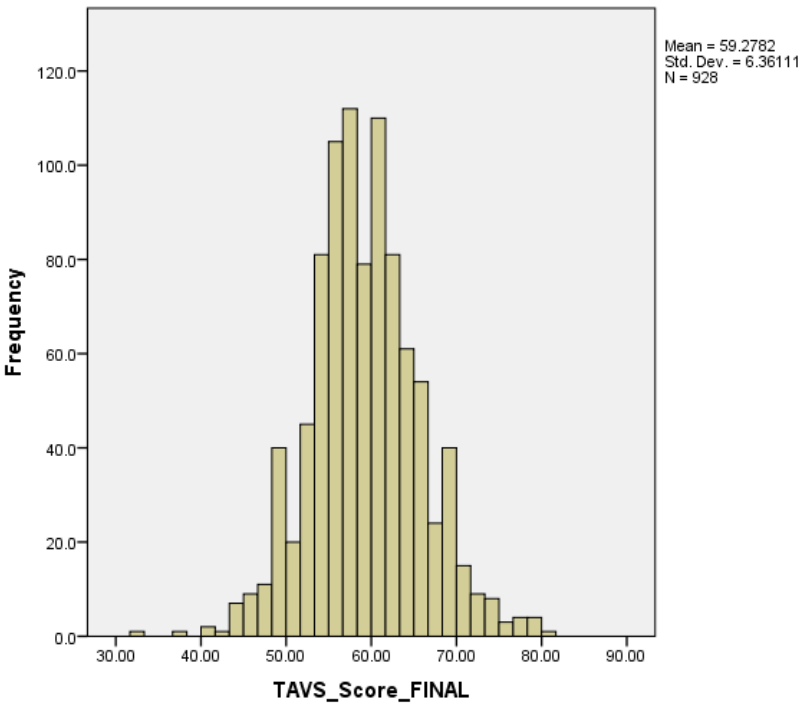


Figure 5-2: Distribution of TAVS scores after use of mean substitution for missing values



The mean TAVS score for participants in this study was 59.28, with a possible range of 0-100 and a population range from 32.41-80.56. Cut-off points for grouping participants into 3 equal groups based on their TAVS scores were calculated as: Low (0.00-56.48), Moderate (56.49-61.11) and High (61.11-100.00).

The use of mean substitution for missing values of the 5/27 missing scale items increases the mean TAVS score (57.30 to 59.28) and reduces the standard deviation for the measure (7.65 to 6.36). For both examples, the scores are normally distributed.

5.1.2 Relationship between AT and demographic variables

5.1.2.1 Age

Figure 5-3 shows how TAVS score changes with participant age and Figure 5-4 shows the mean TAVS score for each age category. There is a positive correlation between age and TAVS score, but this is not significant using a Spearman rank correlation ($P=0.44$). The graph indicates that this correlation is strongly driven by high TAVS scores in participants over 30 years old.

Figure 5-3: Variation of TAVS scores with age of participant. The interpolation line (dotted line) is between mean values for each category.

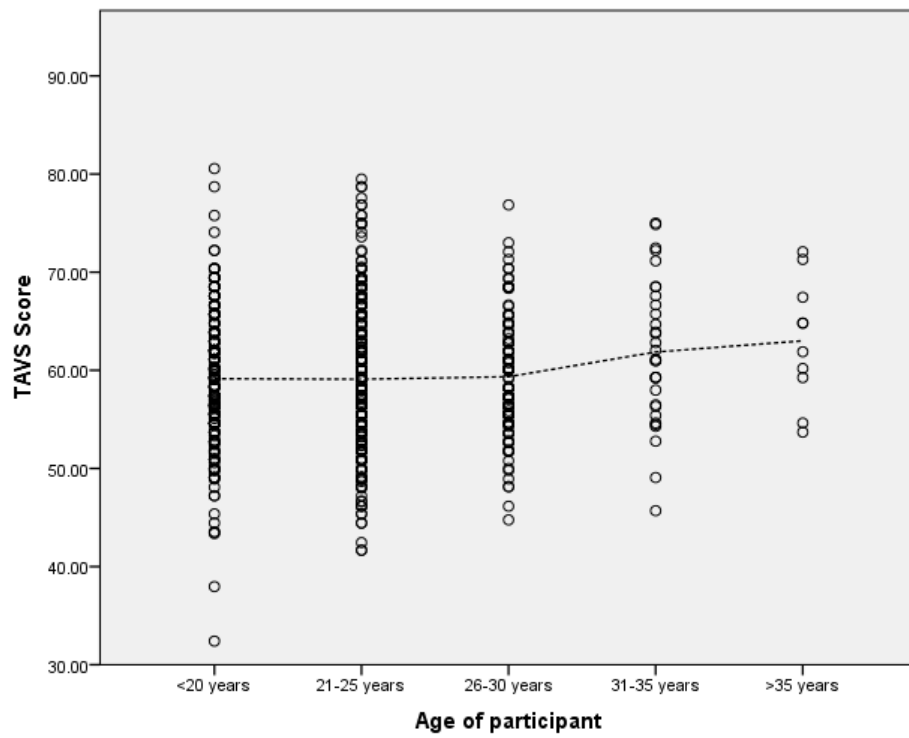
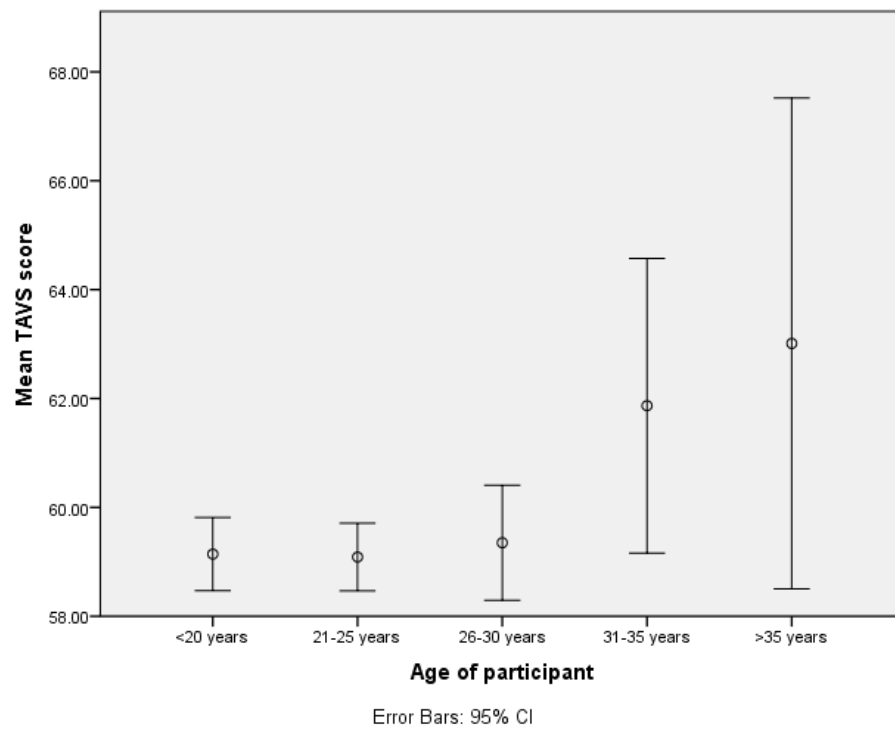


Figure 5-4: Variation in mean of TAVS scores with participant age group



There was no significant difference between age groups as determined by one-way ANOVA ($F(4,917) = 2.281, p = 0.059$). A Tukey post-hoc test showed that there were no statistically significant differences between any of the 5 age groups.

There was, however, a small and statistically significant difference in mean TAVS scores between mature students (30 years and over, $M = 62.15$ $SD = 7.07$) and non-mature students (under the age of 30 years $M = 59.15$ $SD = 6.32$), $t(920) = -2.956, p = 0.003$. Analysis of covariance shows that this difference is still significant after correcting for previous education ($F(1,917) = 4.74, P = 0.03$) but the magnitude of the difference is small.

Comparison of responses from each survey-year demonstrated that mature students on average had slightly higher TAVS scores than non-mature students in all three years of the study. T-tests determined that this difference was statistically significant in the 2013/14 survey group, and approaching significance in the 2014/15 and 2015/16 survey groups. Summary tables are included in Appendix VII.

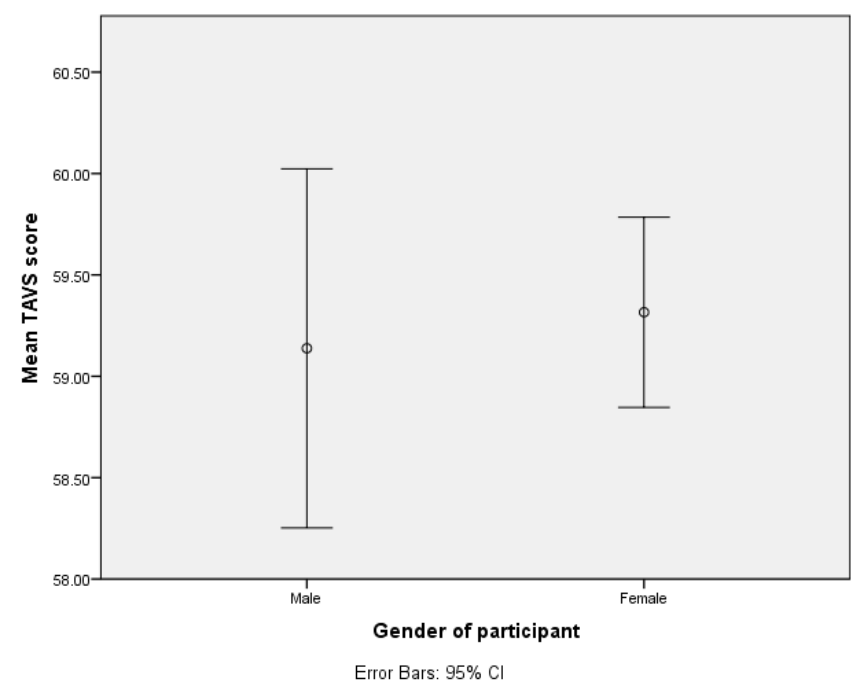
To summarise, there is some evidence for a positive correlation between ambiguity tolerance and age in the current study population, but this is not reflected in significant differences in ambiguity tolerance between specific age groups. On average, mature students have slightly higher TAVS scores than non-mature students, even after correcting for difference in previous education.

5.1.2.2 Gender

Figure 5-5 shows mean TAVS score for male and females in the study population.



Figure 5-5: Mean TAVS score and participant gender

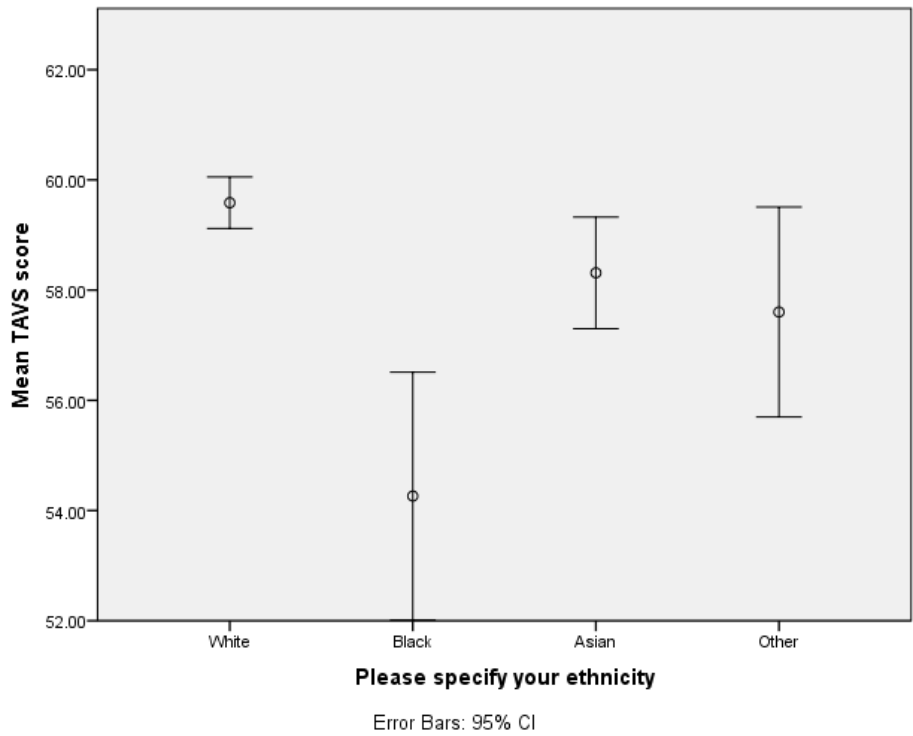


An independent-samples t-test was conducted to compare TAVS scores between males and females. There was no significant difference in the scores for females (59.32, SD = 6.36) and males (59.14, SD = 6.49); $t(916) = -0.353$, $p = 0.724$ in this study population.

5.1.2.3 *Ethnicity*

Figure 5-6 shows mean TAVS scores for different ethnic groups in the study population.

Figure 2: Mean TAVS score by different ethnic groups (No Unknown category is excluded from the graph).



The mean TAVS score is highest among participants who described their ethnicity as White, lower in those who described their ethnicity as Asian or Other and lowest in those who described their ethnicity as Black. There was a statistically significant difference between groups as determined by one-way ANOVA ($F(4,915) = 4.203, p = 0.002$). A Tukey post-hoc test revealed that TAVS scores were statistically significantly lower in students describing their ethnicity as Black ($M = 54.26, SD = 3.72$) than those describing their ethnicity as White ($M = 59.59, SD = 6.52, p = 0.023$). There were no statistically significant differences between the other ethnic groups in the analysis.

An ANCOVA determined that the relationship between TAVS scores and ethnicity was still significant when controlling for nationality ($F(4,913) = 6.123, p = 0.000$).

Comparison of responses from each survey-year demonstrated that Black students on average had lower TAVS scores than non-Black students in all three years of the study. T-tests determined that this difference was statistically significant in the 2014/15 survey group, approaching significance in the 2013/14 and non-significant in the 2015/16 survey group. Summary tables are included in Appendix VIII.

Table 5-3 shows the distribution of individuals of different ethnicity between the different classifications for nationality. The “Other nationality” group includes the majority of responses from those of Asian and Black ethnicities. The numbers here are small and this is particularly significant given that individual students may have more than one response (from different years) in the data set. Interestingly, the mean TAVS score for responses from Black North American students ($M = 52.88, SD = 4.34, N = 5$) is lower than that for Black students of other nationalities ($M = 55.13, SD = 3.28, N = 8$). Although this difference is not statistically significant ($t(11) = -1.069, p = 0.308$), it does differ from what might be expected given that the overall pattern for North American students is, on average, to have a higher tolerance of ambiguity than those of other nationalities. Indeed, comparison of TAVS scores for Black ($M = 52.88, SD = 4.34, N = 5$) and White ($M = 60.49, SD = 6.28, N = 228$) North American students shows that there is a statistically significant difference between the mean TAVS scores for the two groups ($t(231) = 2.694, p = 0.008$). These findings should be interpreted with particular caution given that the total number of responses from Black students is low.

Table 5-3: Distribution of individuals of different ethnicity between the different classifications for nationality

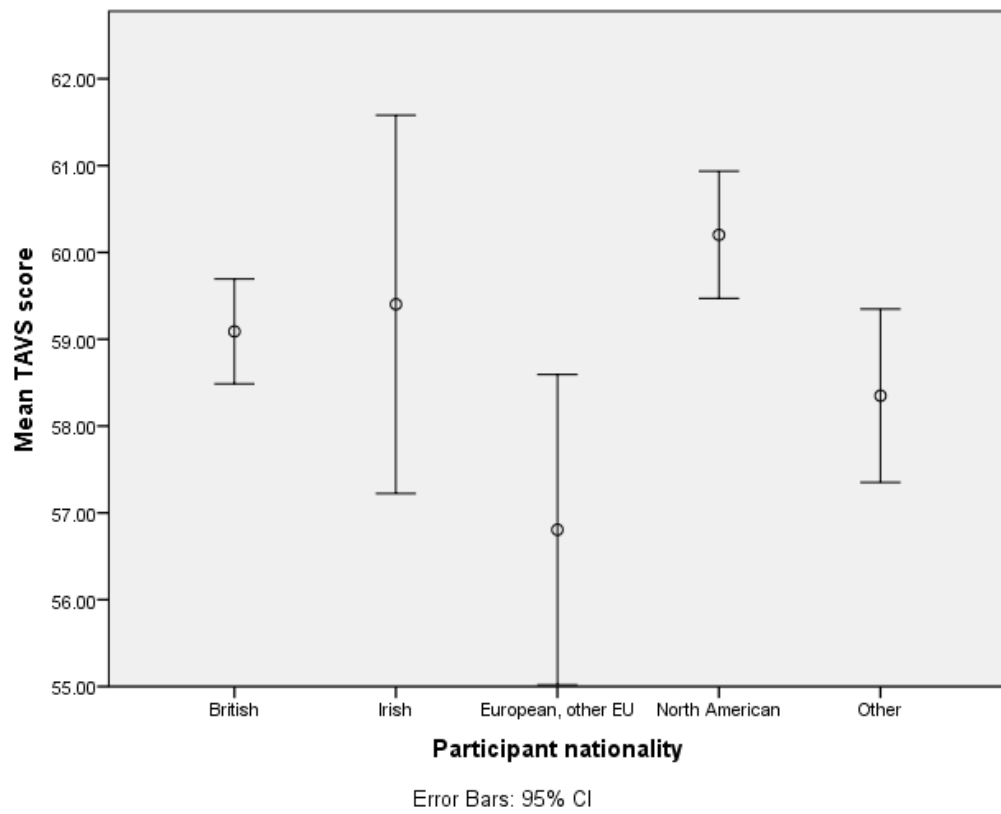
		Please specify your nationality					
		British	Irish	European, other EU	European, outside EU	North American	Other
		Count	Count	Count	Count	Count	Count
Please specify your ethnicity	White	475	21	10	0	228	14
	Black	0	0	0	0	5	8
	Asian	6	0	2	0	16	99
	Other	7	0	4	0	16	5
	Not known	0	0	0	0	3	0

To summarise, these results suggest that participants who classify their ethnicity as black tend to have lower ambiguity tolerance than those who classify their ethnicity as white. Scores for ambiguity tolerance in other ethnic groups were in between these and not significantly different from either group.

5.1.2.4 Nationality

Figure 5-7 shows mean TAVS scores for groups of different nationality in the study population. There was a small statistically significant difference between groups determined by one-way ANOVA ($F(4, 916) = 2.807, p = 0.025$). Although Levene's statistic indicated that there was not homogeneity of variance ($2.767, p = 0.026$), Hartley's F max variance ratio was less than the critical value (4.37) for the sample size ($F_{max}(15, 488) = 4.098, p < 0.005$). There was statistically significant difference between groups as determined by a Welch ANOVA ($F(4, 70) = 4.475, p = 0.003$). A Games-Howell post-hoc test revealed that TAVS scores were significantly lower in European, other EU ($M=56.82, SD=3.35, p = 0.01$) and Other groups ($M= 58.35, SD= 5.66, p = 0.028$), than in North American participants ($M= 60.20, SD= 6.12$).

Figure 5-7: Mean TAVS scores for groups of different nationality in the study population



As North American students are typically older than UK students (having completed a previous degree prior to Veterinary school) the analysis was repeated with a correction for age and for previous education.

Although Levene's statistic indicated that there was a departure from homogeneity of variance, Hartley's Fmax variance ratio (as described above) suggested that this was not serious and the use of ANCOVA was justified.

A One-way ANCOVA was conducted to test the hypothesised differences between British, Irish, North American, European and Other national groups on ambiguity tolerance controlling for age. There is an effect of nationality on TAVS score after controlling for age, ($F(4, 915) = 2.050, p = 0.08$) but this is not significant at $p < 0.05$ level.

A One-way ANCOVA was repeated, this time controlling for previous education. This determined that there is no effect of nationality on TAVS score after controlling for previous education, ($F(4, 913) = 1.250, p = 0.288$).

There was no significant difference in the mean TAVS scores between international and non-international students as determined using an independent samples t-test ($t(919) = -0.966, p = 0.334$).

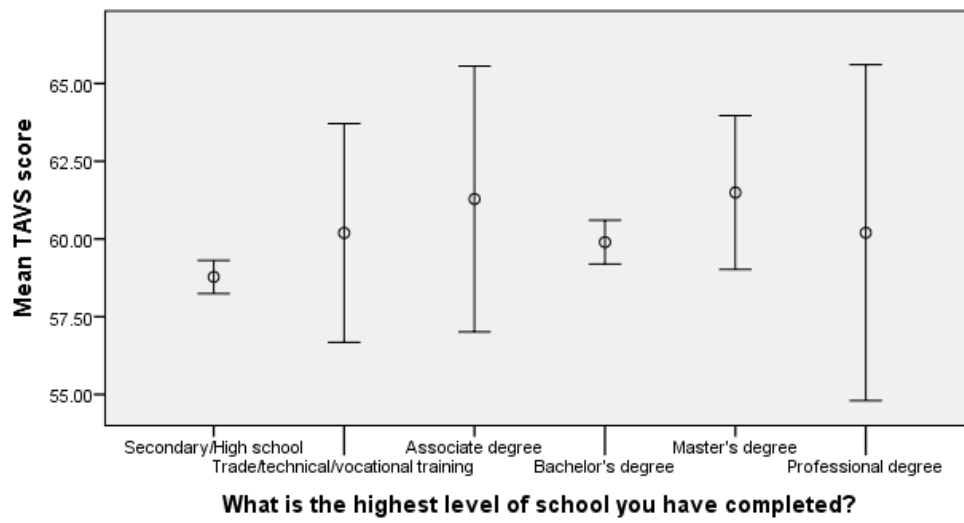
To summarise, although North American students have higher mean TAVS scores than other groups (in particular non-EU and Other international students), the difference between these groups is not significant when the effect of age or previous education is considered.

5.1.2.5 Previous education

Figure 5-8 shows mean TAVS scores for groups with different levels of education prior to starting Veterinary school.



Figure 5-8: Mean TAVS scores presented by prior education (error bars represent 95% confidence interval)



A one-way between subjects analysis of variance (ANOVA) was used to determine whether there were significant differences between the mean TAVS scores based on previous education. There was a significant effect of previous education on TAVS score at the $p < .05$ level for educational groups ($F(5, 914) = 2.316, p = 0.042$). Post hoc comparisons using the Tukey HSD test indicated that the mean TAVS score for students who had previously completed a Bachelor's degree ($M = 59.90, SD = 6.49$) was higher than those who had only completed Secondary school ($M = 58.78, SD = 5.98$) training but that this was not statistically significant ($p = 0.152$). The magnitude of differences here is small and no other inter-group comparisons showed statistically significant differences.

An independent-samples t-test was conducted to compare TAVS scores in participants who had completed a previous degree (including Bachelors, Association, Master and Professional degree) or technical training with those who had only completed secondary education. There was a small significant difference in the TAVS scores for students who had completed a previous degree or technical training ($M = 60.07, SD = 6.07$) and those who had completed secondary school only ($M = 58.78, SD = 6.49$); $t(926) = -3.027, p = 0.003$.

Because age could be a confounding variable for previous education (younger students less likely to have completed a prior degree for example), an analysis of covariance (ANCOVA) was used to assess whether there were significant differences between the mean TAVS scores based on differences in previous education, controlling for the effect of age. There is a small but significant effect of previous education (previous degree/technical training compared with secondary school only) on TAVS scores after controlling for age, ($F(1, 919) = 5.17, p = 0.023$).

Comparison of responses from each survey-year demonstrated that students who had completed a degree or technical training had slightly higher TAVS scores than those who had completed secondary/high school only in all three years of the study. T-tests determined that this difference was statistically significant in the 2014/15 & 2015/16 survey groups, and approaching significance in the 2013/14 survey group. Summary tables are included in Appendix IX.

To summarise, these results suggest that participants who have previously completed a degree or technical training are more tolerant of ambiguity than those who have only completed secondary school level education, even after controlling for age.

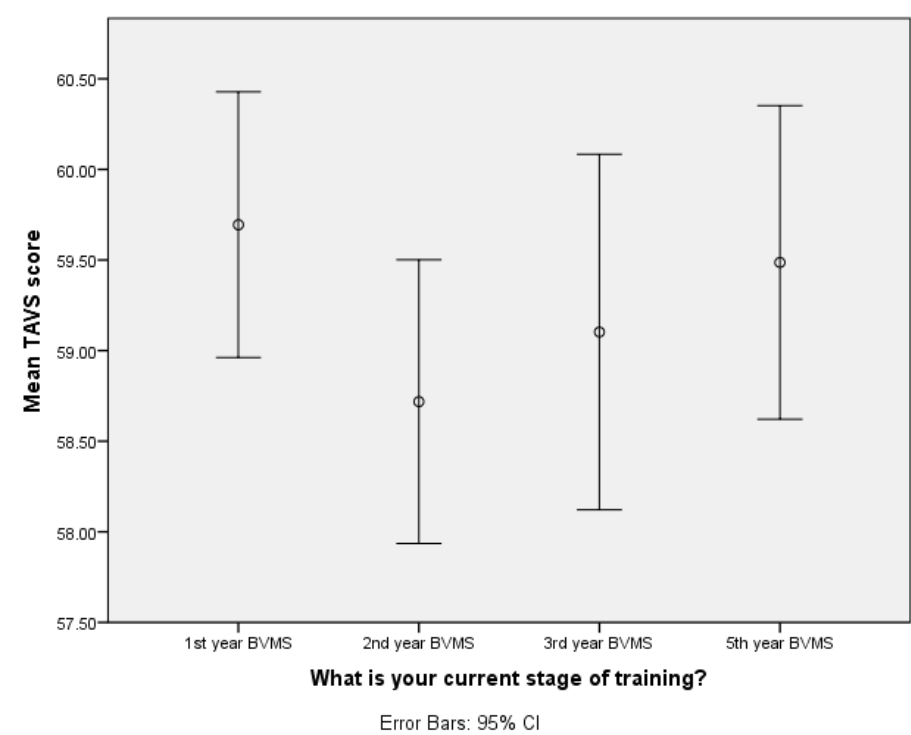
5.1.3 Does ambiguity tolerance change over the course of training?

5.1.3.1 *Cross sectional approach*

The first stage of the analysis describes a cross sectional approach to this research question.

For this study population, there is a decrease in mean TAVS score from 1st (59.70, SD = 6.30) to 2nd (58.71, SD = 6.09) year of training (see Figure 5-9). Mean scores then increase from 2nd to 5th year. A One-way ANOVA was conducted to compare effect of stage of training on TAVS scores. The magnitude of these difference was small and there was no statistically significant difference between groups as determined by one way ANOVA ($F(3,918) = 1.130, p = 0.336$).

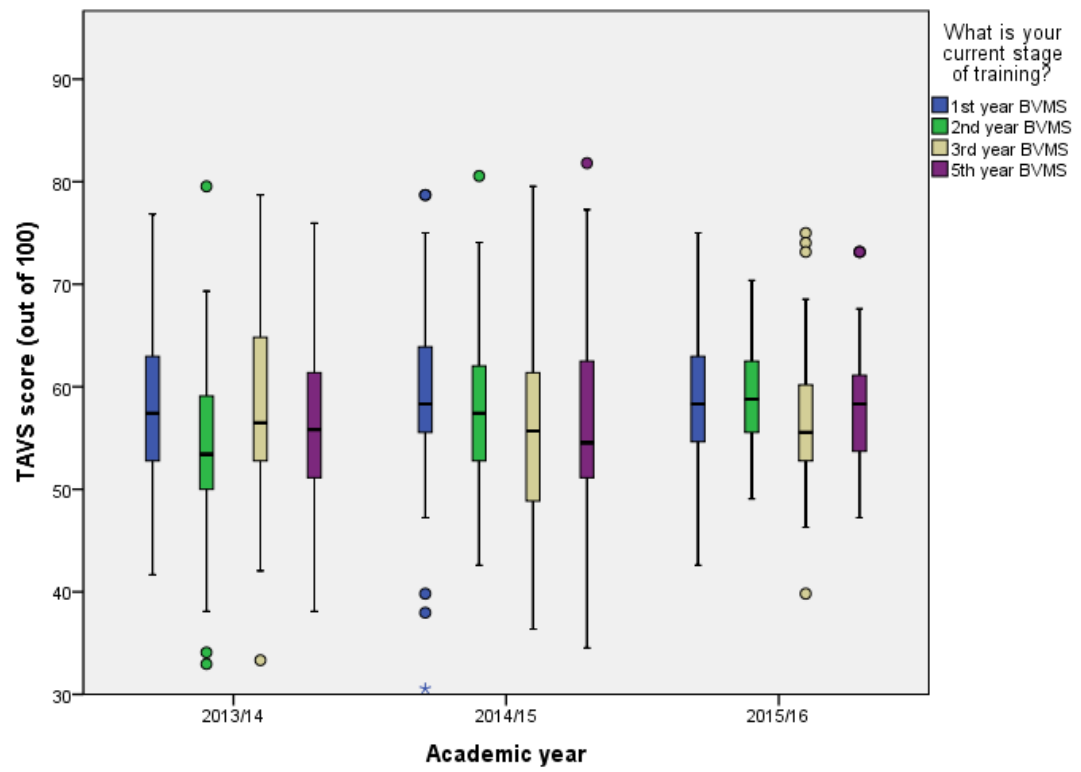
Figure 5-9: Mean TAVS score for each stage of training for all participant responses



As age increases during training, an analysis of covariance (ANCOVA) was used to assess whether there were significant difference between mean TAVS scores based on differences in stage of training, controlling for the effect of age. There were no significant differences in TAVS score between different stages of training, when correcting for age.

When considering each cohort separately the pattern varies from year to year. Figure 5-10 shows mean TAVS scores for each stage of training for each of the 3 cohorts.

Figure 5-10: Mean TAVS scores for each stage of training for each of the 3 Academic years



Analysis of variance for each of the three academic years demonstrates that there is a statistically significant difference between stages of training for some stages in some years but this pattern was not consistent across years. The outcomes of the analyses of variance and Tukey post-hoc analysis for each academic year are included in Appendix X.

To summarise, although mean TAVS scores do change with stage of training in all 3 years of this study, differences are small and there is no consistent pattern. When considered together, these findings suggest that stage of training is not consistently associated with TAVS scores across the study population.

5.1.3.2 Longitudinal approach

The second stage of this analysis adopted a longitudinal approach using data from a single year-cohort (referred to as “test cohort” N=132), who were surveyed annually for 3 years. Overall response rates for the test cohort can be found in Table 5-1.

The characteristics of the test-cohort are broadly similar to the other cohorts in the study (see Table 5-4). Asian students are slightly overrepresented in the test cohort response group and other cohorts had a higher proportion of responses from students with previous degree of technical training than the test cohort.

A total of 67 students from the test cohort completed the survey in 2013/14, 112 in 2014/15 and 61 in 2015/16. Of these, 25 participants (18.9%) completed the survey at all three time points, 56 (42.4%) completed the survey at 2 time points and 51 completed the survey at one time point (38.6). Figure 5-11 shows the mean TAVS score for the test cohort for each year of the study.

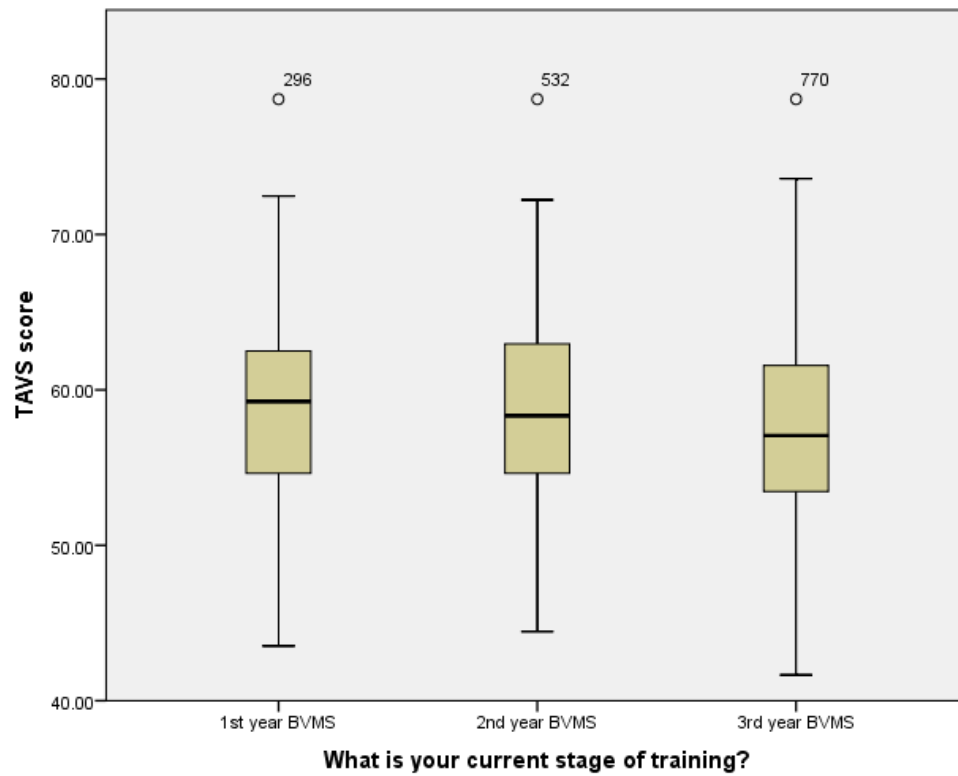
A one-way ANOVA confirms that, like the study population as a whole, there is no significant difference between the mean TAVS scores for the test cohort at each stage of training ($F(2, 248) = 0.30, p = 0.741$).



Table 5-4: Comparison on test cohort responses with remaining cohort responses based on demographic variables. Values show % of responses for each group.

		Responses from:	
		Other cohorts	Test cohort
Gender of participant	Male	22.5%	23.6%
	Female	77.5%	76.4%
Age of participant	<20 years	31.6%	45.8%
	21-25 years	48.3%	42.6%
	26-30 years	15.5%	7.6%
	31-35 years	3.7%	2.4%
	>35 years	0.9%	1.6%
Ethnicity	White	83.4%	75.7%
	Black	1.3%	1.6%
	Asian	11.8%	17.9%
	Other	3.4%	3.6%
	Not known	0.0%	1.2%
Aged over 30 years	No	95.4%	96.0%
	Yes	4.6%	4.0%
Previous degree or technical training	No	59.9%	65.3%
	Yes	40.1%	34.7%

Figure 5-11: TAVS scores for the test cohort by stage of training. Round circles indicate responses from a single participant considered to be an outlier



Using the participant identifier information collected for the test cohort, a Pearson correlation test was used to establish whether there was a significant correlation between individual participant TAVS scores between each of the three years of the longitudinal study. Table 5-5 shows the outcome of this analysis. As shown in Figure 5-12, there was a strong positive correlation between TAVS scores in each of the three years of the study. For all three years, this was statistically significant at a level $p < 0.001$. This provides good evidence to support the validity of the TAVS instrument.

In order to fulfil the assumptions required to perform a repeated measures ANOVA, a single outlying participant was excluded from the analysis. This participant had TAVS scores greater than 2 standard deviations higher than the mean TAVS score for the rest of the group in all three years of the study ($M=57.00$, $SD=6.24$, Outlier TAVS scores range 75.00-85.50). The demographic data revealed that the outlier was female, age 21-25, white, British and a non-graduate student. A repeated-measures ANOVA with Greenhouse-Geisser correction determined that mean TAVS score did not differ statistically significantly between years 1, 2 and 3 ($F(1.588, 39.711) = 0.827$, $p = 0.420$). Post-hoc tests using the Bonferroni correction confirmed that there is no significant difference in mean TAVS score between any of the three stages of training evaluated for the test cohort.

Therefore we can conclude that, for this cohort of students, mean ambiguity tolerance (as measured by TAVS scores) is stable and does not change over the course of Veterinary training from years 1-3.

Figure 5-13 illustrates the TAVS scores for the 25 individual students in the test cohort for which 3 separate surveys (one at each time point were collected).



Table 5-5: Correlation between individual TAVS scores between each of the three years of the longitudinal study. **indicates correlation significant at the 0.01 level (2-tailed).

		TAVS score for 2013/14 (BVMS 1)	TAVS score for 2014/15 (BVMS 2)	TAVS score for 2015/16 (BVMS 3)
TAVS score for 2013/14 (BVMS 1)	Pearson	1	.747**	.836**
	Correlation			
	Sig. (2-tailed)			
	N	61	52	29
TAVS score for 2014/15 (BVMS 2)	Pearson	.747**	1	.542**
	Correlation			
	Sig. (2-tailed)			
	N	52	112	54
TAVS score for 2015/16 (BVMS 3)	Pearson	.836**	.542**	1
	Correlation			
	Sig. (2-tailed)			
	N	29	54	67

Figure 5-12: A plot of Year 1 TAVS score against year 3 TAVS score demonstrating the strong positive correlation

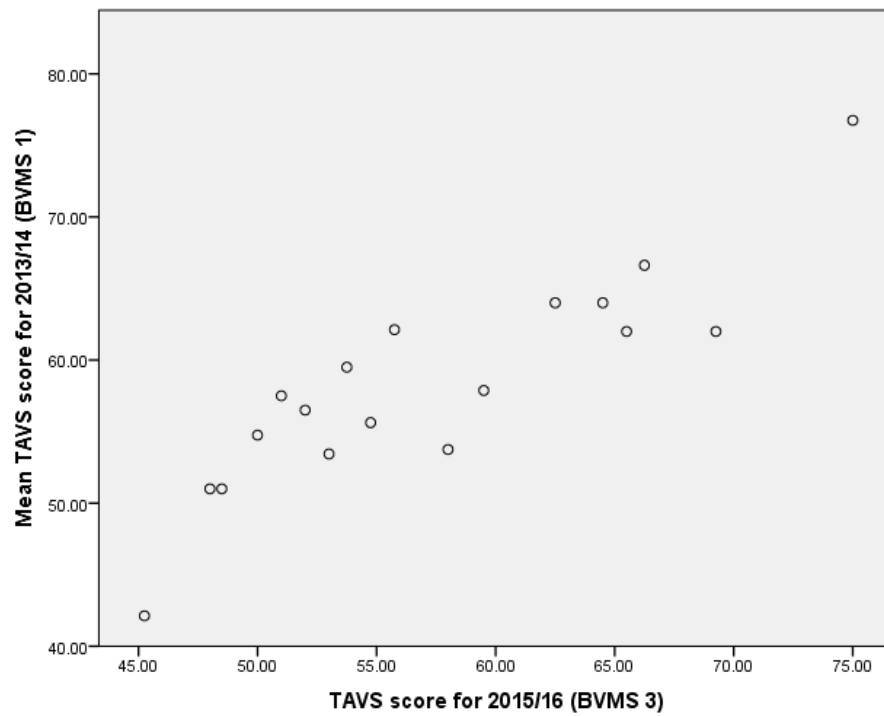
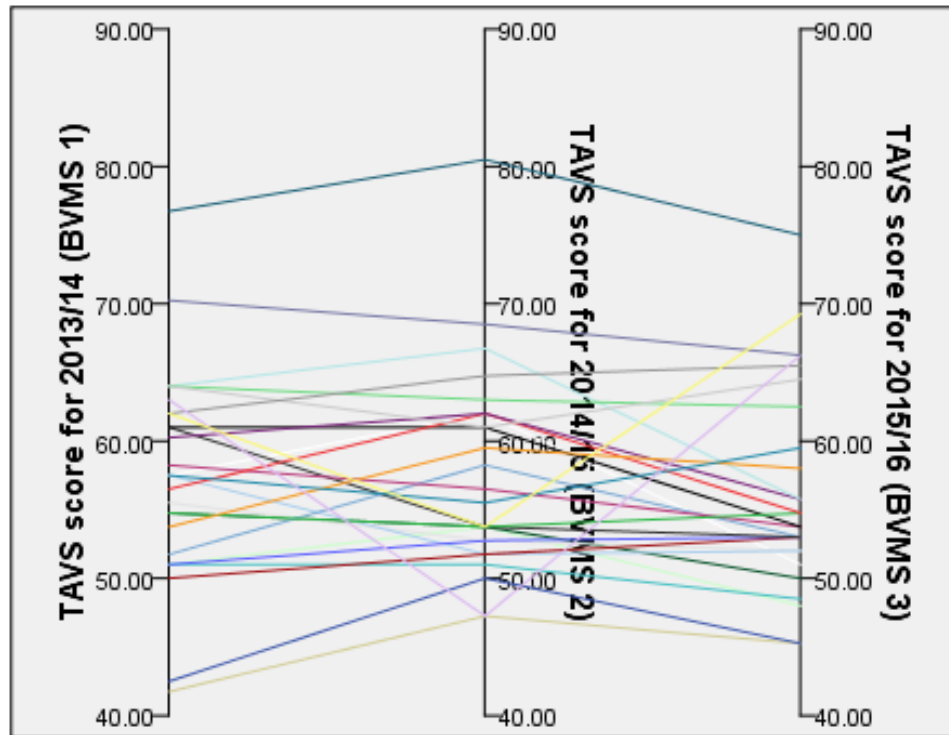


Figure 5-13: TAVS scores at each of three time points for individual students. Each coloured line represents a student's response pattern. The outlier is included in this graph (top line).



As there were only a low number of students in the test-cohort who had completed all three years of the survey (25/132), caution needs to be taken when interpreting and generalising the results of this analysis. As it was possible that participants completing the survey on three occasions may differ in ambiguity tolerance from the rest of the test-cohort, a series of analyses were performed to establish whether the two populations were similar.

Figure 5-14 and Figure 5-15 shows histogram plots for the participants who completed all three surveys from the test-cohort (referred to as test group), participants from the test cohort who completed only 1 or 2 surveys (referred to as non-test group) and the general study population. These suggest a similar pattern of distribution of test scores between the three groups.

A t-test determined that there was no significant difference in the mean TAVS score for the test (57.27) and non-test (57.25) groups ($t(130) = 0.059$, $p = 0.981$).

Figure 5-14: Non-test group distribution of TAVS scores

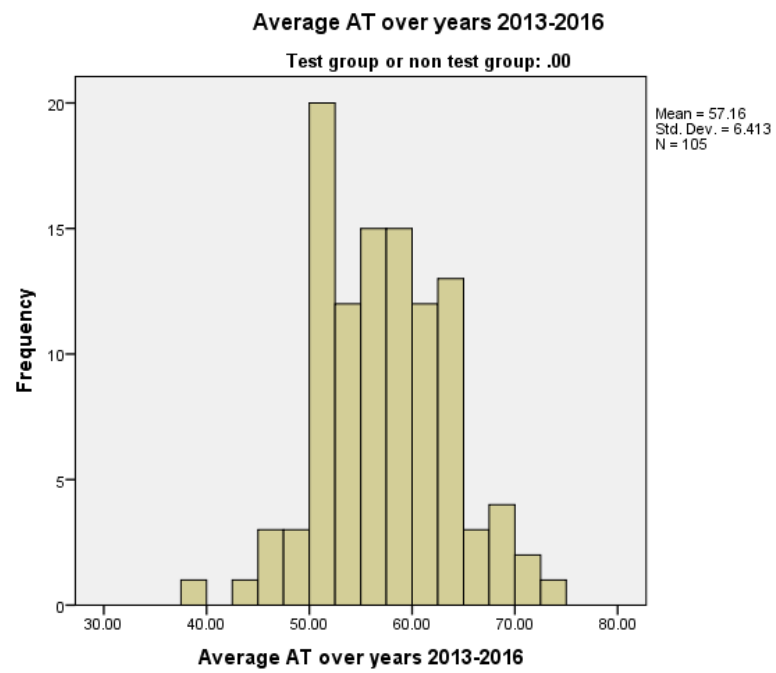
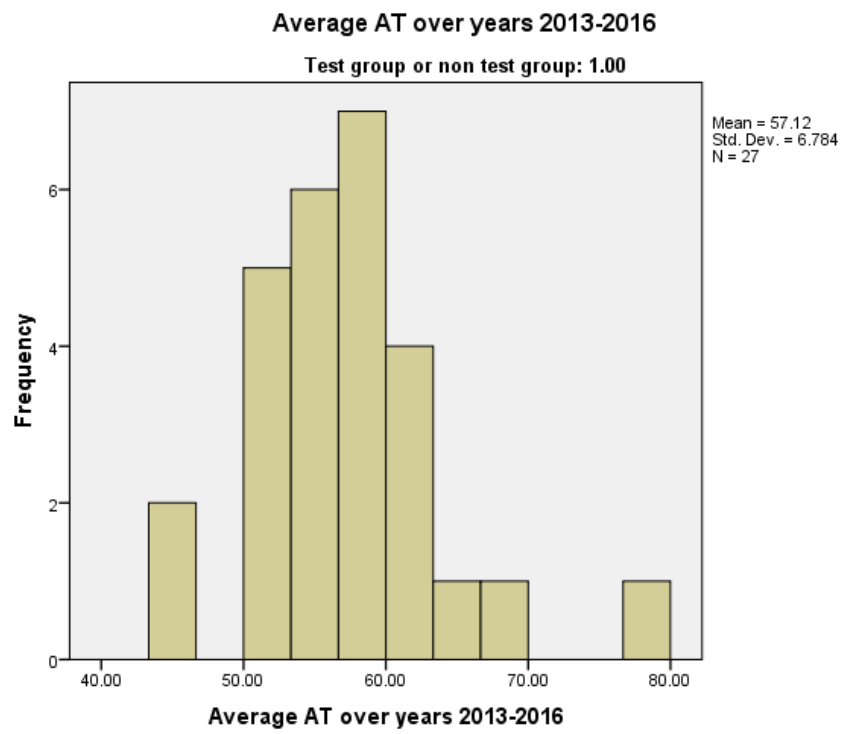


Figure 5-15: Test group distribution of TAVS scores

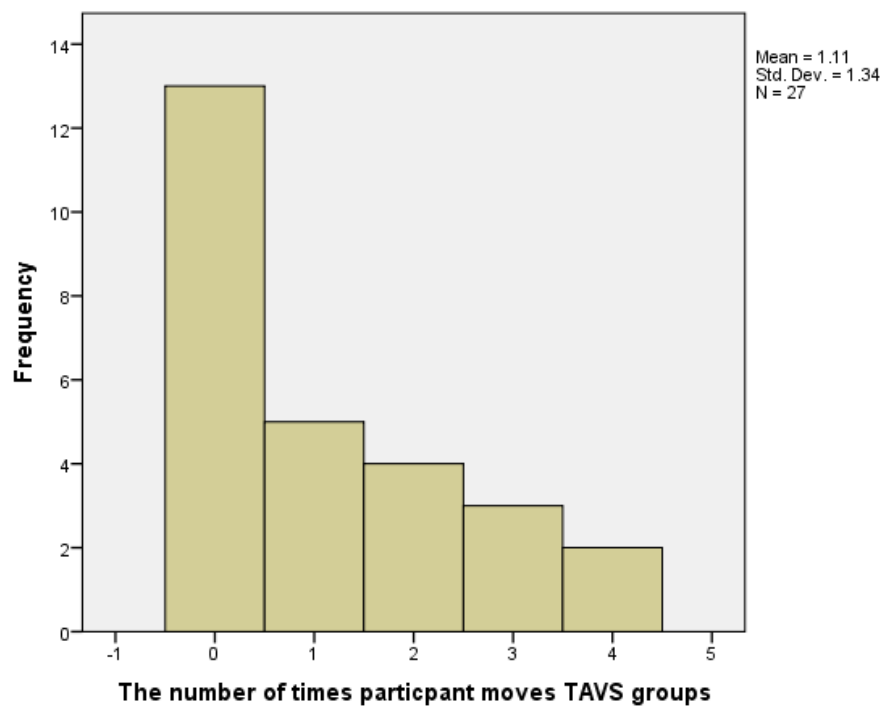


Test-cohort TAVS scores were classified by TAVS group (High, Moderate or Low). For each participant in the test group (those with 3 survey responses) the pattern of movement between test groups was identified. Appendix XI summarises this analysis and includes tables and figures to illustrate movement between groups.

These data illustrate that some participants in the test group do move TAVS groups one or more times during the first 3 years of training. We can observe that the majority of participants who have TAVS scores in the lowest group during the first year of training remain in the lowest group during both year 2 and year 3. Similarly, a majority of participants who have TAVS scores in the highest group during the first year of training will stay in the High group during year 2 and stay in or return to the High group during year 3. Participants in the Moderate group in year 1 show most movement in year 2 (to both Low and High groups) and year 3 (mainly to Low group). The overall pattern between years 1 and 3 suggests that students in the Highest and Lowest groups for ambiguity tolerance will tend to stay in that group, while students in the Moderate group will either remain there or move to the Low group. Movements between Lowest and Highest groups are unusual but do occur. This significance of this is discussed further in section 5.2.

The total number of times a participant moved TAVS groups over the course of the three years is shown in Figure 5-16. Results are for the test group only. 52% of participants (N=14) moved TAVS groups (High, Moderate or Low) at least once during the course of the study. Only 19% of participants (N=5) moved 3 or more groups (equivalent to moving between extremes of High and Low at least once) during the course of training.

Figure 5-16: Movement between TAVS groups (low, medium and high) for test-group participants



A Pearson correlation determined that there is no significant correlation between the number of group-moves and participants' average TAVS score over years 1-3 ($R=0.089$, $p = 0.674$).

However, a Welch one-way ANOVA determined that there was a statistically significant difference in number of group-moves between groups (TAVS group in year 1 of training, $F(2, 12.171) = 8.378$, $p=0.005$). The mean number of group-moves was lower for participants starting in the Low group ($M=0.27$ $SD=0.65$) than those starting in the Moderate group ($M=1.88$ $SD=0.99$) or the High group ($M=1.5$, $SD=1.77$). A Games-Howell post-hoc test revealed this difference was statistically significant in the case of the Low vs Moderate group ($p=0.019$).

This leads to a conclusion that although mean ambiguity tolerance for cohorts (evaluated using TAVS scores) does not change over the course of training; just over half of the participants in the test group moved at least one group (between High, Moderate and Low) over the first three years of training. There are strong correlations between individuals' ambiguity tolerance at each stage of training and, particularly for the Highest and Lowest groups; the TAVS group positions of students in the third year of training are frequently the same as those in the first year.

5.1.4 How does ambiguity tolerance relate to elective and career choices?

Using the full set of participant responses which met the inclusion criteria for the study, descriptive statistics were generated comparing TAVS scores between different groups based on expected career path and species area. Figure 5-17 and Figure 5-18 show mean TAVS scores for students, based on career path and species preference respectively:

There was a statistically significant difference between groups as determined by one-way ANOVA ($F(5,911) = 3.084$, $p=0.009$). A Tukey post-hoc test revealed that participants planning a career in academia had significantly higher TAVS scores ($M=63.22$ $SD=7.06$) than those planning careers in either Government ($M=57.97$ $SD=5.45$, $p=0.043$) or Industry ($M=55.64$ $SD=6.90$, $p=0.035$). A difference in TAVS scores between those planning careers in academia ($M=63.22$ $SD=7.06$) and those planning careers in clinical practice ($M=59.19$ $SD=6.26$, $p=0.053$) was only significant at the 10% level. There were no statistically significant differences between the other career path groups in the study.

Figure 5-17: Mean TAVS scores for different expected career paths

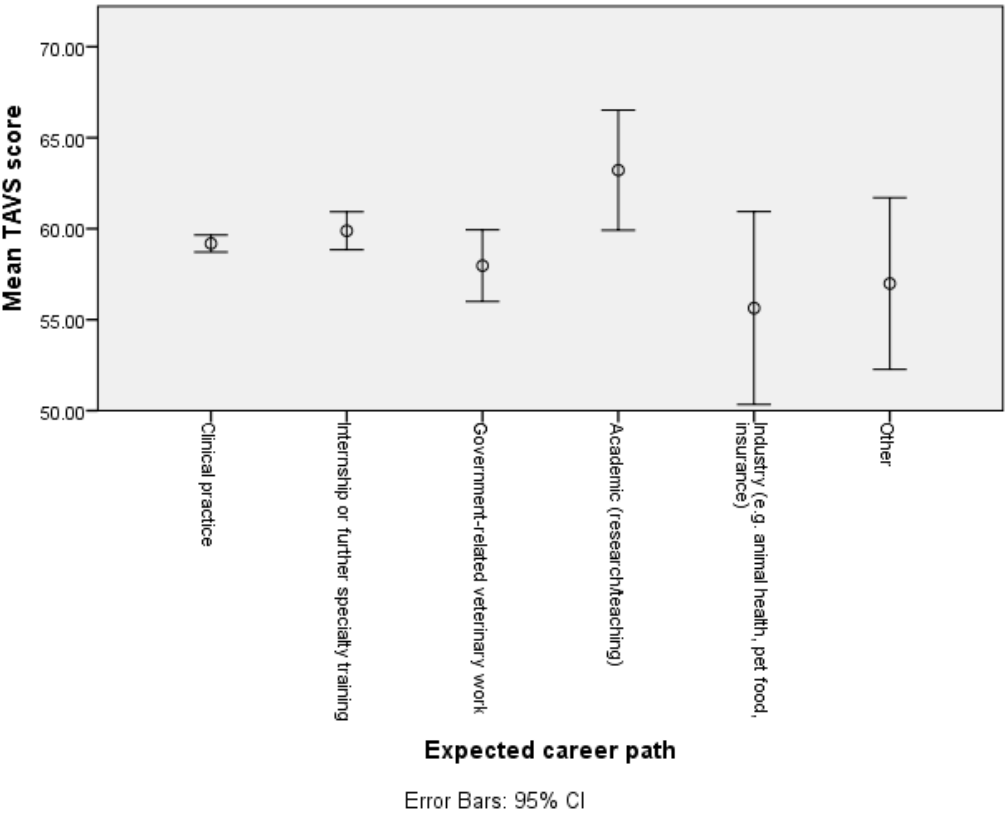
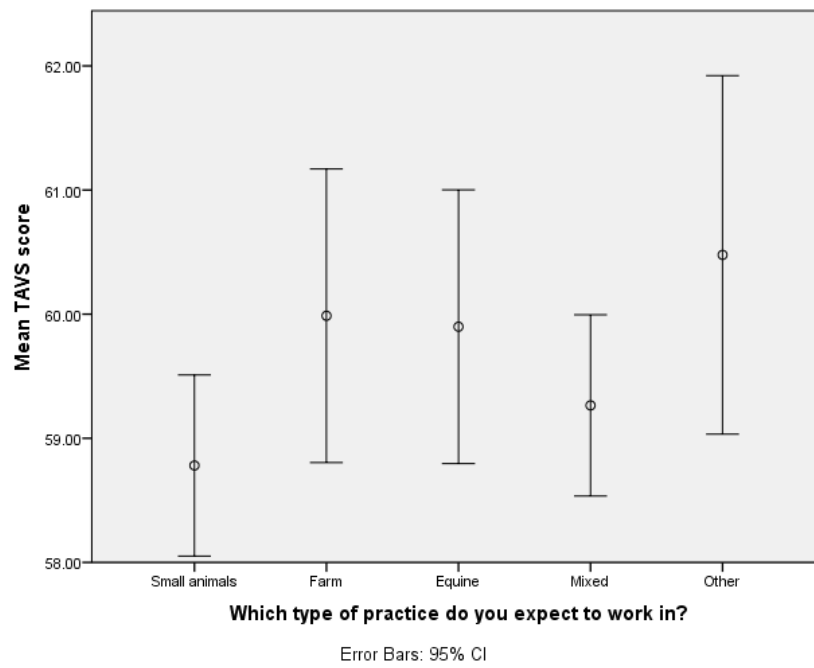


Figure 5-18: Mean TAVS scores for different species preferences



There was no statistically significant difference between groups based on their species area preference as determined by one-way ANOVA. Although the mean TAVS score for those planning to work in small animal practice ($M=57.78$ $SD=6.46$) was lower than the mean for students planning to work in other species areas, a Tukey post-hoc test confirmed that this was not statistically significant.

The second part of this analysis focused on the test-cohort only.

Using ID numbers provided voluntarily by study participants in the test cohort, participants were matched to their choice of final year elective. Descriptive statistics were generated comparing TAVS scores between different groups, based on choices of Tier 1 and Tier 2 elective.

Figure 5-19 shows the mean TAVS scores for participants grouped by Tier 1 elective choices. Figure 5-20 shows the mean TAVS scores for participants grouped by Tier 2 elective choices.

There was no statistically significant difference between different Tier 1 elective choice groups as determined by a one-way ANOVA ($F(5,110) = 1.189$, $p=0.319$).

There was no statistically significant difference between different Tier 2 elective choice groups as determined by a one-way ANOVA ($F(16, 98) = 1.098$, $p=0.368$).

Figure 5-21 compares mean TAVS scores for participants who had chosen an international elective and those who had not. The single outlying value shown (ID 10) was excluded from subsequent analysis.

Figure 5-19: Mean TAVS scores grouped by choice of Tier 1 elective

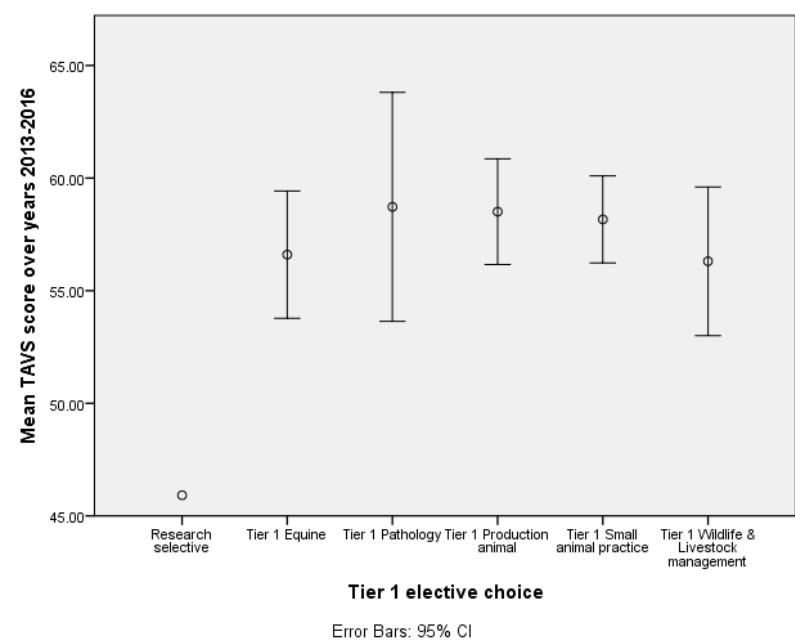


Figure 5-20: Mean TAVS scores grouped by choice of Tier 2 elective (only elective choices made by at least 3 participants are shown in this graph)

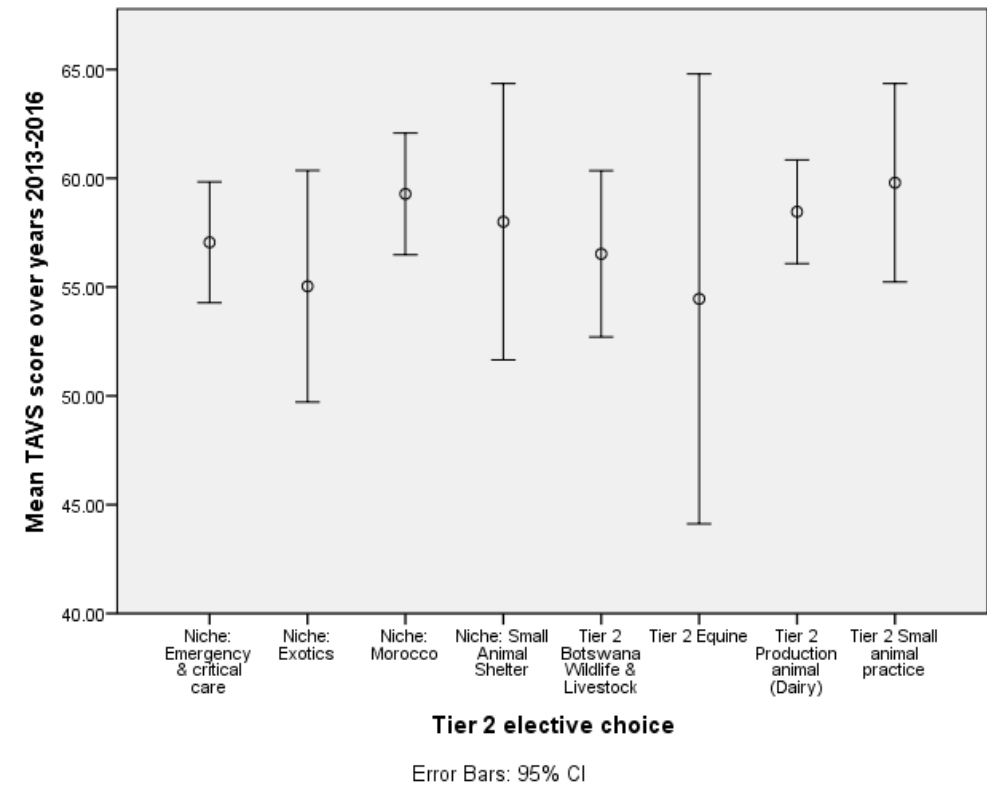
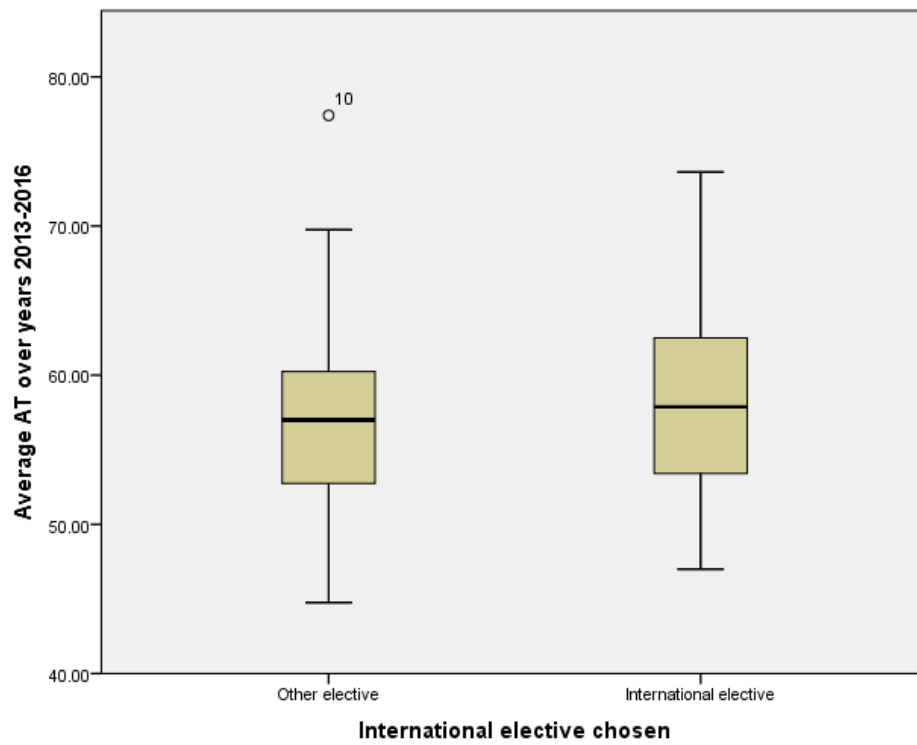


Figure 5-21: mean TAVS scores for participants who chose an international elective compared with participants who had not



A t-test was used to compare the mean TAVS scores for students who had chosen an international elective and those who had not. There was no statistically significant difference in TAVS scores between participants who had chosen an international elective ($M=58.41$ $SD=6.26$) and those who had not ($M=57.15$ $SD=5.98$), $t(113) = -1.101$, $p=0.273$.

A t-test showed that students who had chosen to work with an underserved population for their elective had, on average, higher TAVS scores ($M=59.19$ $SD=6.83$) than those who had not ($M=57.31$ $SD=5.84$) but this difference was not statistically significant ($t(113) = -1.436$, $p=0.154$).

To summarise, there is a relationship between expected career path and ambiguity tolerance in this study population, demonstrated by the fact that individuals expecting to work in academic roles have higher ambiguity tolerance (TAVS scores) than those planning to work in government or industry roles. The majority of participants however, expect to work in clinical practice and there is no significant difference in ambiguity tolerance between this group and other potential career paths based on the current analysis. The choice of elective study opportunities and the species area preference of veterinary students in this study are not significantly related to ambiguity tolerance and interestingly, the choice to complete an international elective or an elective working with underserved populations is not strongly associated with higher TAVS scores.

5.1.5 Can we predict ambiguity tolerance based on demographic parameters?

A multiple regression analysis was run to predict TAVS scores based on demographic variables. Checks confirmed that our data met the assumptions required for multiple regression analysis. The best-fit model included the parameters: age, previous education and ethnicity. These variables were recoded to emphasise the major effects identified in the first part of the analysis (mature vs non-mature students, previous degree or not, and Black vs Non-Black ethnicity). Although these variables significantly predicted TAVS score, $F(3,916) = 7.92$, $p = 0.000$, the model only predicts 2.5% of the variance in TAVS scores ($R^2=0.025$) in the participant group. All 3 variables added statistically significantly to the prediction.

Table 5-6 shows the results of the multiple regression analysis:



Table 5-6: Results of multiple regression analysis for dependent variable TAVS score

Coefficients^a								
		Unstandardized Coefficients		Standardized Coefficients		Collinearity Statistics		
		Std.						
Model		B	Error	Beta	t	Sig.	Tolerance	VIF
1	(Constant)	58.813	.265		222.178	.000		
	Black ethnicity	-5.370	1.771	-.099	-3.033	.002	.992	1.008
	Student aged over 30 years	2.179	1.047	.070	2.081	.038	.928	1.078
	Previous degree	1.183	.446	.090	2.651	.008	.923	1.084

a. Dependent Variable: TAVS score

To draw conclusions from this analysis, we can see that TAVS scores cannot be effectively predicted based on demographic variables alone. Only 2.5% of the variance in TAVS scores can be predicted by our model which suggests that 97.5% of the variance in TAVS scores is related to other factors not included in this data set.

5.2 Discussion of extensive (survey-based) component of study

In the discussion which follows I use the term ambiguity tolerance as synonymous with TAVS scores on the basis of the evidence for the validity of the TAVS instrument as a measure of ambiguity tolerance, provided in Chapter 4 and the paper included in Appendix II. At the end of the discussion I will return to the question of the nature of ambiguity tolerance and the relationship between TAVS scores and ambiguity tolerance.

5.2.1 Relationship between AT and demographic variables

There is some evidence from the data to support the hypothesis that older students will have higher tolerance of ambiguity than younger students and this is particularly evident for mature students (over the age of 30 years). AT has been found to increase with age in previous studies of groups of students in professional training (Geller et al. 1990; DeForge & Sobal 1991). However, none of these studies has corrected for previous education. It is therefore significant that in our analysis, previous education was a more important variable for predicting ambiguity tolerance than age, for students under 30 years old.

The greater tolerance for ambiguity in mature students (over 30 years) may reflect the fact that mature students often come into education from varied routes and the decision to return to study is often a significant life-change (Mercer 2007). One could argue that mature students may be more open in their outlooks, and openness is a personality trait which is closely associated with ambiguity tolerance (Weissenstein et al. 2014; Bardi et al. 2009b) or that generation differences in attitudes to uncertainty could play a role (Eckleberry-Hunt & Tucciarone 2011). Mature students may also have different life experiences outside of formal education, compared with non-mature students and this could be reflected in their tolerance for ambiguity.

Male and female students in this study were not significantly different in their tolerance of ambiguity. Patterns in the general population and in other undergraduate groups vary (although differences are often small), with some studies finding higher AT in females (Geller et al. 1990) some finding higher AT in males (Weissenstein et al. 2014), and others no difference (DeForge & Sobal 1989). Several of these studies are over 10 years old, however, and the impact of changing gender roles in society (Caulfield et al. 2014) has been proposed as an explanation for the identification of similar levels of ambiguity tolerance in male compared with female medical students, which might also apply in the present study.



Based on a previous study in a US medical school student population (Geller et al. 1990), it was hypothesised that students who describe their ethnicity as white will be less tolerant of ambiguity than other groups. This contrasts with the findings from the present study with veterinary students, where ethnicity is a small but significant predictor of ambiguity tolerance in the study population and students describing their ethnicity as black were significantly less tolerant of ambiguity than those who describe their ethnicity as white (even after correcting for nationality). These results should be interpreted with caution as the overall number of black students in the study group (and indeed in the study population) is relatively small.

Although there is no clear theoretical basis for differences in AT based on ethnicity, there is a considerable body of theory which proposes a relationship between national culture and cultural identity and the related construct of Uncertainty Avoidance (Hofstede 1984). While one might expect this to have been identified by our analysis in relation to nationality, this may not necessarily be the case. The classification system for nationality and ethnicity used in this study created broad categories, which made it difficult to differentiate between effects that genuinely relate to ethnicity and those which relate to culture. Although the survey included a question about nationality, the classification for this was limited, and the category of 'Other' included a number of different national groups which may be expected to vary in culture and life-experience. For example, the free text comments accompanying responses from the 'Other' category reveals that it included individuals from Asia (e.g. Singapore & China) and from Africa (Botswana, South Africa). As these groups are culturally very different, then it is possible that the effect of combining these into a single category has limited the ability to identify genuine cultural or national difference.

Adopting a more granular approach to collection of data on nationality and ethnicity in future studies would enable the relationships identified here to be explored further, although the magnitude of differences identified in this study suggest that additional differences are likely to be small.

It is also possible that the experience of Black students (regardless of nationality) within the social and educational environment differs, for example as a result of racial discrimination or prejudice. For this reason, collecting additional data across other veterinary undergraduate population, including individuals of black ethnicity, would help establish whether the effect suggested in this study is significant or whether it is a statistical error relating to the small numbers and potentially outlying responses.



The hypothesis that international students will be more tolerant of ambiguity than UK students was not supported by the analysis. Although North American students tended to have greater tolerance of ambiguity relative to other groups, the differences were not significant when the effects of age and previous education were considered. Although one could argue that international students choosing to attend an overseas vet school will be more open to new experiences and could be expected to have a higher degree of tolerance for ambiguity, it is likely that the situation is more complex than this, particularly when economic and societal influences on study decisions are considered.

The most important demographic variable in predicting ambiguity tolerance seems to be previous education, with students who have completed a prior degree or technical training tending to have higher AT. Again, the magnitude of difference here is small (a difference of 1.19 points on the 100 point scale) which is equivalent to a more positive response on fewer than 2 of the 27 test items. It is questionable whether this small difference in attitude is meaningful for educational or clinical outcomes, even though it provides some support for the hypothesis that students who have completed a previous degree will be more tolerant of ambiguity than those who have not.

The link between previous education and ambiguity tolerance provides some evidence to suggest that educational processes can change ambiguity tolerance. There is an ongoing discussion in the literature as to whether AT can change through education or training (Hancock & Mattick 2012; Geller 2013; Han et al. 2015), and the fact that in this study population, individuals who have completed a degree or technical training tended to be more tolerant of ambiguity informs this debate. Of course, the difference may be because individuals embarking on degree courses or technical training are already more tolerant of ambiguity, but our group of non-graduates (school-leavers) has, by definition, chosen to study in Higher education yet they are still, on average, slightly less tolerant of ambiguity than their graduate peers. This may reflect a malleability in AT, but could also be limited by the precision of the measure.

When considering the relationship between demographic variables and AT it is important to recognise that the overall impact of demographic variables on AT (assessed by TAVS score) is very small (less than 3% of the total variance in the analysis). This raises the important question of what factors may account for the other 97% of the variance in scores or how much of this variance relates to the instrument itself. This is a question which I will return to in the final part of this discussion.

5.2.2 Does ambiguity tolerance change over the course of training?



The initial hypothesis (Appendix III), that veterinary students' tolerance of ambiguity would not change over the course of veterinary training, is supported as there was no evidence of a change in average AT over the course of training in either the cross-sectional or longitudinal parts of the study. This suggests that current models of veterinary education (such as those in place in the study context), do not provide a measurable 'training for uncertainty', which is particularly concerning given that the ability to cope with uncertainty and adapt to change is considered a key 'day one' competency. The analysis suggests that changes in AT did occur over the course of training each academic year studied in the cross sectional part of this study, but the direction of these changes was not consistent. This parallels several cross-sectional studies in undergraduate medical students, which did not find any change in AT over the course of undergraduate training (Weissenstein et al. 2014; Hancock et al. 2014; Geller et al. 1990). The one recent study which did find a change in AT over the course of training used a longitudinal measure of AT and found a decrease in tolerance of ambiguity over the 4 years of undergraduate study (although no change in tolerance of complexity or risk). However, the transferability of these latter findings may be limited, given that all participants were enrolled on an atypical community-based medical training programme (Han et al. 2015). It would be interesting to further explore potential cohort effects on AT, particularly considering the marked differences seen in the patterns of responses for each of the three years of our study.

The lack of measurable impact of the veterinary curriculum on student's tolerance of ambiguity is particularly surprising given that the demographic analysis suggests that AT is higher, on average, in graduate students. This would suggest that other degree programmes can influence attitudes to ambiguity, while the current Veterinary programme does not. One possible explanation could be the timing of our survey points during the programme of study. Although responses were collected annually for the first three years of training, the final survey point was during the induction week at the start of the final year of training. Anecdotally, many students and vets describe the important influence of the final year of their studies on their professional and personal maturation and this could be a critical period for development of tolerance of ambiguity. The challenges of surveying student groups who have significant clinical time commitments and are distributed over multiple sites precluded a survey point at the end of the final year or after the first year following graduation. It is possible that requesting survey completion at the end of the final year would demonstrate an increase in AT not seen in the first 4 years of the programme. The omission of this survey point is a significant limitation of this study. Indeed, the most consistent change in AT across studies of medical professionals seems

to be in the early part of post-graduate training (Hancock et al. 2014) which may reflect the impact of increasing clinical responsibility on ambiguity tolerance.

Geller (1990), in her study of ambiguity tolerance in Medical students, proposed a divergent pattern for changes in AT over the course of medical training. Through the methodology used here to capture individual students' AT trajectories over the first 3 years of training, it is possible to provide some support for this theory. It was unusual for students to cross between High and Low groups (in either direction). There was a slight tendency in our study for students in the Moderate group to move to the lower group and it would be interesting to repeat this analysis with a larger group of students to establish whether a genuine pattern exists. Although an attempt has been made to quantify these group-movements as part of the analysis, there is scope for more sophisticated techniques to be employed in order to track and quantify individual trajectories over time.

The group boundaries determined using a norm-referenced approach are particularly relevant to the conclusions which can be drawn and this is discussed further in section 5.2.5.

5.2.3 How does ambiguity tolerance relate to elective and career choices?

The hypothesis that students planning to work in clinical practice will have a higher tolerance of ambiguity than those choosing to work in other professional roles was not supported by the analysis. A large majority of participants in this study indicated that they planned to work in clinical practice roles and the asymmetrical distribution of destination choice may explain the lack of difference in AT between this large group and the other much smaller groups. This contrasts with evidence from other health professions, suggesting that career choices are related to ambiguity tolerance (Shaw et al. 2010; Geller et al. 1990; Wayne et al. 2011). In this veterinary student population, those planning careers in industry or government were apparently less tolerant of ambiguity than those planning careers in academia. Although the range and variety of career roles open to veterinary graduates is considerable, there is still a strong focus on clinical practice as the predominant professional role, particularly for those early in their careers. Extending the study of AT to the broader veterinary profession may help us to understand whether the small differences in AT which are seen with different career aspirations in undergraduate students are later reflected in the different professional roles in which veterinarians work. Unlike the medical profession, where different medical specialities have well established identities, roles and working practices, there is a much less formal delineation between different areas of veterinary practice and it may be only later in training, or as new graduates, that students become aware of the different experiences which they can expect from different roles.



In veterinary practice, it is the species area or practice type which perhaps best defines the likely nature of the professional role. In the absence of any previous research in this area, the hypothesis proposed that there would be no difference in AT between students with different species area preferences, on the basis that, no one species-area is particularly associated with exposure to ambiguous situations. In fact, there were small differences in AT between student groups based on their species preference and the magnitudes of these differences were greater than those identified in relation to some demographic parameters. Although none of these was statistically significant, it is possible that additional survey points at the end of training and in the early years after graduation may reveal a clearer pattern.

Veterinary programmes frequently provide some opportunity for flexibility in training with either tracking or elective placements common in the later stages of training (Walsh et al. 2009). The hypothesis that students choosing to complete an international elective, or an elective working with an underserved population, would be more tolerant of ambiguity than their peers was not supported. Although there was a higher mean TAVS score for students planning an elective working with underserved populations this was not statistically significant in the test-cohort. A positive correlation is reported between attitudes to underserved populations and AT in some groups of medical students (Wayne et al. 2011), but this has been established using a specific survey instrument (looking at attitudes to the underserved) rather than by considering choices of elective study.

It is also possible that the relationship between AT and attitudes to the underserved in the Veterinary profession is different to that in the medical profession. Particularly in the UK, there are marked differences in roles between veterinarians who typically charge for their services and often work for small or medium sized businesses, compared with medical doctors who usually work in the National Health Service. Further research using an instrument similar to that described by Godkin & Savageau (2003) would help to establish whether attitudes to the underserved are associated with ambiguity tolerance in Veterinary students.

It is suggested by some commentators that understanding the role of AT in career choices can assist with workforce planning (Geller 2013). For example, by increasing selection of individuals with greater tolerance of ambiguity into medical training, it may be possible to increase the number of medical graduates who are likely to take roles working with underserved populations (Wayne et al. 2011). This view has been criticised on the basis that it assumes that AT is relatively fixed and several authors have cautioned against over-interpreting the significance of AT, given that we have such a limited understanding of how difference in measured AT translates into real-life practical decision-making



(Hancock & Mattick 2012). The observation that many students in this study did not maintain a consistent AT group position over the first three years of training, where groups are defined relative to their peers, suggests that similar caution needs to be exercised when considering using measures of AT in selection to veterinary training.

5.2.4 Measuring Ambiguity tolerance

The findings of this study provide further evidence relevant to the validity of the TAVS instrument. Downing's (2003) framework sets out the five aspects of validity that should be considered when making a validity argument for the use of any tool: content validity, response process, internal structure of the scale, the relationship to other variables and the consequences of using the scale measure.

My research provides evidence for the further of these, namely the relationship of TAVS scores to other variables. The fact that TAVS scores for individual participants are highly correlated at different stages of training provides some evidence for the validity of the scale, and the identification of small but significant relationships between scale scores and other hypothesised parameters supports this further. There are a number of hypotheses, however, which were not supported by the findings and it is important to consider how this should affect our view of the validity of the instrument.

There are two primary considerations here: the first is related to the content validity of the scale itself; the second relates to the ontological perspective from which we view our findings.

Adopting a positivist approach to interpretation of this validity evidence might lead to the conclusion that the scale is not yet able to measure all of the components of AT in the study population. One might question the content validity; remembering that the instrument is adapted from one developed for use with medical students and asking whether the generation of new scale items, to more accurately reflect the trait of AT in vet students, is warranted. Or one may question the basis of the initial hypotheses; arguing (as I have done in parts of this discussion) that these hypotheses are based on studies from very different groups and often using different survey instruments to measure AT. The existence of so many different scales to measure ambiguity tolerance (and related constructs) suggests that this may be a common response to equivocal findings using existing instruments.

Positivist approaches are built on an expectation that AT is a real and, potentially measurable trait or state. Adopting a critical realist perspective provides a different way to consider the significance of these findings. If TAVS scores are considered to be empirical (that which can be measured) then, from a critical realist perspective, the next question



would be: what mechanisms could account for these scores and what evidence is there to support the existence of interplay between different mechanisms in this context? The trait or state debate then becomes a critical part of this line of inquiry and shifts the focus away from trying to improve the accuracy of the predictions made on the basis of TAVS scores, towards an understanding of the mechanisms which account for TAVS scores and importantly, the mechanisms which may explain the relationships between TAVS scores and other parameters which have been identified. In this study less than 3% of the variance in TAVS score could be explained by the hypothesised parameters. As well as understanding the mechanisms which underpin these effects; this suggests there are additional mechanisms which should be considered. To follow this line of enquiry further one might review the patterns of responses to specific individual or groups of scale items using the four facets described in the development of the instrument itself (novice view, discomfort from uncertainty, affinity for complexity and accepting indeterminacy) (Hammond et al. 2016) see Appendix II) and compare these between groups (e.g. graduates vs non-graduates) as a way of exploring possible mechanisms for the observed differences.

A recent review of the research into AT (Furnham & Marks 2013) observed that most research into the construct to date has been correlational and there is a real need for a different approach. In the context of Veterinary education, we need a better understanding of how TAVS scores relate to behaviour and to learning, in particular how important the mechanisms are which underpin relationships between TAVS scores and other factors in real-life encounters between teachers, students, veterinarians, patients and clients. The evidence from the medical profession provides very limited support for impacts on patient care (Allison et al. 1998; Benbassat et al. 2001; Carney et al. 2007) and it is important not to overstate the significance of the AT construct in veterinary practice, particularly given the small magnitudes of differences between groups seen in this study.

5.2.5 Strengths and Limitations

This component of the research is novel, and constitutes the first study to use the TAVS scale to investigate Veterinary students' tolerance for ambiguity. The key finding, that ambiguity tolerance did not change over the course of veterinary training, is of considerable importance for a Veterinary profession which requires its day one graduates to be able to cope with the clinical uncertainty which is ubiquitous in clinical practice and other professional roles. The timing of the final data-collection point during the induction week for the final year of training means that it was not possible to capture changes in tolerance of ambiguity during the last period of training. As this year is one where most clinical involvement occurs, this omission is unfortunate. Using the TAVS instrument to evaluate ambiguity tolerance at the end of final year and in early-career vets should be a

priority for future research, particularly as AT is seen to be higher in early-career medical doctors compared with medical students (Hancock et al. 2014).

This is the first study to classify veterinary students into groups showing Low, Moderate and High levels of Ambiguity Tolerance and to use these categories to describe how students move between groups over the first three years of training. However, the group boundaries produced by norm-referencing in this study were narrower than those in studies where the norm-reference was based on the standard deviation rather than percentage groups (Norton 1975; El-Houmy 2000) and this may have affected the interpretation of group moves. There is an argument for setting a criterion-referenced group boundary, for example using scores of 33-66 to determine a moderate group, as described by Chiang (2016). As this is the first study to use the TAVS scale, further calibration may be required, particularly given that a very small group of fewer than 10% of survey responses would be classified as Low if Chiang's criteria was applied in this study.

Overall response rates in this study were good (60% across all years and all cohorts), however, some cohorts had much lower response rates (as low as 31% in one case), which increases the risk of non-response bias in some cohort groups. The low response rates in some groups are most likely to have been related to slight differences in the arrangements for survey distribution and collection (e.g. at the end of an educational activity rather than at the start). There is no reason to believe that respondents and non-respondents in these situations are likely to differ significantly and the collection and comparison of data over three years allowed meaningful conclusions to be drawn despite having a poor response rate in one particular year group.

Around a third of the survey responses in this study used an earlier short form of the TAVS scale and mean substitution, an accepted method for dealing with missing data (Rubin et al. 2007), was used to complete the small number of missing TAVS scale items (5/27) for these participants. The observed changes in variance of the data following this action have been described. In order to avoid the need for mean-substitution and the consequent effects on sample variance for the longitudinal component of this study, only the long form of the survey was used.

Responses in this study were treated as independent between survey years. This enabled data to be pooled and a large sample size to be achieved. Review of consent information from each year reveals that a number of participants participated in the study in more than one year, but because responses (other than those for the longitudinal analysis) were anonymised prior to analysis it was not feasible to identify individual responses. There is a risk that this could impact on the interpretation and as such, for

each of the significant findings, results are included of analysis for each survey year alone, as well as when combined. Findings in each year group supported the findings described for the larger sample.

5.3 Conclusions

In conclusion, research questions 1a, 1b and 1c have been answered through the use of the TAVS instrument with a population of undergraduate veterinary students. Small differences in AT were described based on demographic factors, notably that ambiguity tolerance is higher on average in mature students and those with previous degree qualifications and lower in those describing their ethnicity as black. There was limited association between ambiguity tolerance and career aspirations or international study choices, although students planning to work in academia had significantly higher tolerance of ambiguity than those planning to work in government or industry. Most importantly, no significant change was seen in ambiguity tolerance over the course of the first four years of Veterinary training, using either longitudinal or cross-sectional study designs. This is despite the fact that the ability to cope with uncertainty is considered a day one competency for new veterinary graduates. The research provides further evidence to support the validity of the TAVS instrument to study AT in Veterinary students. and a high priority for additional research in this area should be to use the TAVS instrument to study Veterinary students at the end of training and early in their careers.

6 Learning to cope with uncertainty in the context of an international elective placement: case study design & methods

6.1 Study aims and research question

The focus of the thesis in this chapter moves from the survey component of the research to the case study component. As the two components were conducted concurrently, conclusions are drawn separately before the findings are combined in the final chapters of the thesis.

This case study aims to address the issue of **how** veterinary students learn to cope with uncertainty in veterinary professional practice.

Although veterinary practice is a broad field, the case study method enables an in-depth exploration of learning in a specific context. The approach to case study research adopted here is outlined in chapter 3. Case study design and case selection depends on the purpose of the research, which may include highlighting unusual cases, characterising typical cases or making comparisons between cases (Yin 2003). The aim of this case study is primarily explanatory. The overarching research question guiding this case study component of the research is:

Research question 2: 'How do veterinary students learn to cope with uncertainty in the context of an international elective rotation in a resource limited environment?'

6.2 Case selection rationale

Using the definition of uncertainty outlined in section 2.1.1 and based on a theoretical understanding of uncertainty as a potential response to complexity, ambiguity or risk, potential case studies were considered based on the extent to which they offered access to situations where these factors would be encountered by students.

Previous unpublished research in this area (Hammond 2012) identified the importance of final year rotations and extramural studies placements as contexts where veterinary students frequently reported feelings of doubt and uncertainty. In common with other health professions, there is increasing complexity of the learning environment as students move into clinical settings. This is partly due to encounters with patients and the clinical uncertainty inherent in real-life clinical care, and partly due to integrating into an environment where teaching and student support is not always the primary focus. For these reasons the case selected was one of the clinical rotations that take place during the final year of undergraduate veterinary training. A single case was selected on the basis that it represented an 'unusual case'; specifically a learning environment where students typically experience considerable uncertainty.



In preparation for this case study, clinical rounds discussions across different clinical contexts were observed and I also reviewed student feedback on these rotations, including those where students were working with production animals or companion animals.

The working-equid clinic was selected as the setting for the case study. The contextual factors influencing this decision are described in section 6.5 on 'study context'.

6.3 Units of analysis

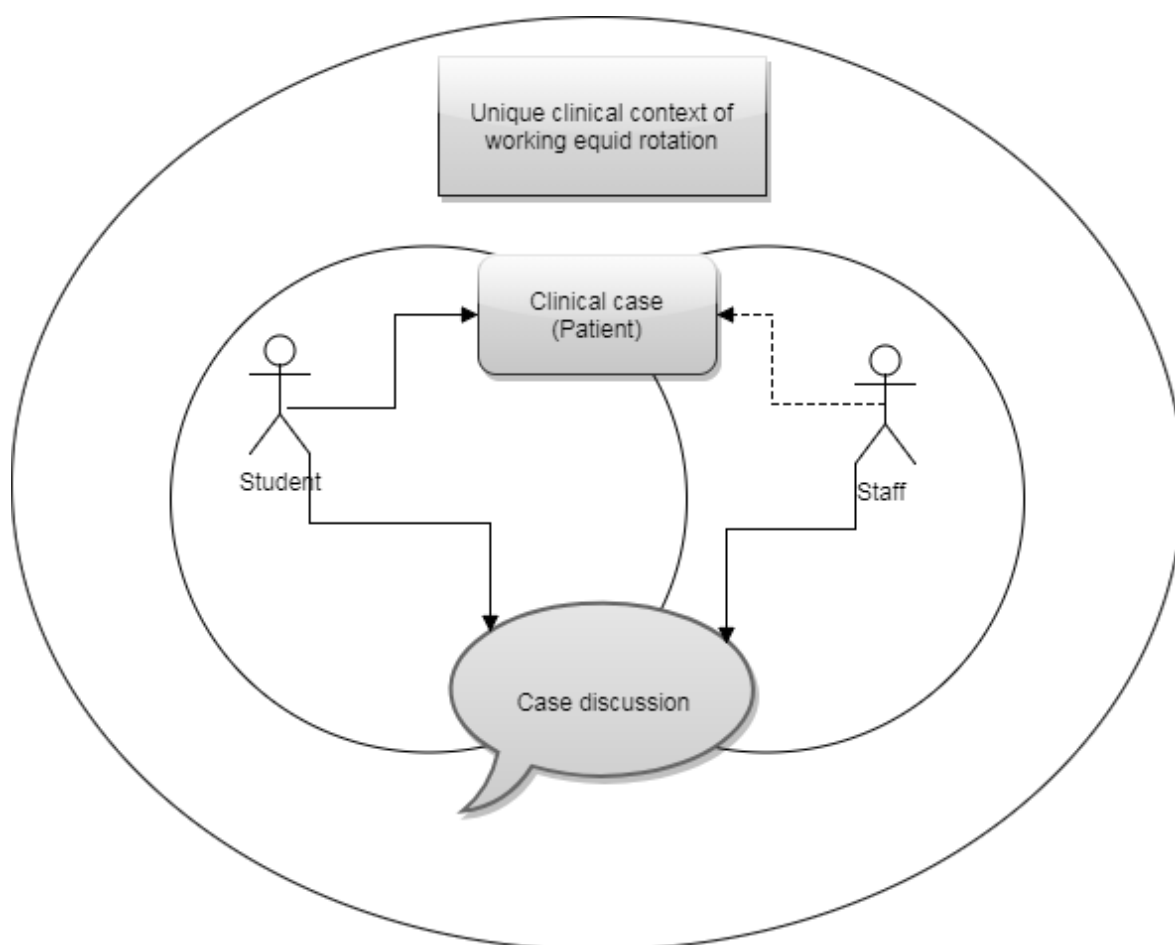
An important first step in case study design is the definition of the unit of analysis. The design adopted here is a single case study, for which the setting is the international elective rotation, and containing nested units of analysis (Yin 2003). The unit of analysis in this case study is not the individual student or staff participant, but each case discussion itself; specifically, discussion that takes place between a member of staff and a student and focuses on a specific patient attending the clinic. This is represented schematically in Figure 6.1

There are several advantages to using the rounds discussion as the unit of analysis in this way.

- 1) They present an opportunity to focus on clinical practice, including patient management decisions, which are discussed during the rounds session. This is important because it is the practice of the community which is relevant to the research question.
- 2) Clinical rounds have been described as a 'signature pedagogy' (Lingard et al. 2003), hence as a form of professional communication with pedagogical intent, so the discourse is likely to be relevant to the research question.
- 3) The rounds discussions provide a practical opportunity for data collection. Direct observation of clinical practice in an international rotation context would not have been feasible within the scope of this study, yet the rounds discussions provide a window on practice which was readily accessible to me and provided ample opportunity for collection of relevant data.
- 4) The involvement of both students and staff in the rounds discussions provides access to the perspectives of both novices and experienced vets and facilitates triangulation of findings.



Figure 6-1: The structure of the case study and relationship between participants, patients and the case discussions which are the units of analysis within the case study



6.4 Middle range theory development

The research design is built around the concept of a middle range theory (Stone & Merton 1958; Smith 2010), the aim of the latter being to provide a provisional conceptual framework, which helps to focus the research questions (see also section 3.5). This is similar to the concept of a 'programme theory' used in realist evaluation (Wong et al. 2012). Although development of a middle range theory is, in reality, an iterative process, it is described here in a linear fashion to provide a more concise account. The middle range theory in this case study is developed from the existing literature reviewed and discussed in chapter 2 and refined through preliminary observations of learning in the clinical rounds context.

The middle range theory draws principally on the concept of situated learning (Lave & Wenger 1991) and proposes that veterinary students learn to cope with uncertainty through legitimate peripheral participation in the 'uncertainty work' of a community of practice.

In developing the middle range theory for this case study, a number of detailed theoretical statements have been inferred from the overall theoretical proposal. These statements form the basis of the 'abduction' stage in the research process and are described in detail in chapter 8.

The theory also guides the overall focus of the case study to concentrate on two specific secondary research questions:

Research question 2a 'How can we describe the uncertainty work of veterinary students in the context of an international elective rotation?'

Research question 2b 'What is it about an international elective placement in a resource-limited environment which facilitates students' legitimate participation in the uncertainty work of the community of practice?'

The first question is primarily descriptive and is the focus of chapter 7, the second aims to identify key causative mechanisms which are important in this context and which may also act in other contexts; this is the focus of chapter 8.

6.5 Study context

The case study was conducted in a UK veterinary school that offers a Veterinary degree programme described in detail in chapter 1.



Study participants are professional phase (Year 5) students and staff participating in a working equid elective rotation. The elective rotation is based in Africa at a working equid charity clinic in the middle of a city. The clinic provides care for donkeys, mules and other equidae, many of which are working animals and provide an income for their owners. The clinic works to provide individual patient healthcare as well as being involved in developing educational and preventive programmes addressing specific issues of equine health and welfare. The student rotation at the clinic is a relatively new development, and has been set up through a member of staff in the university equine hospital who had existing links with the clinic. As it is an elective placement, not all students in a cohort undertake this and typically 30-40 students each year participate in this rotation. The elective runs for 7-8 months each year and students visit in groups of 4-6. There is no selection process and if the rotation is oversubscribed then places are allocated by drawing names from a hat.

The clinic is run by a director, assisted by a team of veterinarians, grooms and technicians. The cultural backgrounds of staff at the clinic are varied; some (including the director) having trained in Europe or North America, others (including most of the grooms and technical staff) are from the local community. Hosting the rotation provides an additional source of income for the charity and has also facilitated development of reciprocal educational opportunities, so that African students complete clinical training scholarships in the UK and specialist vets from the UK provide training courses and ongoing telemedicine support for local staff in Africa.

Historic feedback from students completing the rotation indicates that most find it an extremely worthwhile experience. The level of responsibility they have for the clinic's cases is typically greater than is afforded on other clinical rotations and both the clinical facilities and local support are of a good standard. Many students report considerable improvement in their clinical skills over the course of the rotation and also a growing sense of confidence in their own clinical decisions. A number of challenges are reported by students; these include differing attitudes to euthanasia and cultural status of animals in the local community, the language barrier encountered (most patient histories are translated by grooms from local languages into English) and occasional difficulties with teamwork or conflict relating to differences in personality or clinical judgement.

Support for students on rotation is shared between local staff and those at the UK vet school. A veterinarian from the equine clinical staff from the UK vet school accompanies the students on the first week of their placement and acts as a supervisor during this induction period. After this, they return home and the students remain at the clinic under the supervision of local veterinary staff for 3 further weeks. There are weekly clinical



rounds discussions via a Skype interface, which enable the students on the elective to present and discuss cases with the veterinarian from the UK vet school and their peers who are on their core Equine rotation. The African clinic also has links with other institutions, including a regular online case discussion with a veterinary school in the USA.

6.6 Data collection

Data collection took place over a 6 month period starting in December 2014. Ethical approval was granted by the College ethics committee (Appendix V).

Potential research participants were given written information about the study and asked to sign a consent form if they agreed to participate in the study. Data collected during the course of the study were stored anonymously in encrypted files in accordance with the College research guidelines.

There were three phases of data collection which ran in parallel during the study period.

6.6.1 Phase 1: Audio-recording of clinical rounds discussions

A total of 7 clinical rounds discussions were recorded over the study period and each of the four groups of students on rotation during that time were recorded at least once.

Rounds discussions between the UK vet school and the African clinic take place on weekly basis. The student group sends presentation slides containing relevant images and patient details via email on the morning of the scheduled rounds discussion. The slides are then reviewed by the participants in the UK and Africa during the online discussion. A typical rounds session will last for 30-45 minutes and includes discussion of 4 or 5 patients. Not every rounds discussion in the study period was recorded; where sessions were missed this was usually as a result of my other commitments or occasionally short notice rescheduling by the students or clinicians. Consent was obtained from all participants in advance of recording the sessions. It was made clear in the written information provided to participants that they could ask for the recording to be stopped at any time during the session.

6.6.2 Phase 2: Semi-structured interviews

All students and staff who participated in recorded clinical rounds discussions were invited to attend a follow-up interview within two months of the clinical rounds.

In order to facilitate recall of the patients and associated rounds discussions, a short clip was created using Camtasia video and audio-editing software. Each clip combined the audio recording from a single case discussion (between a member of staff and a student) with the PowerPoint slides which the student group had prepared in relation to the patient



being discussed. Clips lasted between 5 and 14 minutes, depending on the length of the initial discussion.

A copy of the interview schedule which was used to guide each discussion is included in Appendix XIII. The schedule was piloted prior to use and adjustments were made to improve the clarity of language. Although the word 'uncertainty' was used, participants in the pilot interviews frequently asked for clarification of what was meant by this term. For this reason, a short definition was added, describing uncertainty as a 'sense of doubt', consistent with the definition outlined in section 2.1.

During the first part of the interview, each participant was given the opportunity to review two clips of cases which they had previously presented or discussed at a clinical rounds session. Questions were then asked, aiming first to encourage them to describe their memories of the case and the case discussion in their own words; and then asking them to focus on areas or occasions during the case management or the rounds discussion where they had experienced uncertainty. In the second part of the interview the topic of the research study was outlined and participants were asked to talk about experiences from their education which they felt were important in learning to cope with uncertainty.

6.6.3 Phase 3: Focus group

A small focus group was conducted in order to discuss the outcomes of the analysis with participants and stakeholders. The focus group included all 3 of the staff participants who had been involved in phases 1 & 2. Two other staff members who had experience supervising student groups during the international elective were also included as well as one post-graduate student who had visited the clinic. As the original student participants had graduated by this stage in the process, it was unfortunately not possible to include them in the focus group.

A short presentation summarised the findings of elements 1 & 2 and outlined the mechanisms which had been identified in relation to the research question. Field notes were used to capture general discussion of the proposed mechanisms and a written summary of these notes was checked by all focus group participants to ensure accuracy.

6.6.4 Participant sampling

All staff and students who participated in the clinical rounds discussions during the study period consented to participate in phase 1 (rounds recordings) – this was a total of 20 students and 3 members of staff.

All 23 participants were invited to attend a follow up interview (phase 2). Of these, 5 students and all 3 members of staff agreed to participate.



This was effectively a purposive sample (those on rotation during the data collection period). Low participant numbers and self-selection by student participants in phase 2 limits claims for generalisability of our findings, and in the context of a critical realist case study approach this is not necessarily problematic. When considering “what works, for whom, and in what context” all experiences are valid and provide an opportunity to understand and identify the causal mechanisms which produce an outcome in a given context and for a given case.

In phase 3, all staff and residents (postgraduate students) who had supervised students on the elective rotation in the past year were invited to attend a focus group session. Five of the 6 invited agreed to participate.

6.6.5 Selection of rounds discussion clips

The use of the preselected case discussion clips is a significant issue in terms of the design of the case study. From the data collected, each participant had between 2 and 6 possible case clips which could be used as the basis for their interview discussion. Student participants had already exercised some choice in proposing these cases for discussion at clinical rounds. The logistics of creating the clips and organisation of the interview process meant that it was not feasible for participants to choose their own clips for discussion in advance of the interview. For this reason, clips were chosen by me, based on criteria relating to the theoretical framework described in chapter 2.

As uncertainty is considered to be subjective (the subjective perception of doubt), it was not strictly feasible for me to anticipate which clips or cases would have invoked uncertainty in participants. Clips were chosen based on their alignment with the theoretical framework: conflict, inadequate understanding or inadequate information. The rationale for this was twofold: firstly that these situations could reasonably be expected to produce feelings of uncertainty, and secondly that these situations were most likely to be significant both in understanding the uncertainty work of the community of practice and in considering how students might learn to cope with uncertainty.

The fact that participants were subsequently able to discuss their uncertainty in relation to these cases suggests that the case selection process had the desired effect of identifying cases where participants experienced uncertainty on some level. The framing of the research questions in this study does not require participants necessarily to have experienced uncertainty themselves, but for them to encounter or participate in the uncertainty work of the community. This could also include situations where others are feeling uncertain and I believe that the cases selected represented the best opportunities to study this uncertainty work.



6.6.6 Collation of data for each unit of analysis

A total of 14 units of analysis were produced. Each included a rounds discussion clip, a staff and/or student interview relating to the rounds discussion and field notes made in relation to the recording and subsequent interview.

6.6.7 My role as interviewer

At this point it is important to provide a reflexive statement about the interview process itself. I was conscious that participants' responses could be influenced by how I presented the topic and by my responses to their comments. For this reason I was careful to avoid leading questions, or bringing up new topics, instead focusing on exploring their comments and experiences in greater depth. To avoid participants feeling judged, based on their comments, I was primarily affirmative in my responses, and although I would describe my approach as inquisitive, I refrained from challenging or opposing their opinions during the interview process.

My role in relation to the participants in this study is relevant to the interpretation of my findings. As a member of staff on the course team and someone with a known interest in education as a discipline, interactions with staff were those of colleagues. Although perhaps some members of staff might feel that their teaching was being scrutinised, I would consider my relationship with the clinicians in this study to be a close working relationship and I would expect most responses to have been representative of their general opinions. That said, all three of the staff participants in Phase 2 commented on discomfort at listening back to their clinical rounds discussions and they were frequently self-critical or self-reflective during the interview process.

My role in relation to student participants in this study is influenced by several factors. As a member of staff and of the course team I would be in a position of authority and this could result in some students being reluctant to disclose their true feelings or the extent of any uncertainty, for fear of losing face or credibility. However, it is also significant that my role is not one of a clinical teacher, but as a portfolio adviser to these students, and I would describe my relationship with them as one of a supportive mentor rather than a traditional authority figure. The interviews were conducted towards the end of the professional phase course, when many students are near graduation and close to becoming colleagues rather than students. This transition was evident throughout the discussions and around the interviews and I had no particular reason to believe that the student participants were withholding or misrepresenting their opinions during the interview process.



6.7 Data analysis

6.7.1 Data preparation

A series of field notes was created to summarise each of the audio-visual files from the clinical rounds recordings. A total of 1 hour of recordings were summarised in this.

Interviews were transcribed verbatim. There are several advantages to my having transcribed the interviews personally. Immersion in, and close familiarity with, the data is useful to ensure familiarity with the nuances of the interview discussion and to provide an in-depth understanding of the content, context and significance of the data. A total of 9 hours of interviews were transcribed.

Data relating to each of the units of analysis were collated to enable me to review all of the material relevant to a single unit of analysis in one place, providing an opportunity to make connections between staff, student and patient-related aspects of the data.

A field note was completed for each of the 14 units of analysis and a selection of these notes were shared with one supervisor, who served as a peer reviewer with regard to my interpretations.

The focus of the field notes was to piece together as complete as possible a description of the events unfolding in the clinical situations discussed. The clinical rounds discussions represent the empirical (what can be measured) but the individual staff and student interviews provide an opportunity to add detail to this empirical domain, through probing to understand both what happened before and after the specific discussion and also to enable participants to describe their feelings at the time.

Table 6-1 summarises these data sources. Data were managed using a qualitative analysis software package (NVivo10 - QSR international).



Table 6-1: Sources of data used in qualitative analysis

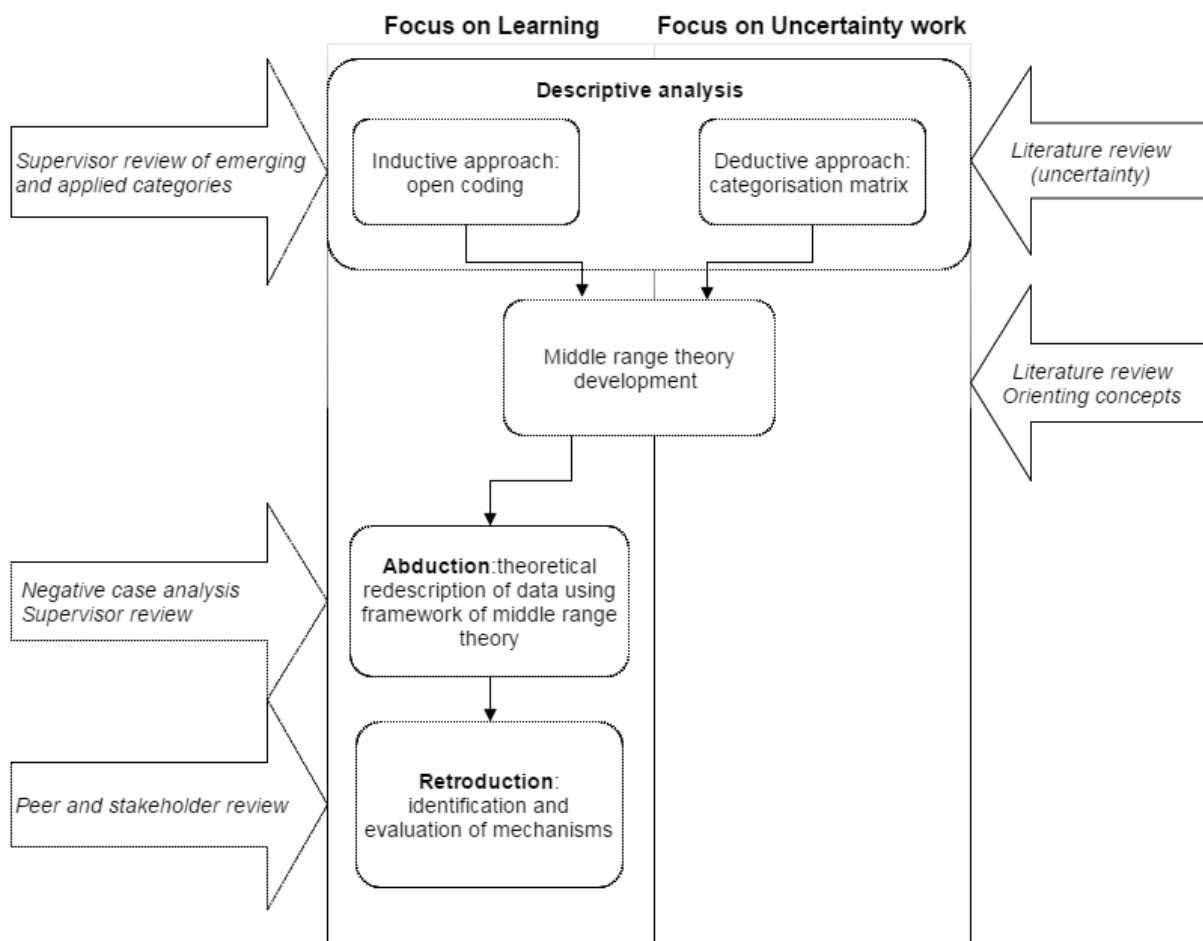
	Title	Source	Description
Phase 1	Rounds recording files	Clinical rounds recordings	Audio-recordings, each around 30 mins length (N=7)
	Case clips	Clinical rounds recordings and associated presentation file	Video clips combining audio from rounds recording and presentation slides (N=14)
	Field notes	Written summary of each case clip	My notes on each case clip, describing clinical situation and key issues discussed (N=14)
Phase 2	Interview transcripts	Staff and student semi-structured interviews	Transcripts of interviews for each participant (N=8)
	Field notes (Case)	Case clip summary	My notes on developing ideas in relation to a specific case clip (drawing on relevant interviews from staff and students as well as original recording) (N=14)
	Field notes (Theory)	Middle range theory summary	My notes on analysis, comparing each of the 10 statements derived from the middle range theory with empirical findings (N=10)
Phase 3	Field notes	Focus group	Annotated summary of presentation given to focus group and comments on major points discussed (N=1)

6.7.2 Qualitative analysis

Proponents of realist case study research propose three elements in data analysis (Easton 2010; Smith 2010; Wynn & Williams 2012). The first is a descriptive focus: the researcher aims to describe what is happening, in a broad sense, in the situations being studied. The second is abductive: the researcher relates their description to the established theory relevant to the situation and evaluates the extent to which these relationships can be described by the existing theory. The final step is retroductive and involves asking “what mechanisms need to exist in order for us to observe the findings which we do” (Easton 2010).

The data analysis proceeded iteratively and comprised multiple steps. Figure 6-2 shows the steps taken. Each step is described in turn in the section which follows.

Figure 6-2: Process of qualitative data analysis



6.7.3 Description

6.7.3.1 *Inductive approach: Open coding*

Open coding of interview transcripts was conducted using a process described by Elo & Kyngas (2008). The approach was inductive, aiming to identify key initial themes which were potentially significant in relation to the research questions, and aiming to describe the phenomenon and facilitate understanding (Cavanagh 1997). The focus was on content, and meanings were taken at face value. The entirety of each interview transcript was reviewed a paragraph at a time and sections which were considered to be significant in relation to the research questions were coded and categorised by theme. Appendix XIII includes several examples from the analysis. All themes were reviewed and discussed with one supervisor. In several cases the titles or emphasis of these themes were revised following discussion and review of further data.

6.7.3.2 *Deductive approach: categorisation matrix*

A pattern-matching approach was adopted for this part of the analysis (Yin 2003, p.136). A categorisation matrix adapted from Lipchitz and Strauss (Lipshitz & Strauss 1997) was used and field notes from Phase 1 were coded using this framework, based on the sources and tactics of uncertainty exemplified in the case. The matrix and coding illustration are included in Appendix XIII.

6.7.4 Abduction

6.7.4.1 *Identifying a theoretical framework*

Following close-reading of each of the participant transcripts, a series of field notes were produced to record developing ideas and thoughts about potential theoretical frameworks. The middle range theory described earlier in sections 2.4 and 6.4 is the result of this process.

Where analysis is interpretative, it is valuable to record the reasoning behind different interpretations and why a certain interpretation is considered more appropriate than other alternatives (Easton 2010; Eastwood et al. 2014; Sayer 1992).

The field notes provide a record of this process and hence an audit trail which is available for external review and critique. Several example field notes are included in Appendix XIV. Additional support for the validity of the abduction is provided by the summary in chapter 8, where the use of direct quotations from participant interviews provides an opportunity for the reader to evaluate the rationale for the abduction and the data that support this.



6.7.4.2 Testing the middle range theory

Drawing on the approach described by Smith (2010), a series of 10 statements were constructed to represent how the middle range theory could be applied to the context of the international elective rotation. A single field note was created to capture information and analysis relevant to each of these statements. The notes were the result of analysis (close reading, review, interpretation and comparison) of data from the descriptive field notes and the original transcripts of the participants' interviews. The technique was based on an explanatory approach to pattern-matching (Yin 2003, p.137) and aimed to identify examples of situations where the statement was supported by the data, as well as examples where data diverged from the expectations of the middle range theory. Evidence in the form of direct quotations and descriptive observations was collected to support interpretations. A process of constant comparative review was adopted, such that each statement was considered in relation to subsequent and previous statements and interpretations were modified or clarified as required.

6.7.4.3 Negative case analysis

Towards the end of this phase of the analysis, a separate field note was created to record the consideration of negative cases. These comprised elements of the data which appeared to contradict the middle range theory (things which did not fit) and elements of the data which had not been extensively quoted or incorporated into the analysis (things which seemed less important). Negative case analysis can help identify additional mechanisms which may act only in specific circumstances, or identify elements of the middle range theory which need further refinement.

The outcome of this phase of the analysis was a series of conclusions in relation to each theoretical statement and supported with reference to quotations from primary data.

6.7.4.4 Peer and stakeholder review

The developing interpretations of the middle range theory were subject to peer review by two supervisors, a critical friend and through presentation to professional peers at educational meetings. A small group of original staff participants and non-participant clinicians were invited to review the middle range theory and comment on the interpretations made. Quotations from primary data are included in chapters 7-9 to aid affirmation of the findings and to help the reader follow the logic of interpretation.

6.7.5 Retrodution

Retrodution is a "dialogue between ideas and evidence" (Ragin 1994, p.55) which aims to identify the causative mechanisms relating to observed events. In this case study it aims to establish the conditions under which students learn to cope with uncertainty.



The term “conditions” refers to the circumstance without which something cannot exist (Danermark 2002). In essence, retroduction is the process of developing an idea (Meyer & Lunnay 2013). Five strategies are described as procedures for retroductive inference: counterfactual thinking, social and thought experiments, studies of pathological cases, studying of extreme cases, and comparative case studies (Meyer & Lunnay 2013).

The analysis in this case study focuses on counterfactual thinking. The use of counterfactual thinking is often required in social sciences research and is adopted in areas of research where it is not feasible to perform controlled experiments (Tetlock & Belkin 1996). One way to describe this process is:

‘[To]Identify the constitutive factors under which concepts exist, and to differentiate between constitutive factors and accidental circumstances.’(Meyer & Lunnay 2013)

Retroductive analysis in this case study is an iterative process, conducted alongside and following the descriptive and abductive analyses. The following three elements describe techniques used in this case study.

6.7.5.1 Focusing

When studying a complex open system like the international elective rotation, there will be multiple mechanisms which could be considered. The process of focusing involves prioritising the most important elements to consider and also deciding at what level to focus the research. For example, early on in the analytic process I decided to focus on explaining the process of learning to cope with uncertainty, rather than on explaining the mechanisms that produced the uncertainty work itself. Similarly, at a later stage in the research I elected to focus on features of the rotation rather than features of the individual patient case. These decisions were guided by the focus of the research questions themselves (on learning) and the overall aims of the research (to inform educational rather than clinical practice).

6.7.5.2 Counterfactual thinking

Field notes and diagrams were used to capture thoughts and ideas and to propose and reflect on possible causative mechanisms. These were annotated and revised as the research progressed. Appendix XIII includes a selection of field notes which exemplify this process.

6.7.5.3 Corroboration

Interpretations were reviewed against primary data, existing themes and discussed with supervisors, and during a focus group session with participants and colleagues. The aim of this process was to subject my interpretations to scrutiny and to establish which of the mechanisms emerging from the analysis were likely to be most important.



7 Uncertainty work

The initial focus of the analysis was on looking at how students and staff encountered uncertainty through their involvement in the international elective rotation and how they coped with this uncertainty. I coined the term ‘uncertainty work’ to use as a working definition for this focus. Indeed, the concept of ‘uncertainty work’ itself developed over the course of the study and the evolving definition is discussed in more detail in section 9.1. At this stage of the analysis I was interested in describing the ‘uncertainty work’ rather than focusing on the ‘learning’ element of the research question. I began by using the existing framework developed by Lipchitz and Strauss and outlined in figure 2.1 In this chapter I present the results of the deductive and inductive analysis in relation to uncertainty work.

7.1 Source of uncertainty

To demonstrate the analytic approach Table 7-1 below provides an example patient case showing categories for sources of uncertainty, which could be classified as due to inadequate information, inadequate understanding or conflict. Additional examples are included in Appendix XV.

Table 7-1: Example of classification system used in framework analysis of sources of uncertainty

Fistulous withers	A mule presented with discharging abscesses in the withers (back of the neck) region. The discussion hinges around whether this may be a case of Brucellosis (a zoonotic condition), associated barrier nursing precautions and options for treatment.	Conflict	<p>There is disagreement between local clinicians and university clinicians about the likelihood of this being Brucellosis.</p> <p>There is also difference of opinion between the two advising universities on whether or not DMSO (Dimethyl-sulfoxide liquid) should be used for treatment.</p> <p>The student working with this case is unaware of the university clinicians' opinion that the likelihood of her contracting Brucellosis (even with the limitations in local barrier nursing procedures) is small.</p> <p>The student is also unclear about the differences in management for Brucella in the UK (rare) compared with Africa.</p>
		Inadequate understanding	
		Inadequate information	<p>There is no diagnosis in this case – clinical staff are awaiting results of samples sent to the laboratory.</p>

7.2 Tactics adopted to cope with uncertainty

Using the different sources of uncertainty exemplified in section 7.1, I then focussed on identifying coping tactics adopted by staff and students. These were classified as reduction, acknowledgement or suppression (see figure 2.1). Sections 7.2.1-7.2.3 present the results of the deductive analysis providing examples from the case study which illustrate different elements of the 'uncertainty work' described by participants.

7.2.1 Tactics to cope with uncertainty from conflict

Uncertainty primarily relating to conflict was often **acknowledged** by participants, such as in this quotation where the student was asked whether they experienced uncertainty or doubt during the process of dealing with the case:

"I think in the beginning whenever they were unsure about [the medication]... and then you saw [the clinician] and [the clinic director] disagreeing about a couple of things, you [thought] ...: "Ok well what are we doing here ... trying to make things better, and nobody can agree on what's happening. And then as a student you feel like [your] opinion is going to be the last one that's taken ... I think that ... made me feel a little bit doubtful about what we were doing"

Student ID04 interview

Conflict (or potential conflict) frequently seems to result in **tactics of suppression**, for both staff and students. This example is from a discussion with a member of staff about a rounds conversation they had had with a student regarding the breakdown of a surgical wound:

"Listening back now I suppose ... she's not saying who did the other [sutures] so that's a discussion to have, because you never know who is in the room ... it could be that other person did their sutures too tight ... But I don't think that's something you could explore ... because you don't know who you are criticising.

And when asked if the student may also have felt that way:

Yes, [because] ... there is a bit of fumbling - well not fumbling words, but it's like ... [it] probably would have happened anyway ...I think they were recognising they didn't want to discuss it... It's the right thing, you never criticise somebody if something breaks down - so it's quite ... important to accept... [it] could just be the luck that yours didn't break down - I don't know"

Staff ID07 interview

It could be argued that this description is of suppressing discussion of uncertainty rather than suppressing the uncertainty itself - it is possible that the individual student may have been comfortable discussing this with another student or in another context.

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Participants also described **tactics of reduction** when faced with uncertainty related to conflict. This would typically involve asking for another opinion (e.g. during rounds discussions) or occasionally doing their own research using the limited literature search facilities available.

Frequently the tactic of reduction was not successful in reducing uncertainty resulting from conflicting clinical opinions and had to be accompanied by **tactics of acknowledgement or suppression**.

"There are ... mixed ideas about ... how long [we] should ... [give] Gentamicin for [and] doing the nebulisation; we also had rounds with [a US Vet School] shortly after having rounds with you [the UK vet school]; and the Vets there [said] "When you do nebulisation, ... the particles of Gentamicin are actually so large that sometime[s] you are really not getting that much into their system anyway ... you are probably just wasting your time! "

Student ID04 interview

When a tactic of reduction failed to provide a clear answer in this case, decisions were made based on several different tactics: these could be classified as **suppression (taking a gamble or relying on intuition)** or **reduction (assumption-based reasoning)**:

"It was one of those things ... well if it makes you feel better; if you think that it's doing something then keep doing it, ... It's quite intensive [giving Gentamicin] 4 times a day and then when you have rounds with another University and they [say] "the particles are so big that you're really not getting them in there anyway" [you wonder if] there [is] really a purpose in ...doing this then? But with [the patient] even after we'd had all those rounds; she had had situations where she just wasn't right and she would start lying down ... and she hadn't been doing that before, and if we hadn't nebulised her then she'd stop trying to do that, so we were like "well, it's not science based ... to say how much medication we're getting in to her (if she's even getting any); but what we know [is] that she stops lying down and acts normal[ly] after we'd nebulised her so for that reason alone we're just going to keep nebulising her."

Student ID04 interview

Managing cases in the context of differing advice or opinion is an example of uncertainty work. Learners may encounter disagreements as outside observers, as participant observers or occasionally because they are the focal point of the disagreement (e.g. where they are liaising between 2 vets). The fact that learners encounter these differences in opinion is one way in which they begin to participate in uncertainty work.



7.2.2 Tactics to cope with Uncertainty from Incomplete Information

In this first example there is some information which is incomplete and some which is partly or completely lacking, other information is unreliable:

"...we were unsure of the course of treatment because we were unsure what was actually causing it and we can't do any diagnostics there ... you could look yourself under the microscope to see if you could see bacteria, but could you see bacteria and say if its relevant? No! You can't send anything away or test anything for viruses, so you just [have] ... to assume it's a pathogen ... you can do the failure of passive transfer [test] and find that out, but the snap tests were out of date so could you really rely on the result? [You] probably could [because] they weren't that out of date, but then I do not know... we didn't really know how to treat it so we just did everything."

Student ID02 interview

This student is **acknowledging uncertainty** in relation to limits of diagnostic investigation, which is compounded by the limitations of working in a resource-limited environment. Clinical decision-making here was limited by inadequate information: relating to the causative agent/pathogen; relating to the significance of any pathogens which may be present and the limits of diagnostic testing (e.g. confidence in the outcome of the snap test which is out of date). Interestingly, the action which she describes taking ("do everything") could be classified as a form of **suppression (taking a gamble)**, a form of **reduction (assumption based reasoning)** or a form of **acknowledgement (pre-empt)**.

Staff from the University also talked in the interviews about the incomplete information, which was considered to be a feature of the perceived limits of the evidence base in veterinary medicine:

"One of the difficulties is that ...for a lot of what we do there's absolutely no evidence base at all ... and ... that might be just as a result of the fact that a lot of the time we are dealing with quite small case numbers and we just don't have the same ... access to the types of numbers that inform the medical profession ... they've got these wonderful ... NICE [National Institute for Health and Care Excellence] guidelines ...- so you present to the A&E department with A ...[and] you are treated with the protocol for dealing with A and that's the same protocol in [other] places for sort of the most common kind of presenting things - we don't really have that"

Staff ID01 interview



Although use of protocols is commonly employed as a strategy for reducing uncertainty at a clinic level, the uncertainty work itself seems to focus more on knowing when to use and when not to use the protocols.

In several of the situations studied, the **tactic of reduction** is also adopted when encountering incomplete information. In this example it was primarily due to diagnosing a novel condition, tracheal collapse, about which little is known in the Mule:

"... we'd asked [the vet] and the interns if they had seen it before in [the clinic]. We did our own research to see if we could find any papers on, or case reports on it in Mules ... I think we [only] found it in one case report in a mule - And the other ones were all in miniature ... Shetlands ... apparently - it's a genetic thing. So I wonder if this probably is a genetic thing in this Mule as well."

Student ID02 interview

7.2.3 Tactics to cope with uncertainty from inadequate understanding

In this case, which might best be described as equivocal, there are two strong influences each pulling in different directions and the learner can see the importance of both influences on the decision in this case:

"The man that owned [the mule] was a dealer and he would lose money on it ... they see them as a kind of working tool as opposed to an animal - none of them have got names ... so he decided that he wanted to take him home and try and sell him. Which was quite sad....we were quite gutted actually because we just thought ... what on earth is going to happen to this poor animal ...they work very hard piled with stuff and he wasn't fit for doing that, ... they don't really believe in putting things down - even if they're really sick - I think it's a bit of a cultural thing - and ... they are very poor so they need their animals - we adjusted to that while we were out there."

Student ID02 Interview

The student in this situation **acknowledges** the uncertainty around the decisions and management of this case and adopts a **strategy of weighing pros and cons** when discussing the ethical considerations in this case.

In the following quotation from a member of staff, the incomplete understanding relates to the group of learners back in the UK vet school. He adopts a tactic of **acknowledgement** by **pre-empting** students' questions/uncertainty and also of **reduction** by providing **more information**. When it was noted that he had stopped the discussion with a student in Africa to explain endoscopy pictures to local students, this staff member responded:

████████

"I think it is quite an important thing to do [because] the students in Africa will be familiar with a case, they will understand the image ... but it's quite a lot for the students in [the UK] [to take in] in a short period of time ... they need some help I think , and it's too easy to make an assumption that ... oh it's obvious, they are going to be able to see that, so [I decided to] stop things"

Staff ID03 interview

This situation is interesting because it demonstrates an individual who adopts a strategy to cope with the perceived uncertainty of others in the community. As an experienced teacher this is part of his own teaching practice: attending to and pre-empting the perceived uncertainties of learners.

7.3 Conclusions

In the preceding sections I have described and discussed a range of examples of situations in which participants in the case study discuss their uncertainty and the perceived uncertainty of others. They describe or allude to different tactics which are adopted to cope with this uncertainty. These examples represent 'uncertainty work' – that which must happen in order to cope with uncertainty. It is notable that all of the units of analysis relate to multiple sources of uncertainty and multiple tactics which can be adopted to cope with that uncertainty. The categorisation matrix used in this part of the study was most valuable in providing a language to describe uncertainty work, but less useful as a tool for categorisation. This is partly as a result of the complexity of the real-life situations which form the units of analysis in this case study. Because of this, I elected not to use the matrix for further explanatory analysis, such as identifying consistent patterns of associations between different source and tactics or exploring the theoretical basis for uncertainty work. Having developed a preliminary understanding of the nature and significance of 'uncertainty work' in this context, the focus in the next section moves to consider themes emerging from participant interviews, which I will use to further develop the concept of uncertainty work and its relationship to learning

7.4 Inductive analysis

The deductive analysis described in section 7.3 focused on applying an existing categorisation matrix as a way of making sense of the case study data. In this section I describe an alternative and complementary approach using inductive analysis. The risk of using only a deductive approach is that important elements of 'uncertainty work' may be overlooked because they do not fit neatly into a predetermined category. Using an inductive approach provides a description of the facets of uncertainty work which is drawn directly from the framing used by participants in the study. In all, eight separate themes were recognised during the inductive coding of the data, these were:

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- Exposure to disagreement
- Openness, Trust & Credibility
- Self-evaluation
- Protocol & Orthodoxy
- Hierarchy
- Becoming a 'nearly vet'
- Ownership & responsibility
- Political sensitivity

Each theme is described below along with one or two exemplary quotations.

1. Exposure to disagreement

When asked about experiences of uncertainty, students frequently talked about disagreements. Disagreements were often between clinicians and represented alternative opinions on how a case should be managed, how protocols should be followed, and occasionally related to engaging in case discussions with other institutions (e.g. the UK vet school, other vet schools). Students were sometimes themselves involved in disagreements (either with peers or with staff) and this was both a source of uncertainty and a source of insight for students into the reality of clinical decision-making. As the following quotation from a member of staff illustrates:

"How do you teach the fact that there are many opinions? There is no evidence base for this particular course of treatment ... how do you rationalise with the students that we've all got a different view and we might all be right and we might all be wrong ... students hate that. How often do we have to have a discussion about [how] they've been given ... ambiguous information about the management of this and therefore we will remove this question from the exam.... But that is in fact the reality of clinical life isn't it that, most things are somewhere in between and there isn't in fact a black or white answer"

Staff ID01 interview

2. Openness, Trust & Credibility

Disclosure of uncertainty and openness about disagreement is not automatic. In several situations discussed, staff did not initially fully disclose or make overt the level of disagreement or uncertainty associated with a given situation. Students often found disclosure of uncertainty by staff and by others a source of reassurance.

Building trust was important for revealing participant's own uncertainties but also for feeling comfortable in relying on another person's judgement and therefore accepting their



uncertainty without doubting their credibility. Building trust takes time and is often described in terms of effective teamwork. Collaborative decision-making is one way in which trust is built, risks are distributed and credibility established.

"I think it made it feel more ...I don't really know how to describe it ... more down to your level, where you're like "oh, thank God I'm not the only one that's sitting here thinking, ...is this just cut and dried for every single thing? .. [realising that] it's not ... it was nice to know that they all do have [doubts]...; everybody doesn't just have ... this one universal opinion about "here's how we do this", that it does actually get worked out, even though as students ... we didn't [always] get exposed to that part of it here in the rotation, but I think it helps you be more confident as a student to say, if you have a different idea"

Student ID04 interview

3. Self-evaluation

During interviews students and staff frequently reflected on decisions where they had been uncertain and talked about how they felt about their actions with the benefit of hindsight. This is a form of self-evaluation. Looking back on a case, students often created a narrative explanation which encompassed the case, their reasoning and the outcome. They used this explanation to rationalise their own actions and to identify things which they would do differently in future. Verbal reflection frequently occurred during the interview process.

"Well I was really annoyed at myself [because] I knew that I shouldn't have removed [the sutures] but I did it anyway ...but I mean it was fine ... they just said Oh well, things like that happen and it'll heal by secondary intention and it'll be fine, it will just take longer... so ... I was just annoyed at myself because I knew that..."

Student ID03 Interview

4. Protocol & Orthodoxy

Clinical protocols are frequently used at the African clinic. The interaction between protocol and decision-making is an important area for developing professional judgement and learning to make decisions under uncertainty. Deciding when to stick to protocol and when to stray from protocol is an important part of student learning. Although there are often formal protocols in place, this theme also relates to orthodoxy: a less formal expression of the expectations of the community about how things should be done.

“Every practice usually has a scheme ... [a] protocol that [they] use and that's ... what everybody's decided on ... the only time that I'd seen people really stray from that was whenever the protocol wasn't working and then you needed to try something different”

Student ID04 interview

5. Hierarchy

There is a hierarchy in the clinic, with the clinic director at the top, followed by supervising vets, interns, the local team of grooms, assistants and the students. Participants differ in the extent to which they experience this hierarchy as “flattened”. Students look to those in higher levels of the hierarchy as a source of information and learning. Yet, students vary in how approachable they consider those above them in the hierarchy. Some individuals within the hierarchy are seen as intimidating at times and it is unclear to what extent this relates to personality and to what extent this relates to position. Students and University staff find ways to negotiate learning in the context of this hierarchy.

“We're used to having this hierarchy of people of how we all fit into the scheme and there's usually like the trickle of knowledge - the people at the top have the most and the people that further down ... are learning from all the people that go higher up ... while we were there we all learned from each other, even the people that were higher up”

Student ID04 interview

6. Becoming a ‘nearly vet’

When talking about their learning, student participants often reflected on how the experience on the rotation had changed them and how they had developed as a professional. This was occasionally described in terms of a developing professional identity, but more often in terms of their own awareness of their developing competency.

Here, one student looks back at how she has developed over the course of the rotation:

“I think I have definitely matured from a student into a nearly vet, going to [Africa], that's the rotation that I feel I've developed the most on.”

Student ID06 interview

7. Ownership & responsibility

Taking ownership of clinical cases is an important feature of learning in the African clinic. Students and staff both reflect that the clinic is unusual in the level of responsibility which

it allows students to take – this seems to be a feature of difference in the institutional culture between the vet school and the African clinic. Individual students vary in their approach to taking responsibility for cases – some take “full ownership” which includes full involvement in decision-making about the case. Others adopt an approach of close involvement in the practical elements of day-to-day care, but which uses the support structures available in the clinic as a way of deferring decision-making to others. The taking of ownership depends both on staff and student attitudes, as well as the extent to which the case is a challenging one. Staff equate high levels of ownership and taking responsibility for cases with effectiveness in the clinic environment.

“I think that ... it’s very hard ... to give people responsibility without ... letting the responsibility go. If you feel that the supervisor’s always watching over your shoulder ... and is at the end of the day taking ultimate responsibility, and if things go wrong you know he’s the one who will talk to the client and deal with the referring vet and do all those things. She’d really taken ownership of that case, you know she’s really interested in it, and it’s not just what [the patient’s] receiving, but its wellbeing Discussing how it was from day to day, how it changed”

Staff ID01 interview

8. Political sensitivity

This theme was evident in both student and staff interviews. It is difficult to capture in the form of individual quotes because it relates to patterns of observation and the differences between staff and student accounts of their experiences. Uncertainty was frequently associated with political sensitivities such as a risk of causing offence, awareness of a professional lapse or inadequacy of clinical facilities or protocols. Many discussions relating to uncertainty included some element of political sensitivity.

The example which follows illustrates this in relation to isolation protocols and zoonotic disease in the clinic. A decision not to discuss the likelihood of zoonotic disease fully with the student seems to relate to two separate political considerations - the risk that attitudes to Health & Safety may be considered inadequate by the university authorities and the sensitivity of openly criticising the judgement of a veterinary surgeon who is closely involved in the rotation.

Staff: “You clearly can’t say ‘it’s absolutely ridiculous to make a diagnosis’ ...because then you’re sort of hammering a colleague you know who is assisting in the rotation and ... maybe it might come across ... that we had a flippancy attitude to student safety ... but we don’t ... [the student] obviously got herself a bit concerned about it...”



Interviewer: "So I'm quite interested in that ... the rounds discussion went slightly differently because it was another member of staff at the clinic that had made the suggestion. If it was a student that had made the suggestion would you have a different approach?"

Staff: "I think if this had been a student that had said - could this be Brucella it would be easier to say well Brucella is really unusual - it's absolutely a differential but it's pretty unusual"

Staff ID01 interview

The member of staff in this situation wanted to reassure a student who was uncertain about her risk of exposure to a zoonotic disease. However, this was challenging because of his awareness of the potential political sensitivity of the situation.

7.5 Conclusions

Using the concept of 'uncertainty work' as a focus, I have taken two different approaches to analysis and description in this chapter. The use of an existing categorisation matrix for the deductive analysis confirms that the uncertainty work described by participants in this case study does indeed relate to similar descriptions in the existing literature in this area. Although certain sources of uncertainty frequently resulted in associated patterns of coping, the matrix was not sufficiently parsimonious to enable me to quantify these further. Nonetheless, it is clear that staff and students experience a full range of sources of uncertainty as well as adopting varied coping tactics in order to manage this uncertainty.

The second approach captures uncertainty work in participants own words and using their own framing. This part of the analysis draws attention to the social nature of uncertainty work. Where the categorisation matrix frames uncertainty work as a feature of individual decision-making, the inductive coding themes recognise that this decision making takes place in a social context and is clearly shaped by this context. This suggests that 'uncertainty work' is as much about social and contextual factors as it is about individual decisions. In the following Chapter, I will go on to consider the implications of this for student learning.

8 Using a situated learning framework to understand learning to cope with uncertainty

Moving on from describing the nature of uncertainty work in the context of the international elective, this chapter focuses on the specific issue of 'learning to cope with uncertainty'. The framework developed in chapter 2 is a starting point for this analysis. I use a middle range theory based on the concepts of situated learning as a framework through which to explore how students learn to cope with uncertainty in the context of the international elective rotation. As such, this chapter focuses on the results of the abductive and retroductive stages of the case study analysis. The case-specific hypotheses developed from the middle range theory are summarised in Appendix XVI. Each case-specific hypothesis is a contextually specific manifestation of a middle-range theory which I have described in relation to the international elective placement. I describe each in turn and use a range of examples to illustrate the analysis and to identify to what extent the ideas of situated learning theory can be used to explain learning to cope with uncertainty in this context.

8.1 Statements about the community of practice

8.1.1 Statement 1:

"The community or communities of practice in which learners are legitimate peripheral participants can be delineated and described as an activity system (or systems) with shared meaning for participants, within which members have different interests, make diverse contributions to activity and hold varied viewpoints".

This statement stimulates questions about the nature and functioning of the community:

- *Do learners participate in one community or many?*
- *Do the communities overlap?*
- *How do communities describe their practice and its' shared meaning?*
- *Is there evidence of different interests and diverse contributions to activity within the community?*

The communities of practice (COP) in which learners are legitimate peripheral participants are fluid and difficult to define and delineate. The question of whether learners are part of one community or many is a difficult one to answer because there are at least three possible interpretations.

8.1.1.1 Multiple COP

Learners participate in multiple communities over the course of training. Each new rotation or placement is seen as a new COP of which the learner becomes a legitimate peripheral participant. A COP is described and delineated as an activity system with shared meaning for participants (Lave & Wenger 1991). The African rotation fulfils these

requirements, as participants share an understanding of the meaning and purpose of their activities. They often reflect on their experiences as part of different communities (e.g. other rotations, placements) when talking about their learning. Making comparisons between communities may be one component of learning through participation.

8.1.1.2 *The Veterinary profession as a single COP*

Considering the 'veterinary profession' as a single COP - this fits more closely with Lave's (1991) original descriptions of COP such as apprenticeships, where one of the defining factors of the lifecycle of the community is based on timescale and the number of months, or more often, years over which a community replaces itself: In Lave's communities, novices eventually become the 'old timers'. This is different to the rotations, clinics and placement-related communities which students encounter because the time scale of these placements is much shorter (weeks or months) and, crucially, the lifecycle does not often involve the individual learner actually becoming an old-timer in the same community where they are learning. Typically they will gain employment and continue to develop their expertise in a different clinic or situation than that in which they are learning, supporting a view where the wider veterinary profession is the COP in which learners are participating. The key question here then, is whether the veterinary profession as a whole can be described as having 'a shared understanding of the meaning and purpose of the activities which constitute practice?'

Statements of professionalism such as the code of conduct (RCVS) suggest that there are shared principles in relation to veterinary practice. There are inevitably cultural and contextual variations in this understanding, but an over-riding concern for animal health and welfare is considered to be central to the practice of veterinary medicine across cultures and contexts.

8.1.1.3 *The Veterinary school as the COP*

Another approach is to consider the Vet School as a COP in itself. In this view of the community, one could argue that learners are not really participating in the practice of the veterinary profession or even in the practice of individual clinics and placements, but are actually participants in the community of veterinary education: they are part of a separate learning environment which is distinct from the general practice of the veterinary profession.

In this community both staff and students would be participants. Indeed, considering both staff and students as learners is consistent with situated learning theory.

Participants in this case study do not use the term COP or activity system when discussing their practice or their learning. They do occasionally talk about the shared

meaning involved in what they are doing, but this is infrequent. Often the shared meaning is implicit in the ways in which participants talk about their practice.

Staff participants in this study encounter an interesting dichotomy. They are considered the 'old timers' in the context of the university equine hospital where they are experienced clinicians, in positions of authority and esteem. In the African clinic however, this changes: although they have clinical expertise which gives them a certain level of influence, and at times puts them in a position of authority, they are themselves still learning how the culture of the clinic works and their role in the practice and activity. As equine veterinarians they have a certain shared conception of veterinary practice as it relates to the clinical practice, which forms a major part of their roles. As clinical teachers, they share an understanding of the educational environment and the practice of working with students and facilitation of student learning.

Statements defining COP, although focusing on the shared meaning, also recognise that within a COP there will be different interests and diverse contributions to activity. This is the case for any of the various COP described in this study: at clinic level, vet school level or profession level. In fact, it is the diversity of interests which is often evident in situations of conflict, and conflict is one potential source of uncertainty.

For example, at clinic level there are different interests between the local veterinarians who want to maintain case control and oversight and university clinicians who would prefer a more structured working environment.

"when we're out there it's an opportunity for the the local veterinarian to ... step out of the clinic ... we get the chance then to (laughs) run things a little bit differently, so when you know the cat's away...(laughs) the mice will play... so, we run things a little bit differently"

Staff ID03 interview

At the level of the vet school COP; students and staff have different interests. Despite the shared practice of 'learning', staff have to balance this with other demands on their own time and other responsibilities. In contrast, students frequently want greater opportunities to develop practical skills and more feedback and this can be a source of tension, as one member of staff describes in relation to the Vet school equine rotation:

"They often write in feedback on the core rotation "we would like to have been more involved in clinical decision-making ", and that can be difficult in our clinic because there are a lot of horses to see, there are a lot of students to teach"

Staff ID 02 interview



Staff and students participate in the same physical contexts and communities, yet the role of the individual in those communities may be quite different. It seems that participants in this case study encounter multiple overlapping communities of practice: at the high level there is the community of the veterinary profession and within this are multiple activity systems, some of which have features of COP and many of which overlap. In the case of the international elective rotation, which forms the basis of this case study, this can be considered as an activity system which involves at least two communities of practice: the African clinic and the Veterinary School. At the point of overlap between these two communities are the clinical placements in which learners participate in clinical practice.

8.1.2 Statement 2:

“Moving towards full participation in practice (including uncertainty work) involves a greater commitment of time, intensified effort, more and broader responsibilities within the community and more difficult and risky tasks. It also confers an increasing sense of identity as a master practitioner.”

This statement stimulates questions about the role and trajectory of learners within the community:

- *What characterises a movement towards full participation in practice – do we see increased responsibility, greater time commitment, effort and engagement in difficult and risky tasks?*
- *What characterises full participation in the uncertainty work of the community? Can we describe uncertainty work in terms of responsibility, time commitment, effort and risk?*
- *Is there evidence that learners develop an increasing sense of identity as a master practitioner? What role does uncertainty work play in the development of this identity?*

Here we move our focus from the structures of communities of practice and begin to focus on the trajectories of learners. Although the major focus is on the "Veterinary profession" community, we will also consider significance of different activity systems, such as the nested communities of the vet school and the clinic.

Both staff and student participants emphasise the importance of case responsibility (taking ownership) as characterising movement towards full participation in a community of practice. Case responsibility is an interesting combination between entrustment of students, which is a decision of the supervisor, and attitude of students. Student readiness to accept responsibility may be related to personality and individual attitudes to risk and responsibility, as well as previous experience.



"I think ... being given the responsibility ... and there not always being help readily available, ... exposure to whether they have to rely on themselves either individually or personally ... realising that they can, ... discovering that they can actually ... cope in those situations. I think it's ... acknowledging that they have reached that stage in their development when they are able to cope and actually ... they are being ... pushed into that situation a little bit because that's just how it is, so that is a bit uncomfortable for them but... they would probably all say that that is a good aspect of that rotation that they are given this responsibility."

Staff ID03 interview

Staff also recognised the challenges of giving responsibility and the factors which might influence that entrustment decision for a given clinician:

"...even if we say this is your case ... you still can to some extent ... abdicate that responsibility ... nobody is saying to you "have you given that gentamicin today"? ... you are the one who has to come forward and say to the clinic director - my horse is dull, my horse is recumbent, ... you are able to feel that real responsibility....If the horse dies, that might be because you missed something or if it gets better it's because you didn't miss something or you saw something and made the right intervention - you know I think this rotation allows us to give the students that level of responsibility"

Staff ID01 interview

This quotation illustrates the significant risks that a clinician must consider when making the decision to give responsibility to a student. Indeed the taking on of responsibility for risky tasks is one characteristic of centrality within a COP reflecting increasing mastery.

Lave (1991) also describes the trajectory of learners in typical communities of practice as increasingly involving long hours and high effort tasks. Although increased time commitment and effort are often a part of increasing participation in a community of practice, the pattern here is slightly different. Although long hours and high effort are often part of veterinary roles, in fact the long-hours responsibility falls to relative newcomers, such as students staying up overnight to care for a sick foal, with old-timers tending to delegate these time-consuming tasks; although being available as a point of contact if problems arise. It appears that the long hours and high effort tasks are ways in which the newcomers contribute to the work of the community (tasks which are of use to the community) and the trajectory of participants moves away from long hours, high effort tasks toward high risk and high responsibility tasks with increasing participation and centrality in the community.



Many of the features of full participation in the practice of the community are characterised by involvement in managing risk, conflict and uncertainty. Increasing involvement in the uncertainty work of the community is a characteristic of the trajectory of learners as they develop increasing participation in practice.

Students are exposed to a large range of new environments as they progress into the clinical years of their studies - these may be during clinical rotations (over which students typically learn in 10-20 different working environments) and extra mural studies (26 weeks across multiple different placements). When students talk about their trajectory as learners they talk about developing self-reliance, confidence and learning to be 'in tune' with things which seems to be important, to gain the trust of supervising staff across a range of different contexts:

"even going to rotations after that ... I just felt more confident in everything I did and that translated into ...small animal or horses ...you are given quite a bit of responsibility in the sense that they just let you get on with things even though you have to double check everything, you just, you get more confident in your own abilities and ... you just notice, you know you are more aware and in tune with things and I think that translates into any sort of small animal or large animal [placement]"

Student ID05 interview

Extra mural studies placements are often mentioned by student participants as examples of growing confidence and ability to participate in practice. Here, when asked what it is about a placement which enables them to participate in practice, a student responded that this related both to the tailoring of the practice to their level, and the perception of the level the student had reached:

"[It's] really both -... I know people who probably have gone to the same practice for a long time so they maybe got to do stuff earlier but I definitely went to a bunch of different ones so they might not know what I am like unless you spend a decent amount of time with them or unless you go back ... I also [think it's because] I'm in 5th year.... I went to places in 5th year that I'd never been before and [just] saying that I am in final year - ... they let you do more"

Student ID01 Interview

Many of these features relate to access to practice and to credibility as a learner: the trajectory of learners in the vet school curriculum is related to increasing ability to access the practice of the veterinary professional community to which it relates. One role of the vet school community is to provide access to opportunities for meaningful participation in



the practice of the veterinary profession. Moving into the final year of the programme, which may equate with becoming an old-timer in the vet school community, seems to confer increased opportunity:

"when you do EMS and you tell them that you are a final year you definitely get to do more things ... because they just expect you to be able to, so other people have confidence in your abilities - whether you have them or notyou just have to do it - you know I would still say if I didn't know how to do something but because they expect you to, and they give you a bit more responsibility to take it on ... while in other years of EMS you are definitely just standing and watching"

Student ID05 interview

Increasing sense of identity as a master practitioner resonates with the theme of becoming a 'nearly vet'. Learners develop an increasing sense of identity as nearly-vets and this is aligned with their developing confidence and increasing responsibility for decision-making.-.

8.1.3 Statement 3:

"Initial partial contributions of learners are useful to the community. As opportunities for understanding how well or poorly one's efforts contribute are evident in practice, legitimate participation of a peripheral kind provides an immediate ground for self-evaluation."

This statement stimulates questions about the contributions of learners to the practice of the community:

8.1.3.1 Is there evidence that the contributions of learners are of use to the community of practice?

In the context of the international rotation there are many examples of situations where the contributions of learners are of practical use to the clinic community. Two examples are described:

- History taking

This student describes her role in taking and interpreting a clinical history for outpatients at the clinic, a task which saves time for the clinical team:

"Because you got to do everything ...the donkey would come in, you would take the history and ... since the owners spoke the local language you had to then ask all your questions to the person who is translating for you, and they wouldn't help you out: if you didn't ask how long it had been going on for you wouldn't find out ... taking a history through translators is quite difficult but, by the end of the 4 weeks ... you were asking all the questions.... Then clinical examining all the animals ... doing the rounds, TPR-ing 7 or 8 animals every morning before rounds and then all the outpatients that came in"

Student ID06 interview

- Nursing care

In this quote, the focus is on the role of the student in the care of a particularly critical patient, this is a time-consuming task which would fall to a clinician or groom if the student was not present:

"[T]here was a lot of nursing with her ... a lot of care with her ... not just ... what the Vet would do, but also ... what your techs [Veterinary Technicians] would do and what the owner would do if they were there ... somebody was going in with her everyday ...and [using the] nebuliser you have to spend a lot of time with them"

Student ID04 interview (speaking about her own contribution to the case)

A list of contributions identified during the course of the analysis is included in Table 8-1

Table 8-1: Student contributions to the practice of the community

Contribution/Activity
Suturing wounds
Maintenance of barrier nursing
Proposing changes to protocols
Administering treatments to patients
Record keeping
Taking histories
Clinical examination
Taking Temperature, Pulse & Respiration rates
Supervised treatment /management planning
Triage
Presenting cases at clinical rounds
Advocacy for patients
Researching clinical queries
Liaising with experts in other institutions about case management
Presenting/suggesting alternative treatment options
Participation in case management discussions

For many learners, contributing to the practice of the community is central to their experience of the rotation and is important for deriving satisfaction and meaning from the rotation.

It is interesting to note that the presence of students in the community itself alters the nature of practice, including the uncertainty work and how it is managed. The contribution students make to practice is not only practical. There are also some general benefits to the clinic which relate to having students on placement. Through having students in the clinic the local team have regular and easy access to the expertise of the clinicians at the University hospital - they are also frequently able to employ the students as a go-between or to help with liaising with experts at the Vet school.

The presence of students adds to the work of the community in some situations; as well as the need to provide supervision; the ethical basis of decisions is frequently the subject of comment by students and it seems that challenges to ethical approaches can be problematic for local staff:

The contribution of learners through their work at the clinic is also of use to the vet school community in a different way: it allows the school to demonstrate to their accreditors and prospective students that they are actively engaged in a charitable programme and supporting international opportunities for student experiences, as well as providing high levels of case involvement and clinical skills development opportunities.

In the multiple overlapping activity systems, and in particular the community of practice of the vet school itself it seems that learners' contributions have influence both at the micro level (of helping with day-to-day practice which can be used as credit with partner institutions) but also at the macro level, as they are critical for sustaining relationships which are strategically important for the educational institution of the Vet school and are considered important in defining the effectiveness of the vet school to external bodies, including the accrediting bodies on which the existence of the institution depends. Accreditors are generally representatives of the wider veterinary profession, so this is another argument for the most appropriate delineation of a community of practice being considered at the level of the whole veterinary profession, of which accrediting bodies, individual clinics and vet schools are a part. If we follow the line of this argument, considering the community of practice at the level of whole Veterinary profession then we might propose that the contributions of learners are important not only for the day-to-day practice of the clinic, but also (at the macro level) for brokering and maintaining relationships between different parts of the profession (clinic and vet school).



8.1.3.2 Does participation and subsequent consideration of one's contribution promote self-evaluation by learners?

Self-evaluation by learners is rarely explicit in the interview discussion but often implicit, expressed through the use of hindsight or reflecting on their development over time:

"We were stupid, we put non-absorbable sutures into her skin [which]... was a bit daft, so she was sedated with ... three times the dose of what she was meant to, and she had a twitch and she had her leg up and... five people were involved to take off the belly bandage and remove the sutures.. so in hindsight we would definitely use absorbable sutures in her"

Student ID06 interview

Because uncertainty work is not always verbalised or explicit in practice, learners will often experience this as a sticking-point in their own understanding of the situation. It is through direct involvement in practice that the learner can encounter this uncertainty work at close range and begin to reflect on its significance for their own future practice.

8.2 Statements about uncertainty work

8.2.1 Statement 4:

"Learners, as peripheral participants, can develop a view of what there is to be learned about the uncertainty work of the community. Hence, a learning curriculum for uncertainty unfolds in opportunities for engagement in practice"

This statement stimulates questions about how learners develop an understanding of a "learning curriculum":

How do learners encounter the uncertainty work of the community?

Do learners develop a view of what there is to be learned about the uncertainty work of the community?

Can we see a learning curriculum for uncertainty developing from opportunities for engagement in practice?

Learners encounter the uncertainty work of the community through participation in day-to-day practice and the discourse around that practice. Involvement in decision-making about case management was a major focus of many of the discussions with both students and staff.

"That doesn't really happen in a university clinic - you know students don't really give their opinion to us as to how we should manage something - they are certainly present in those discussions and they might ask questions as to why you've made those decisions but they are not really ... actively contributing to [the] extent ... [that] they were there"

■■■■■■

Staff ID01 interview

One area in particular, which frequently came up during student interviews was that of decision-making in relation to euthanasia. I use euthanasia here as an example to illustrate how learners encounter and manage uncertainty work.

Euthanasia is an irreversible decision, a high-stakes decision and one which is frequently conducted under conditions of uncertainty. In cases in which euthanasia is considered there are many unknowns - sometimes the diagnosis is unclear, response to treatment unknown, likely prognosis uncertain and there are multiple areas of complexity which affect the decision-making, including the cultural issues around euthanasia in some parts of the world, as well as personal values and how these relate to the ethical and moral elements of decision-making.

In the case of euthanasia, learners typically encounter uncertainty work through discussions with colleagues, supervisors and team members about whether or not euthanasia is appropriate for a specific patient.

"I wrote about ... euthanasia in [the international rotation] because it was quite a controversial subject and actually on day one [the vet] said "do not discuss euthanasia with me - because I do not want to know your opinion on it" that was almost the exact words and we were all like whoa OK! And it was because, I think ... a lot of other groups have put pressure on her to euthanase [animals], but because you're obviously not supposed to euthanase anything without permission of the owners and nobody really wanted [to] euthanase things, so it put [the vet] in quite a difficult situation because you have got the students all saying this should be euthanised and then the owner saying I wanted to keep this alive - so she said don't discuss it with me"

Student ID02 interview

Decisions around end-of-life care or the management of suffering patients are frequently contentious and there are conflicting influences on the decision, which must be considered by the community members. It is interesting to consider the extent to which euthanasia decision-making is transparent within the community of practice - in a hierarchical or patriarchal system one might expect the senior vet to make a decision and this to be accepted without question by the rest of the community. The level of learner-involvement in day-to-day practice and patient care however, means that learners have developed a bond with the patient and have been involved in making and implementing decisions about case management up to that point; it is therefore natural that they should be involved in decision-making around possible euthanasia. This suggests that in the case of euthanasia decisions it is participation in the low-stakes decision-making in

relation to initial case management that provides the learner with access to the high-stakes decision-making and associated uncertainty work entailed in end-of-life care and euthanasia decisions.

If we consider learners' accounts of involvement in end-of-life decision-making in this study, several ideas emerge which demonstrate how learners develop a view of what there is to be learned about this issue. For example, here the student probes the clinician about the non-clinical or more subjective parameters which should be included in the decision-making process, and gives their reason for asking the question.

"I think - I wanted to know when they would call it a day and ... what they would look for ... [because] I didn't think they understood what this foal looked like at the time and that was when [the clinician] ... said that he looks for the demeanour - and when it starts to look like it's going downhill"

Student ID02 interview

Euthanasia discussions were also a strong element in staff discussions of uncertainty work and how students learn to cope with uncertainty around euthanasia. 'What is to be learned' from the perspective of a staff member is an intricate balance of animal welfare, professionalism, religion, culture and ethics:

"It can be quite difficult, but I think usually if they can see the other side of the story ... it just needs somebody to explain; but yes, I've had almost downright arguments with certain students ... looking at a horse and finding a colic ...and they just resolutely don't agree [with the decision] ... but then you talk to them later and they do finally sort of come round a little bit, ...they may always be of that opinion but at least they have ... had that discussion - quite a frank discussion ...they [say that they] ... think it's completely unacceptable and [they] can't believe you are not doing anything... I think [those discussions] are important and I don't mind having that out ... it's a good thing and it is important ... that they have an intermediary to vent this frustration at because it... gives them some insight before they ... start interacting with staff and the people who run it direct ... they've been buffered a little bit and perhaps made to appreciate the other side of the story rather than just launching into this tirade ... which can be a bad thing. So I think it's good that we are there to just help guide them."

Staff ID07 interview

In many cases students seem to have a limited view of what is to be learned about the uncertainty work of the community and they do not frequently articulate what there is to be learned. This may mean that they do not have a view or awareness of what is to be

learned or it may mean that the view of what there is to be learned is difficult to articulate or acknowledge within the process of this study.

Only one student participant made statements specifically describing learning points during the study:

"I guess it made me feel more positive about things; that process and being involved in it myself in the future and not being afraid to think outside of the box with the guidelines that, I said before, they are not always necessarily black and white; there can be some wriggle room when you need it to be if it's in the animals best interest."

Student ID04 interview

This leaves us with an interesting dilemma as we come to consider the last question relating to this statement: Can we see a learning curriculum for uncertainty developing from opportunities for engagement in practice? The analysis so far has suggested several elements which might be considered to constitute a learning curriculum for uncertainty e.g. management of conflicting opinions, collaborative decision-making, building trust, developing confidence in decisions, deferring to more experienced clinicians and so on. However, although these aspects of "curriculum" describe what is to be learned from a researcher's perspective, they are rarely described by student participants in terms of "things to be learned".

This may reflect the scope of the interview process itself: students were not asked to describe a curriculum or "what is to be learned", although they were asked to identify experiences which they considered were important in learning to cope with uncertainty.

Equally, this could reflect the challenges of pinning down uncertainty as a topic of conversation. If it is difficult to be consciously aware of uncertainty 'in the moment' then perhaps it is also difficult to be consciously aware of 'what is to be learned about uncertainty work' in the moment too.

It may be that students do not yet have a view of what is to be learned - either because uncertainty work is intangible or undifferentiated from other elements of practice or, perhaps because awareness of uncertainty work is something which indicates increasing centrality in the community of practice, and is therefore primarily an understanding held by old timers.

Learners, through peripheral participation 'can' develop a view of what is to be learned, but this is a limited view of what is to be learned in relation to uncertainty work. The statement describes the learning curriculum as "unfolding" in opportunities for engagement in practice and this is a good fit with the case study data. Unfolding implies a

gradual reveal, of one step following the last, not all at once but step by step. Only through involvement in uncertainty work and understanding of uncertainty work at one level can students be exposed to uncertainty work at the next level

8.2.2 Statement 5:

"Legitimate peripheral participation in the community creates transparency of the cultural environment with respect to the meaning of what is being learned about the uncertainty work of the community".

This statement stimulates questions about how participation creates transparency of meaning:

Does the cultural environment become transparent to learners through participation?

Many of the statements of the student participants indicate that they have developed an insight into the cultural environment of the African clinic - whether this is an understanding of the hierarchy and how it works, recognition of the impact of resource limitation on case management or an understanding of the intricacies of managing the relationships between the different institutions. In this first example, a student reflects on how resource limitations affect practice:

"I think you ... figure out what their protocols are and how things are run, then you ... work towards that - so it does ...[often] work out [that] what you suggest they'll agree with because you know ... that's the way it's done after a little while, but certain things ... [which] we expect to do here or you see in ...[the university clinic] and you suggest that and that's just not feasible, and that's just not the way it's done ... I think you figure out how it runs there and you kind of tailor [your suggestions] towards that .."

Student ID05 interview

The second example demonstrates a student developing insight into the cultural environment of the clinic:

"I was initially told to... wash her off ... and initially I thought that I wanted to get everything off, and then [veterinarian] came over in the middle of me doing the first things [and said] "Oh we actually don't want to take all the hair off ... we want to try to leave as much of the hair as possible so then we went from wiping the leg ...to blotting the leg ...At the time ... I didn't understand why we [were] doing that because everything was going to slough off anyway, which it did ... but I think with the owner standing there and seeing all of her hair come off of her leg, I think it might have been because it was unsettling to him to see all that come off because they don't like to see their work animals have any defect, so a lot of them wouldn't even let us shave their necks to put a catheter in ... just because



they were planning on taking her back out to work. I guess it's looked down upon to have an animal [which] ... you can obviously see [has] needed medical care."

Student ID04 interview

Staff and peers play an important role in helping students to make sense of what they see as part of the practice of the community. This animal presented with severe chemical burns due to inappropriate treatment by the owner:

"it was quite difficult to understand ...in the beginning, the owners perspectives ... When it first came in your thought was [that it was] ... an abuse case ... how can anybody possibly do this to their own animal ... But then [the university clinician said]: these animals are like ... our car ...you wouldn't maliciously do something to destroy something that you depend on every day for your livelihood. [The owner]... had gotten advice from a friend and he was trying to help, because he thought that [the animal] was lame and he'd never done anything to try to intentionally hurt her and wouldn't have done that... he was quite concerned about [the animal] while she was there [in the hospital] ... But the initial reaction from all the students was ... shock and outrage [saying] ... why would you do this? ... it was just a lack of knowledge really, not a malicious thing at all"

Student ID04 interview

It seems to be through participation in practice that the real insights come and that students are able to begin to appreciate the uncertainty work of the community.

"It's just because you see so many of that type of case that you only need a tiny part of the jigsaw and you can put the ... rest of it together ... you can't teach that in a lecture, you can only teach that by giving somebody responsibility for that type of case where they have become so intimately involved with it that they start to see the little nuances that are really critical and putting all that together allows them to become ... potentially really great clinicians"

Staff ID01 interview

There are examples of "transparency" through participation in practice in this case study and that some of these do relate to uncertainty work. The fact that these were not frequently identified in the interview data suggests that transparency is either not frequently achieved or perhaps not frequently recognised or discussed when students talk about their experiences.



8.2.3 Statement 6:

"Sequestration happens when learners are prevented from peripheral participation, in that they are not given productive access to the uncertainty work which constitutes activity in the community of practitioners."

This statement stimulates questions about sequestration of learners from the uncertainty work of the community:

Can we see examples of learners being denied productive access to the uncertainty work of the community?

What rationale is given for such sequestration?

Some level of access to the uncertainty work of the community seems to be granted to all students who embark on the rotation as there is a clear expectation that they participate fully in the practice of the clinic. The nature of participation, however, varies between students and there is potential for this variation to have an impact on the extent to which any one individual student is included in or granted access to the uncertainty work of the community.

The following example illustrates how access to uncertainty work may be denied and relates to the "Vet school" community of practice rather than the African clinic community of practice itself. The participant describes a situation where clinical rounds discussions which include disagreement and discussion amongst staff members are held behind closed doors, and not opened for student access:

"we don't do that in our general rounds, we do it in staff rounds, where we have a real disagreement about things and you know [A senior clinician] comes up with a drug that nobody else has ever heard of, you know we all start having a discussion about whether we should be using this drug or not - it's not that we don't introduce that, you know there are more than one ways to introduce that to the students"

Staff ID01 interview

The rationale given for this relates to the readiness of students to encounter such uncertainties which echoes earlier discussion about the idea of a curriculum for learning "unfolding" out of opportunities for practice - demonstrating readiness to gain access to the next level of uncertainty work seems to be required before students early in the curriculum can be allowed productive access:

"a lot of our rounds are about them presenting basic clinical data, demonstrating that they can perform a clinical examination, they can monitor parameters, they can recognise abnormal things, as the month goes on you introduce them to the next level and they



come to that - I think also they find it very difficult to contribute ... they really want to start discussing and asking questions and then that sort of higher level rounds almost stops functioning, because it's not dumbed down but it comes down a little bit - and some clinicians find it you know quite difficult to disagree openly in front of students"

Staff ID01 interview

As well as having gained the necessary clinical experience, he describes ownership of the case as being a key prerequisite for access to this uncertainty work:

"maybe having this sort of international rotation where you've got students who have done a core rotation, they've got the basics, they then go to a resource limited setting where they've got loads more responsibility and they really take ownership of the case... that's definitely the appropriate time to start introducing [the idea] that ... there's a number of opinions - what do you think?"

Staff ID01 interview

It appears that the underlying mechanism relates either to individual preparedness (and hence legitimacy) of learners and/or politically sensitive areas of practice (see also example quotation given on page 133). The uncertainty work which relates to political elements of the community of practice seem the most risky to give access to and is reserved only for those participants who have garnered the trust of established members of the community.

8.3 Statements about professional discourse

8.3.1 Statement 7:

"Learners participate in the uncertainty talk of the community which entails learning how to talk (and be silent) in the manner of full participants. Uncertainty-talk includes exchanging information necessary to the progress of ongoing activities as well as certain forms of "talking about" such as stories and community lore".

This statement stimulates questions about learners' participation in the discourse of the community:

How is the uncertainty work of the community represented in the discourse of practice?

Can we see examples of information exchange and "talking about"?

The role of clinical rounds discussions in the uncertainty work of the students and staff is explored further in this section. Clinical rounds are important as a formalised professional discourse; and the aim here is to describe how uncertainty work features in this professional discourse.



Two types of rounds are described: the business rounds discussions and the teaching rounds discussions. As well as informal discussions between students

Business rounds are where local learners and clinicians discuss day to day case management with a practical focus. They were not recorded as part of the data collection, but often featured in participant interviews.

Teaching rounds are where learners and staff in the UK vet school (or other vet schools e.g. in the US) discuss cases over an online video conferencing service; here the focus is on teaching and learning. Many of these rounds discussions were recorded and they also featured heavily in the subsequent participant interviews.

Boundaries of these rounds discussions are not well defined and teaching frequently happens during business rounds

8.3.1.1 Clinical/business rounds discussions

During rounds discussions cases are presented and management decisions are discussed. This provides an opportunity for clinical decision making to be scrutinised and evaluated by other members of the community and for protocols to be discussed and revised where necessary. Clinical rounds are a way of more experienced vets keeping an eye on the practice of newer learners. One important function of rounds in relation to uncertainty work is the identification of errors or possible mistakes in case management of which the learner/novice may be unaware:

“...we are going through every single case at rounds anyway so at that point I would ... say at rounds what I thought the plan would be and then at that point if there was a problem then somebody would say to me.”

Student ID08 interview

The level of this oversight may vary, and there is clearly some disagreement over the necessity of this level of scrutiny - in this clinic business rounds often seem to take a long time:

“I think [sometimes the local veterinarian feels the need] to keep in touch with the case , [which] means that, there is a certain degree disorganisation [during rounds]...during rounds in the morning for example, ...there might be 30 or so animals in the clinic and they will want to have every one brought out for them ... rather than becoming a sort of very useful tool for management, they become really much more about her keeping in touch with the cases and ... they go on for hours and hours”

Staff ID03 staff interview

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Rounds also serve a social function - the hierarchy of decision making is evident during the discussions and the public nature of the discourse provides one way in which learners become aware of the hierarchy at play. This is also an opportunity to disagree or suggest alternative approaches or interpretations. In this way the process of clinical decision making can be collaborative and the uncertainty work entailed in making management decisions in the light of conflicting opinions is played out in the discourse of the clinical rounds discussion:

"having different people from different regions of the world and sharing their opinion [for example], 'this is one case and [these are] ... four different ways that we've all seen it dealt with, and so now how are we going to deal with it here?', 'Here's how we typically deal with it, what are the reasons that we would or wouldn't change that based on these other people's experience' ... I think it was nice to see that working through a lot because there's not always one way to do everything"

Student ID04 interview

8.3.1.2 Teaching rounds discussions

Teaching rounds are different from business rounds because they are more reflective and serve the purpose of supporting learners as well as enabling discussion of interesting, unusual or challenging cases. Although a member of staff leads facilitation of the rounds discussion, there is a great deal of student input and the discussions are typically two-way - those of colleagues, rather than observing a clear hierarchy. The discourses of these rounds seem to relate to uncertainty work in different ways:

- Uncertainty work for teaching staff

The facilitation of these rounds discussions is challenging and requires both clinical expertise, communication skills and diplomacy. Staff in this role find themselves running rounds discussions involving 2 groups of students with very different experiences and levels of understanding (those in the UK and those in Africa), they have to discuss cases with which they are often unfamiliar, comment on management, offer advice, involve and attend to the understanding of both groups of students and manage the intermittent problems with technology which are encountered. Beyond this they have to consider the impact which their suggestions and/or their comments may have on the staff at the African clinic and the implications of this for the relationship between the two institutions.

"I have a sort of mixed feelings about [clinical rounds] - I hate the technology, the technology doesn't really work - mainly because the internet connection is really poor - also I think it's important [that rounds should be] a sequence of ... conversations between two people, rather than it being ... a group discussion ... The scheduling can be a bit of an

issue, but it's a minor one - getting information about the cases in good time before, that's a minor one. And I think sometimes ... [the local veterinarian] ... tends to sort of take over rounds and they become bent to their own purpose."

Staff ID03 interview

Uncertainty work here derives from complexity of managing all of these considerations concurrently and also having to operate under conditions of incomplete knowledge of cases, motives or situations which comes from being away from the clinic and communicating via a Skype interface. It also relates to negotiation/navigation of differences between the two communities.

This theme is captured in a quote from an interview with a member of staff:

"often times it's just sort of acting as a sort intermediary really - just so ... the students [understand that], "this is how it is" ... but it is a bit disorganised - we've just got to sort of run with it ... try and help with giving advice when ... they feel that, they're not getting enough advice for whatever reason about a particular case ... helping them when they feel that they've been given a [telling off] ... having little chats with them about that and not taking it sort of too personally, not taking it too harshly really"

Staff ID07 interview

Uncertainty work also includes the management of different interests within communities of practice.

For example, one staff participant reflects on how these tensions are managed:

"Cases are discussed with a US Vet school and there [are] often vague differences again in how they approach [it], and I just don't think it's - it's not helpful for our relationship with the [African clinic], for our relationship with [the US Vet school], for our student training, for it be, you know massively obvious that we think what they have recommended is [not best practice]"

Staff ID01 interview

- Support for learners

The teaching rounds discussions are also vital for the uncertainty work of the learners in the community. Emotional support is a strong theme in the discussions as well as support for decision making under uncertainty. As a staff participant describes the purpose of rounds:



"For me ... the rounds, I suppose ... some of it is just purely support - and it's almost ... an emotional type of support for the students there, showing that we ...do care ...and we are there to help and some of it is about supporting their clinical work as well when they ... are a bit stuck with a case and they're not sure what to do next. And it might be that the people at the clinic are unsure as well ... or there might be ... a variety of opinions and they are finding it difficult ...to make a decision about what the right way forward is. Or it may be that ... the [one of the vets] is not there at the time and there seems to be ... a lack of guidance. "

Staff ID03 interview

- Questioning case management

Teaching rounds also offer a strong focus for the uncertainty work entailed in discussion about disagreements and differences of opinion and an opportunity for learners to question case management in a 'safe space':

As one clinician comments:

Interviewer "You mention...there may be differences of opinion locally or lack of guidance with cases locally. What do you see as your role as the clinician in the rounds in those sort of situations?"

Staff "I suppose it's giving another opinion ... I think we all try and be diplomatic and ... if they are suggesting something saying yes, that's the right thing to do or ... suggesting doing it another way ... but also I think maybe trying to get a balanced view ... there's not always necessarily a clear right or a clear wrong and being thoughtful about making the decision about which approach you are going to take with a case and being respectful of other people's opinions and being professional about the way you talk about them ... trying to teach that, I suppose ... that's just hopefully coming across in my behaviour and the behaviours of other people. "

Staff ID03 interview

As implied in this quote; staff members lead by example; they can be role models in this situation and they are aware of the importance of their behaviour as role models.

Although there is explicit discussion of case management decisions, the way in which disagreement and difference of opinion is incorporated in teaching rounds discussions is largely implicit. By participating in teaching rounds, learners participate in discussions about disagreements; they learn how to disagree with colleagues and how to talk about disagreement in a professional manner. This is an important component of uncertainty



work and teaching rounds are one way in which this is developed in veterinary professional training.

8.3.1.3 Informal discussions with members of staff and peers

Formal rounds discussions are public elements of the discourse of the community, yet much of the discourse around decision making in the community happen through informal discussions with members of staff or peers. Although these discussions are frequently alluded to by participants, they are rarely discussed in detail in the interviews without prompting. For example, when asked to recall the specific reasons for making a certain case management decision a student may describe a discussion with a peer or a member of staff relating to the case:

Student: "So [we used a]... stallion - he was massive, he was well over 17 hands or something - he was used for pulling a wedding cart and ... he was healthy apart from having sore feet, so we decided to use him".

Interviewer: "Did you discuss that with anybody, or was it a decision for you?"

Student: "It was discussed between ...the students involved and ... the clinician and I think maybe a couple of the interns ... we thought well he's the only suitable candidate at the moment so we used him. And it was fine."

Student ID02 interview

The informal discourse of the team, including students and staff seems to be one way of engaging in collaborative decision making. Where there is a lack of certainty in relation to the decisions to be made then the decision is a shared one. In this way participation in uncertainty work is collaborative.

For learners there is a risk involved in making known one's own lack of knowledge - it may threaten the legitimacy of their participation:

"Anything that we were worried about, we would always ask in among our peers first so that we didn't appear stupid before we went to higher authority if you like"

Student ID06 interview

Revealing uncertainty during collaborative decision making relies on trust between members of the team. The informal discourse around uncertainty work is important for the collaborative decision making in the community, and is rooted in a developing trust both between members of the team and in one's own developing judgement.



8.3.1.4 *Knowing who to talk to, how and when*

Asking for advice and discussion about cases is an essential element of uncertainty work where decision making is frequently collaborative. Learners need to understand who to talk to (and who not to talk to) in each situation. These judgements frequently relate to the hierarchy in the community and reflect the authority and the personalities of individual members of the community:

"There was a volunteer from [another European country] ... and we would go to her first or, ... [Clinicians name] who is a vet there just now, before we went to [the more senior veterinarian] because we just didn't want to look stupid and get our heads taken off ... with silly requests"

Student ID06 interview

It is also important that learners understand when to be silent and when not to talk to a particular individual. There are several examples where student groups use the lack of visual cues from the video rounds to exchange 'off screen expressions' about a potential course of action suggested to them. It is interesting that in these situations they refrain from directly questioning the member of staff:

"We all like sit there in a little group and we're all looking at each other [thinking]...that seems like not the right thing to do! We're just only going to cold hose it? So yes, there was a reservation or scepticism of that being the only treatment that we used."

When the interviewer asks why the group did not question the advice of the clinician, the student seems unsure:

"While we were there? Um [pause], I don't know really, I guess, er, [pause] if you'd asked me at the time I could probably have a better answer for you ... it seems like there's lots of things that sometimes we question there that, ...sometimes [the university clinicians] advice changes the way that we do things."

Student ID04 interview

In some cases, modelling of this behaviour by university staff is one way in which student learners develop an understanding of when to speak and when not to speak, for example in this case where there is discussion about poor isolation facilities:

"I suppose them being aware that there are isolations and them also realising [pause] I don't know what I think about that - because again its coming in to the world of criticism... out there it is [inadequate] - the isolation, so again you are into the world of not being able to really discuss properly why it's important because you are then criticising them



...because they can't build a separate isolation unit and that would cost a fortune, with all the disposables that they would need ... so it's important that [the students] know because it's part of their profession is that they can listen to frank discussions [and] you have to trust them to not go and [pause]... out there I think it is quite an important lesson that they learned is that ... here everyone tries to read from the same sort of rule book as such and do things the same way and out there its, different and they will do things slightly differently and it's [the same in] every work place ... professionalism is to be able to work within that without causing problems "

Staff ID07 interview

8.3.1.5 Knowing how to tell the story

Throughout the interviews both staff and students were asked to recount what they remembered about the clinical cases which they had been listening to in the recorded clips. These narratives form a large part of the data set. Telling the story of the case is something which all participants were comfortable and confident doing - the level of detail in the accounts suggests that in many cases students took ownership of the cases. Most participants used the term 'we' rather than 'I' when telling the story of the case, reflecting the collaborative nature of decision making about case management and diagnosis.

There are few specific examples of developing community lore, which may reflect the limited amount of time which participants spent on the rotation (4 weeks) and/or may reflect the data collection method in this study which focuses on formal rounds discussions and may therefore have missed some of the more informal elements of the discourse.

"She resolved and went home; she was my success story for that whole 4 weeks that I was there... and her box became the box that everything wanted to go into because everything that went in it lived. And the box beside it, everything that went into it died. "

Student ID04 interview

8.4 Statements about conflict and change

8.4.1 Statement 8:

Dissociating learning from pedagogical intentions opens the possibility of mismatch or conflict among practitioners' viewpoints in situations where learning is going on. These differences must be constitutive of the content of learning.

This statement stimulates questions about conflicting viewpoints:

Can we see evidence of conflict among practitioners' viewpoints in situations where learning is going on?



To what extent do these differences constitute the content of learning?

How do these differences relate to the uncertainty work of the community?

There are many examples of conflict among practitioner's viewpoints in situations where learning is going on, as reflected in the inductive coding theme (conflict). Both staff and students acknowledged this in their interviews, typically in relation to case management.

"She was eating really well towards the end which was another bone of contention between all of the different Vets that had ... been around for a while and seen a lot more practice, so it was [one of the vets]] who had been there (and has dealt with mules and donkeys a lot more), [who] was happy enough for her to go out to grass, [on] the second day after we'd resolved the choke and the newer vet that's there, was quite nervous because they had never dealt with one in a horse in that way, and they [said] "Oh, we'd never put them out on grass this fast" ... But then when she came in off the grass, [the first vet said] "well just soak some hay and give it to her, and so it was really quite interesting seeing the different knowledge levels, that you kind of think are equal ... having such a huge disagreement about "what was the actual proper therapy" – but [the first vet] obviously pulls rank because she [is more senior]"

Student ID04 interview

The frequency of examples in this case study and the centrality of disagreement to the interview discussions with staff support the idea that these differences constitute the content of learning. Students seem to differ in the ways in which they make sense of this disagreement, in some circumstances these differences are also part of the learning which is going on.

"I think it helps you be more confident as a student to say, if you have a different idea... it made you feel more comfortable [when he said]... "oh we actually disagree all the time" I guess it made me feel more positive about that process for each patient that we have ...it made me feel more positive about that process and being involved in it myself in the future"

Student ID04 interview

In other circumstances, the student may appear less aware of the learning which may result from such exchanges:

Interviewer: "This was a situation... where one vet was telling you it was definitely one thing and one vet was telling you it's really not likely to be one thing - how did you find that kind of situation?"

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Student: "It was hard because ... I guess going with [the university clinician] who knows everything and that's what you trust but I was kind of thinking well [the local vet] ... knows everything that goes on in Africa and knows cases that [they] see so I didn't really know to be honest who to [believe] ... I guess it could have gone either way".

Student ID08 interview

The differences discussed here are central to the uncertainty work of the community and this seems in part to be due to the fact that practitioners are frequently making decisions with very limited information: this may be due to the limited evidence base, the limited availability of information or resource limitation meaning that a definitive diagnosis was frequently not reached at all or not within a timescale to inform initial case management decisions.

8.4.2 Statement 9:

The movement of learners towards full participation in the uncertainty work of the community does not take place in a static context; instead the practice itself is in motion. Change is a fundamental property of communities of practice and their activities.

This statement stimulates questions about change in the community of practice and its activities:

Can we see evidence of change in the activity of the community?

How does change in the community and its' activities relate to uncertainty work?

In earlier sections we have considered three or more interacting communities of practice which are at play in this case study: the Vet school community of practice, the African clinic community of practice and the Veterinary Profession community of practice. In general the analysis has tended to focus on the African clinic and Vet school communities of practice because this was the physical focus of the case study in this project. When considering the significance of change in the community it is helpful to broaden the focus once more. Both the African clinic and the Vet School communities of practice are subject to change in activity: the relatively short history of this collaborative venture alone (only running for the previous 12 months) draws attention to the fact that both communities existed before the rotation started and that the exchange arrangements between both communities represent a relatively recent change in activity for both. The creation of the rotation has brought considerable changes to both communities, for example, the clinic has additional manpower and resources, yet must accommodate year-round student teaching within its activity structure. One change which this brought fairly early on in the process was the appointment of another supervising veterinarian to work at the clinic and this itself has brought change to the community.



From the perspective of the vet school community, there are resource implications in running the clinic and in sending members of staff and student groups out on placement. I have already discussed the "uncertainty work" which has developed for university staff in managing the relationship between the 2 institutions and managing both their own and their students' responses to cultural differences and political sensitivities which this produces.

It is important to note however, that this study was conducted over a short period of time and so actually may not have been well designed to capture change. In relation to this research question, I conclude that the scope of the data collected for this case study makes it difficult to evaluate fully the significance of change. Although we can describe changes in both communities, it is difficult to pinpoint these in the specific data and the focus of the interviews precludes additional insight as part of the current case study.

8.4.3 Statement 10:

Legitimate peripherality is important for developing constructively naïve perspectives or questions. Inexperience is of use, however, only in the context of participation, when supported by experienced practitioners who both understand its limitations and value its role.

This statement stimulates questions about the influence of constructively naïve perspectives on the activity of the community:

Do learners ask questions or make statements which reflect naïve perspectives on practice, including uncertainty work?

To what extent are these naïve perspectives constructive?

How do experienced practitioners and others in the community perceive and interact with these perspectives?

The challenge here is to confidently identify naïve perspectives and this is a matter of interpretation and therefore may be biased both by my prior experiences and by my own professional opinion of what constitutes a naïve perspective.

It is perhaps best to consider this question from the perspective of staff: as established members of a community of practice they are well placed to identify and comment on naïve perspectives. For example, one staff participant comments on how learners adopt a very different position on euthanasia compared with that which has become established in the community:

"Where they are seeing something suffering and they say well why can't we just put it sleep and [I explain that]... you can't because there are people over here who [have

████████

different religious views] don't want you to euthanase it ... So it's getting them to appreciate the path that ... the people who work there actually have to ... negotiate and follow, trying to do the best but sometimes ... for the good of the unit existing and benefitting lots of animals sometimes some have to be managed in a slightly different way that's not ideal. I suppose those were good things to have to confront really."

Staff ID07 interview

When considering how established members of the community interact with this perspective there seems to be a split between those who will engage with it through active discussions with students and those who will avoid it:

The different approaches may derive from the extent to which the naive perspective expressed is constructive and of value to the different communities. In the context of the African clinic community there seem to be strong and pervasive cultural and political reasons why euthanasia is limited and the learners' naive perspective here serves to highlight a conflict of interest which exists in the work of the clinic, and staff members recognise this as being problematic. However, in the context of the veterinary school community, this naive perspective could be considered constructive because it enables learners and staff to explore the ethical basis of this decision making: as the focus of the vet school practice is on education, then exploration of the student perspective is aligned with the practice of the community and is therefore more constructive.

Not all naive perspectives are considered as valid by the community old-timers however, for example, in this situation a suggestion made by a learner is rebuffed:

"I think it was just at rounds in the morning and then she just ...said well [doing an abdominal scan] wouldn't change anything so there is no point in doing it - and that was ... it"

When asked by the interviewer how she felt about that the student reflected on why it had happened:

"I guess it was right, she wouldn't have changed anything no matter what it was but I guess when you were taught in class, you know you just like to follow things through and you know why you are doing something - not just doing it because. And because the option is there it would have been nice for - just for learning sake ... to see what it was like"

Student ID05 interview



From what the student says here it seems likely that this suggestion would not have been considered to be inappropriate or "naive" at the Vet school, but that it was considered inappropriate in the resource limited context of the African clinic.

Identifying a naive perspective is difficult for someone outside of the community itself and this may be a limitation of the methodology and the boundaries of the case study itself. Based on the examples considered here we can see that learners do ask questions or make statements which appear to reflect naive perspectives on practice. These are occasionally, but not always constructive. Experienced practitioners respond in different ways depending primarily on the extent to which the question is considered constructive from the perspective of the community itself.

8.5 Challenges to the middle range theory

The aim of considering negative cases is to recognise sections of the data set which do not correspond as well with the middle range theory and establish why that may be the case. There are several areas within units of analysis which appear different to the expectations of the middle range theory. For reasons of space the details of these are included in Appendix XVII and the key findings are discussed in the subsequent stages of the analysis.

8.6 Revised middle range theory

8.6.1 Summary of analysis

The analysis described above has evaluated each of the ten statements comprising the middle range theory against the staff and student descriptions of learning to cope with uncertainty in the context of an international rotation. Table 8-2 below aims to bring this analysis together and summarises the findings in relation to each of the statements. For each statement, the middle range theory is redescribed as a 'case specific hypothesis' which outlines how the theory applies to the specific case under discussion.



Table 8-2: Summary of outcomes of analysis in relation to statements of the middle range theory

	<i>Middle-range situated learning and uncertainty work hypotheses</i>	<i>Case-specific veterinary learning in international elective rotation hypotheses</i>
<i>Statements about the community of practice</i>		
1	The community or communities of practice in which learners are legitimate peripheral participants can be delineated and described as an activity system (or systems) with shared meaning for participants, within which members have different interests, make diverse contributions to activity and hold varied viewpoints.	<p>The community or communities of practice in which learners are legitimate peripheral participants are fluid and difficult to define and delineate.</p> <p>Learners are part of multiple overlapping or nested communities of practice which have shared meaning for participants</p> <p>It is particularly at the intersections between these communities that tension, conflict and hence “uncertainty work” emerges.</p> <p>This “uncertainty work” includes negotiation/navigation of differences between communities and the management of different interests within communities of practice.</p>
2	Moving towards full participation in practice (including uncertainty work) involves a greater commitment of time, intensified effort, more and broader responsibilities within the community and more difficult and risky tasks. It also confers an increasing sense of identity as a master practitioner.	<p>The trajectory of learners in the vet school community is related to increasing ability to access the practice of the veterinary professional community to which it relates.</p> <p>Moving towards full participation in practice involves increasing participation in the uncertainty work of the community.</p>



		Through participation, learners develop an increasing sense of professional identity which is consistent with their developing confidence and increasing responsibility.
3	Initial partial contributions of learners are useful to the community. As opportunities for understanding how well or poorly ones' efforts contribute are evident in practice, legitimate participation of a peripheral kind provides an immediate ground for self-evaluation.	<p>Initial contributions of learners are useful to the community on multiple levels: at the micro level learners provide valuable help with day to day practice; at the macro level this contribution is critical for sustaining relationships which are strategically important for the institutions involved.</p> <p>As opportunities for understanding the extent to which ones efforts contribute are evident in practice, learners demonstrate self-evaluation which may be expressed as "hindsight".</p>
Statements about uncertainty work		
4	Learners, as peripheral participants, can develop a view of what there is to be learned about the uncertainty work of the community. Hence, a learning curriculum for uncertainty unfolds in opportunities for engagement in practice.	<p>Learners encounter the uncertainty work of the community through participation in day to day practice and the discourse around that practice.</p> <p>Learners are frequently engaged in uncertainty work, yet they rarely articulate a view of "what is to be learned" in relation to the uncertainty work of the community.</p>

		A learning curriculum for uncertainty unfolds in opportunities for engagement in practice: only through developing an understanding of uncertainty work at one level can students be exposed to uncertainty work at the next level.
5	Legitimate peripheral participation in the community creates transparency of the cultural environment with respect to the meaning of what is being learned about the uncertainty work of the community.	<p>The cultural environment of the community becomes transparent to learners through participation in practice.</p> <p>Staff and peers play an important role in helping students to make sense of what they see as part of the practice of the community.</p> <p>Transparency in relation to the uncertainty work of the community is less frequently articulated than in relation to other areas of practice.</p>
6	Sequestration happens when learners are prevented from peripheral participation, in that they are not given productive access to the uncertainty work which constitutes activity in the community of practitioners.	<p>Productive access to uncertainty work is denied when access is considered risky and is reserved only for those participants who have garnered the trust of established members of the community.</p> <p>Learners are sequestered during the early parts of the curriculum preventing them from gaining productive access to the uncertainty work of the community.</p>
Statements about professional discourse		
7	Learners participate in the uncertainty talk of the community which entails	Learners participate in the uncertainty discourse of the community which



	learning how to talk (and be silent) in the manner of full participants. Uncertainty-talk includes exchanging information necessary to the progress of ongoing activities as well as certain forms of “talking about” such as stories and community lore.	entails knowing who to talk to, knowing when to be silent and talking about (telling case-stories). “Talking about” emphasises the collaborative nature of decision making in learners’ practice.
<i>Statements about conflict and change</i>		
8	Dissociating learning from pedagogical intentions opens the possibility of mismatch or conflict among practitioners’ viewpoints in situations where learning is going on. These differences must be constitutive of the content of learning.	Learning is largely, but not entirely dissociated from pedagogical intentions in this context. The mismatch between the pedagogical intentions of the vet school community and the practice of the African clinic community produces tensions where the two communities overlap There is frequent mismatch or conflict among practitioner’s viewpoints - these differences are constitutive of the content of learning.
9	The movement of learners towards full participation in the uncertainty work of the community does not take place in a static context; instead the practice itself is in motion. Change is a fundamental property of communities of practice and their activities.	The movement of learners towards full participation in the uncertainty work of the different communities does not take place in a static context. The presence of learners changes the community.
10	Legitimate peripherality is important for developing constructively naive perspectives or questions. Inexperience is of use, however, only in the context of participation, when supported by	Learners ask questions or make statements which appear to reflect naive perspectives on practice. These may or may not be constructive.

	experienced practitioners who both understand its limitations and value its role.	Inexperience is of use, however, only in the context of participation, when supported by experienced practitioners who both understand its limitations and value its role.
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8.6.2 Conclusions

Based on the analysis and re-description of situated learning theory in the light of my findings, I conclude that in the context of an international elective in a resource limited environment veterinary students learn to cope with uncertainty through legitimate peripheral participation in the uncertainty work of the community of practice. Uncertainty work is that which needs to happen in order to cope with uncertainty, and is negotiated through the discourse of the community. Access to the practice of the community is contingent upon the balance of risks and benefits for stakeholder institutions. Learners' access to the community itself produces risks and benefits. Institutions can be considered as distinct but overlapping communities of practice within the community of the Veterinary profession. Access to productive participation in the uncertainty work of the community is a feature of increasing participation, which is mediated by the development of interpersonal trust as well as characteristics of individual participants which promote taking responsibility for, and ownership of, cases.

8.7 Proposed causative mechanisms

The aim of the retroductive analysis is to understand what it is about the international elective rotation which facilitates students' access to participation in uncertainty work. Case responsibility is seen as critical for participation in practice and this forms the starting point of the flowchart shown in Figure 8-1.

Six mechanisms are proposed as potentially important for students being given case responsibility in this context. Table 8-3 shows each mechanism and outlines the conclusions of the stakeholder focus group discussion on its' significance:

Figure 8-1 also recognises the role of the learner in gaining access to uncertainty work through accepting case responsibility. Learners have an important role in securing their own access to participation in uncertainty work. Although individual strategies may differ, typically they gain access by building trust (demonstrating competency and commitment), demonstrating political sensitivity and by engaging in different forms of collaborative decision making.



Figure 8-1: Mechanisms important for giving and taking case responsibility

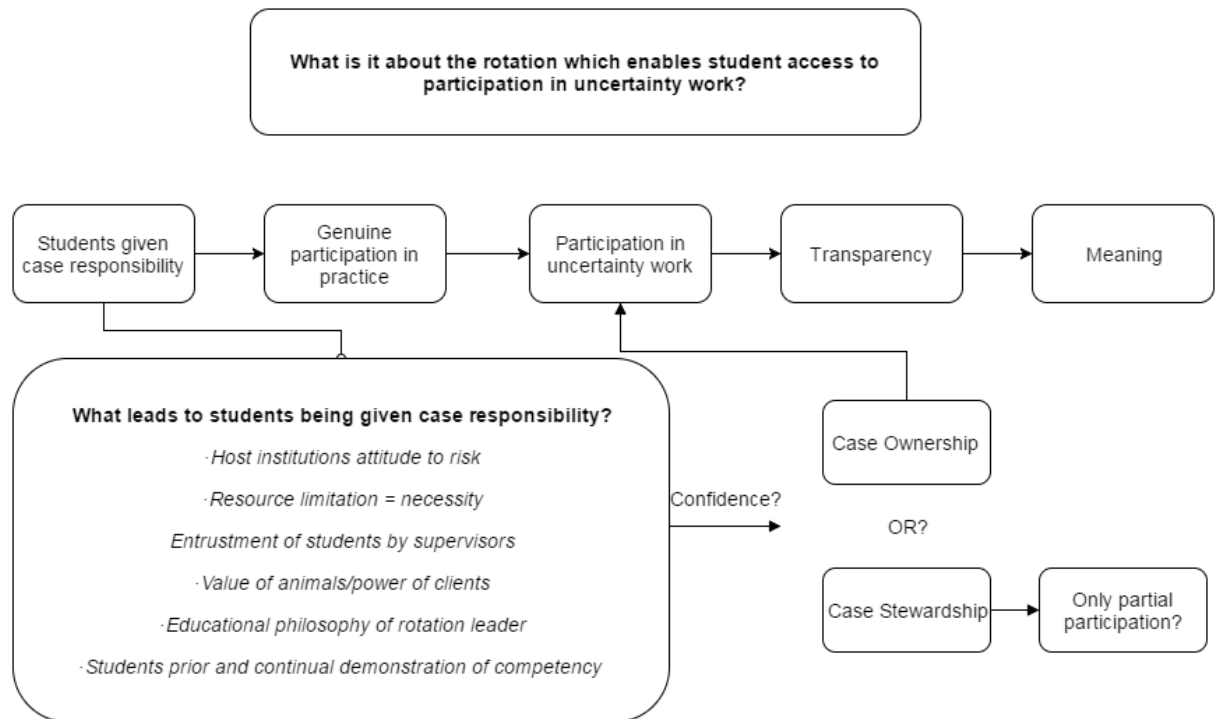


Table 8-3: Mechanisms discussed during focus group

Possible mechanism	Stakeholder focus group discussion	Revised mechanism
Host institutions attitude to risk	This is probably not a big factor. Supervision of the students is good and their involvement is not considered a risk for the institution. More important is the supervisor's perception of the risk, for example, how difficult it will be to pick up the pieces if things go badly.	Supervisors perception of risk
Resource limitations means student responsibility is a necessity	Resource limitations mean that there are lots of cases but necessity is not a major driver for students being given responsibility - trust is more important. The fact that there are lots of cases and close teamwork with supervisor means that more opportunities to build trust are available than in many rotations. This suggests that resource limitations are important but the mechanism is different than that proposed.	Resource limitations promote close teamwork between student and supervisor and large case numbers mean greater opportunity to demonstrate competency and build trust
Entrustment of students by supervisors	This seems to be the most important factor. Usually trust is built gradually as students are given more risky tasks and supervisors determine level of supervision and level of entrustment based on the perceived level of student competency. Occasionally the process is done in reverse - i.e. it becomes clear from adverse outcomes that entrustment has been inappropriate and the student is not ready to be trusted with risky tasks.	Building of trust between students and supervisors based on level of student competency perceived by supervisor
Value of animals/power of clients	This is more complex. Value of animals to their owners is often as high (or higher) at the African Clinic than the Vet school referral centre because owners rely on their animals for	The expectations of animal owners, which relates to client education

	<p>subsistence. Emotional bond is more varied: sometimes very strong, animals sometimes seen as commodity (this is less varied but still relevant in the vet school referral setting). The most important factor discussed was the role of the referral vet (complicated cases sent to them by first opinion vet) compared with a first opinion caseload at African clinic. This means that the important element is the expectations of the client rather than power of client. Another important issue is level of education of the clients - this relates to expectations.</p>	
<p>Educational philosophy of the rotation leader</p>	<p>This was discussed in the context of clinic veterinarians rather than the local rotation leader.</p> <p>Not recognised as an important mechanism in either context; neither is key to the entrustment decisions.</p>	
<p>Students' prior and continued demonstrations of competency</p>	<p>Closely related to discussion of entrustment. Competency characterised by technical skills (practical skills) as well as "thinking along the same lines" as the supervisor.</p>	<p>Students' demonstration of competency in technical skills and through reasoning which is resonant with that of the supervisor.</p>

The differentiation of case ownership and case stewardship may be important here. The nature of participation in practice varies between students and this may impact on the extent to which any one individual student is included in, or granted access to, the uncertainty work of the community.

For example, 2 students in this study (Student ID08 and Student ID04) differ in their level of autonomy and approach to the decision making process at the clinic. These two students adopt differing strategies for managing their involvement in uncertainty work in the clinic - these strategies are examples of typical approaches demonstrated by students in this study.

The first student (Student ID08) adopts a strategy of deferring to supervisors when important decisions are to be made and double checks her proposed course of action. When asked to recall a situation which made her feel doubtful she does not recognise doubt or uncertainty as a significant feature of her experience:

"[Do] you mean ... doubtful of treatment? ... Or what I had to do? ... Not really - I don't [think so] ... as I said I always felt that we were really well supported when we were there so I never really felt too worried about doing things because there was always somebody to ... reassure us that we were doing the right things ... in a lot of my cases [I had to consult local clinicians] to actually understand what I had to do ... I don't like to give something without knowing why I'm giving it ... I think sometimes they can have a tendency to [say] "OK go give that horse whatever" - so I'd always ... make sure that I know why."

Student ID08 interview

The staff member who supervised this rotation, also talked about this students' approach:

Interviewer: "With the previous clip you felt that the student had really taken ownership of this case - did you get the same impression with this student?"

Staff: "No, I - she's quite an interesting student actually because she ... sounds flippant - [but] she's not at all , there are some cultural differences there. She's a really good student and it was a really difficult case and you could hear that that animal had become really intractable to treatment and clearly she was persisting with it and ... she'd been treating that Mule for 4 weeks at that stage and ... she hated it and it hated her and ... and the fact that she'd persisted and ... [when asked] "is it responding?" [she said] "it's got no discharge" [and I said] "brilliant - so actually you've fixed it!" ... So yes, I think she had taken ownership - probably not quite in the same [way] ... [Student ID08] was... slightly more detached ... but logical ... I'd suggested in the last week about the radiograph and

she had obviously ... gone and taken it - and they don't routinely - I am always berating them for not taking radiographs so she must have pushed for the radiograph to be taken, so again that shows a certain level of interest and ... compassion and ownership of the case."

Staff ID01 interview

The member of staff contrasts this with the approach of the other student (Student ID04):

"[Student ID04 was] probably one of the best students who did that rotationshe bought in to the whole ... experience ... culturally, clinically,... she made it her business to get to know the local people and ... when we were there she was talking to the yard lads you ... communicating with them about how her cases were doing ... clearly she is probably at one end of the spectrum, there's probably others at the other end who actually would have found that case really difficult ... I think most people are pretty open when they you know come across a student like [Student ID04] you know to discuss the pros and cons and the how and why "

In this example, taking ownership of the case appears to facilitate increased access to the uncertainty work of the community.

9 Case study discussion

9.1 Learning as legitimate peripheral participation

There is a close fit between the ideas of situated learning theory and the features of learning in the context of the international elective rotation which formed the basis of this case study. The observation that learners start as peripheral participants, gaining legitimate access to the practice of the communities, as well as the trajectories which we observe as they develop in confidence, skill, and understanding and build trust are remarkably similar to those described in very different contexts such as the apprentice tailors or the support group members described in the original text (Lave & Wenger 1991). We can see examples of transparency as learners gain real insight into the work of the community through participation in practice. We also see sequestration: where learners are prevented from productive access to the practice of the community. In the context of this study this is most significant where learners are prevented from accessing the uncertainty work of the community through exclusion from professional discussions, or in the early years of the veterinary programme and some extramural studies placements, being excluded from productive access to practice entirely. Situated learning theory also provides an explanation for this sequestration, recognising that opportunities for learning unfold as learners participate in practice. We have seen that, in the case of uncertainty

work, this unfolding is particularly important because it is only through demonstrating readiness that learners are given access to the next level of uncertainty work. Indeed, access to politically sensitive uncertainty work is only permitted to those who are trusted and more established members of the community.

The idea that learning gradually unfolds, that each new phase of learning is built on that which precedes it, is a common theme among many theories of learning, such as the constructivist concept of the zone of proximal development (Engestrom & Sannino 2010; Jonassen & Rohrer-Murphy 1999) and through the cyclical process described in experiential learning theory (Kolb 1984).

9.1.1 The importance of responsibility, ownership and trust

Concepts of responsibility, trust and ownership are central to the middle range theory in this case study. Learners earn the trust of the community through participation in practice. Taking ownership of cases and participation in collaborative decision making is one way in which this trust is built, and access to responsibility and further uncertainty work is allowed. The idea of professional entrustment resonates with the 'Entrustable professional activities' (EPAs) assessments which have recently been developed for postgraduate education in the Medical field (Ten Cate 2013). This assessment system is based on the idea that making an entrustment decision is one way in which a teacher or supervisor can make a judgement about the competency of a learner. Importantly, EPAs are considered to allow for the tacit elements of the trust decision as well as the more tangible practical elements to be considered. Although EPAs are gaining popularity, the method lacks a strong basis in theory. The findings of this case study are potentially relevant. Trust is a key mediator in providing access to the next layer of practice: in this case the next layer of uncertainty work. An entrustment decision by a supervisor represents recognition that a learner has reached a level of participation in practice which grants them further access. With this access comes increased responsibility. An entrustment decision represents a judgement that an individual is ready to manage that responsibility and associated risk in the context of the community of practice. Although the language of EPAs considers these as individual discrete decisions in relation to single specific skills; in the context of our case study and uncertainty work, entrustment does not seem to occur in discrete single events but in patterns of events over time.

In the Veterinary profession in the UK, graduation represents a key transition, from student to practitioner. The change in level of responsibility at this transition can be considerable, and even with the introduction of the 'Professional Development Phase' which provides a structured approach to learning in the first few years of practice, there is still a clear difference between veterinary and medical professions in their approach to the

levels of responsibility and support afforded to new graduates. Creating learning environments which foster increasing levels of responsibility before graduation will be key in enabling future new- graduate veterinarians to learn to cope with uncertainty.

9.1.2 Communities of practice and activity systems

Defining the community or communities of practice has been challenging in this case study. The identification of multiple overlapping activities within the wider community of the veterinary profession is the most useful interpretation. Participants spend a relatively short time in the clinic, and they will not subsequently go on to work in the environment in which they are learning. The fact that student participants in this study will not go on to become members of the international clinic community of practice has certain implications for learning and practice.

There has been building criticism of international health electives on the basis that they are focused on the learning of students from developed nations and can be poorly aligned with the meeting the needs of local communities (Ackerman 2010). The short-term destabilisation of local health systems which can result from electives has been criticised, as have the ethical implications of relatively inexperienced students performing surgical procedures on patients from these communities (ibid). Good-practice principles described for international elective placements include the need for educational institutions to demonstrate sustained and sustainable approaches to engagement with local communities and to work within defined ethical and professional frameworks for practice (Crump et al. 2010).

A parallel debate has arisen within the veterinary profession regarding the role of working equid charities in developing nations and similar themes have emerged: the importance of community engagement, an increasing emphasis on prevention and education, the need to work within existing systems of health care (Stringer 2014).

It is interesting to note that both of these debates identify short-termism, the lack of a sustained and ongoing approach as problematic in the context of health care communities. This resonates with the limitations of the community of practices approach in this case study. Suggesting that the fact that the vet students who are the learners in the African clinic activity system are not invested in the community beyond the limitations of their month long placement has implications for their learning within that community. Although we are unlikely to be able to train veterinary undergraduates in the same practices in which they will later work at a new graduate, and indeed we may not wish to limit their experience to a single practice context, it is clear that building trusting relationships and contributing to the community of practice underpins learning in clinical environments.



9.1.3 Understanding uncertainty work

The aim of this case study was not to explain uncertainty work itself, but to explain how students learn to cope with uncertainty. Yet, the concept of uncertainty work is central to middle range theory and as a concept it merits further definition and discussion here.

9.1.3.1 *Defining and delineating uncertainty work*

The term ‘uncertainty work’ was initially coined as part of an analytic strategy. It provided a way to recognise the practices associated with encountering and managing uncertainty without needing to define what might be considered ‘effective’ coping with uncertainty. This was encapsulated in the working definition of ‘that which must be done to cope with uncertainty in professional practice’. Even though the main focus of the research moved away from characterising uncertainty work and towards understanding learning to cope with uncertainty, the definition continued to evolve over the course of this research.

Drawing on the characterisation of the uncertainty work of the case study community of practice developed in Chapters 7 & 8 and the initial literature review of the area in Chapter 2, I propose a working definition of uncertainty work as ‘navigating ambiguity, complexity and risk in professional practice’. Navigation is defined as ‘the process or activity of accurately ascertaining one's position and planning and following a route.’ (Pearsall 2004). Uncertainty work can be described in terms of ‘navigating uncertainty’ because it entails recognising uncertainty (ascertaining ones position), identifying appropriate tactics to use (the destination) and continual re-evaluation and adjustment of responses as uncertainty changes over time and with the perspectives of individuals (following a route). The examples of uncertainty work described in Chapters 7 & 8 such as managing conflicting opinions and deciding to go ‘off protocol’ exemplify this.

Building on this definition, I propose several key features of uncertainty work:

- **It is socially mediated, defined and determined:** A recognition of the social processes, which underpin coping with uncertainty, suggests that uncertainty work should be considered as a feature of the work of a community of practice as much as an individual cognitive process. Although uncertainty work is enacted through individual practice, it is more meaningful to think about the uncertainty work of a group such as veterinary students, equine veterinarians or specialists in internal medicine than to focus on specific clinical decisions made by individual trainees. Within this feature is the idea that communities differ in the nature of their uncertainty work and that the uncertainty work of one group may be very different from the uncertainty work of another group even within the same profession.



- **It is a fundamental element of professional practice:** Given that uncertainty arises from ubiquitous features of 'real-life' open systems such as complexity, ambiguity or risk, uncertainty work can be seen as an inevitable feature of professional practice. In this sense, it encompasses both recognising and responding to situations which are complex ambiguous or indeterminate.

9.1.3.2 It is frequently tacit 'knowledge in practice': As a concept, uncertainty work shares some of these features with the description of 'mindlines' ('collectively reinforced, internalised, tacit guidelines') proposed by Gabbay and Le May (Gabbay & le May 2004) and adopted by other authors (Wieringa & Greenhalgh 2015). One key finding of the analysis of uncertainty work in this study is that it was difficult to properly define and to delineate, partly because participants did not frequently discuss their uncertainty or responses to complexity, ambiguity or risk explicitly.. Much uncertainty work seems to occur in the realm of tacit knowledge (Eraut 2000), similar to the indeterminate zones of practice (Schön 1983). It is unclear how explicit and tacit knowledge are combined in navigating uncertainty, although the concept of engaging with 'collectively reinforced tacit' mindlines is potentially of value in conceptualising access to uncertainty work. Describing uncertainty work

Uncertainty work related to conflict or contradiction was a recurring theme at all levels of the analysis; situated learning theory describes conflicting opinions as 'constituting the content of learning' (Lave & Wenger 1991). The link between conflict and learning is also evident in theories of transformative learning (Mezirow 1997) which are built around the idea that learners encounter a 'disorientating dilemma' or the concept of a second or third order contradiction in Engeström's development of Vygotsky's theory (Engeström 1995; Engeström 2001).

Uncertainty work also seems to differ between communities and between activity systems within communities. The uncertainty work of the clinic, for example, is frequently related to managing the cultural challenges and the limitations of working in a resource-limited environment whereas the uncertainty work described in the vet school community is often related to tensions between teaching and clinical roles for staff and between the knowledge and exchange values of learning for students. Classifying or quantifying these differences is beyond the scope of this case study, but there is some evidence elsewhere in the literature to support the idea that different communities of practice encounter different types of uncertainty work. One example is the proposal that tolerance of ambiguity may differ in different medical professional roles (Furnham & Ribchester 1995; Kearl et al. 1992; Geller et al. 1990). A high degree of ambiguity tolerance is considered important for those working in primary care roles (Weissenstein et al. 2014), in psychiatry (Shaw et al. 2010) and with underserved communities (Wayne et al. 2011).

A key priority for future research will be the description of the uncertainty work of different groups within the veterinary profession. By characterising how these groups navigate complexity, ambiguity and risk we can broaden our understanding of uncertainty work and identify key areas for students to access in order to develop their own approaches.

9.1.3.3 Professional discourse and uncertainty

When considering the signature pedagogy of clinical rounds discussion in medical education both the practical case-management elements and the socio-cultural elements have been highlighted (Fox 1980; Lingard et al. 2003). Rounds discussions are important for students learning to use the language of the community and learning how to talk about (and how not to talk about) their uncertainty (Lingard et al. 2003). This was certainly evident in this case study, for example where the hierarchy of the clinic becomes clear and learners develop an understanding of their place and role in the community. There are also different areas identified such as the role of rounds in collaborative decision making, emotional support for learners and a safe space for discussions relating to conflict of a sensitive nature.

9.1.3.4 The importance of uncertainty work for developing professionals

One important difference between learning in the context of this case study, when compared with that described in other examples of situated learning, relates to the hallmarks of increasing centrality in the community. Lave describes increased time-commitment and involvement in increasingly challenging and riskier tasks as features of increasing centrality in the communities which she studied (Lave & Wenger 1991). Although a similar pattern is seen in this community; it is interesting that there is less emphasis on the physical elements of practice (the manual skills, the time commitment) and more on the cognitive elements of practice.

Engagement in uncertainty work seems to be integral to increasing centrality in the community of practice. Yet it is possible that the focus of this case study on uncertainty work has led to an over-emphasis of the significance of uncertainty work in the learners' trajectory, when compared with other elements of practice. Although we can conclude that in this context participation in uncertainty work is important for developing a more central role on the community of practice, we cannot conclude that other elements of practice are unimportant for developing this role.

This argument is also significant from the broader perspective of professional learning. The veterinary profession, like many of the other health professions, must redefine the unique knowledge and skills which it offers in the modern world. Reframing professional expertise moves the focus from obtaining a unique mastery of propositional knowledge towards a renewed focus on the nature of professional expertise: the tacit knowledge

which makes a true expert or the unique skill of the experienced professional. Expertise in navigating complexity, ambiguity and risk has always been a key element of professional judgement yet it is not commonly articulated in descriptions of expertise, which are more focused on recognising a mastery of the relevant clinical evidence base. As a profession, we need to give greater recognition to the importance of developing judgement and highlight the value of professional judgement to society.

9.1.4 Professional capabilities and uncertainty work as tacit learning

One area where our findings differed from that expected by the middle range theory is that student participants rarely described or stated an explicit understanding of a learning curriculum: what there is to learn about coping with uncertainty. This is in contrast with members of staff who were frequently able to verbalise what they felt veterinary surgeons needed to understand about coping with uncertainty. The fact that students are unable to articulate what there is to be learned about coping with uncertainty may reflect a reluctance to discuss this during the research process or, alternatively, a lack of conscious awareness of what is being learned. The second of these options would support the idea that uncertainty work is largely tacit and learning to cope with uncertainty is a component of tacit learning. The recognition of tacit elements of learning in developing healthcare professionals has been a key feature of the developing the capabilities approach to outcomes based education in the health professions. Uncertainty work fits well as a professional capability (S. W Fraser & Greenhalgh 2001) because there is no fixed outcome and learning is through legitimate peripheral participation in practice. Recent moves to develop a capability framework with the aim of promoting veterinary employability (Cake et al. 2016) demonstrates the relevance of the concept for Veterinary education.

9.1.5 The role of schooling

In its original form, the role of schooling within communities of practice, was seen as a form of sequestration of learners (Lave & Wenger 1991). In the apprenticeship-type learning described in Lave & Wenger's original text, schooling is described as detrimental to real learning, as a way of teaching learners what others thought they should know rather than exposing them to the self-developed learning curriculum entailed in participation in practice.

The findings here suggest that the Vet school community of practice overlaps with the Vet profession community of practice. The role of the Vet School is to prepare students for a gradually increasing access to practice. Through this practice they encounter uncertainty work and differences in uncertainty work between different activities systems. The role of the Vet school is one of supporting sense-making, providing scope for students to transfer

learning and providing practical and emotional support during this transition into becoming an autonomous professional. This highlights a key role for the Veterinary Schools in preparing students for practice, providing emotional support and as a mechanism for providing access to practice.

9.1.6 Strengths and limitations

The study context is novel and the insights developed through the abductive and reproductive stages of the analysis are illuminating. In particular, proposing the novel concept of ‘uncertainty work’ and providing a working definition based on the descriptive analysis in this study, is an important idea which is of relevance to those across the professions and working in professional education. Investigation of the ‘uncertainty work’ of veterinarians could readily be extended to consider the ‘uncertainty work’ of dentists, medics, nurses, teachers and so on. Similarly, the insights developed into how professional training can provide access to uncertainty work, are potentially transferable to many other contexts and professions.

Although only a small number of students and staff participated in the study, this is not necessarily a limitation in the context of qualitative research in a critical realist paradigm which prioritises explanatory power and ‘thick’ description over questions of generalisability. It does mean, however, that caution needs to be taken when generalising the outcomes of this study to different contexts as the mechanisms identified here may not be active in other contexts. Further insights could have been developed had the voices of service users and local veterinary staff been included in the study.

This case study demonstrates a robust approach to qualitative research, considering trustworthiness through maintaining an audit trail and transparency in the research process. The use of verbatim quotes from interviews and recordings are presented in the results section and relevant appendices to enable the reader to evaluate analytic interpretations.

The use of a stakeholder focus group provides valuable support for the validity of the interpretations and provided an opportunity to refine these. Member checking is not necessarily a gold standard, given that it represents another range of viewpoints which are not necessarily more valid than the original researcher. I found the process valuable, however, as a research tool and there would have been significant benefit in involving veterinary students in this stakeholder group, which was sadly not possible within the timescale of this research.

The timescale of the study also precluded multiple rounds of data collection or the synchronous collection and analysis of data. This meant that questions relating to the



middle range theory could not be added to interview schedules as the theoretical perspective developed. In the case of statements 9 & 10 this limited the ability of the case study to address these questions with the data available.

10 General discussion and Implications for Veterinary education

In this final discussion section I focus on how the findings of the two parts of the thesis help to address the primary research questions (see section 3.1):

- (1) To what extent do veterinary students tolerate ambiguity, and*
- (2) How do they learn to cope with uncertainty in veterinary professional practice?*

10.1 Key findings

A lack of development of ambiguity tolerance over the classroom based part of veterinary training is a key finding of this research. Although the veterinary students participating in this study vary in their tolerance of ambiguity and individual trajectories can be erratic, there is a clear correlation between ambiguity tolerance in years 1 and 3 for students followed in the longitudinal part of this study. This suggests that the extent to which veterinary students tolerate ambiguity (research question 1) depends more on their experiences prior to entering the programme than on their veterinary training. This is particularly important because the ability to cope with uncertainty is a day one competency for new veterinary graduates. Identifying a key day one competency which is not developed during the classroom based part of veterinary training is a real concern and this research highlights the need for veterinary educators to address this as a priority.

The omission of an 'end of final year' survey point is a significant limitation of this research. It is possible that the final year is particularly formative in relation to learning to cope with uncertainty and the collection of data from students at the end of the veterinary programme is a high priority for further study. This research project is ongoing and although the timescale of this research has precluded inclusion within the thesis itself, it will form an important component of any publication in this area.

It is clear from the case study that taking on case responsibility and participating in the uncertainty work of the community is key to learning to cope with uncertainty in veterinary professional practice. It is notable that access to uncertainty work is largely limited to the final year of the veterinary programme and that even within this final year, students may still be denied access to uncertainty work. This has significant implications for our new graduates who may not be adequately prepared to cope with the uncertainties inherent in professional practice.

10.2 Combining intensive and extensive perspectives

The relationship between individual attitudes to ambiguity captured by measures of ambiguity tolerance and the experiences of students learning to cope with uncertainty is a key focus of this thesis.

Although the two studies are designed to offer complementary perspectives, an open-minded approach has been taken to thinking about areas of overlap which are relevant to understanding how veterinary students learn to cope with uncertainty. I use the situated learning concept of 'access' to practice as a way to frame the findings of the two studies

and to discuss how individual differences may be important in learning to cope with uncertainty.

The first point to make about learning to cope with uncertainty is to recognise that the issue of access to legitimate peripheral participation in practice is critically important, as Lave states: “it is all about access” (Lave & Wenger 1991).

If access to uncertainty work is a necessary condition for learning to cope with uncertainty in professional practice then the relationship between ambiguity tolerance and access to uncertainty work is of particular interest. The lack of development of ambiguity tolerance during the first four years of veterinary training suggest that access is particularly limited during this part of the programme. There are a number of possible reasons for this.

Geller’s theory (Geller et al. 1990) that ambiguity tolerance is important for determining how students engage with educational opportunities is relevant here. Developing Geller’s theory in the context of access to practice, one might argue that individuals with relatively low scores on measures of ambiguity tolerance will avoid ambiguous educational situations and therefore fail to gain access to practice situations where they might encounter uncertainty work.

In Veterinary education, there are few opportunities for flexibility and choice, as many educational activities are considered core training. Opportunities for students to exercise choice are generally limited to extra mural studies and final year elective placements. A chance to study abroad is a significant opportunity to exercise educational self-determination and in other areas of education it has been noted that students with a high degree of openness and a high tolerance of ambiguity were more likely to participate in a study abroad programme compared with students who were in the lowest category for these measures (Bakalis & Joiner 2004). The fact that ambiguity tolerance is not strongly associated with elective choices in this study context suggests either AT is not important here, or that other mechanisms are also important and may have a greater or opposing influence. This is not surprising given that financial considerations, career aspirations and personal circumstances are all likely to influence study choices and that the commitment involved in a 4 week elective placement is less than a decision to spend many months living and studying abroad.

It may be more relevant to consider access to uncertainty work at the level of individual staff-student interactions. The intensive study identified the importance of developing trust and taking responsibility in enabling access to uncertainty work. Two strategies were postulated: that of case ownership and that of case stewardship. Considering Geller’s theory at the level of individual interactions, ambiguity tolerance may be important in



shaping whether students opt for ownership or stewardship or indeed in influencing the entrustment decisions of staff.

It is individual community members who are involved in granting, denying or seeking access to uncertainty work – hence the individual differences in tolerance of ambiguity between those individuals may also impact on access. Not all supervisors will be comfortable with providing access to uncertainty work, not all students will seek access to uncertainty work in the same way. By understanding how patterns of access relate to patterns of individual differences we may be able to improve access to uncertainty work, and improve the opportunities for students to learn to cope with uncertainty. One way to do this could be to create an institutional cultural environment, which fosters constructive responses to uncertainty. This could include the concept of a ‘learning culture’ rather than a ‘blame culture’ which forms one of the recommendations of the Vet Futures action plan developed by the Veterinary profession in the UK REF.

Treating ambiguity tolerance as an outcome measure, for example a way of determining whether an educational intervention has ‘produced’ a change in the ability to cope with uncertainty, may be helpful, however a productive avenue for further research would be to adopt a comparative case study approach, with a focus on differences in educational experiences of individuals classified as ‘low’ or ‘high’ for ambiguity tolerance. Alternatively, an experimental approach could develop theories around ambiguity tolerance and ownership vs stewardship decisions.

The possibility of using ambiguity tolerance measures in selection to veterinary training is an interesting one which has provoked debate in the medical profession too. (Hancock & Mattick 2012) The literature from other health professions suggests that ultimately the evidence for ambiguity tolerance being an important personality variable with respect to clinical behaviour and clinical outcomes is weak. We don’t have enough information about what constitutes optimal AT. Particularly given that AT interacts with many other mechanisms in complex real world situations.

Until more convincing evidence is produced,,I would suggest that it is inappropriate to consider use of ambiguity tolerance measures in selection and that providing students with feedback on their ambiguity tolerance scores may be of limited value on the basis of current research evidence.

10.3 Strengths and limitations

The interaction between the intensive and extensive elements of the research highlights the strengths and limitations of the two approaches. The case study is able to provide explanations and suggest causative mechanisms in the context of the international



elective rotation. The extensive study can describe relevant features of the population but is limited in its explanatory power. The two taken together create questions and suggest theoretical developments which can guide future research.

Framing coping with uncertainty as ‘uncertainty work’ is a novel approach and provides scope to change the way in which we think about uncertainty in professional practice, positioning it as an inevitable and routine aspect of professional work, rather than a negative aspect to be avoided. The choice to focus on learning rather than characterising uncertainty work in different contexts means that the concept is only partially developed in this thesis. I have proposed a working definition of uncertainty work and outlined several of its key features, however, further theoretical refinement would be of value, particularly once the concept has been more widely explored in different areas of practice.

The main limitation of the approach taken in this thesis is that the links between the two approaches are not more explicit. A linking study of the type described above was an initial ambition of the research design but as the other elements developed, I elected to discontinue planning for a third element due to limitations of time and word count. This provides a clear direction for future research.

10.4 Implications for practice

Answering the question ‘What is it about veterinary education which enables or constrains students’ learning to cope with uncertainty?’ leads to the consideration of a number of implications for practice. Here I outline these considerations before going on to propose a modern veterinary curriculum for the 21st century designed to provide an effective training for uncertainty for the next generation of veterinarians.

10.4.1 Current challenges for the veterinary profession

The RCVS Vet Futures report and action list published in 2016 (RCVS/BVA 2016) highlighted key issues facing the veterinary profession over the coming years. The high incidence of mental ill health in the profession and growing issues of retention of veterinarians, particularly in primary care roles, are two areas of particular concern (ibid). The findings of this research are closely related to a key discourse developing around these issues, which relates to the expectations of new graduates and a perceived mismatch between the realities of primary care practice roles and the more specialist clinical training environments in which they learn (Ravetz 2017; May 2015; Armitage-Chan 2017; Moffet et al. 2015). According to this discourse, recent graduates are discouraged when they face the realities of clinical practice and find themselves unable to apply strategies developed during training, often due to resource limitations. High client expectations, long working hours and lack of support may compound this, with consequent impacts on mental health, wellbeing and retention of early-career vets in primary care roles. This discourse mirrors that in the medical profession in relation to recruitment and retention in GP training. The uncertainty of clinical practice and inexperience in coping with this is one factor that is considered important. There is a growing critical focus on the adequacy of programmes of education, which leave new

graduates unable to cope with the realities of primary care practice. My findings are important in several ways. Firstly, the recognition that there was no change in tolerance of ambiguity over the first four years of veterinary training supports the suggestion that the current approaches to education are not adequately preparing students for this element of their professional role. The findings of the case study may cast some light on why this may be the case; if students are not encountering ambiguity, complexity and risk as part of their training then they will not learn the skills and approaches to enable effective navigation of uncertainty in professional practice. Put simply, inadequate access to uncertainty work during training leaves new graduates ill-prepared for the uncertainty work of the professional workplace.

10.4.2 The issue of access

At one level, access to practice is a political process and will necessarily have associated risks and benefits for different institutions. Although students frequently contribute to the practices where they participate, these relationships themselves can create uncertainty work and can be difficult and challenging to maintain. However, rather than seeing the uncertainty work which occurs at the intersections between organisations as only problematic, educators could also acknowledge the value of this for learning. It may be that encountering these conflicts and contradictions is necessary for learners to learn to cope with uncertainty.

Different placement types may provide different levels of access to uncertainty work. In the context of this study, examples described by staff and students where they were able to take on responsibility for cases were often also those where they were most able to participate in uncertainty work. Primary care placements and placements based in charity clinics are both identified as good examples, whereas access to productive practice in referral hospitals for example, is often described by participants in this study, as more limited. Innovative approaches to medical education are built on early and sustained access to clinical practice through longitudinal integrated clerkships. In these clerkships, students report feeling better prepared for “dealing with problems that do not have clear answers” (Norris et al. 2009, p.904). Although these innovative models for education may be promising in providing productive access to uncertainty work, the fact that they are still small in number and scope may reflect political, administrative and resource related barriers to wider adoption. This is also important in understanding the importance of trust for enabling access to uncertainty work. It is difficult to build trust over a short period of time. Longer clinical placements, high caseloads and stable supervisory roles are some ways in which learners could build the trusting relationships which would enable them to access to the uncertainty work of professional practice.

10.4.3 Transfer and preparation

How might a Veterinary curriculum support learning to cope with uncertainty? An important part of this relates to the question of transfer. Transfer of learning from one

context to another is a key challenge for educators across many disciplines (Eraut 2016); although students may demonstrate a skill in one context, they may struggle to apply this in a different context. A similar question then arises in relation to uncertainty work; if students learn to cope with uncertainty in one context, does this improve their ability to cope with uncertainty in a different context? Or, using the language of situated learning: does legitimate participation in uncertainty work in one context necessarily grant access to legitimate participation in another context. This is important in understanding the extent to which uncertainty work encountered in a Vet school context can transfer to other practice environments, or indeed whether these navigational skills can be transferred between similar practice environments.

Another important question here is whether Veterinary educators can better prepare students for entering practice communities. This touches on what the role of the early veterinary curriculum should be. Currently the early years of veterinary curricula are focussed on developing the knowledge and understanding of body systems, animal production systems and disease processes. There is an increasing emphasis on contextualising this learning using clinical cases or problem based approaches to learning and there is also a greater focus on providing longitudinal training in clinical and professional skills from year 1. The extent to which a curriculum like this provides access to uncertainty work is debatable. Certainly, approaches like Problem Based Learning (Howell et al. 2002) are built around the premise of producing questions, uncertainty and doubt to motivate learning. Exposure to professional dilemmas through ethics education for example, may also promote the role of uncertainty and contradiction in early professional education and pave the way for more productive access to the uncertainty work of professional practice.

Yet it is early clinical and professional skills development which may be of particular importance in building confidence in the practical elements of professional practice which could prepare students to participate in the practical elements of professional practice. This is important because participants in this study recognised that students' practical skills were one important factor, which was taken into account when making entrustment decisions.

There are also some pressures which may have an opposite effect, making students less prepared for the uncertainty work of professional practice. The first is the fine balance between supporting student learning and providing a space where uncertainty and doubt can be encountered. There is a risk that increasing commoditisation of higher education, with students developing an increasingly consumer-like role, there is pressure to limit this space for uncertainty, particularly as uncertainty can feel uncomfortable and may lead to

adverse student evaluations of the learning process. Providing a language to recognise the value of uncertainty might be one way in which educators could draw attention to the importance of this space. Assessment practices, as mentioned in the current case study, may also send a very different message to students. The proliferation of structured assessments (such as multiple choice questions and extended matching questions) which are valued for their reliability and relative ease of administration, mean that students are typically assessed in a way in which there is only one right answer, there is no space for contradiction, difference of opinion or variation in interpretation.

10.4.4 Supporting students

There is clear scope to support students better, both in participation in practice and in learning from participation. This should include support for developing an understanding of clinical reasoning and facilitating reflection on conflicts encountered in the workplace. In other professional disciplines, where practice is frequently related to uncertainty work, approaches such as Balint groups (Lichtenstein & Lustig 2006; Torppa et al. 2008) or action learning sets (Gillett et al. 2017; Dunphy et al. 2010) are adopted to provide a collaborative approach to uncertainty work.

The strength of such initiatives suggests that participation alone may not be enough to learn to cope with uncertainty and that learners may need to reflect on learning in order to make sense of it. Because the navigational skills underpinning uncertainty work may be largely tacit, and students rarely articulate their learning in relation to uncertainty work, this may be particularly challenging. The case study component of this research demonstrated the key importance of uncertainty talk and the discourse of the community as a form of verbal reflection on practice. The concept of reflective practice is proposed as a core element of professional learning (Adams et al. 2006; Epstein 2008) and it may be the case that the most productive role for formal veterinary education is to facilitate, promote and support reflection on learning. Indeed uncertainty work, whether relating to conflict, incomplete information or incomplete understanding represents an obvious stimulus for the reflection (Nevalainen et al. 2010). There is a risk that these activities: reflection, mentoring and peer-discussion are squeezed out of already overloaded professional curricular (Hodgson et al. 2013). Yet, if we are to support learning to cope with uncertainty, I would argue that these are the key activities which must be accommodated. Training staff in facilitation, mentoring and supporting reflection are at least as valuable as developing structured learning activities to deliver a 'curriculum for uncertainty'.



10.5 A training for uncertainty: proposal for a modern veterinary curriculum for the 21st Century

Traditional curriculum design in veterinary education has focused on providing the knowledge and skills required to practice as a veterinarian. Although outcomes based approaches direct us to consider development of attitudes as well as knowledge and skills, we are still, as a profession, highly focused on a cognitive model of learning. This model, seeing learning as a cognitive process, builds educational approaches primarily around delivery of the relevant knowledge and skills. Yet, it is becoming clear that having the relevant knowledge and skills is not, in itself, enough to be effective in veterinary roles. The attitudes and capabilities required to succeed in veterinary practice requires more than this. Coping with uncertainty is just one example of a capability, which does not fit the mould of a cognitive approach to learning (S. W Fraser & Greenhalgh 2001).

Modern veterinary education needs to adopt a new perspective on learning and, based on the findings of this research, I would suggest that social learning theories, such as situated learning theory, should underpin modern curriculum design. A social learning curriculum would be designed around social participation; Wenger outlines 4 interconnected components which are fundamental to this approach: meaning (learning as experience), practice (learning as doing), community (learning as belonging) and identity (learning as becoming)(Wenger 1998).

The veterinary curriculum should be built around learning from experience and participation in practice. Through becoming part of communities of veterinary practice, learners can develop a sense of belonging, and it is through these experiences of practice that a sense of professional identity as a veterinarian is developed (Armitage-Chan et al. 2016). Noble and colleagues (Noble et al. 2011), discussing a similar challenge in pharmacy education, propose a series of questions which should be considered as part of designing a curriculum for uncertainty around social learning principles. Rather than focus on whether we have covered everything which students need to know, they propose considering the experiences and opportunities to practice that the curriculum should provide. (Noble et al. 2011, p.1). Table 10-1 outlines the features of a veterinary curriculum designed on this basis and focusing on training for uncertainty. I have used examples developed from the international elective case study to illustrate the concepts.

Table 10-1: Features of a veterinary curriculum designed around social learning principles with a focus on training for uncertainty

Question about the curriculum	Proposed features of a curriculum for uncertainty (examples from the case study component of the research)	Associated educational approaches (examples)
What experiences do students have?	<ul style="list-style-type: none"> • Taking action with incomplete information • Navigating ambiguous and complex situations • Encountering conflicting opinions and perspectives • Communicating uncertainty • Participation in clinical case discussions • Working in teams 	Group work Clinical experience Workplace learning Problem solving Data interpretation and analysis Communication (e.g. role play/simulated encounters) High fidelity simulation Peer tutoring Debates

	<ul style="list-style-type: none"> • Working under time pressures and resource limitations • Taking responsibility • Adjusting plans and changing course • Working with treatment protocols • Working in unfamiliar cultural environments • Self-reliance • Asking for help and support 	Exchange programmes
What meaning do they derive from these experiences?	<ul style="list-style-type: none"> • Nature of professional judgement • Challenges of applying veterinary knowledge to concrete situations • Self-awareness • Ethical awareness • Veterinary professional values • Evaluation of evidence 	Reflective practice e.g. written reflection (portfolio), group discussion/reflection (e.g. Balint group, action learning sets). Mentor discussions/clinical coaching
When are students given an opportunity to practice? To do the things professionals do?	<ul style="list-style-type: none"> • Involvement in practice throughout training • Active role in practice activities • Supervision and feedback • Effective preparation to facilitate production access to practice • Progress in practice roles over the course of training 	Early and sustained clinical experience Long placements and small group sizes Preparation (e.g. clinical skills training) Experience of non-clinical professional practice (e.g. research, teaching, commercial)
In which communities of practice are students actively engaged?	<ul style="list-style-type: none"> • Communities aligned with future practice roles • Diverse communities representing the scope of the veterinary profession • Communities which reflect and display key professional values • Communities which value learning and support learners 	Clinical placements include primary care practices Varied clinical and non-clinical placement opportunities Quality assurance of placements based on alignment with professional values and opportunities for participation in practice
Who are students becoming as a result of their curricular experiences?	<ul style="list-style-type: none"> • Capable veterinary professionals • Fulfilled in their chosen professional roles • Adaptable • Responsible 	Role models Offer flexibility and choice Give responsibility Extracurricular activities Mentoring

10.6 Conclusions

This thesis has used the conceptual lens of situated learning theory to draw together findings from both intensive and extensive perspectives suggesting that access to uncertainty work is an important element of professional learning. In the context of an

international elective placement, access to uncertainty work is dependent on building trust and this is reflected in increasing clinical responsibility. Ambiguity tolerance is described in this context as a disposition of individuals which can influence their engagement with, and access to, uncertainty work. Although my findings indicate that differences in ambiguity tolerance based on demographic factors, career aspirations and previous education are small in magnitude, further investigation is required to understand the extent to which individual differences in ambiguity tolerance may be important in learning to cope with uncertainty. The finding that ambiguity tolerance did not change significantly during the classroom based part of the veterinary training suggests that veterinary curricular may be failing in their development of this key professional outcome. There is clear scope for programmes of education to support students in accessing uncertainty work and to highlight encounters with uncertainty work as key opportunities to promote personal and professional development through reflective practice.

Appendix I: BVMS Curriculum change

The BVMS is a 5 year programme and adopts a fairly typical structure. During the study period the school underwent several changes to the BVMS Curriculum including a major change to the structure of the final year (Professional phase) of the Programme in 2013 and the introduction of a new modular systems-based curriculum starting in Year 1 in 2013 and rolling out one year at a time (due to start the new 4th year in September 2016). The pre-2013 programme adopted a lecture and practical based approach with pre-clinical (years 1 & 2), para-clinical (year 3), clinical (year 4 & 5) areas of study. The final year was lecture-free and focused on a series of placements in different areas of clinical practice. Although a vertical theme of Professional and clinical skills was introduced in 2010, the major changes to the curriculum occurred following the curriculum renewal in 2013. The post-2013 curriculum adopted a phase structure with Foundation phase (years 1 & 2) adopting a systems based integrated approach to teaching, Clinical phase (years 3 & 4) a clinical problem-focused primarily lecture based approach and Professional phase (year 5) adopting a Core and elective structure focused on delivering day one competencies. The table below shows the major features of the Pre-2013 and Post 2013 curricular.

	Pre 2013	Post 2013
Structure	<p>Multiple courses per year</p> <p>Subjects taught in “Silos”(2-5 per year)</p> <p>High didactic load (multiple lectures/day)</p>	<p>Systems based integrated modules (6 x 4 week modules per year)</p> <p>Vertical themes (e.g. Clinical and Professional skills)</p> <p>Consolidation week (few lectures) each month</p>
Teaching & Learning approaches	<p>Lectures</p> <p>Laboratory practical sessions</p> <p>Limited clinical and professional skills</p> <p>Self-directed learning assumed but not formalised</p>	<p>Lectures</p> <p>Practical sessions</p> <p>Rotating practical sessions (clinical skills)</p> <p>Timetabled self-directed and group based learning</p>

		Case-based modules
Assessment	<p>Separate assessment for each course</p> <p>OSCE assessment of clinical competency</p> <p>Little/no in-course assessment</p>	<p>Integrated assessment for each year</p> <p>OSCE, DOPS and Portfolio assessment for clinical competency</p> <p>10-50% in course assessment each year</p>
Years 1 & 2	<p>Courses in Anatomy, Physiology, Animal Husbandry, Biochemistry & Veterinary Professional & Clinical skills.</p>	<p>12 systems-based modules e.g. Basic body systems, Respiratory system, Neuro-locomotor systems.</p> <p>Rotating practicals.</p>
Years 3 & 4	<p>Courses in Pharmacology, Parasitology, Microbiology, Pathology, Companion animal studies and Production animals & Public health.</p>	<p>12 clinical-based modules e.g. Supporting the patient, Alimentary, Ruminant production.</p> <p>Rotating practicals.</p> <p>Professional and Clinical experience (PACE) activities</p>
Year 5	<p>28 weeks rotations taught in semester structure.</p> <p>Tracking (Equine or Farm animal)</p> <p>Limited first opinion practice</p> <p>OSCE assessment</p>	<p>32 weeks rotations taught year round</p> <p>6 Core and 2 Elective rotations for each student</p> <p>Increased first opinion practice</p> <p>DOPS, Portfolio & Computer-based assessment</p>



Appendix II: Manuscript describing development of Tolerance of Ambiguity in Veterinary Student (TAVS) scale*.

Published in 2017

Hammond, J.A. et al., 2017. Development of a New Scale to Measure Ambiguity Tolerance in Veterinary Students. *Journal of Veterinary Medical Education*, 44(1), pp.38–49. Available at: <http://jvme.utpjournals.press/doi/10.3138/jvme.0216-040R> [Accessed September 12, 2017].

Appendix III: Hypotheses relating to ambiguity tolerance in veterinary students

- 1) How are individual differences in ambiguity tolerance related to demographic variables?

Older students will have higher tolerance of ambiguity than younger students

Male students will be more tolerant of ambiguity than female students

Students who describe their ethnicity as white will be less tolerant of ambiguity than other groups

International students will be more tolerant of ambiguity than UK students

Students who have completed a previous degree will be more tolerant of ambiguity than those who have not

- 2) Does ambiguity tolerance change over the course of training?

Ambiguity tolerance of veterinary students will not change over the course of veterinary training

Individual students will move no more than one AT group (High, Moderate or Low) during the first three years of veterinary training.

- 3) How does ambiguity tolerance relate to elective and career choices?

Students planning to work in clinical practice will have a higher tolerance of ambiguity than those choosing to work in other professional roles

There will be no difference in ambiguity tolerance between students with different species area preferences

Students choosing to complete an international elective will be more tolerant of ambiguity than those completing a UK-based elective.

Student choosing to complete an elective working with underserved populations will be more tolerant of ambiguity than those choosing not to work with these groups.

Appendix IV: Copy of Survey form and TAVS scale item details

Consent to participate

By completing this survey you are giving tacit consent to participate in the research study on Tolerance of ambiguity and reaction to clinical uncertainty in Veterinary students.

*1. Consent to participate

- ☐ I have read and understood the information given in the Subject Information Sheet (Version 2 010514)
- ☐ I understand that my participation is voluntary and I am free to withdraw at any time without giving any reason, without my legal rights being affected.
- ☐ I agree to take part in this study

Section A - About you

Please answer all the questions by selecting the appropriate box or writing free text comments where required.

2. What is your age?

- ☐ <21
- ☐ 21-25
- ☐ 26-30
- ☐ 31-35
- ☐ >35

3. What is your gender?

- ☐ Female
- ☐ Male

4. What is the highest degree or level of school you have completed?

- ☐ Secondary/High school
- ☐ Trade/technical/vocational training
- ☐ Associate degree
- ☐ Bachelor's degree
- ☐ Master's degree
- ☐ Professional degree
- ☐ Doctorate degree

5. What is your current stage of training?

- ☐ 1st year BVMS
- ☐ 2nd year BVMS
- ☐ 3rd year BVMS
- ☐ 4th year BVMS
- ☐ 5th year BVMS
- ☐ Junior clinical training scholar (intern)
- ☐ Senior clinical training scholar (resident)

6. Please specify your ethnicity

- ☐ White (includes White and Irish Traveller)
- ☐ Black (includes Black or Black British - Caribbean, Black or Black British - African, and other Black background)
- ☐ Asian (includes Asian or Asian British - Indian, Asian or Asian British - Pakistani, Asian or Asian British - Bangladeshi, Chinese, and other Asian background)
- ☐ Other (including mixed) includes mixed - White and Black Caribbean, mixed - White and Black African, mixed - White and Asian, other mixed background, and other ethnic background.
- ☐ Not known (includes not known and information refused)

7. Please specify your nationality

- ☐ British
- ☐ Irish
- ☐ European, other EU
- ☐ European, outside EU
- ☐ North American

Other (please specify)

Section B - About your career plans**8. What is your expected career path following completion of this stage of training?**

- ☐ Clinical practice
- ☐ Internship or further speciality training (in either private practice or vet school)
- ☐ Government-related veterinary work
- ☐ Academic (research/teaching)
- ☐ Industry (e.g. animal health, pet food, insurance)

Other (please specify)

9. If you selected clinical practice, academic or internship; which type of practice do you expect to work in?

☐ Small animals

☐ Farm

☐ Equine

☐ Mixed

☐ Not applicable

Other (please specify)

Section C - About your attitudes

***10. Please respond to the following statements by indicating the extent to which you agree or disagree with them. Select the option on the right that best represents your evaluation of the item.**

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
I am comfortable to acknowledge that I'll never know everything about veterinary medicine.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Even when there is conflicting information, I prefer to make a decision and move on.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I would enjoy tailoring treatments to individual patient problems.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I think it is important to attribute a percentage likelihood to a diagnosis or a specific patient outcome.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
As a vet I would prefer the clear and definite work of someone like a surgeon to the uncertainties of a behaviour specialist.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I have a lot of respect for specialist vets who always come up with a definite answer.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I would be comfortable if a clinical teacher set me a vague assignment or task.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
A good clinical teacher is one who challenges your way of looking at clinical problems.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
What we are used to is always preferable to what is unfamiliar.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I feel uncomfortable when people claim that something is 'absolutely certain' in veterinary medicine.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
A Vet who leads an even, regular work life with few surprises, really has a lot to be grateful for.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I enjoy reducing the complexity of veterinary medical information to something more tangible.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I think in veterinary medicine it is important to know exactly what you are talking about at all times.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
'I don't know' are really important words in veterinary medicine.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I would prefer to work in a veterinary specialty where patients normally get better after treatment.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I enjoy reducing detailed scientific problems to their core concepts.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I feel comfortable that in veterinary medicine there is often no right or wrong answer.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
A patient with multiple diseases would make a vet's job more interesting.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I am uncomfortable that a lack of veterinary knowledge about some diseases means we can't help some patients.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
The unpredictability of a patient's response to medication would bring welcome complexity to a Vet's role.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
It is important to appear knowledgeable to clients at all times.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Being confronted with contradictory evidence in clinical practice makes me feel uncomfortable.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I like the mystery that there are some things in veterinary medicine we'll never know.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Variation between individual patients is a frustrating aspect of veterinary medicine.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I find it frustrating when I can't find the answer to a clinical question.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I am apprehensive when faced with a new clinical situation or problem.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I feel uncomfortable knowing that many of our most important clinical decisions are based upon insufficient information.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
No matter how complicated the situation, a good Vet will be able to arrive at a yes or no answer.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I feel uncomfortable when textbooks or experts are factually incorrect.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
There is really no such thing as a clinical problem that can't be solved.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
It's an exciting feeling when you listen to a client tell you their animal's symptoms and you just know what disease it is.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I like the challenge of being thrown in the deep end with different Veterinary situations.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
It is more interesting to tackle a complicated clinical problem than to solve a simple one.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
In Veterinary medicine as in other professions, it is possible to get more done by tackling small, simple problems rather than large and complicated ones.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I enjoy the process of working with a complex clinical problem and making it more manageable.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
A good job is one where what is to be done and how it is to be done are always clear.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Veterinary medicine has a lot of gray areas because we haven't found the answers yet.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
To me, Veterinary medicine is black and white.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
The beauty of Veterinary medicine is that it's always evolving and changing.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I enjoy working out which opinion is right in situations where many different opinions are expressed.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I would be comfortable to acknowledge the limits of my Veterinary medical knowledge to clients.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Section D - ID Number

In order to match your responses to this survey from year to year, please enter your student ID number (matriculation number). The information held on this page of the survey will be removed from the stored data once you have been allocated a project code so that your responses cannot be directly linked to you.

11. What is your student ID (matriculation) number?

End of survey

Thank you for completing this survey

If you have any questions or comments on the survey or research project please email jennifer.hammond@glasgow.ac.uk

Appendix V: The 41 scale items used in the study and subsequent use in TAMSAD/TAVS scales.

Values for Cronbach's α if item deleted and item total correlation are shown for each scale item. (RC) items were reverse coded prior to analysis

Scale item	Item text	Corrected Item-Total Correlation)			Cronbach's Alpha if Item Deleted	Included in 29 item TAMSAD scale	Included in 27 item TAVS scale
Q1	I am comfortable to acknowledge that I'll never know everything about veterinary medicine.	.169			.472	No	Yes
Q2	Even when there is conflicting information, I prefer to make a decision and move on. (RC)	-.107			.504	No	No
Q3	I would enjoy tailoring treatments to individual patient problems.	.214			.470	Yes	Yes
Q4	I think it is important to attribute percentage likelihood to a diagnosis or a specific patient outcome.	.073			.484	No	Yes
Q5	As a vet I would prefer the clear and definite work of someone like a surgeon to the uncertainties of a behaviour specialist.(RC)	.082			.484	No	No
Q6	I have a lot of respect for specialist vets who always come up with a definite answer.(RC)	-.040			.497	Yes	No
Q7	I would be comfortable if a clinical teacher set me a vague assignment or task.	.019			.492	Yes	No
Q8	A good clinical teacher is one who challenges your way of looking at clinical problems.	.258			.467	Yes	Yes
Q9	What we are used to is always preferable to what is unfamiliar.(RC)	.190			.469	Yes	Yes
Q10	I feel uncomfortable when people claim that something is 'absolutely certain' in veterinary medicine.	-.024			.497	Yes	No
Q11	A vet who leads an even, regular work life with few surprises, really has a lot to be grateful for.(RC)	-.007			.495	Yes	No
Q12	I enjoy reducing the complexity of veterinary medical information to something more tangible.	-.054			.497	No	No
Q13	I think in veterinary medicine it is important to know exactly what you are talking about at all times.(RC)	.206			.467	Yes	Yes
Q14	'I don't know' are really important words in veterinary medicine.	.193			.468	No	Yes
Q15	I would prefer to work in a veterinary specialty where patients normally get better after treatment.(RC)	-.036			.500	No	No
Q16	I enjoy reducing detailed scientific problems to their core concepts.	.078			.484	No	Yes
Q17	I feel comfortable that in veterinary medicine there is often no right or wrong answer.	.197			.468	Yes	Yes
Q18	A patient with multiple diseases would make a vet's job more interesting.	.127			.478	Yes	Yes
Q19	I am uncomfortable that a lack of veterinary knowledge about some diseases means we can't help some patients.(RC)	.233			.464	Yes	Yes
Q20	The unpredictability of a patient's response to medication would bring welcome complexity to a Vet's role.	.099			.481	Yes	Yes
Q21	It is important to appear knowledgeable to clients at all times.(RC)	-.122			.515	Yes	No
Q22	Being confronted with contradictory evidence in clinical practice makes me feel uncomfortable.(RC)	.324			.453	Yes	Yes
Q23	I like the mystery that there are some things in veterinary medicine we'll never know.	.253			.460	Yes	Yes
Q24	Variation between individual patients is a frustrating aspect of veterinary medicine.(RC)	.263			.458	Yes	yes
Q25	I find it frustrating when I can't find the answer to a clinical question.(RC)	.227			.466	Yes	Yes
Q26	I am apprehensive when faced with a new clinical situation or problem.(RC)	-.009			.496	Yes	No
Q27	I feel uncomfortable knowing that many of our most important clinical decisions are based upon insufficient information.(RC)	.206			.469	Yes	Yes

Q28	No matter how complicated the situation, a good Vet will be able to arrive at a yes or no answer.(RC)	.285			.456	Yes	Yes
Q29	I feel uncomfortable when textbooks or experts are factually incorrect.(RC)	.190			.469	Yes	Yes
Q30	There is really no such thing as a clinical problem that can't be solved.(RC)	-.027			.500	Yes	No
Q31	It's an exciting feeling when you listen to a client tell you their animals symptoms and you just know what disease it is.(RC)	.001			.492	No	No
Q32	I like the challenge of being thrown in the deep end with different veterinary situations.	.252			.461	Yes	Yes
Q33	It is more interesting to tackle a complicated clinical problem than to solve a simple one.	.100			.481	Yes	Yes
Q34	In Veterinary medicine as in other professions, it is possible to get more done by tackling small, simple problems rather than large and complicated ones.(RC)	.058			.486	No	Yes
Q35	I enjoy the process of working with a complex clinical problem and making it more manageable.	.081			.483	Yes	Yes
Q36	A good job is one where what is to be done and how it is to be done are always clear.(RC)	.267			.459	Yes	Yes
Q37	Veterinary medicine has a lot of grey areas because we haven't found the answers yet. (RC)	-.107			.503	No	No
Q38	To me, veterinary medicine is black and white.(RC)	.168			.474	Yes	Yes
Q39	The beauty of veterinary medicine is that it's always evolving and changing.	.193			.471	Yes	Yes
Q40	I enjoy working out which opinion is right in situations where many different opinions are expressed.(RC)	-.193			.514	No	No
Q41	I would be comfortable to acknowledge the limits of my veterinary medical knowledge to clients.	.109			.480	Yes	Yes

Appendix VI: Ethics approval letters, consent forms and participant information sheets for both studies



1st April 2014

Dear [REDACTED]

MVLS College Ethics Committee

Project Title: Clinical teaching exchanges in Veterinary education: what do students learn about clinical uncertainty?

Project No: 200130065

The College Ethics Committee has reviewed your application and has agreed that there is no objection on ethical grounds to the proposed study. It is happy therefore to approve the project, subject to the following conditions:

- Project end date: **30th September 2017**
- The research should be carried out only on the sites, and/or with the groups defined in the application.
- Any proposed changes in the protocol should be submitted for reassessment, except when it is necessary to change the protocol to eliminate hazard to the subjects or where the change involves only the administrative aspects of the project. The Ethics Committee should be informed of any such changes.
- If the study does not start within three years of the date of this letter, the project should be resubmitted.
- You should submit a short end of study report to the Ethics Committee within 3 months of completion.

Yours sincerely

Dr Dorothy McKeegan
College Ethics Officer

Dr Dorothy McKeegan

Senior Lecturer

R303 Level 3

Institute of Biodiversity Animal Health and Comparative Medicine
Jarrett Building

Glasgow G61 1QH Tel: 0141 330 5712

E-mail: Dorothy.McKeegan@glasgow.ac.uk



Centre Number: N/A

Project Number: N/A

Subject Identification Number for this trial:

CONSENT FORM

Title of Project: *Clinical teaching exchanges in Veterinary education: what do students learn about clinical uncertainty?*

Name of Researcher(s): [REDACTED]

Please initial box

I confirm that I have read and understand the information sheet dated _____
(version _____) for the above study and have had the opportunity to ask questions.

I understand that my participation is voluntary and that I am free to withdraw at
any time, without giving any reason, without my legal rights being affected.

I agree to take part in the above study.

Name of subject

Date

Signature

Name of Person taking consent

Date

Signature

Researcher

Date

Signature

(1 copy for subject; 1 copy for researcher)

[REDACTED]

PARTICIPANT INFORMATION SHEET

Study title: *Clinical teaching exchanges in Veterinary education: what do students learn about clinical uncertainty?*

You are being invited to take part in a research study. Before you decide it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish. Ask us if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part.

What is the purpose of the study?

As in many areas of Professional work, veterinary practitioners encounter and have to cope with uncertainty as part of their professional practice. In other disciplines including human medicine, there is evidence that uncertainty in diagnosis and case management is frequently encountered and that this can cause stress in patients and physicians.

The Royal College of Veterinary Surgeons stipulate in their Day-1 competencies that new Veterinary graduates should be able to cope with uncertainty (“Day and Year One Competences - RCVS,” n.d.). Indeed, both final year veterinary undergraduates and recent veterinary graduates have identified the ability to cope with uncertainty as an important attribute to help ease the transition from student to practitioner.



In the context of medical education, learning to cope with uncertainty has been described as a significant component of professional socialisation (one of the ways in which students learn to be part of the profession). This study aims to explore what is learned and taught about clinical uncertainty in the context of clinical teaching exchanges in Veterinary education.

Why have I been chosen?

You have been chosen because you are a final year student or supervising staff member participating in clinical teaching in one of the environments identified for study. All individuals who are on rotation (or supervising) during the period of study will be offered the opportunity to participate in this study.

Do I have to take part?

It is up to you to decide whether or not to take part. If you do decide to take part, you will be given this information sheet to keep and be asked to sign a consent form. If you decide to take part, you are still free to withdraw at any time and without giving a reason.

Please note that a decision not to participate will not affect your grades or academic standing in any way.

What will happen to me if I take part?

During the 4 week rotation block individual student and staff participants may be recorded during specified clinical teaching exchanges (generally clinical rounds case presentations). Where this happens the researcher and the recording process will be as unobtrusive as possible. A sign on the door will notify all other staff and students who are present but not participating in the study that recording may take place, but that all material involving non-participants will be deleted following the session.



Please note that any individual in the room may request that recording is paused at any point in the teaching exchange and that this would be done immediately and without question.

After this, staff and student participants may also be contacted by email and invited to participate in an interview focusing on clinical teaching exchanges and clinical uncertainty. This interview is expected to last 30-60 minutes and will be audio recorded.

All participants will be offered the opportunity to review the transcripts (typed out copies) of their interviews to check that they are accurate.

What are the possible disadvantages and risks of taking part?

The risks to subjects involved in this study relate only to the voluntary and relatively minor time commitment and the possible (but small) effect of the researcher on the learning process.

What are the possible benefits of taking part?

You will receive no direct benefit from taking part in this study. The information that is collected during this study will give us a better understanding of clinical uncertainty in the Veterinary Curriculum. It is also possible that through discussion of their clinical teaching and learning experiences as part of the study, there might be unforeseen benefits to individual students and staff in terms of their awareness and ability to reflect on the experience and its significance.

Will my taking part in this study be kept confidential?



All information (including video footage) which is collected about you during the course of the research will be kept strictly confidential. You will be identified by an ID number, and any information about you will have your name and address removed so that you cannot be recognised from it.

What will happen to the results of the research study?

The results of this research study will be reported to School of Veterinary Medicine Course teams, School learning and teaching committee once the study is complete.

Wider dissemination will be via conference presentations and publication in national or international journals. Please note that participants will not be identified in any report/publication and video footage will not be used without the express additional consent of the participants.

Who is organising and funding the research?

The research study is organised by [REDACTED]

[REDACTED] *The study is not funded.*

Who has reviewed the study?

*The project has been reviewed by the **MVLS** College Ethics Committee.*

Contact for Further Information

Further information on this study can be obtained from [REDACTED]

[REDACTED]

[REDACTED]

And finally...

You will be given a copy of this information sheet and a signed consent form to keep.

Thank you for taking part in this study



1 May 2014

[REDACTED]
University Teacher in Veterinary Education,
School of Veterinary Medicine
College of Medical, Veterinary and Life Sciences
University of Glasgow
Bearsden
Glasgow G61 1QH

Dear [REDACTED]

MVLS College Ethics Committee

Project Title: Tolerance of ambiguity and reaction to clinical uncertainty in Veterinary students

Project No: 200130067

The College Ethics Committee has reviewed your application and has agreed that there is no objection on ethical grounds to the proposed study. It is happy therefore to approve the project, subject to the following conditions:

- Project end date: 31 December 2017.
- The research should be carried out only on the sites, and/or with the groups defined in the application.
- Any proposed changes in the protocol should be submitted for reassessment, except when it is necessary to change the protocol to eliminate hazard to the subjects or where the change involves only the administrative aspects of the project. The Ethics Committee should be informed of any such changes.
- You should submit a short end of study report to the Ethics Committee within 3 months of completion.

Yours sincerely

[REDACTED SIGNATURE]

Professor William Martin
College Ethics Officer

Approval200130067.docx

Professor William Martin
Professor of Cardiovascular Pharmacology

R507B Level 5
School of Life Sciences
West Medical Building
Glasgow G12 8QQ Tel: 0141 330 4489
E-mail: William.Martin@glasgow.ac.uk



CONSENT FORM

Study title: *Tolerance of ambiguity and reaction to clinical uncertainty in Veterinary students*

Name of Researcher(s): Mrs Jennifer Hammond, Professor Dominic Mellor & Mr Phillip Evans

Please initial box

I confirm that I have read and understand the information sheet dated 010514 (Version 2) for the above study and have had the opportunity to ask questions.

☐

I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason, without my legal rights being affected.

☐

I agree to take part in the above study.

☐

Name of subject

Date

Signature

Researcher

Date

Signature

Version 2 Survey 010514



University of Glasgow | College of Medical,
Veterinary & Life Sciences



PARTICIPANT INFORMATION SHEET

Study title: *Tolerance of ambiguity and reaction to clinical uncertainty in Veterinary students*

You are being invited to take part in a research study. Before you decide it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish. Ask us if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part.

What is the purpose of the study?

Ambiguity (being open to more than one interpretation) and uncertainty (not being able to be relied on; not known or definite) play a central role in veterinary medicine, whether this is related to limitations of knowledge or uncertainty of patient response. Given that ambiguity is inherent in veterinary medicine; how an individual responds to this ambiguity and uncertainty will have a significant influence on how they practice veterinary medicine. Despite this we actually know very little about how tolerance of ambiguity changes during an individual's time at medical school, and as they begin working as a vet in practice or other roles. We also know very little about how tolerance of ambiguity influences individuals' career choice. We have developed a questionnaire which we are hoping will help us to answer some of these questions, and we are asking all veterinary students, interns and residents at Glasgow to complete the questionnaire that we have provided and return to us. By completing this questionnaire you will help us to understand better whether these parameters are important. Of course you will be at no disadvantage if you decide not to complete this questionnaire and any response we do receive will be coded so that you cannot be directly identified.

Why have I been chosen?



You have been chosen because you are a Veterinary student currently studying on the Glasgow BVMS Programme. All individuals who are students on the BVMS Programme during the period of study will be offered the opportunity to participate in this study.

Do I have to take part?

It is up to you to decide whether or not to take part. If you do decide to take part, you will be given this information sheet to keep and be asked to sign a consent form. If you decide to take part, you are still free to withdraw at any time and without giving a reason.

Please note that a decision not to participate will not affect your grades or academic standing in any way.

What will happen to me if I take part?

You will be asked to sign a consent form (or complete the online equivalent) and complete the survey which is expected to take around 10 minutes.

You will not receive individual feedback on the survey outcomes, but the data from your year cohort will be fed back to the year group at the end of the project.

What are the possible disadvantages and risks of taking part?

The risks to subjects involved in this study relate only to the voluntary and relatively minor time commitment.

What are the possible benefits of taking part?



You will receive no direct benefit from taking part in this study. The information that is collected during this study will give us a better understanding of ambiguity tolerance in the Veterinary profession and this may provide an indirect benefit to the Veterinary profession as a whole.

Will my taking part in this study be kept confidential?

All information which is collected about you during the course of the research will be kept strictly confidential. You will be identified by a participant ID number, and any information about you will have your student ID number removed so that you cannot be recognised from it.

What will happen to the results of the research study?

The results of this research study will be reported to School of Veterinary Medicine Course teams, School learning and teaching committee and relevant student and alumni groups once the study is complete.

Wider dissemination will be via conference presentations and publication in national or international journals. Please note that participants will not be identified in any report/publication.

Who is organising and funding the research?

The research study is organised by the Jennifer Hammond of University of Glasgow, School of Veterinary medicine. The study is not funded.

Who has reviewed the study?



The project has been reviewed by the MVLS College Ethics Committee.

Contact for Further Information

Further information on this study can be obtained from [REDACTED]
[REDACTED]

And finally...

You will be given a copy of this information sheet to keep.

Thank you for taking part in this study

Appendix VII: Summary tables comparing AT between mature and non-mature students analysed by academic year

Academic year 2013/14

	Mature student (over 30 yrs)	N	Mean	Std. Deviation	Std. Error Mean
TAVS score (out of 100)	.00	292	56.05	8.056	.471
	1.00	12	61.92	7.449	2.150

t (302) = -2.481 p = 0.014

Academic year = 2014/15

	Mature student (over 30 yrs)	N	Mean	Std. Deviation	Std. Error Mean
TAVS score (out of 100)	.00	325	57.31	7.855	.436
	1.00	13	60.93	11.517	3.194

t (336) = -2.181 p = 0.111

Academic year = 2015/16

	Mature student (over 30 yrs)	N	Mean	Std. Deviation	Std. Error Mean
TAVS score (out of 100)	.00	256	58.14	6.306	.394
	1.00	15	60.42	8.129	2.099

t (269) = -1.337 p = 0.182

Appendix VIII: Summary tables comparing AT between Black and non-Black students analysed by academic year

Academic year 2013/14

	Black ethnicity	N	Mean	Std. Deviation	Std. Error Mean
TAVS score (out of 100)	.00	300	56.34	8.112	.468
	1.00	3	49.24	4.593	2.652

a. Academic year = 2013/14

t (301) = 1.510 p = 0.132

Academic year 2014/15

	Black ethnicity	N	Mean	Std. Deviation	Std. Error Mean
TAVS score (out of 100)	.00	330	57.63	8.011	.441
	1.00	7	50.79	5.288	1.999

a. Academic year = 2014/15

t (335) = 2.248 p = 0.025

Academic year 2015/16

	Black ethnicity	N	Mean	Std. Deviation	Std. Error Mean
TAVS score (out of 100)	.00	268	58.27	6.455	.394
	1.00	3	57.53	2.589	1.495

a. Academic year = 2015/16

t (269) = 0.200 p = 0.842

Appendix IX: Summary tables comparing AT between students who had completed a previous degree or technical training and those who had not; analysed by academic year

Academic year 2013/14

	Completed degree or technical training	N	Mean	Std. Deviation	Std. Error Mean
TAVS score (out of 100)	.00	200	55.85	8.405	.594
	1.00	104	57.12	7.455	.731

t (302) = -1.302 p = 0.194

Academic year 2014/15

	Completed degree or technical training	N	Mean	Std. Deviation	Std. Error Mean
TAVS score (out of 100)	.00	194	56.67	7.910	.568
	1.00	143	58.57	8.106	.678

t (335) = -2.160 p = 0.031

Academic year 2015/16

	Completed degree or technical training	N	Mean	Std. Deviation	Std. Error Mean
TAVS score (out of 100)	.00	168	57.60	6.500	.501
	1.00	102	59.35	6.205	.614

t (268) = -2.181 p = 0.030

Appendix X: Summary tables comparing AT between stages of training analysed by academic year

2013/14 Academic year

Dependent Variable: TAVS score (out of 100)

Tukey HSD

(I) What is your current stage of training?	(J) What is your current stage of training?	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
1st year BVMS	2nd year BVMS	3.673*	1.346	.034	.19	7.15
	3rd year BVMS	-.641	1.439	.970	-4.36	3.08
	5th year BVMS	1.600	1.290	.602	-1.73	4.93
2nd year BVMS	1st year BVMS	-3.673*	1.346	.034	-7.15	-.19
	3rd year BVMS	-4.314*	1.352	.009	-7.81	-.82
	5th year BVMS	-2.073	1.193	.306	-5.15	1.01
3rd year BVMS	1st year BVMS	.641	1.439	.970	-3.08	4.36
	2nd year BVMS	4.314*	1.352	.009	.82	7.81
	5th year BVMS	2.241	1.296	.311	-1.11	5.59
5th year BVMS	1st year BVMS	-1.600	1.290	.602	-4.93	1.73
	2nd year BVMS	2.073	1.193	.306	-1.01	5.15
	3rd year BVMS	-2.241	1.296	.311	-5.59	1.11

*. The mean difference is significant at the 0.05 level.

F (3,300) = 4.178 p = 0.06

2014/15 Academic year

Dependent Variable: TAVS score (out of 100)

Tukey HSD

(I) What is your current stage of training?	(J) What is your current stage of training?	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
1st year BVMS	2nd year BVMS	1.614	1.065	.429	-1.14	4.36
	3rd year BVMS	3.712*	1.335	.029	.26	7.16
	5th year BVMS	2.550	1.275	.190	-.74	5.84
2nd year BVMS	1st year BVMS	-1.614	1.065	.429	-4.36	1.14
	3rd year BVMS	2.099	1.320	.386	-1.31	5.51
	5th year BVMS	.937	1.259	.879	-2.32	4.19
3rd year BVMS	1st year BVMS	-3.712*	1.335	.029	-7.16	-.26
	2nd year BVMS	-2.099	1.320	.386	-5.51	1.31
	5th year BVMS	-1.162	1.495	.865	-5.02	2.70
5th year BVMS	1st year BVMS	-2.550	1.275	.190	-5.84	.74
	2nd year BVMS	-.937	1.259	.879	-4.19	2.32
	3rd year BVMS	1.162	1.495	.865	-2.70	5.02

*. The mean difference is significant at the 0.05 level.

F (3,334) = 2.987 p = 0.031

2015/16 Academic year

Dependent Variable: TAVS score (out of 100)

Tukey HSD

(I) What is your current stage of training?	(J) What is your current stage of training?	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
1st year BVMS	2nd year BVMS	-.577	1.225	.965	-3.74	2.59
	3rd year BVMS	1.733	.969	.281	-.77	4.24
	5th year BVMS	.534	1.087	.961	-2.28	3.34
2nd year BVMS	1st year BVMS	.577	1.225	.965	-2.59	3.74
	3rd year BVMS	2.310	1.311	.294	-1.08	5.70
	5th year BVMS	1.111	1.401	.857	-2.51	4.73
3rd year BVMS	1st year BVMS	-1.733	.969	.281	-4.24	.77
	2nd year BVMS	-2.310	1.311	.294	-5.70	1.08
	5th year BVMS	-1.199	1.183	.742	-4.26	1.86
5th year BVMS	1st year BVMS	-.534	1.087	.961	-3.34	2.28
	2nd year BVMS	-1.111	1.401	.857	-4.73	2.51
	3rd year BVMS	1.199	1.183	.742	-1.86	4.26

a. Academic year = 2015/16

F (3, 267) = 1.447 p = 0.230

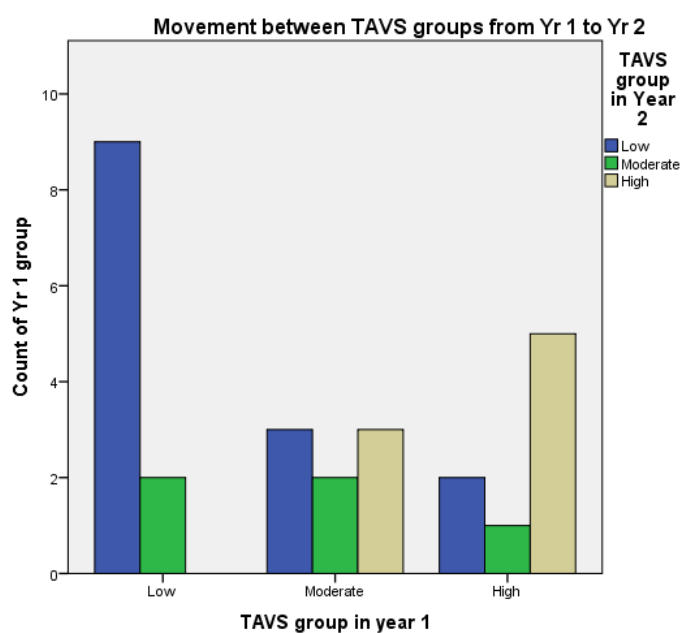
Appendix XI: Summary of test-moves analysis

Test group positions for test cohort: group in year 1 compared with group in Year 2

			TAVS group 2013/14 (BMVS 1)			
a			Low	Moderate	High	Total
TAVS group 2014.15 (BVMS2)	Low	Count	9	3	*2	14
	Moderate	Count	2	2	1	5
	High	Count	*0	3	5	8

* move of 2 group positions (e.g. High to Low or Low to High)

Test group positions for test cohort: group in year 1 compared with group in Year 2



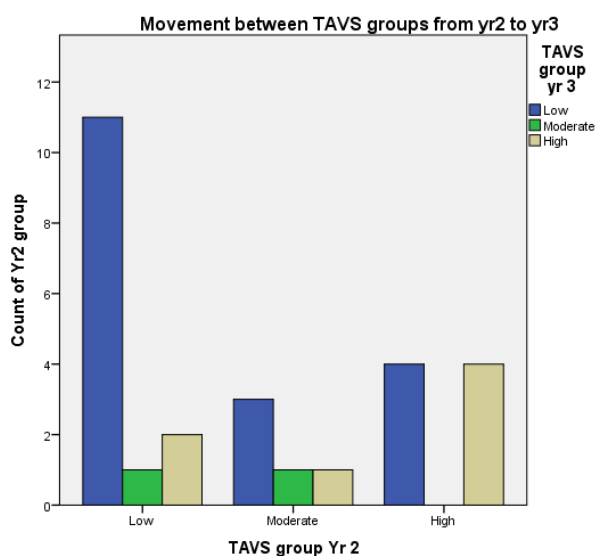
Test group positions for test cohort: group in Year 2 compared with group in Year 3

* move of 2 group positions (e.g. High to Low or Low to High).

			TAVS group 2015/16 (BVMS3)		
a			Low	Moderate	High
TAVS group 2014.15 (BVMS2)	Low	Count	11	1	*2
	Moderate	Count	3	1	1

	High	Count	*4	0	4
--	------	-------	----	---	---

Test group positions for test cohort: group in year 2 compared with group in Year 3

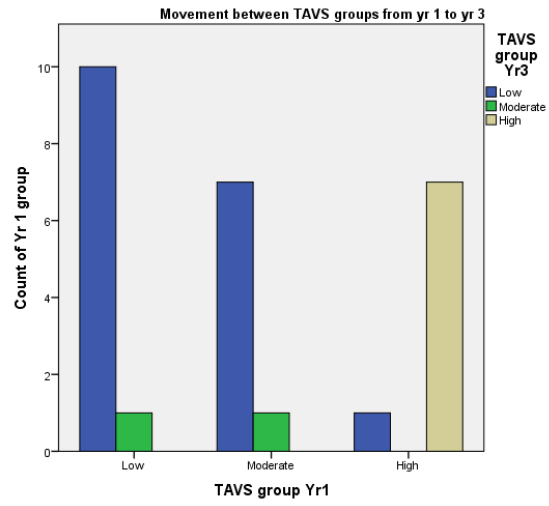


Test group positions for test cohort: group in Year 1 compared with group in Year 3

			TAVS group 2015/16 (BVMS3)		
a			Low	Moderate	High
TAVS group 2013/14 (BMVS 1)	Low	Count	10	1	*0
	Moderate	Count	7	1	0
	High	Count	*1	0	7

* move of 2 group positions (e.g. High to Low or Low to High).

Test group positions for test cohort: group in year 2 compared with group in Year 3



Appendix XII: Schedule for semi-structured interviews

Interview schedule – clinical rounds discussions (Student interview)

1. Gain consent (this has already been done but is an opportunity to remind participants of the nature of the study and to check that participant is still happy to take part.
2. Outline of the interview process
 - a. Interview will take around 1 hour
 - b. Interview will be audio recorded – participant may ask for recording to be stopped at any time
 - c. There will be three parts to the interview
 - i. Review of short audio/image clip of rounds case 1 (5 min)
 - ii. Discussion of this case
 - iii. Review of short audio/image clip of rounds case 2 (5 min)
 - iv. Discussion of this case
 - v. General questions/discussion opportunity
3. Show video of Case 1
 - a. Ask candidate if they recall the case
 - b. Ask general recollections
 - c. Focus on case management
 - d. Focus on rounds presentation
 - e. Ask “was there anything with this case which made you feel uncertain or doubtful?”
 - f. Ask “was there anything in the rounds discussion which made you feel uncertain or doubtful?”
 - g. Ask “How did you cope with your uncertainty in this situation?”
4. Show video of Case 2
 - a. Ask candidate if they recall the case
 - b. Ask general recollections
 - c. Focus on case management
 - d. Focus on rounds presentation
 - e. Ask “was there anything with this case which made you feel uncertain or doubtful?”
 - f. Ask “was there anything in the rounds discussion which made you feel uncertain or doubtful?”
 - g. Ask “How did you cope with your uncertainty in this situation?”
5. General discussion opportunity

- a. State that this study is looking at how Vet students learn to cope with uncertainty, is there anything else which you would like to discuss from your experiences on this rotation which you feel may be relevant to the study?
 - b. Ask if there is anything else from experiences on other rotations/other parts of the course which you feel may be relevant to the study?
6. Close
- a. Ask if anything else
 - b. Remind of option to withdraw from study and process for seeking support if required
 - c. End recording & thank student

Interview schedule – clinical rounds discussions (Staff interview)

1. Gain consent (this has already been done but is an opportunity to remind participants of the nature of the study and to check that participant is still happy to take part).
2. Outline of the interview process
 - a. Interview will take around 1 hour
 - b. Interview will be audio recorded – participant may ask for recording to be stopped at any time
 - c. There will be three parts to the interview
 - i. Review of short audio/image clip of rounds case 1 (5 min)
 - ii. Discussion of this case
 - iii. Review of short audio/image clip of rounds case 2 (5 min)
 - iv. Discussion of this case
 - v. General questions/discussion opportunity
3. Show video of Case 1
 - a. Ask member of staff if they recall the case (was it one they saw or just encountered at rounds?)
 - b. Ask general recollections
 - c. Focus on case management
 - d. Focus on rounds presentation
 - e. Ask “did you perceive anything with this case which made the student feel uncertain or doubtful?”
 - f. Ask “did you perceive anything in the rounds discussion which made the student feel uncertain or doubtful?”
 - g. For staff – focus may be more on: “Why did you choose to focus this rounds discussion in the way which you did?”
 - h. Specific questions relating to observations from rounds

4. Show video of Case 2
 - a. Ask member of staff if they recall the case (was it one they saw or just encountered at rounds?)
 - b. Ask general recollections
 - c. Focus on case management
 - d. Focus on rounds presentation
 - e. Ask “did you perceive anything with this case which made the student feel uncertain or doubtful?”
 - f. Ask “did you perceive anything in the rounds discussion which made the student feel uncertain or doubtful?”
 - g. For staff – focus may be more on: “Why did you choose to focus this rounds discussion in the way which you did?”
 - h. Specific questions relating to observations from rounds
5. General discussion opportunity
 - a. State that this study is looking at how Vet students learn to cope with uncertainty, is there anything else which you would like to discuss from your experiences working with students on this rotation which you feel may be relevant to the study?
 - b. Ask if there is anything else from experiences teaching on other rotations/other parts of the course which you feel may be relevant to the study?
 - c. “How well do you think the BVMS Programme prepares students to be able to cope with uncertainty in professional practice?”
6. Close
 - a. Ask if anything else
 - b. Remind of option to withdraw from study and process for seeking support if required
 - c. End recording & thank member of staff

Appendix XIII: Inductive and Deductive elements of Descriptive analysis

Inductive approach: Example of N-Vivo coding references for node describing the theme of exposure to disagreement

The screenshot shows the NVivo software interface. On the left is a navigation pane with icons for Nodes, Relationships, and Node Matrices. Below this is a list of project components: Sources, Nodes (highlighted), Classifications, Collections, Queries, Reports, Models, and Folders. The main window is titled 'Nodes' and contains a table with columns: Name, Sources, References, Created On, Created By, Modified On, and Modified By. The table lists one node: 'Exposure to disagreement' with 3 sources and 7 references, created on 23/03/2016 13:37 by JH, and modified on 17/11/2016 13:58 by JH. Below the table, the 'Exposure to disagreement' node is selected, showing a list of references. The first reference is from '<Internals>\Staff transcripts\01 Transcript clinical rounds FINAL>' with 4 references coded (2.25% coverage). The text of this reference is: 'know the fact that there are many opinions - there is no evidence base for this particular course of treatment, you know as the case is often um you know how do you rationalise with the students that we've all got a different view and we might all be right and we might all be wrong - you know - students hate that - how often'. The second reference is from the same source with 0.24% coverage, with text: 'there are multiple different treatment options and it might be case of trying something different and'. The third reference is from the same source with 0.51% coverage, with text: 'and you know [redacted] comes up with a drug that nobody else has ever heard of, you know we all start having a discussion about whether we should be using this drug or not - it's not that we don't introduce that,'.

Categorisation matrix used in deductive analysis

Category	Nodes	Defined as:
Source	Conflict	Differing interests Apparent contradiction
	Inadequate understanding	Equivocal Unstable Novel
	Inadequate information	Information completely lacking Information partly lacking Information unreliable
	Other	Does not fit existing categories
Tactic	Acknowledgement	Pre-empt Avoid irreversible action Weigh pros and cons Improve readiness
	Suppression	Ignore Rely on intuition Take a gamble
	Reduction	Solicit advice Delay action Rely on SOPs Delay action Collect additional information Assumption based reasoning
	Other	Does not fit existing categories

Deductive approach: Example of N-Vivo coding references for node describing the tactic of acknowledgement of uncertainty

Nodes

Look for: Search In: Nodes Find Now Clear Advanced Find

Nodes

Name	Sources	References	Created On	Created By	Modified On	Modified By
Tactics	8	64	05/04/2016 20:44	JH	05/04/2016 20:44	JH
Acknowledgement	7	19	05/04/2016 20:45	JH	22/06/2016 21:26	JH
Other	5	15	05/04/2016 21:59	JH	05/04/2016 21:59	JH
Reduction	7	25	05/04/2016 20:45	JH	05/04/2016 20:45	JH
Suppression	4	5	05/04/2016 20:45	JH	05/04/2016 20:45	JH

Acknowledgement ☒ 03 Transcript clinical rounds F ☒ 05 Interview transcript ☒ 02 interview transcript

References

Reference 1 - 0.47% Coverage

Ahm, I think probably amongst our group its fairly standard - I think probably some of, one of the difficulties is that you know for a lot of what we do there's absolutely no evidence base at all

Reference 2 - 2.67% Coverage

rather than just well - I give Gentamicin for 4 days and John gives Gentamicin for 6 days and David gives Gentamicin for 10days and that's what we do - student hate that - that's we do - whereas if you say well there's lots of discussion about you know renal toxicity and you know horses in here might be more volume compromised so maybe they are more at risk so absolutely you should be careful - what do you think we could do to decided? How will we inform the decision about whether to carry on and you know they'll all come up with you oh: we could run some bloods and look at the renal parameters and you know we could, the same discussion arises with non-steroidals for all the all the sort of similar reasons - and I think as long as you happen to do that then you know

Appendix XIV: Examples of field notes documenting processes of abduction and retroduction

List of field notes providing record and audit trail for analytic process

Memos							
Name	Nodes	References	Created On	Created By	Modified On	Modified By	
Research questions revisited	0	0	11/07/2016 21:44	JH	12/07/2016 11:04	JH	
Statement 1	9	14	25/05/2016 18:39	JH	15/06/2016 23:33	JH	
Statement 10	20	34	10/07/2016 15:11	JH	10/07/2016 21:03	JH	
Statement 11	0	0	10/07/2016 15:13	JH	11/07/2016 17:18	JH	
Statement 12	11	13	10/07/2016 15:18	JH	11/07/2016 17:18	JH	
Statement 13	7	10	10/07/2016 15:20	JH	11/07/2016 17:18	JH	
Statement 2	11	27	01/06/2016 08:42	JH	13/06/2016 12:11	JH	
Statement 3	13	32	13/06/2016 12:11	JH	15/06/2016 18:14	JH	
Statement 4	31	123	15/06/2016 11:56	JH	09/07/2016 20:15	JH	
Statement 5	13	29	09/07/2016 15:29	JH	10/07/2016 14:12	JH	
Statement 6	11	24	09/07/2016 17:40	JH	10/07/2016 13:38	JH	
Statement 7	8	14	09/07/2016 21:11	JH	10/07/2016 13:52	JH	
Statement 8	10	35	10/07/2016 13:52	JH	10/07/2016 18:23	JH	
Statement 9	19	36	10/07/2016 15:07	JH	10/07/2016 18:08	JH	
Thoughts on aspiration pneumonia	0	0	06/04/2016 08:19	JH	07/04/2016 18:04	JH	
Thoughts on Bleach scald	12	42	04/04/2016 07:11	JH	05/04/2016 22:06	JH	
Thoughts on coronary band laceration	9	18	05/04/2016 07:44	JH	05/04/2016 22:08	JH	
Thoughts on dramatic lameness	5	5	21/04/2016 22:17	JH	21/04/2016 22:32	JH	
Thoughts on fistulous withers	0	0	21/04/2016 22:32	JH	21/04/2016 22:59	JH	
Thoughts on general discussion	0	0	26/05/2016 06:08	JH	26/05/2016 08:08	JH	
Thoughts on mandibular fracture	0	0	22/05/2016 10:32	JH	25/05/2016 22:44	JH	
Thoughts on respiratory mule	12	50	23/03/2016 16:03	JH	04/04/2016 07:11	JH	
Thoughts on situated learning	0	0	05/04/2016 08:26	JH	09/04/2016 08:47	JH	
Thoughts on uncertainty work	0	0	05/04/2016 21:21	JH	07/04/2016 21:40	JH	
Thoughts on what is missing and what doesn't work	0	0	10/07/2016 23:18	JH	11/07/2016 12:42	JH	

Section of field note from Phase 2 documenting thoughts one the case of the coronary band laceration having reviewed student and staff interviews

PHD case study.nvp - NVivo

File Home Create External Data Analyze Query Explore Layout View

Workspace Item Edit Clipboard Format Paragraph Styles Editing Proofing

Look for: Search in: Memos Find Now Clear Advanced Find

Name	Nodes	References	Created On	Created By	Modified On	Modified By
Thoughts on Bleach scald	12	42	04/04/2016 07:11	JH	05/04/2016 22:06	JH
Thoughts on coronary band laceration	9	18	05/04/2016 07:44	JH	05/04/2016 22:08	JH
Thoughts on dramatic lameness	5	5	21/04/2016 22:17	JH	21/04/2016 22:32	JH

Thoughts on coronary band lac

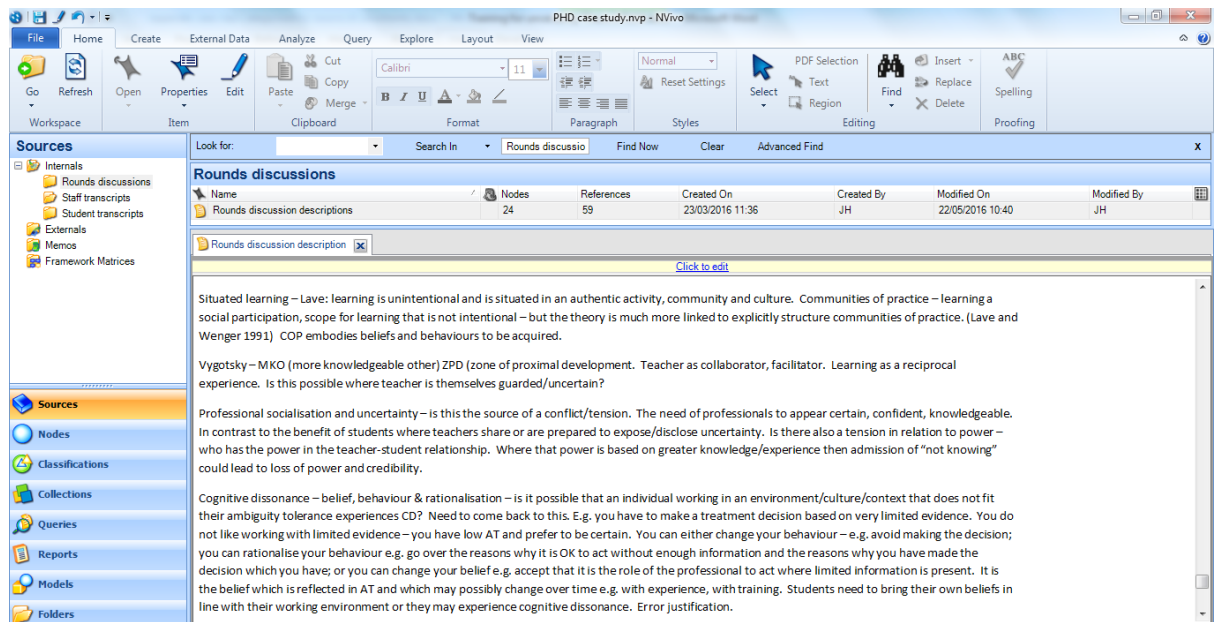
[Click to edit](#)

Towards the end of my interview with the student it became clear that the student had already had suspicions about the need to radiograph prior to the rounds discussion and that was why she asked the question she did of the Glasgow team. As a novice she would not have the power/authority to raise the issue herself with the clinic director, but she is able to use the mediating power of the glasgow staff to add weight to the argument and be more likely to influence the situation.

This is a recording which is entirely from the student perspective. One could speculate that the glasgow staff were having to be fairly diplomatic in their responses, but there is no direct interview with either of the staff members to confirm this.

This student seems to have learned about being thorough and cautious in an initial assessment, they seems to have been able to provide multiple alternative rationales for observed clinical patterns and also to have used the social structure of the community to influence an outcome. They have also learned how to follow up on their own doubts by raising with another member of staff and questioning someone with more experience. Interestingly this seems to model the strategy used by the clinic director who was also seen to email another authority when faced with something rare/unusual or inexperienced. As a community, the veterinary community seems to value experience above almost all else.

Section of field note from Phase 2 documenting thoughts on learning approaches during rounds discussions and how these relate to theoretical perspectives



The screenshot shows the NVivo software interface with the 'Rounds discussions' field note selected. The left sidebar shows the 'Sources' tree with 'Internals' expanded, containing 'Rounds discussions', 'Staff transcripts', 'Student transcripts', 'Externals', 'Memos', and 'Framework Matrices'. The main window displays the text of the field note.

Rounds discussions

Name	Nodes	References	Created On	Created By	Modified On	Modified By
Rounds discussion descriptions	24	59	23/03/2016 11:36	JH	22/05/2016 10:40	JH

[Click to edit](#)

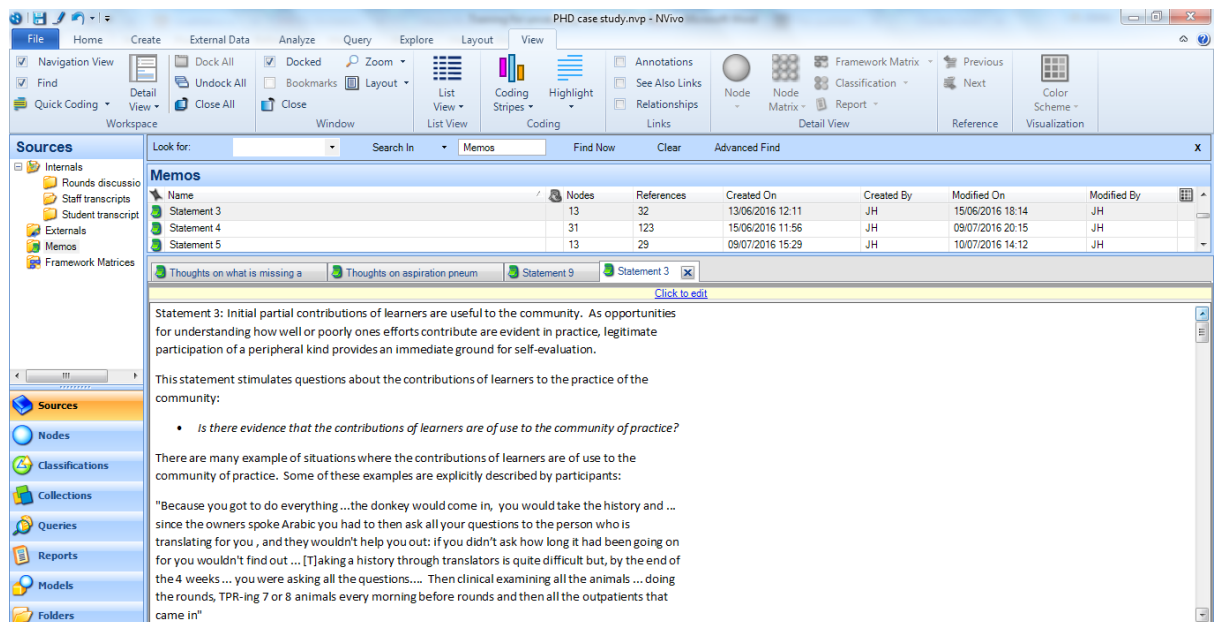
Situated learning – Lave: learning is unintentional and is situated in an authentic activity, community and culture. Communities of practice – learning a social participation, scope for learning that is not intentional – but the theory is much more linked to explicitly structure communities of practice. (Lave and Wenger 1991) COP embodies beliefs and behaviours to be acquired.

Vygotsky – MKO (more knowledgeable other) ZPD (zone of proximal development. Teacher as collaborator, facilitator. Learning as a reciprocal experience. Is this possible where teacher is themselves guarded/uncertain?

Professional socialisation and uncertainty – Is this the source of a conflict/tension. The need of professionals to appear certain, confident, knowledgeable. In contrast to the benefit of students where teachers share or are prepared to expose/disclose uncertainty. Is there also a tension in relation to power – who has the power in the teacher-student relationship. Where that power is based on greater knowledge/experience then admission of “not knowing” could lead to loss of power and credibility.

Cognitive dissonance – belief, behaviour & rationalisation – is it possible that an individual working in an environment/culture/context that does not fit their ambiguity tolerance experiences CD? Need to come back to this. E.g. you have to make a treatment decision based on very limited evidence. You do not like working with limited evidence – you have low AT and prefer to be certain. You can either change your behaviour – e.g. avoid making the decision; you can rationalise your behaviour e.g. go over the reasons why it is OK to act without enough information and the reasons why you have made the decision which you have; or you can change your belief e.g. accept that it is the role of the professional to act where limited information is present. It is the belief which is reflected in AT and which may possibly change over time e.g. with experience, with training. Students need to bring their own beliefs in line with their working environment or they may experience cognitive dissonance. Error justification.

Section of field note from Phase 2 documenting comparison between empirical findings and middle range theory



The screenshot shows the NVivo software interface with the 'Memos' field note selected. The left sidebar shows the 'Sources' tree with 'Internals' expanded, containing 'Rounds discussion', 'Staff transcripts', 'Student transcript', 'Externals', 'Memos', and 'Framework Matrices'. The main window displays the text of the field note.

Memos

Name	Nodes	References	Created On	Created By	Modified On	Modified By
Statement 3	13	32	13/06/2016 12:11	JH	15/06/2016 18:14	JH
Statement 4	31	123	15/06/2016 11:56	JH	09/07/2016 20:15	JH
Statement 5	13	29	09/07/2016 15:29	JH	10/07/2016 14:12	JH

[Click to edit](#)

Statement 3: Initial partial contributions of learners are useful to the community. As opportunities for understanding how well or poorly ones efforts contribute are evident in practice, legitimate participation of a peripheral kind provides an immediate ground for self-evaluation.

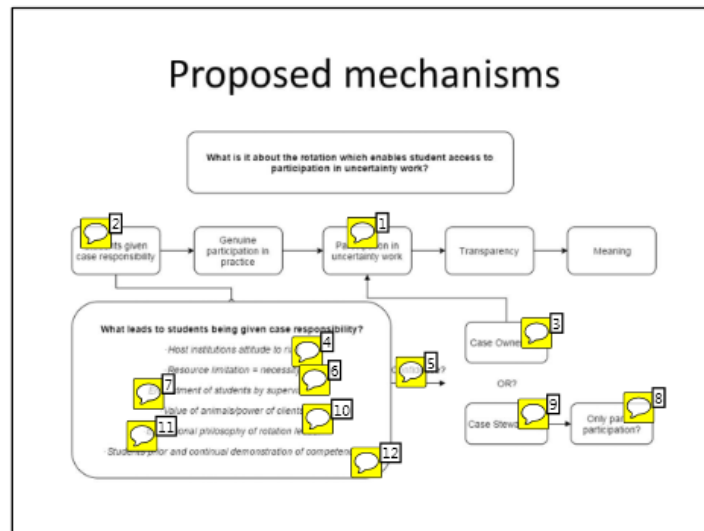
This statement stimulates questions about the contributions of learners to the practice of the community:

- Is there evidence that the contributions of learners are of use to the community of practice?

There are many example of situations where the contributions of learners are of use to the community of practice. Some of these examples are explicitly described by participants:

"Because you got to do everything ...the donkey would come in, you would take the history and ... since the owners spoke Arabic you had to then ask all your questions to the person who is translating for you, and they wouldn't help you out: if you didn't ask how long it had been going on for you wouldn't find out ... [T]aking a history through translators is quite difficult but, by the end of the 4 weeks ... you were asking all the questions.... Then clinical examining all the animals ... doing the rounds, TPR-ing 7 or 8 animals every morning before rounds and then all the outpatients that came in"

Section of field note from Phase 3 documenting outcomes of focus group discussion



Summary of Comments on Morocco Study Group discussion 150916

Page: 1

Number: 1	Author: jah13a	Subject: Sticky Note	Date: 15/09/2016 13:08:24 +01'00'
Time limits of the discussion precluded detailed exploration of the nature of uncertainty work and how this might differ from practice more generally. However exemplar given of daily TPR's which are part of practice but not considered uncertainty work.			
Number: 2	Author: jah13a	Subject: Sticky Note	Date: 15/09/2016 13:36:00 +01'00'
All agreed that this generally happened on the Morocco rotation. Not only here though - also on other rotations in some/many cases.			
Number: 3	Author: jah13a	Subject: Sticky Note	Date: 15/09/2016 13:11:04 +01'00'
The taking of ownership for a case involves accepting responsibility and therefore risk associated with this. Not all students take responsibility equally. Those who take more responsibility get more out of it. Likened to first week in practice when you realise there is no-one else there to do the job - although in that situation it is necessity which drives participation in practice.			
Number: 4	Author: jah13a	Subject: Sticky Note	Date: 15/09/2016 13:33:30 +01'00'
Maybe not a big factor ... supervision is good. Not discussed in detail. More important is the supervisors perception of the risk i.e. how difficult it will be to pick up the pieces if things go badly.			
Number: 5	Author: jah13a	Subject: Sticky Note	Date: 15/09/2016 13:14:36 +01'00'
Closely linked to experience. Confidence of student in themselves. Confidence of staff member in student.			
Number: 6	Author: jah13a	Subject: Sticky Note	Date: 15/09/2016 13:19:19 +01'00'
This means lots of cases but necessity is not a major driver for students being given responsibility - trust is more important. Lots of cases and close teamwork with supervisor means that more opportunities to build trust are available than in many rotations.			
Number: 7	Author: jah13a	Subject: Sticky Note	Date: 15/09/2016 13:23:13 +01'00'
This seems to be the most important factor. Usually trust is built gradually as students are given more risky tasks and supervisors determine level of supervision and level of entrustment based on the perceived level of student competency. Occasionally the process is done in reverse - i.e. it becomes clear from adverse outcomes that entrustment has been inappropriate and the student is not ready to be trusted with risky tasks.			
Number: 8	Author: jah13a	Subject: Sticky Note	Date: 15/09/2016 13:15:29 +01'00'
Is supervising vet sometimes less motivated to engage with student who is participating less?			
Number: 9	Author: jah13a	Subject: Sticky Note	Date: 15/09/2016 13:13:42 +01'00'
Associated with lack of confidence, lack of effort, lack of motivation (e.g. not relevant, student doesn't want to be there). Impression is the stewardship can be due to having less experience in which case it represents a starting point (i.e. student moves on from this) or due to a lack of motivation in which student may not move on unless motivation changes.			
Number: 10	Author: jah13a	Subject: Sticky Note	Date: 15/09/2016 13:28:14 +01'00'
This is more complex. Value of animals to their owners is often as high or higher at the Clinic of Referral centre because owners rely on their animals for subsistence. Emotional bond is more varied - sometimes very strong, animals sometimes seen as commodity. Important factor discussed was the role of the referral vet (complicated cases sent to them by first opinion vet) compared with first opinion caseload at Morocco clinic. i.e. it is expectations of client rather than power of client. Another important issue is level of education of the clients - this relates to expectations and power.			
Number: 11	Author: jah13a	Subject: Sticky Note	Date: 15/09/2016 13:28:55 +01'00'
Discussed in context of clinic director. Not in context of local rotation leader.			
Number: 12	Author: jah13a	Subject: Sticky Note	Date: 15/09/2016 13:30:17 +01'00'
See above discussion of entrustment. Competency characterised by technical skills (practical skills) as well as "thinking along the same lines" as the supervisor.			

Appendix XV: Sources of uncertainty - example cases coded using category matrix

Case clip title	Summary of situation	Associated sources of uncertainty	Rationale
Foal euthanasia discussion	Rounds discussion involving two students with differing opinions on whether a severely ill diarrhoeic foal should be euthanized. Glasgow supervisors are drawn into the discussion to provide clinical advice and to comment on the likely prognosis and whether euthanasia is required.	Conflict Inadequate understanding Inadequate information	Students disagree on whether euthanasia of the foal is warranted. Staff members are unable to offer complete explanation for the clinical findings described by the students (e.g. aetiology of the joint swellings). Clinic facilities make measuring fibrinogen (a diagnostic and prognostic parameter) infeasible, so management decisions are made without a definitive diagnosis.
Oesophageal obstruction aspiration pneumonia	Case of aspiration pneumonia following incident of choke (oesophageal obstruction). Management of the case is proving challenging as the patient is not eating and multiple possible treatment options are under discussion.	Conflict Inadequate understanding (weak)	Disagreement between local staff and university clinicians (over 2 sites) on whether gentamicin should be used and method of delivery. Similar disagreement on the timing of putting patient back out to grass. Student expresses confusion about why differing opinions among clinicians and the clinical basis for this.



		Inadequate information	<p>Radiographs of chest are of poor quality and are unable to confirm whether there is pulmonary abscess.</p> <p>Unknown outcome regarding whether patient will subsequently develop oesophageal stricture.</p>
Bleach scald	Lame mule which had been "treated" by owner using bleach which had caused scald and subsequent slough of skin at the site. Discussion focused on management options and on rationale for using bleach in the first place.	<p>Conflict</p> <p>Inadequate understanding</p> <p>Inadequate information (weak)</p>	<p>Difference of opinion between local vets, student and 2 university clinicians over the use of cream vs cold hosing in this case.</p> <p>Students (in UK and partly also in Africa) are initially unable to understand why owner would use bleach on legs of mule.</p> <p>Student aware of potential for use on honey in this case but does not know how frequently and how much to apply.</p>
Mandibular fracture	Donkey with mandibular laceration/fracture which had been stabilised and managed with nursing and tube feeding. It had been difficult to manage the wound. The donkey had shown a sudden deterioration in the 24hrs prior to the rounds discussion and signs of colitis.	<p>Conflict</p> <p>Inadequate understanding</p>	<p>University clinician suggests alternative feeding regime which is rejected by student.</p> <p>There is (indirect) disagreement between clinic director and university clinician on whether an abdominal scan is indicated.</p>

		Inadequate information	<p>There was confusion over the process for feeding the patient using the tube and making up feed correctly.</p> <p>The student is unsure whether the colitis is due to the problematic feeding or the use of antibiotics.</p> <p>Without the results of the abdominal scan a diagnosis cannot be confirmed.</p>
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Appendix XVI: Case specific hypotheses development from Middle Range Theory

<i>Middle-range situated learning and uncertainty work hypotheses</i>	
<i>Statements about the community of practice</i>	
1	The community or communities of practice in which learners are legitimate peripheral participants can be delineated and described as an activity system (or systems) with shared meaning for participants, within which members have different interests, make diverse contributions to activity and hold varied viewpoints.
2	Moving towards full participation in practice (including uncertainty work) involves a greater commitment of time, intensified effort, more and broader responsibilities within the community and more difficult and risky tasks. It also confers an increasing sense of identity as a master practitioner.
3	Initial partial contributions of learners are useful to the community. As opportunities for understanding how well or poorly ones efforts contribute are evident in practice, legitimate participation of a peripheral kind provides an immediate ground for self-evaluation.
<i>Statements about uncertainty work</i>	
4	Learners, as peripheral participants can develop a view of what there is to be learned about the uncertainty work of the community. Hence a learning curriculum for uncertainty unfolds in opportunities for engagement in practice.
5	Legitimate peripheral participation in the community creates transparency of the cultural environment with respect to the meaning of what is being learned about the uncertainty work of the community.
6	Sequestration happens when learners are prevented from peripheral participation, in that they are not given productive access to the uncertainty work which constitutes activity in the community of practitioners.
<i>Statements about professional discourse</i>	
7	Learners participate in the uncertainty talk of the community which entails learning how to talk (and be silent) in the manner of full participants. Uncertainty-talk includes exchanging information necessary to the progress of ongoing activities as well as certain forms of “talking about” such as stories and community lore.
<i>Statements about conflict and change</i>	
8	Dissociating learning from pedagogical intentions opens the possibility of mismatch or conflict among practitioners’ viewpoints in situations where learning is going on. These differences must be constitutive of the content of learning.
9	The movement of learners towards full participation in the uncertainty work of the community does not take place in a static context; instead the practice itself is in motion. Change is a fundamental property of communities of practice and their activities.
10	Legitimate peripherality is important for developing constructively naive perspectives or questions. Inexperience is of use, however, only in the context of participation, when supported by experienced practitioners who both understand its limitations and value its role.

Appendix XVII: Detailed notes relating to negative case analysis and challenges to the middle range theory

The notes below are taken direct from field notes and are presented in their original draft format.

Participation in practice

The middle range theory implies that participation in practice is critical for learning to cope with uncertainty.

All participants were asked about students' early experiences at Vet school and how these related to preparing them to cope with uncertainty. Most responses focused on the limitation of a didactic course in preparing students to cope with uncertainty or examples of other rotations or EMS placements where students may encounter uncertainty, which is consistent with the idea that it is participation in practice which is required in order to learn to cope with uncertainty.

There was one interview which differed from this pattern. This was a student who had intercalated between 3rd and 4th year and reflected that this has been an extremely important experience in order for her to develop confidence and the ability to cope with uncertainty. She describes the vet course as very structured and reflects that there is little uncertainty on the vet course whereas she experienced a lot of uncertainty during her intercalated year and considers that this has helped her learn to cope with uncertainty:

"Is there anything else from your experiences across the whole of Vet school that you think ...[is] relevant [to] experiencing doubt or learning to cope with doubt or uncertainty. It's a big question so take a moment to think about it.

I don't know - I can think of something.... the year that like I had the most doubts and issues [was when] I intercalated between 3rd and 4th year so that was my ... getting thrown into the deep end...

So what did you do for your intercalating year?

I just did a year of research ... [and] I think because I didn't have a structured course that year, that was quite a lot to take because I think you are so used to at Vet school having all your set classes and set things to learn and so then I had to like manage all my own time and plan things for myself

And did you find that a positive experience, a negative experience?

...It was hard at the time but I look back on it, [and] I think that was really good for me, it gave me a lot more confidence to do things myself and to sort of step outside the box a little bit and not just follow what everyone else is doing .. it definitely gave me a lot of confidence ... because I think on the actual vet course you get quite comfortable because you are really looked after and everyone has the same classes"

ID08 student interview

Although the research project could be considered a form of "practice", but it is a very different type of practice to that at the Moroccan clinic and it is one which occurs within a different community of practice. The students' research was carried out in the university



small animal hospital and the SSPCA clinic so these are perhaps not as far from the practice of the African clinic as a lab-based research project may have been. An interesting question here is whether this represents 'transfer' between learning to cope with uncertainty from one area of practice to another, or whether it is the high level skills (confidence, communication) which the student has developed which are transferred and which then enable her to cope better in the clinic environment generally.

This raises the question of the extent to which uncertainty work in one community of practice overlaps with uncertainty work in another. The concept of transfer does not seem to be represented in situated learning theory yet this case suggests that transfer could be significant when learning to cope with uncertainty. Indeed, situated learning theory and the concept of sequestration through schooling suggests that learning away from the context of practice may be problematic.

Encountering uncertainty work

One participant differed from others in her response to initial questions about doubt and uncertainty. While other participants were able to describe examples of uncertainty and doubt which they had experienced, her response was different:

"So, for either of those cases, so your first colic which wasn't in for all that long - proximal enteritis and your fistulous withers case which was there for a whole month - were there any situations where you felt yourself a sense of doubt about what was going on or about what you needed to do or anything

Not really ...they have really good support there - especially we had [the clinician] and she was really good and kind of always helped you through your cases so I - always felt like I was ... well informed"

ID08 Student interview

Despite this, there are several examples in the close questioning about the cases where the participant talks about being unsure.

At several points in the discussion the student uses language which implies uncertainty or describes incomplete information e.g. *"I still wouldn't say I know much about it"* and *"it was quite a vague disease"* and *"probably not being too sure about them maybe?"* and *"we were a bit confused"*. Despite this the student does not describe experiencing a sense of doubt.

There are several possible explanations for this apparent anomaly. The first is that the student cannot remember the situation clearly enough to accurately recall her feelings at the time. She repeatedly talks in the interview about having limited memory of the situation e.g.

"I suppose the first thing would be can you just tell me your general recollections of that case and what went on with it?"

Um, well I can't remember - I do remember that after this it died - I remember that

Oh did it?

Yes, we ultra-sounded its chest and its lungs were just awful I think it would probably have inhaled some reflux or something - I can't remember exactly - I just remember that its

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lungs were just absolutely awful and it was starting to struggle to breath so we ended up euthanasing it ... I think it was just the next day or something - it was like just after the rounds"

The timing of this interview was a similar time after the rotation as for other participants and the subsequent discussions indicate that the student did have a good memory of many of the details of the cases at the time.

The second is that the student did not experience doubt at the time - this may relate to her own personal tolerance of ambiguous situations or possibly her understanding of the meaning of the term used in the interview.

The third is that, because the student was not as actively involved in the decision making entailed in practice: *"I mean I wasn't making like the decisions of what we were going to do - I was told what to do"* she is not participating in practice at a level where she is aware of the uncertainties or takes ownership of the uncertainties which appear to be present.

It is not clear which of these explanations is the most appropriate here and further research would be needed to explore these hypotheses.

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