AN EVALUATION OF ANATOMY TEACHING IN A CLINICALLY INTEGRATED VETERINARY CURRICULUM

Erica Gummery

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Abstract

Anatomy is a traditional subject, and remains largely unchanged despite developments in higher education and advances in veterinary practice. The research for this thesis aimed to investigate the impact of practical anatomy teaching in a modern, clinically integrated veterinary curriculum.

The context for the main body of research is cadaver-based practical teaching at the University of Nottingham's School of Veterinary Medicine and Science (SVMS). The mixed method approach involved conducting five studies utilising questionnaires, focus groups and semi-structured interviews. In study one first- and second-year students were surveyed to assess their perceptions of cadaver-based teaching methods used in anatomy classes. Study 2 consisted of an extension of study 1 and the questionnaires were distributed to first- and second-year students studying at two other UK vet schools. Study three is a longitudinal study of SVMS students, and used questionnaires and focus groups to assess changes in students' perceptions between pre-clinical and clinical years of the curriculum. Study four correlated perceptions of teaching with academic achievement using assessment data and questionnaires. Finally, study five assessed staff perceptions of anatomy teaching and the preparedness of SVMS students for their final year of teaching.

Undergraduate students valued cadaver-based learning opportunities in all the teaching contexts investigated for this project. Practical classes were appreciated for providing opportunities to consolidate and apply knowledge. SVMS students particularly valued the classes for developing clinical skills alongside learning anatomy, and their appreciation of this continued into clinical years of teaching. No evidence was found to suggest a relationship between perceptions of teaching methods and academic performance. Although students performed well in anatomy assessment items, questions assessing anatomical knowledge largely tested recall rather than practical application of knowledge. Students' struggles to apply knowledge to clinical cases was identified by some clinicians, although clinical teachers' expectations of students varied.

The place of anatomy within a modern veterinary curriculum is discussed. Recommendations for teaching practices are made with a view to fostering approaches to learning that are aligned with the intended outcomes of the undergraduate veterinary course.

The work contained in this thesis has resulted in the following publication:

Student perceptions of veterinary anatomy practical classes: a longitudinal study

Gummery E, Cobb KA, Mossop LH, Cobb MA

For my family

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Abbreviations

AHDOPS	Animal Handling Directly Observed Procedural Skills
AVMA	American Veterinary Medical Association
BERA	British Educational Research Association
BVM BVS	Bachelor of Veterinary Medicine, Bachelor of Veterinary Science
CA	Curriculum alignment
CAL	Computer Assisted Learning
CBR	Cambridge Vet School
CR	Clinical Relevance
CT	Computed Tomography
CTT	Classical Test Theory
CVB	Comparative Vertebrate Biology
DOPS	Directly Observed Procedural Skills
EAVE	European Association of Establishments for Veterinary Education
EMS	Extra-Mural Rotations
EMQ	Extended Matching Questions
FA	Formative Assessment
FC	Flipped Classroom
FIBs	Fill in the Blanks
GDPR	General Data Protection Regulation
HE	Higher Education
HND	Higher National Diploma
IAPP	Integrated Anatomy Practical Paper
ILO	Intended Learning Outcome
IMR	Intra-Mural Rotations
LSI	Learning Styles Inventory
MCQ	Multiple Choice Questions
MRI	Magnetic Resonance Imaging
NAB	Neurobiology and Animal Behaviour
OBE	Outcomes-Based Education
OSCE	Objective Structured Clinical Examination

OSPE	Objective Structured Practical Examination
PBL	Problem-Based Learning
RCVS	Royal College of Veterinary Surgeons
RPA	Rotational Professionalism Assessment
RVC	Royal Veterinary College
SA	Summative Assessment
SAQ	Short Answer Question
SDL	Self-Directed Learning
SPQ	Study Process Questionnaire
SVMS	School of Veterinary Medicine and Science
TA	Thematic Analysis
UCAS	Universities and Colleges Admissions Service
VAP	Veterinary Anatomy and Physiology
VARK	Visual, Aural, Read/write and Kinaesthetic
VAS	Visual Analogue Scales
VRB	Veterinary Reproductive Biology
YOE	Year of Entry

1 Introduction

The aim of this research is to investigate student and staff perceptions of anatomy teaching in modern veterinary curricula. Four research questions are generated following a review of the literature at the end of chapter 2. This introductory chapter provides an outline of the structure of this thesis. It also includes a section on the researcher's background and motivation for the study, and provides an overview of the curriculum at School of Veterinary Medicine and Science at the University of Nottingham (SVMS) in which this study is set. Chapter 2 provides a review of the literature relevant to the studies in this thesis. This consists of a review of educational theories in higher education (HE), including those related to approaches to learning, and assessment. A section of the literature review is dedicated to anatomy, its history, and methods of teaching. Chapter 3 describes the research design and discusses the methods of data collection and analyses used in this research.

Chapters 4, 5, 6, 7 and 8 describe the studies used within the thesis and are reported as follows. Chapter 4 provides an account of study 1, investigating the perceptions of first- and second-year students studying anatomy at SVMS. Chapter 5 reports study 2, which explored perceptions of anatomy students in a further two UK vet schools. Chapter 6 describes study 3, a longitudinal study of SVMS students, investigating retrospective and current perceptions of anatomy teaching. Chapter 7 describes study 4, an investigation into perceptions of teaching and assessment performance. Chapter 8 describes the final study forming this thesis; the perceptions of clinical academics of SVMS students' preparedness for practice.

Chapter 9 provides a discussion of the results and considers the wider implications of the research to veterinary anatomy education. Figure 1 illustrates how each of the studies add to this evaluation of anatomy teaching and its impact in the veterinary curriculum.

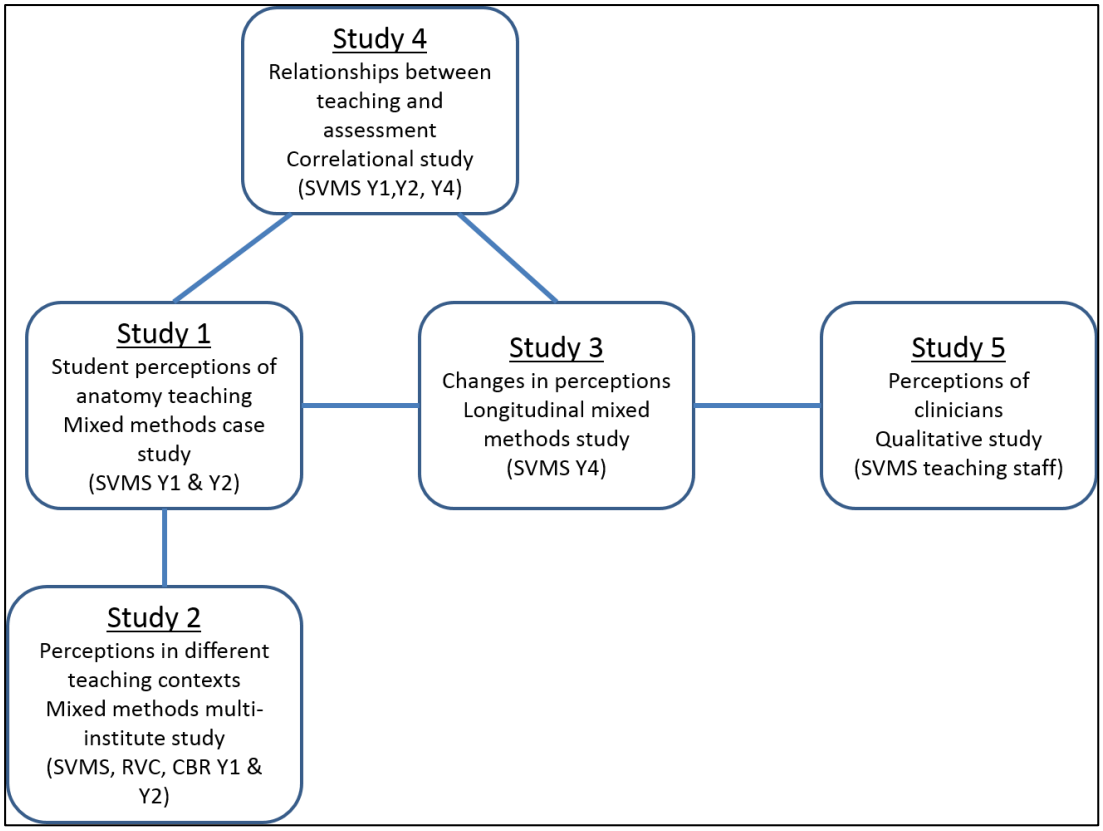


Figure 1. Overview of studies in this thesis. Schools recruited for study: SVMS, School of Veterinary Medicine and Science; RVC, Royal Veterinary College; CBR, Cambridge Vet School

The research within this thesis was carried out over a 5 year period; the timeline for this is shown below:

March 2012
Study 1: Survey pilot
April 2012
Study 1: Student survey, year 1
May 2012
Study 1: Student survey, year 2
February 2013
Study 2: Student survey, RVC and Cambridge
March 2014
Study 3: Pilot survey; student survey, year 4; focus groups
March 2015
Study 5: Pilot interview
March – April 2015
Study 5: Staff interviews
August 2016
Study 4: Assessment data accessed (January 2012 year 1 and 2, June 2012 year 1 and 2, June 2014 year 4)

1.1 Background and motivation for the study

This section describes my professional background to give an insight into the rationale for carrying out this project. The brief reference to methodologies will be expanded upon in later chapters.

I approach this study not as a vet, nor as a qualified anatomist, but as an observer of anatomy teaching primarily through the delivery of practical classes. I originally trained in audiology, before moving to London and accepting a post as a junior technician in the anatomy department of the Royal Veterinary College's (RVC) Camden Campus. I quickly became fascinated by what the students were learning and endeavoured to learn more anatomy myself through reading texts during my commute, and pre-dissecting cadavers to show anatomical structures for use in class. As my knowledge of anatomy developed so did my role within the vet school and I was offered opportunities to demonstrate anatomy during practical classes.

I was able to further develop my career when I was offered the position of Senior Teaching Technician at the new School of Veterinary Medicine and Science (SVMS) at the University of Nottingham. Here I led the team supporting practical classes through the sourcing and preparation of cadaver materials. The new school had developed a curriculum in which the subject of anatomy is delivered using a clinically oriented approach, whereby the students have the opportunity to learn anatomy alongside the application of the knowledge, such as through practicing surgical techniques or diagnostic imaging for example. This interested me as my previous experience had been gained around a more traditionally structured curriculum, in which students studied the basic sciences during the first two years, before moving to an entirely separate campus to study the clinical sciences.

However, I found the clinically integrated classes to be labour intensive for my team and other staff members. The approach required a considerable investment of time from clinical staff and the high turnover of fresh cadaver materials used to practice clinical techniques necessitated vigilant planning of space and time requirements of collection and preparation of specimens, in addition to the financial costs to the school. Moreover, the desire to work ethically and to adhere to the health and safety and legal requirements of transporting, handling and disposal of cadaver materials can prove challenging.

The difference in the two approaches raised questions about the educational impact of the method of delivery. I questioned whether all the additional work required to deliver the clinically integrated classes was generating an appropriate and useful academic output in terms of students' knowledge and competence. A transition to a teaching-based role enabling a slightly different perspective further drove my desire to carry out this research. I became keen to explore student perceptions of the process of learning anatomy and the place of anatomy within both the veterinary curriculum and the veterinary profession and discovered that others had asked similar questions about the impact of anatomy teaching in Higher Education.

In designing this research I was aware that how data are collected, analysed and interpreted are all influenced by the researcher's own assumptions and experiences (Partington, 2002) and that recognising these assumptions is important in remaining objective, and this will be discussed in later chapters. As my past experiences had led me to no particular research paradigm, I have chosen a mixed methods approach based on the requirements of appropriately investigating my research questions, rather than any pre-conceived ideas of how research is best conducted. Cohen et al. (2011) describe mixed methods research as working with the fact that the world itself is not exclusively quantitative or qualitative, and I find I concur with this view, myself believing that there is a risk of forgoing a deeper understanding of a phenomenon through limiting the approach used. Using a combination of complementary methods has enabled me to gather large amounts of quantifiable data for statistical analysis and comparison of data across schools, alongside rich qualitative data allowing for exploration of experiences and motivations of student learners.

Through carrying out this research, I aim to present a picture of how anatomy is taught in the veterinary curriculum, as well as understanding the motivations of veterinary students in learning anatomy and if this correlates with assessment performance and professional outcomes. Education is a vast and complex topic, but by continuing to build upon the growing body of evidence in clinical education literature, we can better understand the learning process, and better facilitate understanding. This must ultimately benefit the veterinary profession.

1.2 Context

The School of Veterinary Medicine and Science (SVMS) at the University of Nottingham employs a horizontally and vertically integrated systems-based curriculum. It was designed implementing an outcome-based approach as described by Harden (1999a). Outcome-based Education (OBE) focuses on the attributes required of a veterinary graduate and aligning the curriculum to these outcomes. The course at SVMS is designed to promote a deep learning experience through providing clinical context for the basic sciences. Modules are delivered by body system and are integrated horizontally with basic science subjects and with personal and professional skills; and vertically, emphasising clinical relevance through the introduction of clinical concepts early in the course. Anatomy is considered an embedded module, due to its horizontally integrated nature. Models of curriculum integration are illustrated in Figures 2 and 3.

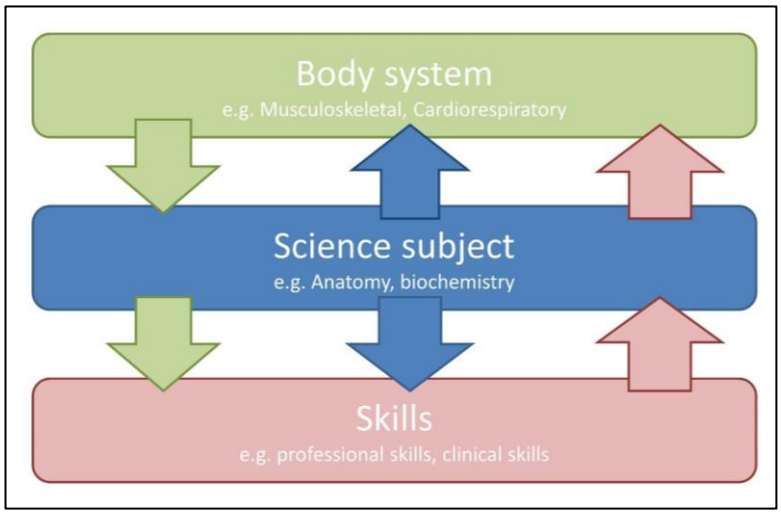


Figure 2. Model of a horizontally integrated curriculum
Horizontal integration is demonstrated by the arrows linking science subject with skills and body systems.

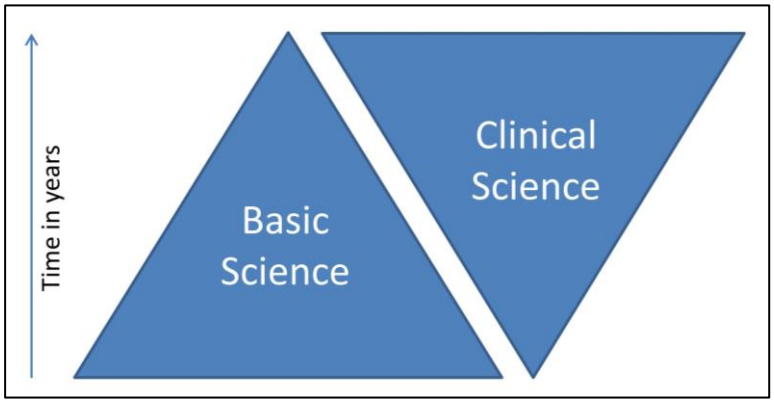


Figure 3. Vertical integration is illustrated to show basic science content reducing as clinical science delivery increases.

The SVMS course is a 5-year course and students are awarded the Bachelor of Veterinary Medical Sciences (BVMedSci) degree at the end of their 3rd year and the Bachelor of Veterinary Medicine Bachelor of Veterinary Surgery (BVM BVS) at the end of their final year. The curriculum follows a spiral model as described by Harden (1999b). Students study each body system with a focus on basic sciences in years 1 and 2 and then re-visit each system in years 3 and 4 where the emphasis is on clinical science. Final year consists of workplace-based learning. An overview of the curriculum is included as Figure 4.

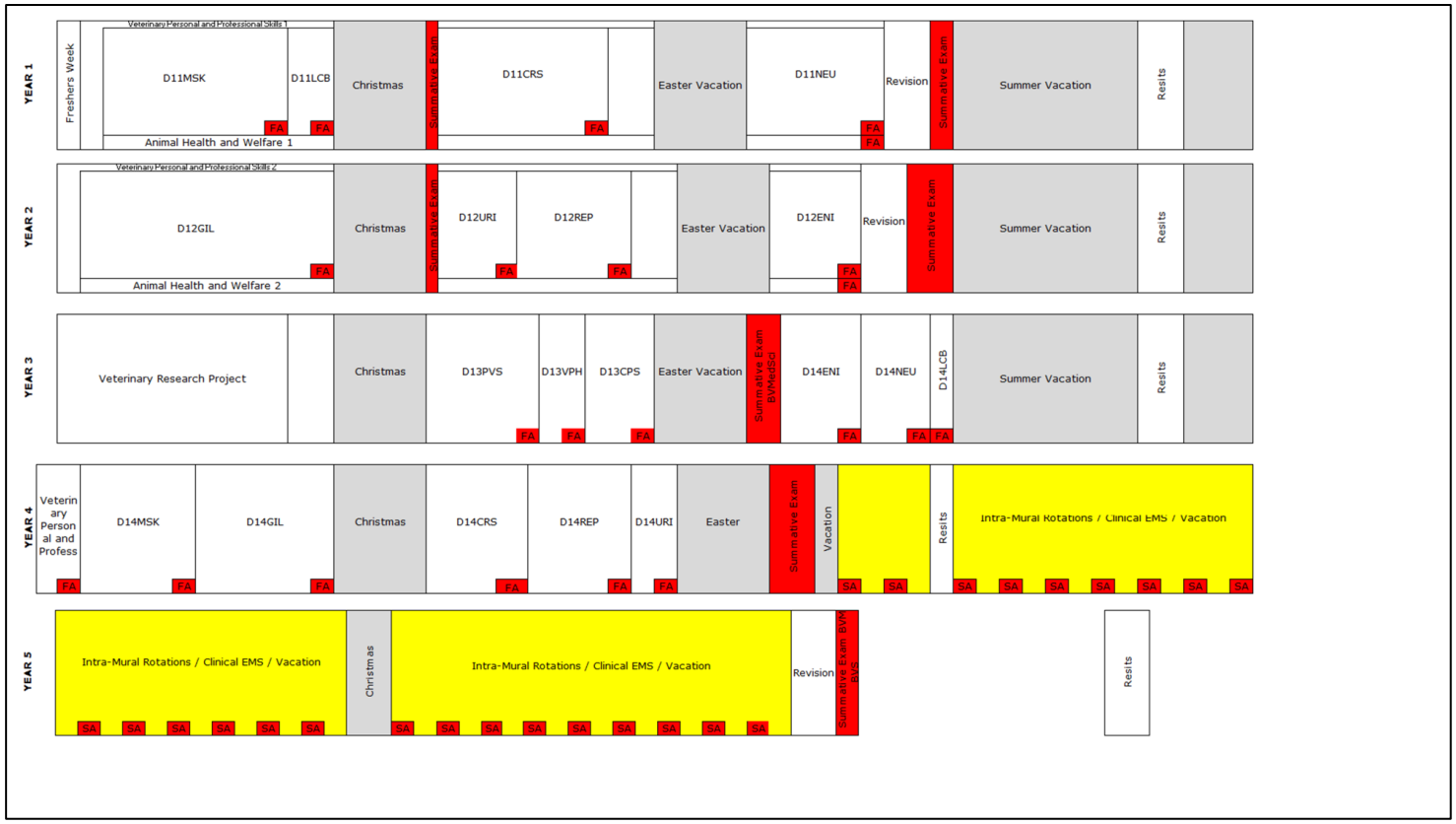
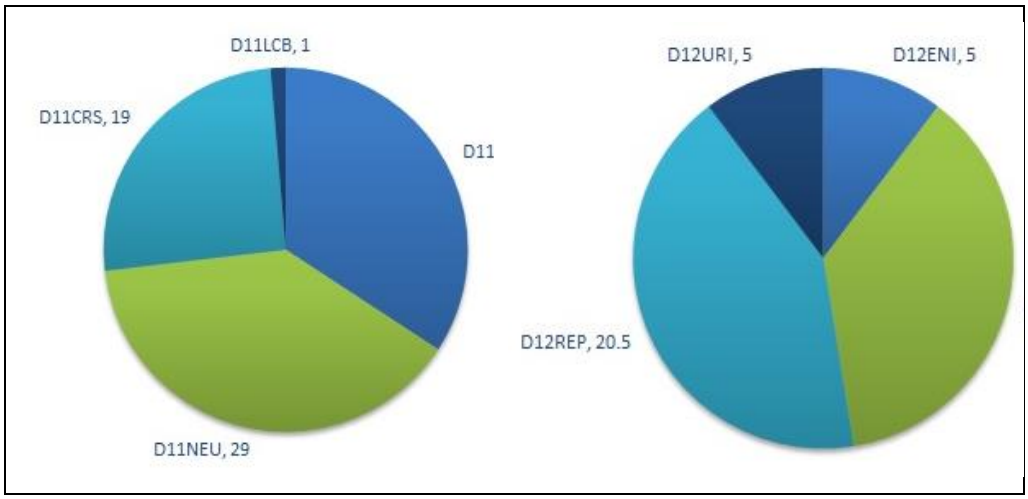


Figure 4. The SVMS curriculum overview. Key to the modules: MSK, musculoskeletal; LCB, lymphoreticular cell biology; CRS, cardiorespiratory; NEU, neuroscience; GIL, gastrointestinal; URI, urinary; REP, reproduction; ENI, endocrine and integument; PVS, principles of veterinary science; VPH, veterinary public health; CPS, clinical and professional skills; FA, formative assessment; SA, summative assessment.

During the first and second year of the course 32.1% and 26.6% of timetabled hours respectively are supervised practical teaching, and comprises this method of delivery. Of the time allocated for practical sessions in year 1, 42.1% is spent in the dissection facilities, compared to 33.0% of year 2 allocated practical time. The division of this time according to each module is illustrated in Figure 5.



a *b*

Figure 5. Hours spent in cadaver practicals by year and module. a: Year 1; b: Year 2. Module codes: D11LCB, lymphoreticular cell biology; D11MSK, musculoskeletal system; D11NEU neuroscience; D11CRS, cardiorespiratory system; D12URI, urinary system; D12ENI endocrinology; D12GIL, gastrointestinal system; D12REP, reproductive system.

Fresh and preserved complete and part cadavers of the major domestic species are used for practical teaching of anatomy in years 1 and 2. Whilst this teaching is generally referred to as dissection, a combination of methods are employed; traditional dissection, the demonstration of pre–dissected prosections, and practising practical clinical techniques. Table 1.1 illustrates the different teaching methods of teaching using cadaveric materials used in the dissection laboratory at SVMS. Examples used are taken from the year 1 musculoskeletal module.

Table 1.1 Teaching methods using cadaver materials

Teaching method	**Description**	**Example learning objective**
Traditional dissection 	Students sit typically four to a table to dissect out anatomical structures according to a dissection guide or task sheet. Staff members are available for guidance	Dissect and identify the major structures involved in the canine shoulder, elbow and carpal joints and the digits on a cadaver specimen
Demonstration using prosections 	A demonstrator will use a prosection to point out highlight anatomical structures. This can be performed to groups of students around a specimen, or to the class as a whole via a camera	Identify the main extensor and flexor groups of the forelimb and hindlimb and describe their function
Practising clinical skills 	Students use cadaver material to practise skills or techniques that will be used on live animals later in the course. Examples include ultrasound examination, epidural injection, endoscopy etc.	Inject common perineural and intra-articular sites of a cadaver equine distal limb

1.2.1 Assessment

The assessment strategy within SVMS is designed to student progress toward overall clinical competency to meet RCVS Day 1 competences (RCVS, 2014). The strategy is designed to assess competences and skills and underpinning professionalism and knowledge through a range of appropriate assessment formats. In years 1 to 4, skills, behaviours and knowledge are assessed using a variety of summative examinations. Knowledge is principally assessed online using Multiple Choice Questions (MCQs), Extended Matching Questions (EMQs), Fill in the Blanks (FIBs), imaged-based hotspot and drag and drop questions, short answer questions and spot tests. Assessment of skills and behaviours is carried out through coursework, presentations, Objective Structured Practical Examinations (OSPEs), Objective Structured Clinical Examinations (OSPEs), Animal Handling Directly Observed Procedural Skills (AHDOPS), research projects, reflective portfolios and completion of a skill diary. In year 5 students undertake several workplace-based assessments including Directly Observed Procedural Skills (DOPS) and a Rotational Professionalism Assessment (RPA). These are followed by end of year online exams including higher level multiple choice around a series of case scenarios or vignettes and clinical reasoning. The focus in this thesis is on assessment of knowledge in years 1- 4. A brief description of formats relevant to this thesis and example questions are provided in Table 1.2.

Assessments take place in January and June, and practical and written formats are employed. Anatomy teaching at SVMS is delivered as an embedded, or integrated module and as such, anatomy is assessed as part of body system modular assessments. Each assessment is blueprinted to the curriculum map to ensure content validity. External examiners are employed to ensure comparable academic standards and objectivity. At the time this research was conducted, students were required to achieve a pass mark of 50% in each module in any given year before progressing to the subsequent year. Each academic year carries 120 credits. First year modules D11MSK (musculoskeletal system), D11CRS (cardiorespiratory system) and D11NEU (neuroscience) are worth 30 credits each, second year D12GIL (gastrointestinal system) and D12REP (reproduction) modules 40 and 20 credits respectively. The year four musculoskeletal module, D14MSK is a 25-credit module. In the case of year 1 and 2 Observed Structured Practical Examinations (OSPE), a pass in seven out

of ten stations was required for each year of study before progression to year 4.

Table 1.2 SVMS assessment formats relevant to this thesis

Format	**Description**	**Year of study**
Multiple choice questions	Delivered online. Includes extended matching and diagrammatic images. Intended to assess knowledge and the application of knowledge	1-5
Spot test	Multiple stations containing trigger material prompt short answer responses. Intended to assess knowledge and the application of knowledge	1-4
Objective structured practical exam (OSPE)	Series of stations assessing completion of a practical task against a checklist of objectives. Intended to assess practical skills	1-3

2 Literature Review

The literature review for this thesis will be divided into two main sections for ease of navigation. The first section presents fundamental theories and practices within higher education in order to understand how students approach their learning as individuals. A particular characteristic of anatomical teaching is that it commonly consists of an abundance of dry facts that must be memorised to be reproduced in assessments. However, this method of learning is known to be of poor quality and readily forgotten (Marton and Säljö, 1976) and therefore particular attention is paid to approaches to learning in this review. Assessment is also widely accepted as affecting student learning and as such this section will also include a review of literature on assessment in higher education and in anatomy. It includes Biggs' model of constructive alignment (Biggs and Tang, 2011) and how it relates to learning taxonomies.

The rise in educational research has afforded more attention to be paid to the teaching of anatomy, which has been studied in largely the same way for thousands of years. The second section of the review will explore the history of anatomy teaching up to the present day including challenges faced by students and educators in the anatomy curriculum. This section will review anatomy teaching from secondary school curricula and the transition to undergraduate education, including methods most commonly used, the impact of technology and imaging techniques, and the impact of the spiral curriculum on the transition to practice. The chapter concludes with an overview of factors influencing student learning in anatomy.

2.1 Learning in Higher Education

Drawing on Plato's concept of the upward ascent, and the ideas of the cardinal John Henry Newman, Barnett (1990) defines Higher Education as 'A higher form of understanding gained through self-reflection on what is taken for knowledge'. As a final stage of formal learning following achievement of qualification at level 3, (A-level or equivalent), an undergraduate degree should prepare students for a profession or post-graduate education. On completion of a higher education qualification, graduates should have learned how to learn, and should be equipped to continue as lifelong learners, adapting to new information. Higher Educational research is concerned with achieving a better understanding of

this educational process with the aim of improving its effectiveness. The focus of this thesis is anatomy education in the veterinary context, but wider higher educational principles apply and will be explored in this section.

The topic of student learning is vast and multifaceted, not least because there are many factors affecting the learning process, and students are diverse in their individual ways of working and processing information. Some of the major models and theories on styles of learning are introduced in this section to illustrate the context against which this research is set. Anatomy is commonly portrayed as a subject consisting of many facts that must be memorised, or learned by rote. This 'surface' approach to a topic has been found to be less effective in producing high quality learning than a 'deep' approach, whereby an understanding of a subject is sought (Marton and Säljö, 1976). Therefore, in this section particular emphasis is centred on theories concerning student approaches to learning and if anatomy is, or can be learned through a deep approach.

2.1.1 Learning styles

Learning styles research explores the idea that learners have different preferences for ways of learning and thus different modes of instruction are more or less effective for different individuals. By recognising learners vary on an individual basis, instructors can 'mesh' delivery methods to accommodate differences in abilities, styles and preferences to improve learning outcomes (Jonassen and Grabowski, 2012). In dissection practical classes at SVMS 3 different methods of teaching anatomy are used to facilitate individual learners' needs.

The topic of learning styles is vast and wide ranging, with several theories, models and measurement tools developed and applied across various disciplines in higher and secondary education. However, this diversity has led to disparity in interpretation and application of theories on the topic (Smith et al, 2002), and the field of learning style research has been criticised for its use of confusing terminology, poor measurement and a lack of validity (Peterson et al., 2009). Whilst there is no widespread acceptance of any one theory to determine individual learning differences, there is general consensus that the learning process varies at an individual level, and that the way in which a student approaches a learning situation has an impact on learning outcome (Smith, 2002).

A demonstration of the construct of learning behaviour has been provided by Curry in the onion model, shown in Figure 6 (Curry, 1983, Curry, 1987). This model distinguishes concepts on the basis of their stability, organised as the layers of an onion. The model assumes that the further out in the onion a concept is positioned, the more it is influenced by external factors, and hence less stable.

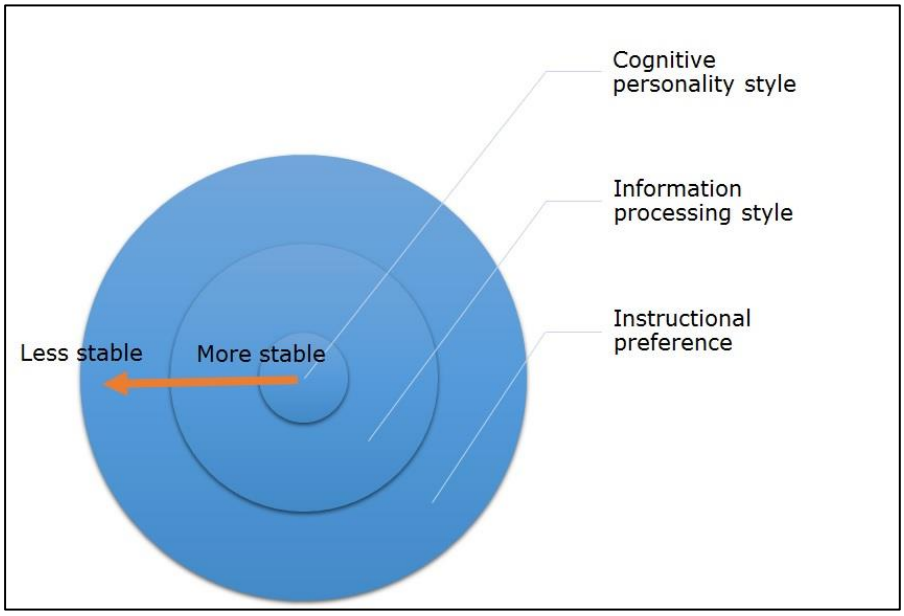


Figure 6. Curry's onion model of learning behaviour, adapted from Curry, 1983

Cognitive Style

Rooted in cognitive psychology, the cognitive style construct describes individual ways of perceiving, organising and processing information, distinct from the environment. It is the most stable trait of those in Curry's model, only visible when observing behaviour across several learning situations (Riding and Cheema, 1991). Research focused on cognitive personality includes Myers-Briggs Type Indicator (Myers, 1962) aimed at measuring personality type. However, its value in educational research is inconclusive (Coffield et al., 2004).

Information processing style

The information processing style level represents the individual's intellectual approach to assimilating information. It is to some degree determined by personality style and is modifiable by learning strategies. Influential work in this area was carried out by Kolb, who published his model of experiential learning in the 1980s (Kolb, 1984). His theory described a cyclic four step process whereby a learner engages in a learning experience, then reflects upon the experience before developing an abstract conceptualisation that is tested through active experimentation, as is shown in Figure 7.

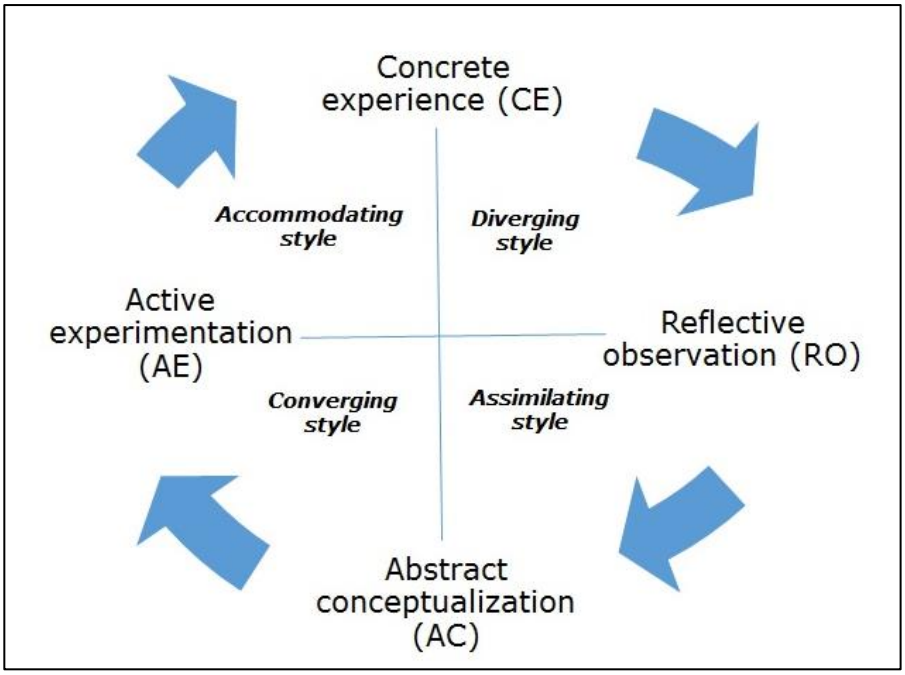


Figure 7. Kolb's experiential learning cycle, from Kolb, 1984

Kolb (1984, 2001) developed and later revised a self-report scale, the Learning Styles Inventory (LSI) in which respondents' scores reflect an individual's emphasis on the dimensions of prehension – the grasping of information from experience, represented by CE-AC; and transformation – the processing of information, represented by AE-RO. The scores enable categorisation into one of the four quadrants of learning styles, demonstrated in Figure 7.

- The diverging style approach combines reflective observation with concrete experience to integrate experiences with the self, adapting by observation.
- The assimilating style perceives abstract concepts and theoretical models.
- The converging style uses abstract understanding of the task to drive active experimentation.
- The accommodating style favours a 'hands-on' approach, solving problems by trial and error.

Individuals will show a preference for some stages and will therefore cope with these stages better than others in the cycle. Kolb emphasises the need to individualise instruction, and suggests preferred learning situations according to learning style. For example, a learner using the accommodating style would benefit most from practical experiences, with opportunities to receive feedback, and an assimilator style learner would learn most from lectures and self-directed reading (Kolb, 2000). However, McNeal and Dwyer (1999) used Kolb's LSI to ascertain learning styles of

nursing students. They found no significant difference between the students who had been assigned to a teaching group matching their learning style, those that had been assigned to a group that did not match their learning style, or those assigned to a control group. There is some debate as to whether matching or mismatching instructional style to learning style is most effective, and a review carried out by Smith (2002) found that for every study that supports the matching hypothesis, there is a study which rejects it.

Instructional preference

The outermost layer of Curry's model is instructional preference. As this is the layer involving most direct interaction with the learning environment, it is the least stable of the layers. It is also the layer most susceptible to pedagogical influence (Curry, 1983). Dunn et al's (1989) model of learning style preferences focuses on instructional preferences and divides the concept of learning styles into five streams: environmental; emotional; sociological; physical; and psychological. Versions of Dunn et al.'s LSI, designed to measure these instructional preferences have been adapted for use with children and adults. The VARK model developed by Fleming and Mills (1992) is widely recognised and frequently used due to its ease of accessibility and limited number of questions (Husmann and O'Loughlin, 2018). This model proposes four modalities in which students prefer to receive information: visual, auditory, read/write and kinesthetic. However, models claiming to measure instructional preferences have come under increasing scrutiny and have been criticised for their lack of validity (Li et al., 2016), and Pashler et al. (2008) found that few studies met rigorous methodology standards.

2.1.1.1 Approaches to learning

During the 1970s a body of research drawing on an alternative perspective and using terminology such as 'strategies' and 'approaches' began to emerge. Researchers in this area worked with models that describe the way in which a student will choose to tackle a particular task, taking into account its perceived demands. In this way an approach to learning is different to a learning style in that it is less fixed. Laurillard (1979) highlights the difference between learning approaches and learning styles, in that a style indicates a preference for a particular way of learning. A learning approach, however, is adopted in a particular context, and the emphasis is not solely on the individual, but on the learner's interaction with the

environment. An approach to learning includes not only process, but also intention (Entwistle, 1991), as such the approach to learning framework provides opportunity for manipulation of contributing factors to best achieve high quality learning outcomes.

Research in this area commonly discusses the dichotomies of high quality learning approaches versus low quality learning approaches. Ausubel et al. (1978) discuss meaningful learning versus rote learning, and this was reflected in the work of others including Pask's holistic and serialist strategies (Pask, 1976); Svensson's holistic and atomistic approaches (Svensson, 1977) and Schmeck's deep and elaborative processing (Schmeck, 1988). Biggs (1979) originally used the terms transformative and reproductive learning. The most widespread terminology in use today is that presented by Marton and Saljo (1976) of deep and surface approaches. Marton and Saljo asked students at a Swedish University to read academic texts and then subsequently examined their knowledge through interviews. During surface level learning the student focusses on 'the sign', and the recall of it. The emphasis is placed on the memorisation of information and ideas in isolation, with the intention of reproducing the material presented (Entwistle and Smith, 2002). Deep level processing involves the student directing their attention to what is signified, and seeking real meaning in the discourse (Marton and Säljö, 1976). In order to assess how students were using deep and surface level approaches in the learning process, Biggs (1979) developed the Study Process Questionnaire (SPQ). Biggs was able to identify a third approach which he named 'achieving'. In parallel work, a similar third category had been identified by Entwistle in his Approaches to Study Inventory, which he named as 'strategic' (Entwistle and Ramsden, 1983). This third approach involves using deep or surface approaches depending on what is deemed appropriate in order to achieve high grades. Students are known to combine an achieving approach with a surface or deep approach according to their motives (Biggs, 1987). Both questionnaires have subsequently been revised and have been used in a number of studies investigating student approaches to learning (Gow and Kember, 1993, Duff, 2004, Smith and Mathias, 2007).

Deep, meaningful learning allows for the establishment of concepts and ideas that can be related to experience and more readily utilised across different contexts. A number of studies have associated high quality learning outcomes with deep approaches to learning (Marton, 1997, Booth et al., 1999).

Table 2.1 shows a summary of the defining characteristics of the approaches to learning (Entwistle, 1997).

Table 2.1 Defining features of approaches to learning

Approach	**Intention**	**Methods**
Deep (Transforming)	To understand ideas for oneself	Relating ideas to previous knowledge and experience Looking for patterns and underlying principles Checking evidence and relating it to conclusions Examining logic and argument cautiously and critically Becoming actively interested in course content
Surface (Reproducing)	To cope with course requirements	Studying without reflecting on either purpose or strategy Treating the course as unrelated bits of knowledge Memorising facts and procedures routinely Finding difficulty in making sense of new ideas presented Feeling undue pressure and worry about work
Strategic (Organising)	To achieve the highest possible grades	Putting consistent effort into studying Finding the right conditions and materials for studying Managing time and effort effectively Being alert to assessment requirements and criteria

Whilst the terminology used to describe approaches to learning can invoke a perception of those students applying a surface approach as being lazy, this is not the case. Some students adopting this approach invest large amounts of time and energy into it (Fransson, 1977), and it can be a major cause of fatigue and perceived overload in students. Moreover, this approach can appear successful if the assessment process rewards surface learning (Newble and Entwistle, 1986).

Factors affecting approaches to learning

Approaches to learning differ from learning styles in that students will use different approaches for different tasks. The approaches to learning concept remains influential in higher education as educators endeavour to design learning activities that encourage deep approaches to learning. Fransson demonstrated that the approach to learning used is dependent on the student's intentions, motives and interest in the topic, and also on assessment demands (Fransson, 1977). Biggs built upon this work in his Presage-Process-Product (3P) model, and demonstrated how various factors interact to affect learning and this is displayed in Figure 8 below (redrawn from Biggs,1994).

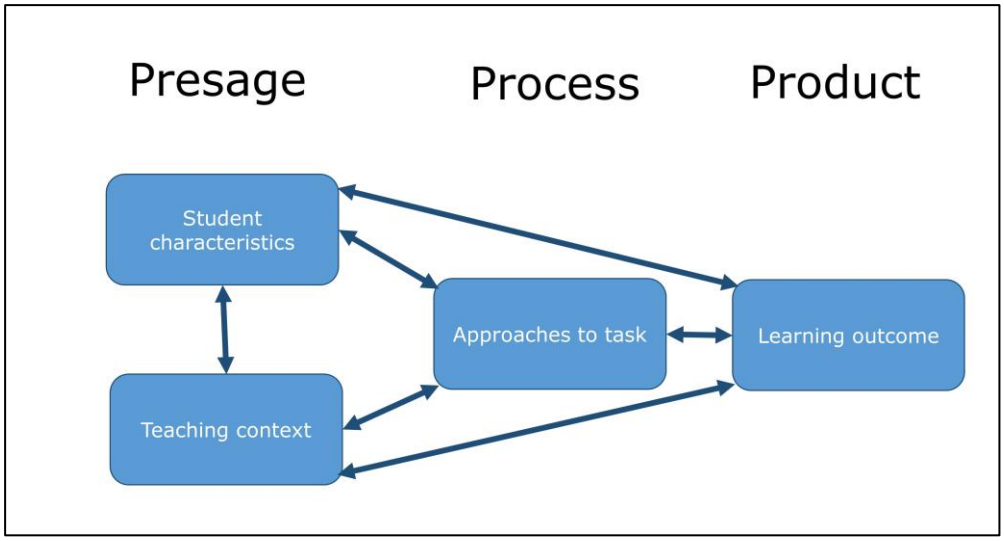


Figure 8. The 3P model of teaching and learning (Biggs, 1994)

Presage factors Biggs defined as factors which exist independently of the learning situation. They can be personal such as ability; or situational such as learning tasks and objectives. Process factors include a student's approach to learning. Presage factors will influence process factors to create the product, the learning outcome (Biggs, 2001).

When comparing the learning environments of nursing programmes Cowman (1998) found constituents of teaching context such as perception of the task and assessment to have

page 117the greatest influence on a student's approach to learning, supporting the earlier work of Entwistle and Ramsden (1983). This would indicate that the creation of an academic environment in which a deep approach to learning is encouraged results in higher quality learning outcomes.

Ruohoniemi and Lindblom-Ylänne (2009), asked veterinary students to report factors most influential in learning, and found that students cited the teaching environment and practices rather than any intrinsic causes. However, as the authors themselves acknowledge, this could be due to students finding it more difficult to report on their own contributions to a learning task. Most commonly cited as an impediment to learning was curriculum overload (Ruohoniemi and Lindblom-Ylänne, 2009). Ryan et al. (2004) in their study of pre-clinical veterinary students found that perception of a high workload correlated positively with a surface approach to learning, with some students reporting feeling trapped by time restraints and having too much information to learn.

In a further study, Ruohoniemi et al. (2010) found that students applying a deep approach, but with poor organisational skills suffered the most with workload. Planning of the learning task, monitoring one's own understanding and reflecting upon and responding to learning errors is known as metacognitive self-regulation and has been shown to lead to a deeper understanding (Ross et al., 2006), and as such Ruohoniemi et al. propose the need to make students explicitly aware of their approaches to learning in order to support their development. The teaching of metacognitive skills to students was supported by Naug et al. (2011) in a study of first-year anatomy students in Australia. Naug found that students appreciated an activity combining metacognition with active learning as increasing self-awareness of their own learning.

Approaches to learning and assessment

Assessment is widely accepted as influencing student learning. Svensson (1977) investigated relationships between learning approach and examination performance and found that the search for understanding of the subject matter made the topic more interesting to those adopting a deep approach. They were more inclined to spend longer hours studying, and subsequently performed better in assessments. The rote learning methods associated with surface learning proved to be tedious and unrewarding. Students employing this method spent less time studying. Employing an achieving approach used in combination with a deep approach resulted in good assessment performance and feelings of satisfaction. (Biggs, 1987, Ramsden, 2003).

Newble and Entwistle (1986) stress the importance of assessment in directing medical students' learning. They note that a failure to interest students in the preclinical subject matter, or of its vocational relevance will likely encourage the use of surface or strategic approaches. As such, if students are to be encouraged to adopt a deep approach to learning, assessments should be designed appropriately, ensuring that skills and attributes other than factual knowledge are evaluated and rewarded.

Anatomy teaching and approaches to learning

The teaching of anatomy can entail delivering a large amount of detailed factual information, which can encourage students to adopt a surface, rote learning approach to the topic (Newble and Hejka, 1991). Furthermore, attempting to condense vast, detailed textbooks into easy to memorise tables and mnemonics can later hinder the application of 'learned' knowledge in practice (Miller et al., 2002), and reinforces the message that anatomy is a subject to be memorised rather than understood.

This leads to the question of whether the largely factual topic of anatomy can be studied using a deep approach. Grant suggests students are able to 'reason anatomically' once the underlying principles of the subject are understood (Grant 1937, cited in Eizenberg 1988). Ward (2008), when researching medical students learning human anatomy, found that the majority of participants were utilising deep approaches to study. Similarly, Smith and Mathias (2007), found that undergraduate medical students favoured the use of deep approaches in their learning of anatomy.

It has been suggested that practical classes support deep learning strategies (Coffield et al., 2004, Ryan and Sweeney, 2004). However, Ryan et al. (2009) found no significant correlations between approaches to learning and practical classes involving the use of cadavers. Nevertheless, Smith and Mathias (2011) found that students using a deep approach to learning anatomy were more likely to agree that the 'hands on' approach of dissection was important, and that it was an important factor in building links and relationships to enable understanding.

Pandy and Zimitat (2007) suggest that anatomy may be one area in which the distinction between deep and surface learning is blurred. They found that nearly half the students they studied adopted memorising techniques, but that these were used most commonly in conjunction with understanding and visualisation techniques. This raises the question of

whether the use of mnemonics is an indication of surface learning, or if students who usually practice deep learning techniques use these as frameworks to build on. These authors also suggest that it is the balance between the approaches that is the key. This reflects Entwistle and Ramsden's proposal (1983) that the complex use of vocabulary in the sciences can result in the need for rote learning in the preliminary stages, with the intention of gaining the required framework for subsequent deep learning. Wilhelmsson et al. (2010) report that students vary their approaches between the whole body and the detail of the structure and that the dichotomy of deep and surface learning is a pseudo problem as most students recognize the need to master both learning techniques.

The reality of the place of anatomy within a medical curriculum as but one subject in amongst several others has been highlighted by Eizenberg (Eizenberg, 1988). He found that although 94% of students expressed an intention to fully understand anatomy, 62% 'realistically' shifted their intentions to avoiding failure when considering the entire workload.

It is evident that educators are influential in how students perceive a curriculum. In encouraging students to adopt a deep or holistic approach to learning anatomy factors to consider are those discussed above; namely assessment, workload and excessive detail in the curriculum. Furthermore, the integration of anatomy in such a way that the student understands the animal as a whole and how this understanding is applied in professional practice.

2.2 Anatomy teaching in UK Education

Anatomy as a subject has been studied for thousands of years and is a cornerstone of medical, veterinary and allied healthcare courses. With the rise of educational research, more attention has been afforded to the learning activities used in anatomical education. However, in order to understand the issues particular to anatomy teaching it is important to understand the subject in the context of its history. A summary of the teaching of anatomy in the UK, and the evolution of anatomy in education is presented in this section.

2.2.1 Anatomy in schools

Students arrive at vet school with little in the way of anatomical knowledge and minimal, if any, experience of dissection. As a result of this, students beginning a veterinary course have to encounter terminology and concepts unfamiliar

to them, as well as face the potentially traumatic position of working with cadavers for the first time.

Examination boards are responsible for setting and awarding level 2 and level 3 qualifications in the UK, and are selected by the individual school. The most commonly used awarding bodies in the UK are AQA, Edexcel and OCR. Each exam board produces a specification document available online (AQA, 2018, OCR, 2018, Pearson Education Ltd, 2018). Examination of A-level specification documents for this thesis found that anatomy is variably covered in secondary school curricula and is delivered at a basic level. Furthermore, subject choice will influence a student's experience of anatomy teaching. Level 3 Physical Education covers more anatomy than level 3 Biology, but this qualification is not accepted by all UK vet schools and has a necessarily human focus. Anatomy in schools is also largely theoretical and there is virtually no comparative anatomy, as most outcomes are centred on human anatomy, with some inclusion of fish and insects. A list of relevant outcomes extracted from the specification documents for A-Level Biology is available as Appendix 1.

The lack of anatomy teaching at secondary school level is surprising considering the number of tertiary education subjects containing the topic as part of a wider course. A search of courses on Universities and Colleges Admissions Service (UCAS) returned 119 undergraduate degree courses containing an anatomy component, and a further 20 other tertiary level courses such as higher national diploma (HND) across 37 Universities and colleges in England, Scotland and Wales.

Reasons for excluding dissection in secondary schools include cost and health and safety concerns. Ethical issues such as offense caused to students, lessening of the respect for life, and taking of a life (when not abattoir derived) are also cited (Lock and Reiss, 1996). However, a study led by A-level students asking their peers opinions on the science curriculum found that 86% of their peers would like to be given the choice to dissect (Murray and Reiss, 2005). Student recommendations from the study, endorse the notion that schools should provide the opportunity to dissect, and allow the individual student to choose. This would at least provide opportunity for students to consider what certain careers may entail (Lock and Reiss, 1996)

2.2.2 Why teach anatomy?

Anatomy is the basis for understanding the normal function of animals. It is the foundation for recognising how normal

function can be affected by damage, disease or developmental defect and consequently how normal function can be restored. Knowledge of normal anatomy and comprehension of the topographic relationships between structures is essential for carrying out clinical examinations (Lockwood and Roberts, 2007), for imaging (Allen and Roberts, 2002) and for practicing many clinical procedures safely (Fitzgerald et al., 2008). Furthermore, aside from the overt learning objectives, other outcomes of anatomy teaching include the introduction of medical terminology, a 3D appreciation of the body, an appreciation of biological variation and also professional skills such as teamwork and the development of manual skills among others (Patel and Moxham, 2006). With the advent of more sophisticated imaging technologies such as computed tomography (CT) and magnetic resonance imaging (MRI), a thorough understanding of the 3D structure of the body is arguably of more value than ever.

2.2.3 A history of dissection and anatomy teaching

Human interest in anatomy is said to date back as far as prehistoric times, with cave paintings depicting animal anatomy thought to be drawn from animal carcasses before 5000 BC (Kalof, 2007), and the oldest record of veterinary medicine is from Babylonia, where Urlugaledinna (3000 BC) was said to be an 'expert in healing animals' (Jones, 2011). Anatomy teaching was developed in Alexandria, Greece. Aristotle (384 – 322 BC), said to be the founder of biological science and perhaps the best known of the Greek biologists is understood to have practiced dissection in his methods. His texts Parts of Animals and The Gait of Animals included several illustrations and thoughts on function (König et al., 2007). Galen (c. 130 AD – 210 AD) followed, producing the first work to be published on practical anatomy, dissecting animals and equating the results to the human body (Cole, 1944).

Veterinary education was stagnant during the Middle Ages, although pigs were dissected for the purpose of human medicine as a consequence of a ban on human dissection imposed by the church (Bouchet, 1996). Leonardo De Vinci revived the discipline, with his interest in comparative anatomy as the indirect result of his work as a painter and sculptor (Figure 9). The publication of "De Humani Corporis Fabrica" by Vesalius in 1543 (Figure 10), brought about a more scientific approach, and direct observation of the body

by students (Aziz et al., 2002). However, study of animals was largely for the purpose of extrapolation to the human form, reflected in the nomenclature applied to animals.

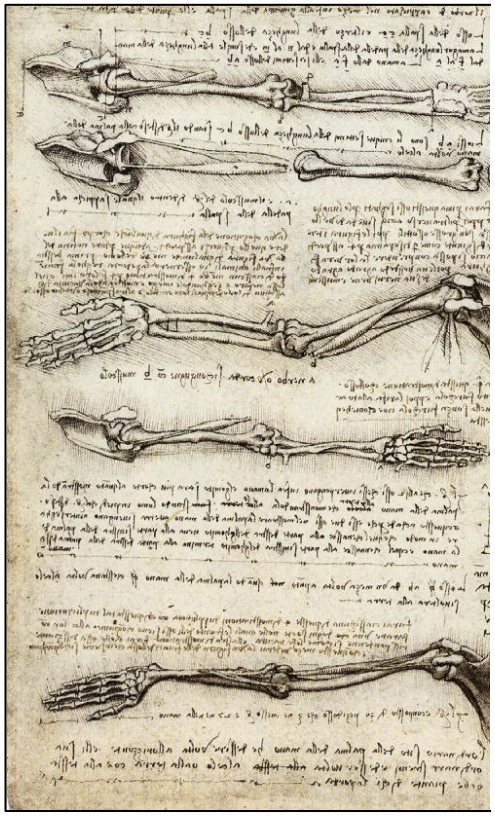


Figure 9. Da Vinci's study of the right upper limb, showing examination of movement and function



Figure 10. Frontispiece of Vesalius' De Humani Corporis Fabrica, 1543

The anatomy of the horse was practically unknown until 1598, when Carlo Ruini published the veterinary anatomy handbook Dell' Anatomica e delle' Infirmita del Cavallo, a comprehensive monograph on the anatomy and diseases of the horse (Figure 11).

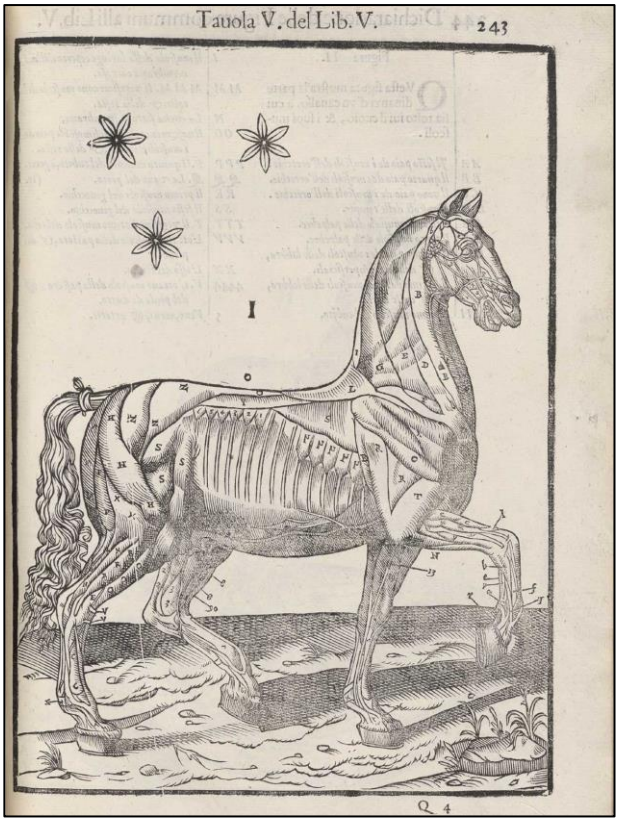


Figure 11. Illustration of the equine musculature from Dell' Anatomica e delle' Infirmita del Carvallo; Carlo Ruini, Venice, 1598

Vesalius, and later Fabricius occupied the chair of anatomy position at the medical school in Padua, which housed a veterinary anatomy theatre (Figure 12). It was a student of Fabricius, William Harvey who was later able to accurately describe how the blood circulates through the human body. He practised dissection and experimentation on the circulatory system of animals in 1628, and held in interest in the comparative anatomy of the heart. He is credited with advancing anatomy as an area for experimental research and an increased focus on animals as an area of study in themselves (Cole, 1944).

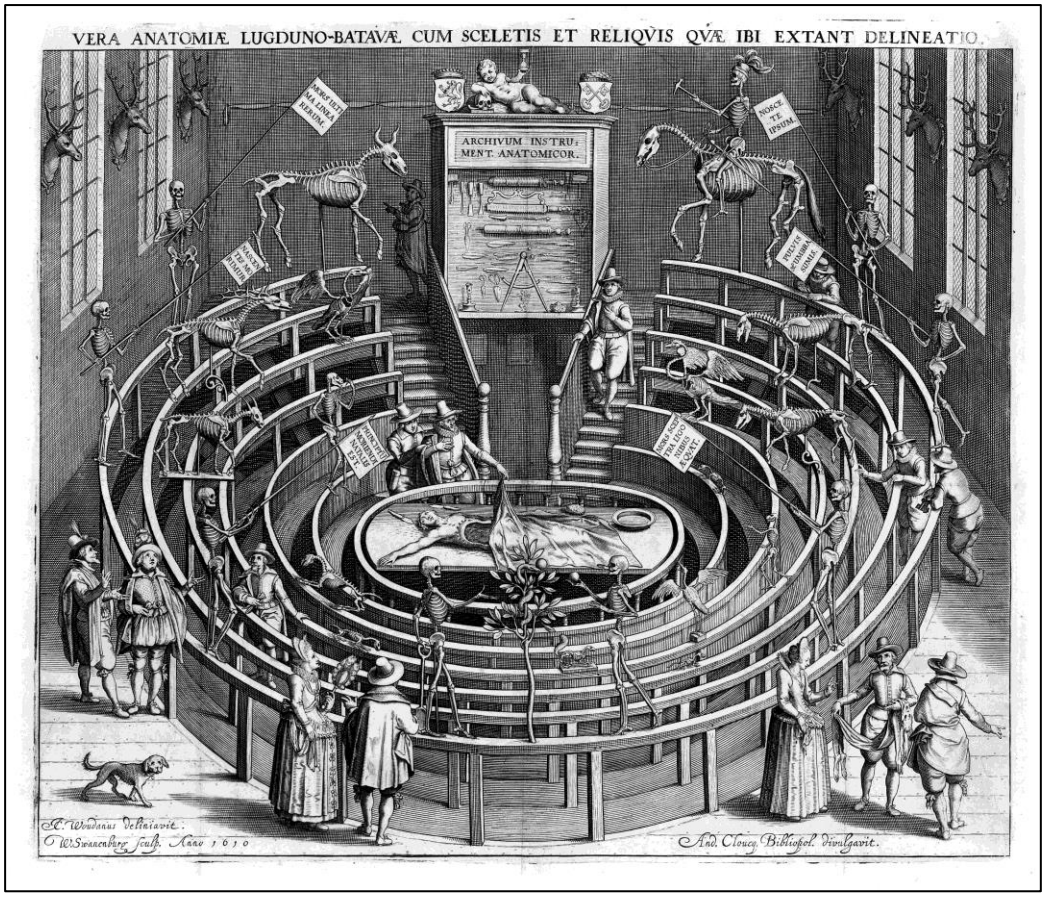


Figure 12. Padua-style demonstration theatre, the likes of which are still in use today

Anatomy's intrinsic link to art continued. George Stubbs (1724 – 1806), as a young artist, made use of his father's tannery to dissect horses and dogs, and continued his dissection of horses following artistic training. A description of his dissections show little change from those in use today, as can be seen by this excerpt from Fountain (1968):

The horses were bled to death by cutting the jugular vein and the blood vessels were injected with tallow. He lifted the carcase with a tackle of hooks and bars attached to the ceiling: the beast's feet were arranged in suitable positions on a wooden plank beneath. He would then cut his way towards the skeleton, preparing the muscles layer by layer and drawing them as he went.

Stubbs painted for the anatomist and physician William Hunter (1718-1783), and continued comparative anatomy works until his death. Despite this, Stubbs is almost exclusively known as an artist.

The English anatomist Richard Owen (1830 – 1868) was pivotal in the resurgence of comparative anatomy as a discipline in Europe. He was concerned with the homologous nature of limbs in mammals, birds and fish, and offered

theories regarding their adaptations (Owen, 2008). While anatomy was developing as a scientific discipline, developments did not lead to the development of the veterinary profession. The treatment of animals focused on horses due to their economic importance and role in war. 'Horse doctoring' was carried out by farriers and horsemen with no formal veterinary education. The first veterinary school was founded in Lyon, in 1761 following the rinderpest epidemic in the eighteenth century, and a graduate of Lyon became founding Professor of the first vet school in Britain, the Royal Veterinary College (RVC), in 1791. Throughout the nineteenth century the veterinary curriculum was dominated by equine medicine, and surgery and anatomy were viewed as 'the cornerstone on which veterinary science is raised' (Kraft, 2004). As veterinary knowledge increased and the curriculum continued to expand, the publication of the Pew Report (Pritchard, 1989) marked a shift to the teaching of general competencies such as professionalism and communication skills. This was echoed in medical education after the publication of "Tomorrow's Doctors" (General Medical Council, 2009). These reports called for a reduction in factual knowledge, and a move to a more outcomes-based approach to education, reflected in veterinary education by a lack of specificity with regard to anatomical knowledge in the list of Day One Skills (RCVS, 2001). The recently published update no longer cites anatomical knowledge, instead referring to the graduate as needing an underpinning knowledge and understanding of the 'structure, function and behaviour of animals' (RCVS, 2014). Table 2.2 summarises events in veterinary education and anatomy teaching that have influenced veterinary education to date.

Table 2.2 Events influencing veterinary anatomy education

Date	Event	Description
1598	Carlo Ruini publishes "Anatomia del cavallo, infermita et suoi rimedii"	The first monograph on the anatomy of an animal (Cole, 1944)
1645	Severino's "Zootomia Democritea" published	He uses the term 'Zootomia' to mean 'animal dissection carried out to the point of indivisibility' Refers to an anatomy lesson as 'an anatomy'
1761	Claude Bourgelat establishes first veterinary school in Lyon	An equerry renowned for his skill in horse management established L'Ecole Vétérinaire de Lyon in France to teach equine medicine and as response to the economic and social devastation caused by Rinderpest (cattle plague).
1785	Odiham Agricultural Society proposes British Vet School	Proposed England needed its own system for farriery education
1791	Charles Vial de Sainbel establishes first veterinary school in Britain	Charles Vial de Sainbel was a Lyon graduate with a passion for the dissection of racehorses (Dunlop, 2004)
1844	Royal College of Veterinary Surgeons (RCVS) formed	The RCVS was formed after the Royal Charter was granted, recognising veterinary practice as a profession
1944	Second Loveday Report (Loveday, 1944)	The committee recommended that two new vet schools should be developed at Cambridge and Bristol, and that vet schools should be included within universities
1988	European Association of Establishments for Veterinary Education (EAVE) established	The accrediting body for veterinary education establishments in Europe
1989	Pew Report (Pritchard, 1989)	Called for an abandonment of the unrealistic concept of the omni-competent vet and for a focus on professional behaviours and the ability to find and use information rather than the accumulation of facts
2001	RCVS Education Strategy Steering Group (RCVS, 2001)	Listed the Day One skills expected of a graduate. 'Understand normal basic anatomy' is listed
2014	RCVS Day One Competencies (RCVS, 2014)	Anatomy no longer features in list of competencies

It is perhaps the subject's long history that leads many authors to discuss the traditions of teaching anatomy when evaluating methods of teaching in today's curriculum. Furthermore, in reflecting a divide in perceptions of how anatomy is best taught, anatomists have been described as either 'traditionalist' or 'modern' by some authors (Patel and

Moxham, 2006). The following sections therefore discuss different methods of teaching anatomy, including the traditional approaches of dissection and prosection, as well as more innovative approaches using computer assisted programmes and the integration of clinical skills.

2.2.4 Methods of teaching anatomy

The 'best' way of teaching anatomy is a matter of some contention in medical education. There is little conclusive data, and there are concerns regarding objectivity in relation to the subject. The majority of research into methods of delivery is carried out by anatomists, or by teachers developing new course designs. Thus there is an interest for the results to reflect their own teaching designs in a positive light (Winkelmann, 2007).

Patel and Moxham (2006) surveyed attitudes of anatomists toward different methods of teaching anatomy. Surveys were distributed to academics involved in medical teaching in Higher Education and to anatomical societies in Europe. Their findings showed that most anatomists (69%) favoured the use of dissection over other teaching methods such as prosection, living anatomy, didactic methods, models, and computer assisted learning. It can be argued that anatomists tend to be traditionalists (Turney, 2007) and therefore potentially resistant to curricular change. However, in their study, Patel and Moxham also measured attitudes toward curricular change. Their results indicated a general appreciation of educationists' input into medical curricula. However, while the authors report the number of responses, they do not report the response rate and the number of surveys originally distributed is not stated. The possibility must be considered that more traditionalist thinkers did not respond. Thus, the findings may not represent the perceptions of anatomists more widely.

Many have reported a reduction in time and resources allocated to anatomy teaching in medicine in the UK (Verhoeven et al., 2002, Older, 2004, Raftery, 2007, Fitzgerald et al., 2008). In 1993 the General Medical Council issued guidelines to medical schools calling for a reduction in the factual detail delivered in the medical curriculum (General Medical Council, 1993) and it has been suggested that by limiting time spent by students dissecting cadavers is having a negative impact on the knowledge of graduates (Patel and Moxham, 2008). Furthermore, there is interest in the impact of technological advances and increased use of digital computer based programs. Many researchers have discussed the educational benefits of traditional dissection versus

prosection-based courses or newly introduced computer-based programs. Moreover, an increasing amount of research has been published investigating the covert learning outcomes of learning anatomy in the dissection laboratory. Some of these matters will be discussed in the following section, however in light of a lack of published investigations into teaching methods in use in veterinary anatomical education; research discussed in this section has been drawn from wider clinical science curricula delivering anatomy, such as dentistry, nursing and medical education. It cannot therefore be assumed to be directly applicable to veterinary students.

Traditional methods of anatomy teaching: Dissection and prosection

The role of dissection in medical education has changed, with modern medical courses facing a reduction in time and resources allocated to the subject (Gartner, 2003, Waterston and Stewart, 2005a, Waterston and Stewart, 2005b). Some have removed cadavers from anatomical teaching entirely (McLaughlin et al., 2014). However, there is little in the way of evidence on the educational impact of dissection and prosections in the curriculum.

Dissection is seen by many as a key tool in the acquisition of anatomical knowledge, but is also appreciated for teaching other skills such as teamwork, time management, independent learning, self-reflection, manual skills and appreciation of individual variation (Older, 2004, Böckers et al., 2010). Many have professed dissection to be the most effective way of teaching anatomy either through published communications (Cahill and Dalley, 1990, Jones, 1997, Older, 2004) or through research studies (Sandra and Ferguson, 1998, Johnson, 2002, McWhorter and Forester, 2004). However, the designs of studies comparing methods of teaching anatomy have been criticised for showing a lack of sophistication (Winkelmann, 2007), with many studies exhibiting a lack of control of variables. For example by the very nature of dissection, students will usually spend more time on task in comparison to those learning by other methods, which is an important factor in learning (Bergman et al., 2008).

The demonstration of pre-dissected specimens, or prosections is cited as a more efficient way of delivering anatomical teaching than traditional dissection (Nnodim, 1990, Hasan et al., 2011), and a number of studies show the method to be at least as effective as students carrying out dissections themselves (Jones et al., 1978, Scott, 1993, Nnodim et al., 1996). In a study of pre-clinical medical students in Nigeria, Nnodim (1990) found the students that had studied anatomy

through the use of prosections performed better in both theory and practical examinations. In a follow up study of the same cohort investigating the long-term recall of anatomical knowledge, Nnodim found no significant difference between test scores of the dissection-based group or the prosection-based students. The results did however indicate that the non-dissecting group were more confident in their responses (Nnodim et al., 1996). As the prosection based course took only 74% of the time of the corresponding dissection course, the results support a move to this method of delivery. However, it should be noted that the sample sizes were small in these studies, with 42 participants in the original study, and 23 in the following investigation. Furthermore, the context of teaching medical students in Nigeria is quite different to that of veterinary students in the UK, thus the results of this study may not be directly transferable. The pressures of curriculum time are not only felt by educators but also by the students themselves, and working with prosections has been recognised as a more efficient modality of teaching by medical students (Dinsmore et al., 1999). Although there was a shift toward dissection by the end of the course, the majority of students still appreciated the efficiency of demonstration of prosection. However, the results of this perception-based research were not correlated with any educational outcomes.

The introduction of new techniques in specimen preparation has opened up new opportunities for teaching with cadaveric material. Plastination is the process of replacing tissue fluids and lipids with polymer under vacuum (Von Hagens et al., 1987). Plastination prevents dissected specimens from deteriorating, extending the life of a prosection and thus reduces the number of specimen preparations. Plastinated specimens are increasingly being adopted as a teaching resource in anatomy (Jones, 2002, Jones and Whitaker, 2009, Latorre et al., 2007), and their use has been well-received by undergraduate students (Latorre et al., 2007, Fruhstorfer et al., 2011). In a study of medical and veterinary anatomy students, Latorre observed significant differences in the post-test scores between the control group (learning from prosected wet specimens) and an experimental group learning with plastinated specimens. Students using plastinated specimens performed significantly better than those using wet specimens, despite similar pre-test scores. A similar analysis of fourth year veterinary surgery students in the study returned no significant differences between the two groups of students (Latorre et al., 2007). The absence of a significant difference between the two groups of fourth year students, and seemingly smaller gains between pre- and post-test

scores may indicate lower order learning outcomes were tested. Details of the content of the wet specimen class and of the questions used in the tests in this study make it difficult to draw conclusions for the reasons behind these differences.

Plastinated specimens are limited by their lack of flexibility, and this can create difficulties in exploring function and appreciating spatial relationships (Fruhstorfer et al., 2011), and are unlikely to replace the use of wet cadaveric specimens in their usefulness. However, plastinated specimens have the potential to benefit students' learning when used alongside wet specimens in the dissection lab. In particular, cross-sectional specimens can be of value to help understand diagnostic imaging techniques such as CT and MRI, and endoscopy (Magiros et al., 1997, De Barros et al., 2001). Furthermore, as biological material is replaced with polymer during the preparation process, plastinates can be used as supportive resources outside of the anatomy lab.

Contemporary anatomy teaching

There are many reasons cited for not teaching anatomy with cadavers at all, not least because of technological advances allowing for greater understanding of the body without the need for cutting in to it (Azer and Eizenberg, 2007). Other contraindications include health and safety concerns; a lack of cadavers; a lack of anatomists; time; expense; aesthetics; and the psychological distress caused to students (Aziz et al., 2002). There is a growing body of research into the psychological effects of first-year students working with cadavers (Horne et al., 1990, Evans and Fitzgibbon, 1992, Nnodim, 1996), many concluding that it has a detrimental effect on their well-being. However, there are others reporting that students rapidly develop coping mechanisms that result in a separation of perceptions of dissection specimens to living humans (Charlton et al., 1994). Others have seen the dissection experience as an opportunity to teach humanistic values (Dyer and Thorndike, 2000). Whilst any psychological effect would clearly manifest itself differently in the veterinary curriculum, there may still be potential value in dissection as an opportunity to discuss the death of a sentient being, and the issues of consent and ethical treatment prior to, and after death.

Availability of cadavers is an additional pressure in teaching anatomy, in both human and veterinary medicine. To address some of the issues raised by teaching with cadavers, there has been increasing focus on the use of supporting materials such as Computer Assisted Learning (CAL). Advantages of using computer software include the ability to see structures without

risk of damage, to study a range of sexes and ages of animal, to work at an individual pace with the opportunity to review sections a number of times (Predavec, 2001). There are a number of studies in veterinary education supporting the use of CAL in anatomy teaching (Linton et al., 2005, Josephson and Moore, 2006, Al-Khalili and Coppoc, 2014, Nemanic et al., 2016). However, it is suggested that as with plastinates, CAL is most beneficial as a supportive resource, and should not replace traditional cadaveric teaching in the veterinary curriculum. In a study of first-year veterinary students, Theoret et al. (2007) found that students performed better following study of the bovine abdominal cavity on a prosected cadaver when compared to students studying a video alone. Students were allocated to one of two groups based on their pre-instruction test score, to ensure an equivalent knowledge base. Instruction involved either a prosection demonstration or video instruction and a re-test of knowledge was performed. Both groups significantly improved their scores, but a statistically significant difference was found between the post-instruction scores of the two groups (p=.0007) in favour of the prosection group. However, all students were tested on a prosection, which may favour the group taught by this method, and the 'tag' method used tested recall. In order to replicate experimental conditions no questions were allowed in either group, nor were the prosection group allowed to touch the specimen. This is not representative of the real teaching situation in which students are encouraged to participate through asking questions and touch. The objective of Theoret's study was to determine if students would be able to transpose their video learning to 'real life', thus the author suggests a laparotomy as an alternative method of assessment of students' knowledge. This would test higher order learning outcomes and students ability to apply their knowledge, something that is reported to be lacking in anatomy students and graduates (Waterston and Stewart, 2005a, Waterston and Stewart, 2005b).

Multimodal approaches are increasingly common within anatomy teaching, with the introduction of interactive multimedia, body painting, plastic models and medical imaging into medical anatomy curricula (Dangerfield et al., 2000, Sugand et al., 2010). The integration of clinical imaging to supplement traditional methods of teaching anatomy has been positively received by students in medicine and dentistry courses (Dangerfield et al., 2000, Fitzpatrick et al., 2001, Ivanusic et al., 2010, Brown et al., 2012, Dreher et al., 2014, Moscova et al., 2015). Students were enthusiastic about their learning with these modalities and believed they were

beneficial to their learning through gaining a better understanding of the living body. However, there is little in the way of evidence that early integration of medical imaging improves learning. Brown et al. (2012) carried out a study with first-year medical students studying ultrasound integrated into the gross anatomy course. Students completed a questionnaire assessing their perceptions of the course and their ability to interpret ultrasound images of the neck. 96% of students felt that the ultrasound teaching had increased their knowledge of anatomy. In the assessment of students' comprehension, 95% of students correctly identified the vascular structures of the neck. However, it is not clear how long after the teaching this test was carried out, and the material in the test was likely directly related to the intervention, thus the results may indicate an ability of the students to immediately recall what they had just seen. Lufler (2010) investigated the impact of CT imaging on academic performance in anatomy at one medical school in Massachusetts. A test of visual-spatial ability was carried out pre- and post-instruction and practical examinations as part of course unit examinations were also included in the study. The study found no positive correlations between the use of CT scans and examination scores for any modules other than the head and neck. Lufler suggests the reason for this may be that other body regions are more visually accessible on cadavers than the complex anatomical relationships of the head and neck. Furthermore, senior medical students assisting as anatomy demonstrators during the study highlighted the long-term benefit to medical students from learning how to use the technology before reaching the demanding clinical years of the course. Increased time for the gradual development of clinical abilities has been cited as a benefit of vertical integration between clinical and basic science. Other advantages include scrutiny of content and collaborations between departmental staff in both teaching and research (Dahle et al., 2002, Lufler et al., 2010).

Problem-based learning (PBL), pioneered by McMaster University in the late 1970s by Barrows and Tamblin (1980) aimed to integrate basic science and clinical learning. It is argued that integration in a PBL curriculum can lead to improved knowledge retention (Norman and Schmidt, 1992). However, there is an absence of evidence that PBL improves learning outcomes in clinical curricula, and there are even concerns that PBL leads to a lack of knowledge (Prince et al., 2000). A further study was carried out by Prince et al. (2003) to investigate previous findings of PBL students' perception of inadequate basic science knowledge. In investigating

perceptions of students at eight medical schools she found that PBL and non-PBL students had similar perceptions with regard to their anatomy knowledge at the end of year 4. Similarly, no significant differences were found between the scores of the specifically constructed test of PBL and non-PBL students. However, it is not possible to assess the impact of different contexts of individual schools in this study including variations in teaching time, content and methods. However, if there is little perceived difference in education outcome, but the approach is found to improve motivation to learn then it can be argued that it is a justified educational strategy.

Discussion of methods of teaching

Winkleman's (2007) review of studies into the most effective methods of teaching anatomy found that no study was able to produce a statistically significant, unequivocal outcome. Likewise, a review of the literature by Hasan et al. (2011) concluded no one modality of anatomy teaching as better than any other. Furthermore, modern technology and dissection are complementary tools in learning. There is currently not enough empirical evidence regarding the impact of learning anatomy with or without the use of cadavers, and the outcomes reported to be gained are difficult to measure. With students exhibiting individual preferences and varying performance results, a blend of learning modalities may offer the best opportunity for students to learn. This is particularly appropriate when considering different cultures (Żurada et al., 2011). A range of activities offered early in the course also reflects the range of skills and aptitudes required in practice. However, as Harden (1986) proposes, teaching methods should not be considered in isolation, but as part of an holistic approach to curriculum planning which includes consideration given to aims and assessment, content and teaching strategies

2.2.5 Assessment in anatomy

Assessment is universally used to measure student progress. Furthermore, it is widely accepted that assessment drives learning, and the way in which students are assessed influences the learning process. Consequently, the goals of assessment should include supporting high quality learning outcomes (Gibbs and Simpson, 2004). In this section the role of assessment in higher education is introduced, and assessment in the context of the anatomy curriculum is discussed with a view to better understanding of how anatomy can be assessed to measure students' understanding and knowledge needed to progress through the course and careers.

Assessment of clinical competence is the ultimate aim in a clinical curriculum. Clinical competence is defined by the RCVS as the integration of knowledge, skills and attitude to perform in a clinical context (RCVS, 2014). Miller's pyramid of competence provides a framework commonly applied in medical and veterinary education (Figure 13).

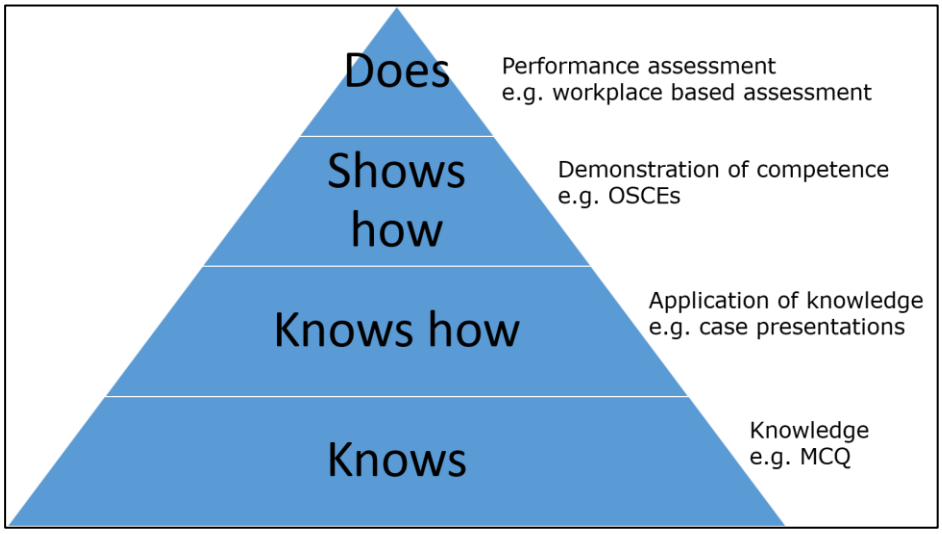


Figure 13. Miller's pyramid of competence (Miller, 1990). OSCEs, objective structured clinical examination; MCQ, multiple choice question.

Knowledge sits at the base of Miller's pyramid as the foundation on which competence is built. As a student progresses they must be able to apply their knowledge before demonstrating a competence in a simulated environment. The final stage is the demonstration of competence in a work environment. Traditionally, anatomy is assessed at the 'knows' and 'knows how' level of the pyramid.

The acquisition of knowledge is described by the cognitive domain of Bloom's taxonomy (Bloom, 1956) revised by Anderson et al. (2001). The taxonomy describes cognitive learning hierarchically arranged as a progression from simple functions to those that are more complex, enabling the matching of learning outcomes with what is expected of a student at a particular stage of a course.

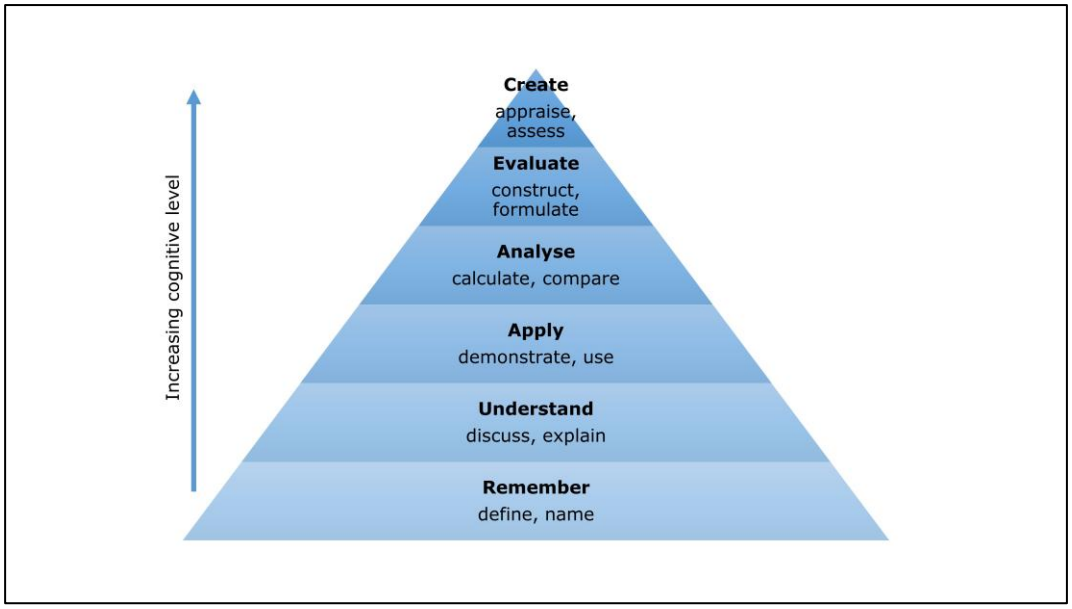


Figure 14. Bloom's revised taxonomy of learning (Anderson et al., 2001)

Lower-order thinking involves the recall and recognition of structures and terminology required of a student. The next level indicates a student should be able to demonstrate their understanding of concepts by giving descriptions and interpreting information. The application of knowledge is the ability to use acquired knowledge to solve a problem. The next step is to analyse information and make inferences, as is required for clinical reasoning. Evaluation of information allows a student to combine elements and form new solutions based on judgements made about the quality of information. Successful evaluation leads to the creating step, in which the students form their own opinion.

If a student perceives their learning to be measured in terms of reproducing facts, level one of Bloom's taxonomy, they will adopt surface approaches to learning (Entwistle, 2000). Eizenberg (1988) found that students were using surface approaches to learning anatomy as a consequence of perceiving the course to be a mass of facts to be rote learned. Moreover, approaches to learning are driven by students' perceptions of assessment demands, and linking assessment to the intended learning outcomes of the course will encourage deep approaches to learning. (Entwistle and Ramsden, 1983).

Assessing anatomical knowledge has traditionally involved written examinations, oral examinations (viva voce) and practical assessments. Written assessments typically consist of multiple-choice questions (MCQs), fill in the blanks (FIBs), and short answer questions (SAQs). MCQ style questions are commonly used in clinical programs for anatomy (Craig et al., 2010) but have been shown to encourage a superficial

approach to learning (Cobb et al., 2013). Furthermore, the format has been found to penalise those employing a deep approach to learning if not constructed to test understanding (Scouller, 1998).

Short answer or open-ended questions provide the opportunity for students to explain the function or clinical significance of a structure. As students are required to supply an answer, the effect of recognition or guessing is reduced. However, SAQs require careful construction and a transparent mark scheme to ensure objectivity in marking. Oral examinations have been used extensively in the past in clinical training programs and employ a discussion-based format. Low reliability as a consequence of a lack of standardisation and concerns around subjectivity are common issues raised around oral examinations (Hounsell et al., 2007). The reliability of orals can be improved by increased testing time and examiners, but this approach is resource intensive in terms of time and examiners (Wass et al., 2003).

Practical assessments include spot tests, objective structured practical examinations (OSPEs) and objective structured clinical examinations (OSCEs). Spot tests are also referred to as spotter or steeplechase examinations and are used for identification of structures on pre-dissected specimens. Trigger questions may lead to further assessment of understanding of application. However, spot tests can elicit the same effect as MCQs in steering students towards a superficial learning approach through testing recall of knowledge. (Yaqinuddin et al., 2013). While spot tests are typically carried out in the dissection laboratory and include the use of dissected specimens, often students are unable to handle the dissections and questions assess knowledge rather than skills, thus it is reasonable to argue the format is not truly practical. Other than spot test, there is little in the literature that describes practical assessment of anatomy. This is perhaps surprising given the large proportion of practical time allocated to anatomy teaching, and may reflect a focus on knowledge – based learning objectives in anatomy assessment. OSPEs or OSCEs are a common format for assessing skills in a clinical curriculum and the format comprises multiple stations that the students rotate through completing a different task in each station. Unlike other assessment formats discussed here, the OSCE assesses skills rather than knowledge. Smith and Mcmanus (2015) implemented a hybrid of the spotter and OSCE formats at the University of Southampton; the integrated anatomy practical paper (IAPP). The assessment aimed to test higher-order learning outcomes through integrating anatomy with other disciplines and clinical and

pathological features. The new format was found to be reliable and the application of Blooms' taxonomy to questions resulted in an increase in complexity level tested. However, application of the taxonomy to the traditional format could have resulted in a similar shift up the levels. Furthermore, students were unable to handle the specimens during the IAPP, thus it is not truly a practical assessment, and the problem of assessing the tactile component of anatomy remains.

The interactions that take place in cadaver classes provide opportunities to develop professional attitudes appropriate to clinical contexts such as attitudes toward teamwork (Huitt et al., 2015), communicating humanistic and ethical values (Rizzolo, 2002), and fostering professional relationships (Burns et al., 2006). However, while attributes of professionalism are assessed through a range of instruments (Mossop and Cobb, 2013), a search the of literature for this thesis found no summative assessment of professionalism taking place within the context of anatomy.

Assessment has a powerful influence on student learning and as such, rigorous assessment practices are critical in enhancing the quality of teaching. Furthermore, students may be able to escape the effects of poor teaching practice, but they are unable to escape the effects of poor assessment (Boud, 1995). Assessment quality can be observed through the validity of the test. Validity refers to how well the assessment instrument actually measures what it is intended to measure. Four types of validity should be examined; face, content, criterion and construct validity to ensure the assessment measures what it claims to measure, with adequate sampling of the course content and correlation to external criterion considered to represent performance (Hecker and Violato, 2009). Validity is not easily measurable, but Kane (2013) advocates using a three stage process. Stage one is to define the intended purpose of the assessment. This should be stated and understood by all stakeholders and the intended use should inform the design, delivery and analysis of the test. Stage two entails gathering meaningful evidence to support the interpretation of the test results. This includes how the test's content is decided and planned, such as the use of blueprints and mapping tools. Evidence of how the test is constructed, the sampling of items, testing hours, standard setting processes and reliability all form part of validity measurement, and this evidence is used in stage three of Kane's model to justify the decisions made based on the results of the test (Kane, 2013).

For a test to be valid, it must be reliable. Reliability is a test's ability to generate similar results when applied on different occasions and can be measured using Classical Test Theory (CTT) or Generalisability Theory (G-Theory). Cronbach's alpha is a commonly used reliability coefficient developed in the framework of CTT (Brennan, 2010). It estimates test score reliability based on the relationship between items internal to a test and provides an index of measurement consistency between 0 to 1.00. Coefficients of .80 are considered reliable enough to make decisions about individuals, although .90 is recommended for high stakes decisions (Webb et al., 2006). G-theory is a more complex framework and enables the identification of sources of measurement error and estimates each one (Brennan, 2010).

Assessment practices will be affected by feasibility issues such as cost, availability of time and staff, and other logistical restraints. Van der Vleuten (1996) proposes a formula to evaluate the utility of an assessment format:

Utility = reliability x validity x feasibility x acceptability x educational impact

In this model, acceptability refers to the beliefs and attitudes of examiners and examinees. The educational impact of an assessment refers to assessment as a driver for learning, such that if practical skills are perceived to be assessed, students will practise those skills. Different assessment formats will require varying levels of compromise in one or more components. For example, an MCQ exam can reliably test knowledge, but will lack the desired educational impact of a workplace based assessment format (Van Der Vleuten, 1996).

2.3 Summary of Chapter 2

This chapter has provided an overview of literature relevant to learning in higher education, and to anatomy education in clinical curricula, including teaching and assessment methods. The SVMS curriculum was designed with the intention of aligning teaching, learning and assessment methods to outcomes appropriate for a new veterinary graduate. The resulting anatomy curriculum is one that is clinically integrated, employing a blend of teaching methods. Using the SVMS curriculum as a case study, this thesis aims to investigate the impact of anatomy teaching practises through exploring students' and clinicians' perceptions. To address this aim, the following research questions were generated:

1. What are student perceptions of anatomy classes?
2. Is there a relationship between perceptions of teaching and assessment?

3. Do perceptions of learning anatomy change during the course?
4. Does the SVMS anatomy curriculum prepare students for clinical placements?

Figure 15 demonstrates in which study the individual research questions will be addressed.

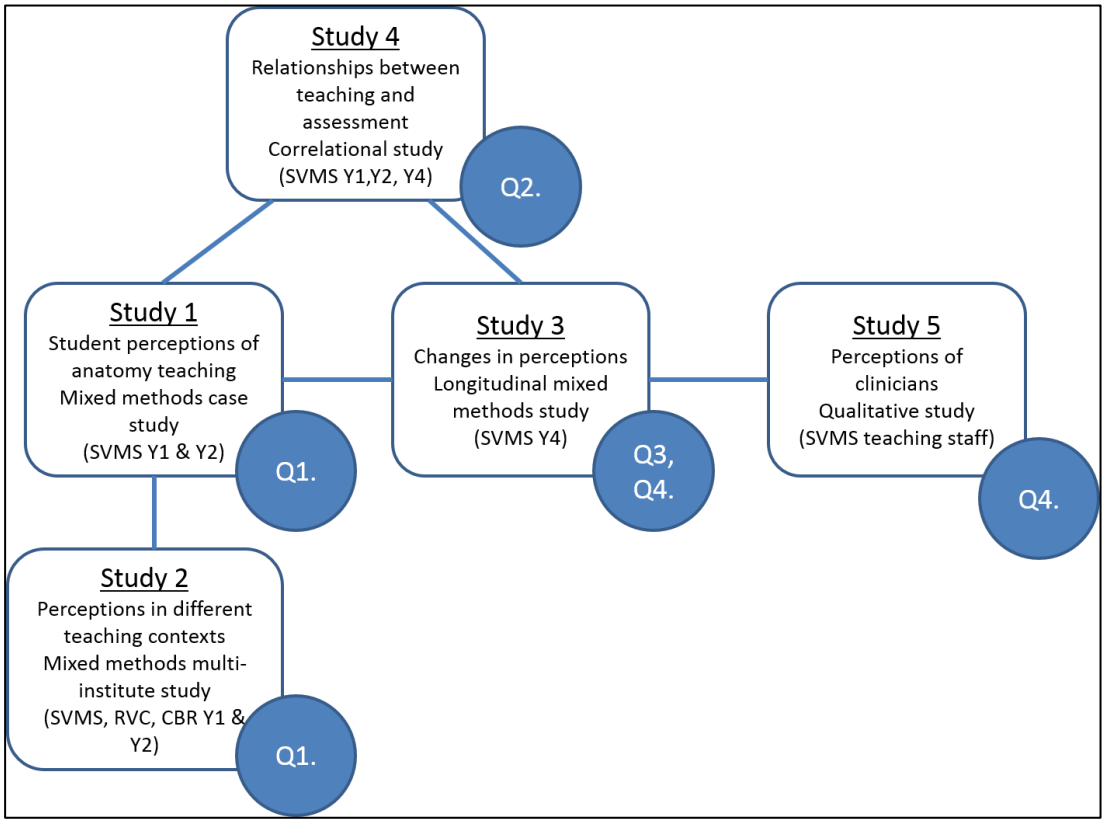


Figure 15. Studies addressing thesis research questions. Schools recruited for study: SVMS, School of Veterinary Medicine and Science; RVC, Royal Veterinary College; CBR Cambridge Vet School.

3 Methodology

This chapter will provide an overview of the research methods used in this thesis. The use of mixed methods research will be discussed, including justification of its application in this research. Details of the methods used in each study will be provided in the methods section of the relevant chapters. Details of ethical approval are also provided in this chapter.

Student perceptions of their learning environment are an important determinant of behaviour (Genn, 2001), and provide valuable feedback in the evaluation of curricula. Kirkpatrick's (1959, 1996) four-level model is a framework for evaluating effectiveness of training and has been applied in the context of medical education (Belfield et al., 2001). Level 1 is the students' reactions to the course; Level 2, their learning; Level 3, a change in behaviour as a consequence of their learning, and Level 4 is the final outcome for the institution.

This research studies the reactions and satisfaction of students (level 1) in studies 1, 2 and 3, and considers their learning (level 2) in study 4 and behaviour (level 3) in study 5. However, this thesis was not designed to be a comprehensive evaluation of the curriculum at SVMS. While perceptions of the learning environment alone should not be used as conclusive evidence in curriculum development, they form an important part of the evaluation process.

3.1 Mixed methods research

Mixed methods research involves combining elements of both quantitative and qualitative research. It is a synthesis of the intellectual and practical components of each (Johnson et al., 2007) to gain a better understanding of research problems than either approach alone.

Quantitative research is typically employed to make objective measurements. Therefore, the researcher must remain impartial, avoiding bias. A positivist philosophy drives the collection of numerical data generated for statistical analysis to generate laws that can be tested empirically (Cohen et al., 2011). Sample sizes are relatively large and intended to be representative. This approach has been criticised for disregarding the subjective decisions made by the researcher, for example, choice of measurement tools, subjects and conclusions drawn (Johnson and Onwuegbuzie, 2004). Post-positivists accept possible effects of likely researcher biases, and therefore that while striving for general laws and theories

through which to understand the social world, reality can only be known imperfectly (Robson and McCartan, 2016).

A qualitative paradigm intends to understand the meaning individuals give to a phenomenon inductively. It is based on constructivism (Guba and Lincoln, 1994, Johnson and Onwuegbuzie, 2004) with the emphasis on the researcher to interpret observations on conversations and actions rather than numbers. Qualitative research aims to provide explanations for phenomena through studying people in their natural setting, upholding the view that conclusions drawn can never be entirely objective (Creswell et al., 2003). Sample sizes are small and intended to provide material that is more detailed. However, qualitative research has been criticised for lacking scientific rigour, being subject to researcher bias and lacking in generalisability (Sandelowski, 1993). Qualitative research involves small scale studies that are not meant to be transferred from one context to another. The generalisability of the qualitative findings of this research will need to be interpreted with caution. Reflexivity and an awareness of the impact of the research design and approach to analysis is essential in qualitative research to improve reliability, and protocols and coding structures should be documented. Independent coding by a secondary researcher to arrive at a point of inter-coder agreement aids good qualitative agreement (Creswell, 2014).

There is growing support for the notion that a quantitative-qualitative dichotomy is unhelpful, and the two approaches can be used to complement each other (Pope et al., 2007). An alternative worldview to positivism/post-positivism and constructivism is offered by pragmatism. Pragmatism focuses on the problem to be researched and the consequences of the research (Creswell et al., 2003). Pragmatism in mixed methods research works with the idea that the world is not exclusively quantitative or qualitative, and involves the use of both forms of data in a single study, or series of studies investigating the same phenomenon (Leech and Onwuegbuzie, 2009). The combination of data types provides a more complete picture by observing trends and generalisations as well as in-depth insight into participants' perspectives. A framework for combining research methods has been described by Greene (1989), identifying five broad reasons for mixing methods:

1. Triangulation, seeking convergence and corroboration of results from different methods.

2. Complementarity, seeking elaboration and clarification of results between methods.

3. Development, using the results from one method to inform the other

4. Initiation, seeking the discovery of contradiction to reconstruct meaning

5. Expansion, extending the breadth and range of investigation using different methods for different aspects

Interaction between the quantitative and qualitative strands can be implemented at different stages of the research process, this may depend on the relative importance of the strands within the design, and the timing data sets are collected. Concurrent timing involves the implementation of quantitative and qualitative strands during the same phase of the study. Sequential timing occurs when the timing of the strands is distinct, with the collection and analysis of one type of data occurring after the collection and analysis of the other. Concurrent and sequential timing refers to the use of data rather than data collection. (Creswell et al., 2003).

Morse and Niehaus (2009) describe the point at which the mixing of the quantitative and qualitative strands takes place as the point of interface. Morse argues that this can occur at either the stage of analysis, or the interpretation stage. Mixing data at the point of analysis involves the transformation of one data type into the other type. Merging data types at the point of interpretation involves analysing the two data sets separately and then merging the two sets of results at the interpretation or discussion phase (Creswell et al., 2003).

Mixed methods research approaches are seen as a necessity for studying education environments as these particular contexts are complex and constantly evolving (Greene et al., 2001). The design of the research used in this thesis was driven by the individual questions being investigated. In this research investigating perceptions of students and staff within veterinary education, the quantitative approach allows for the exploration of relationships between cohorts of students, between perceptions and attainment, and allows an attempt to be made to produce generalisable results. A qualitative approach capturing the experiences of individual students provides greater insight into the motivations behind the learning behaviour of students and attitudes of teaching staff. The findings from both converge to help answer complex research questions. Table 3.1 provides an overview of the quantitative and qualitative components of the studies within this thesis.

Table 3.1 Overview of quantitative and qualitative components used within the mixed method approach to this research

Research question	**Quantitative component**	**Qualitative component**	**Rationale**
What are student perceptions of practical anatomy classes? Part 1: Opinions of SVMS students Part 2: Opinions of RVC and Cambridge students	Statistical analysis of responses from student surveys	Thematic analysis of free text responses collected via surveys	Concurrent studies where qualitative data are used at the interpretation stage to explain in more depth the quantitative findings (Tashakkori and Teddlie, 2010)
Is there a relationship between perceptions of teaching methods and assessment performance?	Statistical analysis of assessment data with survey data		Analysis of survey data providing information on entire cohorts
How do perceptions of learning anatomy change during the veterinary course?	Statistical analysis of survey responses	Focus groups with year 4 students	A sequential study for which the components of the survey were used to guide group discussion in order to explore quantitative and qualitative findings in more detail. (Creswell et al., 2003)
Does the SVMS anatomy curriculum prepare students for clinical placements		Thematic analysis of semi-structured interviews with teaching staff	Answers to open ended questions provide a rich data source

3.2 Methods of data collection and analysis used within this thesis

3.2.1 Surveys

Surveys facilitate a number of modes of data collection, for example, personal or telephone interviews, or self-administered online or paper-based surveys. Each will have implications for response rates, time- frames and cost. For example, paper-based surveys can yield better response rates (Lockyer et al., 2006), and self-administered surveys allow participants to respond in their own time, increasing the acceptability of asking similar questions. The anonymity of a self-administered survey can increase validity (Fowler Jr, 2013).

Questionnaire-based surveys are a widely used method of collecting data from a large sample, as the quantitative data generated are amenable to statistical analysis. Closed questions in which participants are asked to choose from a number of fixed options are an efficient method of data collection as data are easy to collect, code and analyse (Robson and McCartan, 2016). A closed question followed by an open question can be used for expansion, providing richer qualitative data. The respondents are asked to elaborate on the answer given within the closed question, explaining and expanding upon a quantitative question. However, as the qualitative data generated by open-ended questions must be subjected to appropriate analysis techniques, the process can be time consuming and requires expertise and so must be carefully planned for at the at the survey design stage (Boynton and Greenhalgh, 2004). A combination of fixed response and free text questions is common in survey research (O'Cathain et al., 2007, Braun and Clarke, 2013).

There exist some limitations to the use of surveys including data being affected by the characteristics of the respondents, for example their personality, motivation and experience. Furthermore, respondents will not necessarily accurately report their attitudes. For example, a response bias may be apparent in people wanting to show themselves in a positive light (Robson and McCartan, 2016). Poorly worded questions and a lack of flexibility on fixed response questions are common pitfalls in questionnaire-based research, therefore piloting of the survey is important in addressing potential difficulties in analysis (Foddy, 1993).

3.2.1.1 Rating scales

Measurement scales are widely used in questionnaires to measure attitudes. In 1932 Likert (1932) devised a summated rating scale, providing a range of responses by which respondents can indicate their strength of feeling. Visual Analogue Scales (VAS) were first described by Hayes and Patterson (1921). They are continuous scales commonly used in pain assessment, and allow patients or participants to make finely graded assessments. Rating scales allow the researcher to determine quantitative analyses of frequencies and correlations combined with measurement of opinion. However, they should be used with an understanding of their limitations. VAS scores can be difficult to interpret, while interpretation that is more meaningful is easier to reach with a modest number of categories available in a Likert scale (Wewers and Lowe, 1990). When interpreting Likert data it cannot be assumed that intervals between categories are equal. For example, it cannot be inferred that a rating of 4 is twice as powerful as a rating of 2 and as such, the Likert data in this thesis is treated as ordinal data and analysed using non-parametric statistical tests (Cohen et al., 2011). However, there is some debate around the use of parametric tests with Likert data, and Norman (2010) claims that criticism of such an approach are unfounded. The statistical tests used in this thesis are based on ranked data. As such, mean ranks are reported as they capture the extent to which the values of one group score against the values of the other groups. The medians and modes as measures of central tendency showed little in the way of detail and means are not an appropriate measure for ordinal data as the intervals between values cannot be presumed equal. A further limitation with rating scales is that they suffer from a number of respondent-centred biases. For example, an acquiescent effect can result in respondents tending to agree rather than disagree to a statement. It is suggested therefore, that questionnaires should include some negatively phrased items (Boynton, 2004). Some respondents prefer to avoid the extreme poles at each end of the continuum, reducing the number of available options. This effect known as the central tendency effect and can be minimised by the use of a larger scale, for example a 7-point scale rather than a 5-point scale. However, this could indicate a degree of precision which is inappropriate for the question presented. This is particularly true when considering that numbers have different meanings for different respondents (Cohen et al., 2011). The sensitivity of the data captured by rating scales makes them particularly useful for gathering attitudes and perceptions. Thorough piloting of

items to refine categories is an important step in developing Likert-based questionnaires.

3.2.2 Data analysis

Creation of a dataset, if not achieved through direct automatic entry, can be manually entered into a software package. When entering data, a distinction should be made between missing data where there is no response from a participant, and a 'don't know' or a 'not applicable' response. Missing data must be coded in such a way that the software can deal with it intelligently and that isn't confused for a genuine response (99 or -1 are frequently used) (Robson and McCartan, 2016). Data can then be 'cleaned' and checked for errors by independent entry by a second researcher, or by checking a percentage of the dataset for errors (Robson and McCartan, 2016). Exploratory analysis can then be carried out through the creating of frequency distributions or percentages, and summary descriptive statistics such as measures of central tendency and measures of variability represent data succinctly. Confirmatory analysis is then carried out through statistical testing and will be described as appropriate as part of the individual studies for this thesis.

3.2.3 Focus groups

Focus groups originated in market research in the 1920s (Robson and McCartan, 2016), and are sometimes referred to as focus group interviews, indicating its similarity a group interview on a specific topic (or focus). Focus groups however, rely on interaction within the group to discuss a topic supplied by the researcher (Morgan and Krueger, 1998). This is intended to generate data relating to a collective rather than an individual view.

Focus groups are able to provide greater coverage of issues than would be possible in a survey, and generate data useful to triangulate with questionnaire data. They are an efficient technique in qualitative data collection as data is collected from several people at the same time. Focus groups utilise the interaction of the group, adding depth to the data and provide a setting in which participants feel empowered to speak out, while being stimulated by the comments of others in the group (Cohen et al., 2011).

However, Morgan (1998) highlights several issues to be addressed, including group size and composition. The group size needs to be large enough to facilitate open discussion, yet small enough to be managed by the facilitator without fragmentation. Opinion in the literature varies regarding the optimum size of a focus group, with recommendations

including 4–12, 6-8, and 3-8 (Tang and Davis, 1995, Morgan et al., 1998, Braun and Clarke, 2013).Whether a focus group is homogenous and composed of participants of a similar position or experience, or heterogeneous, in which participants will differ should also be considered. Homogenous groups are more likely to facilitate communication and group members gain a sense of safety in expressing opinions, but may present a similarity of views. Heterogeneous groups may stimulate discussion, but may present issues around group dynamics (Robson and McCartan, 2016). Effective facilitation of group discussion is required in order to manage the group, ensuring the participants are comfortable in the discussion and keeping the meeting open-ended but maintaining focus (Cohen et al., 2011). In the study carried out for this thesis, free discussion was intended to be facilitated by the student's familiarity of working in small groups on the SVMS course. As the focus group facilitators were members of SVMS staff, consideration was given to the relationship between the participants and the researchers and a reflexive approach (Hockey, 1993) was taken during data collection and interpretation.

The number of focus groups run on a particular topic should also be considered since a single group discussion may represent behaviour particular to the group (Cohen et al., 2011) and sampling should continue until saturation has been reached (Braun and Clarke, 2013)

3.2.4 Interviews

Interviews are a widely used qualitative technique and can be classified as structured, semi-structured, or depth format (Pope et al., 2007). Structured interviews are a formalised, usually with a structured questionnaire and as responses are fixed, data is quantitative (Cohen et al., 2011). Depth, or unstructured interviews may cover one or two issues in great depth and detail. An interview of this style would begin with an open question and further questions would be based on the interviewee's responses (Pope et al., 2007). Structured interviews consist of predetermined open-ended question (Robson and McCartan, 2016). Semi-structured interviews are used in this study. They consist of a guide of open-ended questions defining the area to be explored, but the flow may evolve according to interviewee responses (Robson and McCartan, 2016).

Interviews offer the flexibility of adapting the line of enquiry to follow up interesting responses. However, this flexibility leads to a lack of standardisation and raises concerns about reliability (Robson and McCartan, 2016). Piloting questions to ensure that respondents understand them can improve

reliability, but it should also be accepted that interview behaviour is a form of social interaction and should be analysed accordingly, allowing for variation in responses (Foddy, 1993). Misunderstandings in interpretation of the questions by the interviewee and misinterpretation of responses by the interviewer can also threaten validity in research (Cohen et al., 2011). Further threats to validity include researcher bias. The researcher must avoid leading questions based on pre-conceived ideas and interpretation of the data must reflect a true account according to the interviewee (Pope et al., 2007). Within this study the researcher is known to the interviewees and thus a reflexive approach must be adopted and the relationship between interviewer and interviewee considered during data collection and analysis.

3.2.5 Thematic analysis

Thematic analysis (TA) is a method of qualitative data analysis by which the researcher systematically organises data into patterns of themes meaningful to the research question. Outlined by Braun and Clarke (2006), TA involves familiarisation of the data set before generating codes. Once initial codes have been generated, these are further analysed to create overarching themes which are then reviewed and defined. The TA approach is accessible to researchers and to readers. It is also a flexible approach as it can be applied to data irrespective of collection methods. However, it should be used within an existing theoretical framework in order to provide more than merely descriptive accounts of the results (Braun and Clarke, 2006).

Identification of codes and themes is carried out through two approaches. An inductive approach is a bottom-up, data-driven method in which the themes are strongly linked to the data themselves (Braun and Clarke, 2006). A deductive approach, as described by Crabtree and Miller (1992) involves the application of *a priori* codes to the data to investigate a specific research question. Commonly the two approaches are combined in one analysis, and this combined approach is used in analysis in this research.

3.3 Sampling

Sampling plays an important role in producing legitimate results from research. Cohen et al. (2011) identifies several key factors to consider in determining the sampling population to be used. Firstly, the sample size and representativeness will affect the generalisability of the results. Access to the sample

is key in determining the feasibility of the study and the sampling strategy then must be decided (Cohen et al., 2011).

In mixed methods research, sampling strategies must be chosen for both the qualitative and quantitative components. Sample sizes in quantitative studies tend to be larger than those in qualitative studies and seek to be representative of the wider population. A large sample size provides greater reliability and enables more sophisticated statistical analysis (Cohen et al., 2011). Utilisation of a paper-based survey and incentives have been found to improve response rates and increase sample size (Yu and Cooper, 1983, Sax et al., 2003) and these methods have been employed in this thesis to maximise the number of participants.

Probability, or random samples are primarily used in quantitative studies and involves random selection from a population where the probability for inclusion of the wider population is of equal chance (Yu and Cooper, 1983, Teddlie and Yu, 2007).

Convenience sampling is a form of non-probability sampling commonly used in qualitative data collection and is used in studies forming this thesis. Non-probability sampling does not attempt to replicate the wider population, but rather just the sample in question. However, selecting participants based on availability can lead to bias as respondents may have their own motivations for participation. This must be borne in mind when considering representativeness (Farrokhi and Mahmoudi-Hamidabad, 2012).

A purposive sample is one chosen based on characteristics of the population in relation to the research question. Purposive sampling has been used in this research to recruit staff participants with the knowledge and experience required to address a specific research question. The sample is therefore not representative of the wider population, and thus the results are of limited generalisability, but the knowledge the participants possess provides in-depth information specific to the aims of the research. Furthermore, the participants have all previously worked in other veterinary education institutions, conveying some application beyond SVMS.

3.4 Ethical considerations

It is important to consider the potential impact that contribution to a study may have on the participants. The research within this thesis involves the collection of data from students and staff of this university and others. The primary researcher is a member of SVMS staff and all participants must feel able to speak freely without concern about

consequences resulting from their participation. Confidentiality and anonymity of responses needs to be described to participants during the consent process.

Full ethical approval was obtained for this research through SVMS' ethical review committee, approval number 461 11 11 03. Research was conducted according to the guidance outlined in the 'Revised Ethical Guidelines for Educational Research' by the British Educational Research Association (BERA, 2011). The concept note and ethical review document is included as Appendix 2.

Data used in the study were anonymised and personal details obtained are held securely, and will be destroyed upon completion of the project to ensure General Data Protection Regulation (GDPR) compliancy.

Details of consent obtained for each study are provided within the relevant chapters.

3.5 Summary of Chapter 3

This chapter has provided an overview of the pragmatic mixed methods approach used to address the research questions within this thesis. A summarising discussion of research methods used has been included within this section and specific details of each study method will be provided in the relevant chapters.

4 Study 1. Perceptions of first- and second-year students at SVMS

4.1 Introduction

Traditionally, anatomy teaching has been delivered in the first two years of a clinical curriculum, as part of a 'Flexnerian' structure (Flexner et al., 1910). In this model, two years' basic science teaching set the foundation for clinical disciplines delivered later in the course. Recent years have seen a shift toward outcome-based education (OBE) (Davis, 2003) and has led to a focus on horizontal and vertical integration of the basic sciences. This is reflected in the SVMS curriculum, in which anatomy is embedded into the systems-based modules of the course. It is delivered through a blend of lectures, small group teaching sessions and live and cadaver practicals (see section 1.2).

However, cadaver classes are staff and resource intensive, thus, investigation of student perceptions of teaching methods used can inform the use of these valuable resources. In a study of first-year veterinary students at University College Dublin, students perceived cadaver handling classes to be most useful to their learning when compared to animal handling and lab-based practical classes (Ryan et al., 2009). Furthermore, a sample of third year students studying veterinary medicine at the Royal Veterinary College considered cadaver dissection as the most useful modality of teaching anatomy (54.7%) over 3-dimensional models (35.9%), textbooks (4.7%) and lectures (4.7%)(Preece et al., 2013).

Traditional methods of teaching anatomy involve students dissecting specimens with the use of an atlas or guidebook, or through examination or teacher demonstration of prosections. As discussed in Chapter 2 of this thesis (2.2.4), there has been much literature published on the benefits and disadvantages of each of these methods, but a clear consensus has not been reached (Winkelmann, 2007). The vertically integrated anatomy curriculum at SVMS enables the inclusion of clinical skills into practical teaching sessions to compliment and reinforce anatomy learning. For example, in a class designed to deliver teaching on the distal horse limb, students can perform ultrasound scans on cadaver limbs alongside dissecting the relevant structures. There is scant literature on the impact of integration of clinical skills into the anatomy curriculum, particularly in the context of veterinary education. However, within medical curricula the introduction of clinical topics alongside anatomy has been found to increase

motivation (Dettmer et al., 2010), and the most frequently mentioned reason for high evaluations of teaching by Harvard medical graduates was the emphasis of integration between basic science and clinical medicine (Wilkerson and Abelmann, 1993).

In addressing research question 1, and investigating students' perceptions of anatomy classes, this study focuses on the following objectives:

A. What are the perceived learning outcomes of cadaver classes?
B. Do students perceive a difference in value in different teaching methods?
C. Does perception change from the first to second year of the course?

Figure 16. illustrates where study 1 fits within the overall study plan.

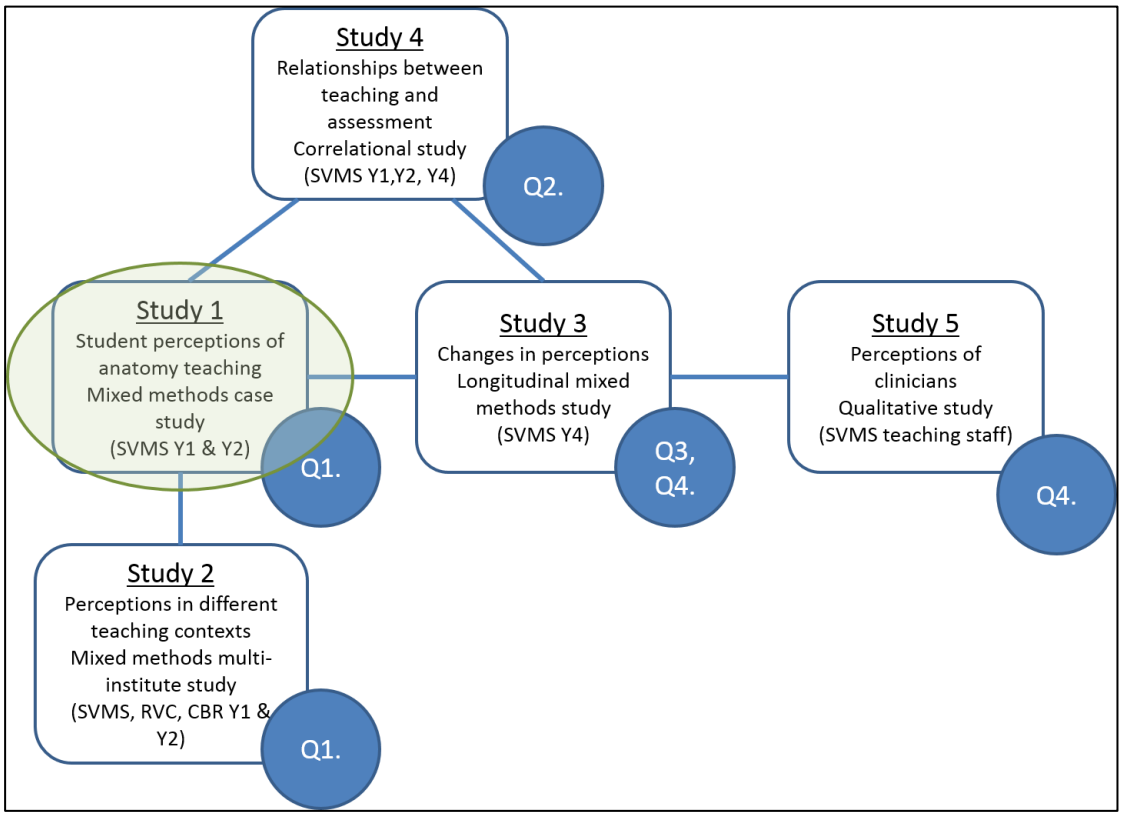


Figure 16. Map of studies in this thesis, study 1 highlighted. SMVS, School of Veterinary Medicine and Science; RVC, Royal Veterinary College; CBR Cambridge Vet School.

4.2 Methods

A Likert-style survey was developed based on consideration of learning objectives and study of current literature and previous questionnaires (Lempp, 2005, Azer and Eizenberg, 2007, Patel and Moxham, 2008). The questionnaire consisted

of 5 teaching and learning domains. Each domain contained statements requiring students to rate items on a 5-point Likert scale scored from 1 for 'strongly agree' through to 5 for 'strongly disagree'. There were 13 Likert items in total and students were asked to respond to each item 3 times considering dissection, prosection and practical techniques. To reduce response bias, a negatively phrased question was included in the survey. Table 4.1 demonstrates the Likert items within each learning domain. The rationale for each domain is briefly described.

Table 4.1 Learning domains and constituent Likert items

Learning domains	**Likert items**
Gaining anatomical knowledge (Kn) Knowledge outcomes highlighted in the literature as being supported by cadaveric teaching methods (Patel and Moxham, 2008)	1. Helps me relate structure to function 2. Helps me with 3D appreciation of structures 3. Improves my understanding of anatomy
Application of knowledge (Ap) Identified as an area of difficulty for students in clinical curricula (Waterston and Stewart, 2005b)	1. Opportunity to put theory into practice 2. It is relevant to my career
Enjoyment (En) As an (intrinsic) driver for learning	1. I find it interesting/motivating 2. I find it to be a negative experience
Assessment (As) As an (extrinsic) driver for learning	1. It is important because it is assessed in exams 2. I find it useful preparation for exams
The learning process (Le) Investigates how students perceive learning anatomy to fit within the wider learning context	1. It relates to other teaching sessions 2. It promotes peer learning 3. It provides the opportunity to participate and ask questions 4. It encourages respect for the material

A free text space at the end of each of these sections allowed for further comment as appropriate. A representative extract of the survey is shown in Figure 17.

Section 1 Gaining anatomical knowledge

Please rate how strongly you agree or disagree with each of the following statements relating to how cadaver material aids in your understanding of anatomy by placing a tick (✓) in **one** of the boxes for each statement.

Dissection of cadaver material

	Strongly Agree 1	Agree 2	Neutral 3	Disagree 4	Strongly Disagree 5
Helps me to relate structure to function					
Helps me with 3D appreciation of structures					
Improves my understanding of anatomy					

Figure 17. Extract of Likert survey

The questionnaire was reviewed by colleagues prior to piloting the survey with year 3 and year 5 BVM BVS students studying the 5-year veterinary course at Nottingham. Changes were made accordingly and are demonstrated in Table 4.2. The final survey is included as Appendix 3. A section for participant consent was included in the survey (Appendix 4)

.

Table 4.2 Outcomes of pilot study and resulting changes

	Participants	Outcomes
Pre-pilot review	Colleagues (n2)	• Typing error rectified • Indication of completion time
Pilot	Year 3 students (n3)	• Themes and titles made more explicit • Number of statements reduced to maximise engagement • Extra question added to confirm understanding of statements
Re-pilot	Year 5 students (n5)	• Clarification that statements refer specifically to cadaver material practical classes • Student ID included as a result of pilot participants indicating that they would be comfortable in doing so

4.2.1 Participants and Data Collection

The participants were recruited from the University of Nottingham's School of Veterinary Medicine and Science, studying the 5 year D100 BVM BVS course. In the spring term of 2012 students in years one and two were verbally invited to participate during practical classes in the school's dissection facilities whereupon the paper based survey was administered to all those present.

4.2.2 Data Analysis

4.2.2.1 Descriptive statistics and bar charts

SPSS version 21 (IBM Corp, 2012) was used to obtain the means, medians and quartiles of the dataset. As the mean is more sensitive to changes in the data, mean values were reported for descriptive purposes but were not used in statistical analysis. Charts were created in Excel to gain a

visual representation of distributions and missing values were not displayed so that charts represent valid percentages rather than actual values.

4.2.2.2 Statistical analysis

Non-parametric tests were performed in SPSS version 21 to investigate research questions as per Table 4.3. Analysis was performed at the domain level, and individual items analysis was carried out if further analysis was deemed appropriate. Cronbach's co-efficient alpha was used to assess the homogeneity of items within the domains. In the case of the negatively phrased question (item 7), reverse scoring of the item was performed to ensure consistency with other items before combining with item 6 to compute the enjoyment domain. Regarding missing data, cases were excluded pairwise. Missing values analysis was not carried out due to the small number of missing values occurring in the dataset.

Table 4.3 Statistical tests used in analysis of quantitative data

Question presented	**Statistical test used**
Is there a significant difference in the perceived value of delivery methods?	Friedman's ANOVA
Is there a significant difference between the responses of year 1 and year 2 students	Mann-Whitney U

The Friedman test was used to compare student responses to the three teaching methods; dissection, prosection and practising clinical skills. Post-hoc analysis of differences between the three was not considered appropriate as no new information could be obtained from such analysis of the small dataset. Mann-Whitney U tests were used to analyse differences between year group ratings and means of the summed ranks are used to report data. The level of significance was defined as $p < .05$.

4.2.2.3 Analysis of free text questionnaire responses

A thematic analysis of the free text data as described by Braun and Clarke (2006) was carried out. After familiarisation with the dataset, coding of qualitative data was performed manually using an inductive approach. Thus coding was driven by the data itself rather than by approaching the data with *a priori* concepts to use in the process. Codes were then

combined to form overarching themes, before being reviewed and refined. To reduce experimenter bias the data were first analysed by two researchers independently before comparison and review (Patton, 1999). The finalised coding structure was then used to define the themes presented for analysis.

In reporting free text responses, comments were numbered and coded as follows: F/M = gender of respondent, 1/2 = year of study. E.g. Q1:M2 indicates a response from a male second-year student.

Frequency counts were not used in analysis as no further meaning could be elicited from such figures. Not all respondents completed the free text sections of the questionnaire and some of those that did repeated similar opinions on multiple occasions, thereby making any frequency reports inaccurate and potentially unrepresentative of the sampled population.

4.3 Results

A total of 149 first and second-year students on the D100 BVMBVS course completed the survey representing a 69% response rate. Of first-year students (2011 cohort) 82% participated in the study, compared to 59% participation from the year 2 (2010) cohort. Of the respondents, 26% were male, which is representative of the population studied.

The quantitative and qualitative aspects of data collection are reported individually in the following sections, followed by a concluding section synthesising the results.

4.3.1 Internal consistency

Alpha scores for the combined items forming learning domains are shown in Table 4.4.

Table 4.4 Internal consistency of items within a learning domain

Items and domain	**Cronbach's α**
1-3, Gaining knowledge	.754
4-5, Application	.654
6-7, Enjoyment	.690
8-9, Assessment	.731
10-13, Learning process	.830

4.3.2 Descriptive statistics and main features of the data

Table 4.5 shows summary measures of centre of the dataset. The median rating of the responses for all teaching methods, dissection, prosection and clinical skills was 2, 'agree' or greater, and the median response to the reverse-phrased question was 4, 'disagree' or 5, 'strongly disagree'. This demonstrates the high value students place on learning with cadaver material.

Table 4.5 Summary of combined year 1 and year 2 Likert responses. Likert scale: 1, strongly agree - 5, strongly disagree. IQR, Inter-Quartile Range

Domain	Question		Dissection	Prosection	Techniques
Knowledge	1. Relate structure to function	Median	2	2	1
		Mode	2	2	1
		Mean	1.80	1.70	1.63
		IQR	1	1	1
	2. 3D appreciation of structures	Median	1	1	1
		Mode	1	1	1
		Mean	1.39	1.53	1.57
		IQR	1	1	1
	3. Improves understanding	Median	1	1	1
		Mode	1	1	1
		Mean	1.49	1.40	1.53
		IQR	1	1	1
Application	4. Theory to practice	Median	2	2	1
		Mode	1	2	1
		Mean	1.57	1.92	1.28
		IQR	1	1	0
	5. Relevant to career	Median	1	2	1
		Mode	1	2	1
		Mean	1.42	1.67	1.16
		IQR	1	1	0
Enjoyment	6. Interesting/motivating	Median	2	2	1
		Mode	2	2	1
		Mean	1.77	1.78	1.21
		IQR	1	1	0
	7. Negative experience	Median	5	4	5
		Mode	5	5	5
		Mean	4.47	4.30	4.51
		IQR	1	1	1
Assessment	8. It is assessed	Median	1	1	2
		Mode	1	1	1
		Mean	1.56	1.57	1.70
		IQR	1	1	1
	9. Useful preparation for exams	Median	2	2	1
		Mode	2	1	1
		Mean	1.71	1.62	1.60
		IQR	1	1	1
Learning process	10. Relates to other sessions	Median	1	1	1
		Mode	1	1	1
		Mean	1.52	1.51	1.44
		IQR	1	1	1
	11. Promotes peer learning	Median	2	2	2
		Mode	2	3	1
		Mean	1.72	2.38	1.72
		IQR	1	1	1
	12. Participation	Median	1	2	1
		Mode	1	1	1
		Mean	1.59	1.71	1.51
		IQR	1	1	1
	13. Encourages respect	Median	2	2	2
		Mode	2	2	1
		Mean	2.22	2.17	2.00
		IQR	1	1	2

Overall distribution of responses is shown in Figure 18. In this chart, each question represents the number of responses by bubble area for dissection, prosection and techniques. The chart shows that the majority of students responded ‘strongly agree’ or ‘agree’ to all questions with the exception of the statement ‘I find it to be a negative experience’, to which the respondents largely disagreed.

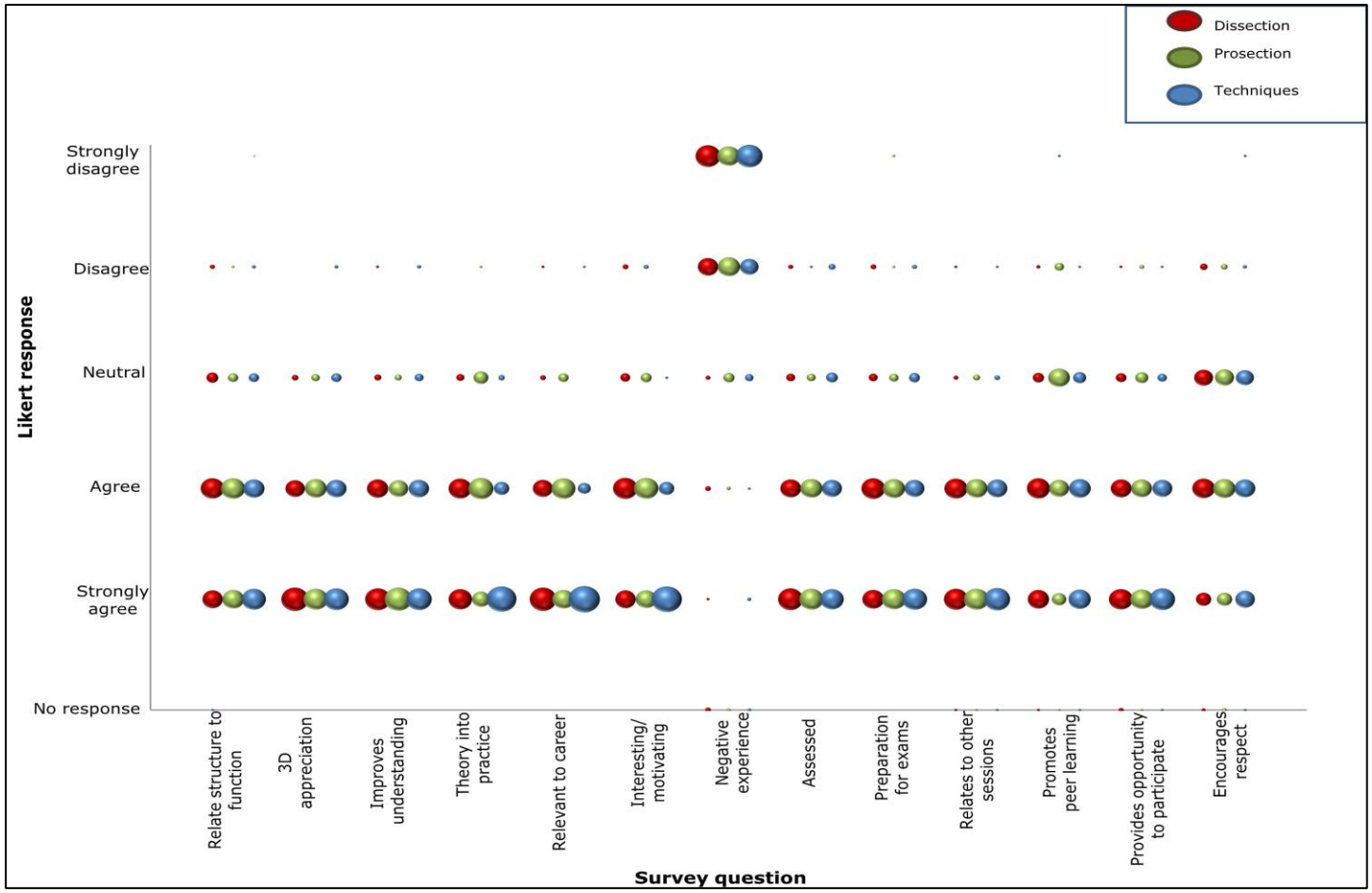


Figure 18. Chart to show the spread of responses of Y1 and Y2 students

Figure 18 highlights an outlier in the responses to prosection 'promotes peer learning'. It also demonstrates a difference in the spread of data for the question concerning respect for the cadaver (item 13) compared to other items. The difference in the data is confirmed in Table 4.5, demonstrating the mean values of 2 or above, therefore indicating a less positive response to these particular items. To investigate whether any methods of learning with cadaver specimens were perceived to be any more or less effective in encouraging respect for the material the data were further analysed. Figure 19 shows the percentage frequency of responses in the Likert data for this question and demonstrates that students perceive practising clinical skills to encourage more respect for the material than the other approaches. Statistical analysis was carried out for this question and is discussed in the next section.

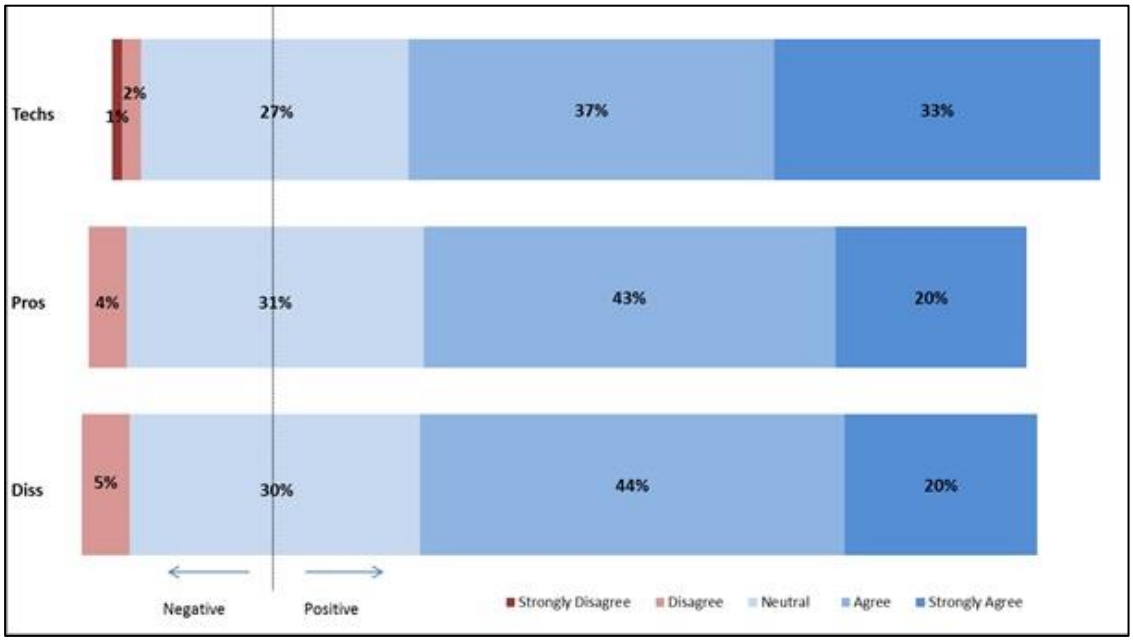


Figure 19. Chart showing percentage frequency of responses to question 13, 'encourages respect for the material'. Techs, practising clinical skills/techniques; Pros, demonstration of prosections; Diss, dissection.

4.3.3 Statistical analysis

4.3.3.1 Methods of delivery

Table 4.7 shows the mean rank scores of the Friedmans' ANOVA comparing dissection, prosection and practising techniques as perceived by SVMS students in years 1 and 2. As the Likert scale was numbered from 1 - strongly agree, to 5 - strongly disagree, a lower score means a higher level of agreement to the statement.

*Table 4.6 Perceptions of teaching methods by learning domain using Friedman's ANOVA. Mean rank scores for dissection (Diss), prosection (Pro) and techniques (Techs). Learning domains Kn, knowledge; Ap, application; En, enjoyment; As, assessment; Le, learning process. Significant results are shown by *.*

Teaching method	Mean Ranks				
	Kn	Ap	En	As	Le
Diss	2.00	2.00*	2.11*	2.07	1.97*
Pro	2.01	2.47*	2.30*	1.95	2.34*
Techs	1.98	1.52*	1.59*	1.98	1.69*

Gaining anatomical knowledge

No significant differences were found between the scores for the different methods of teaching in gaining anatomical knowledge (X^2=.097, p=.953), with students finding value in all of the methods used in the dissection laboratory.

Application

There was a significant difference found between the perceived value of methods in terms of providing the opportunity to apply knowledge (X^2=103, p<.001). Perhaps predictably, in this domain students scored practising clinical techniques as more valuable than dissection (Z=-5.86, p< .001) and more so than prosections (Z=-7.92, p<.001). There was also a significant difference between the scores for dissection and prosection (Z=-5.34, p<.001), with dissection perceived more favourably than prosection.

Enjoyment

The Friedman test found there to be a significant difference in the scores of methods in the enjoyment category of questions (X^2=61.7, p<.001). Students rated practising techniques as more enjoyable than dissecting specimens (Z=-4.80, p<.001), and more enjoyable than studying prosections (Z=-6.34, p<.001).

Assessment

Prosection was found to be rated most highly in terms of assessment, followed by techniques and then dissection. However, this was not found to be statistically significant (X^2=2.20, p=.333) thus it cannot be concluded that prosection was perceived to be more valuable.

Overall learning process

Analysis of the responses found there to be a significant difference in scores in this domain (X^2=42.3, p<.001). Practising techniques was found to be rated more positively than the demonstration of prosections (Z=-5.79, p<.001). Similarly, dissection was found to be rated more favourably than prosections (Z=-4.55, p<.001).

Based on the findings of the qualitative study, individual analysis of the ethics item using Friedman's ANOVA found a significant difference between the scores (X^2=17.6, p<.001). Practising techniques (mean rank=1.83) was perceived to hold most value for encouraging respect for the material, followed by the use of prosections (mean rank=2.05) and carrying out dissection (mean rank=2.11) was rated as the least valuable method of learning for promoting respect for the cadavers.

The results in this domain reflect an overall pattern in the data in that although not statistically significant, for all domains other than assessment, practising skills was rated most positively, followed by dissection of cadavers by students, and viewing demonstrations of prosections was shown to be least valuable. However, it is interesting that although not statistically significant, there is a change in the pattern of responses for assessment questions. That prosection is perceived as most valuable reflects the students' perception that they acquire the 'correct' knowledge this way, and this is supported by the free text responses garnered by the survey. However, there is a difference in perception of students according to year group as reported in the next section of results.

4.3.3.2 Differences in perceptions of year groups

Mean ranks for Mann-Whitney U tests comparing perceptions of first- and second-year students are shown in Tables 4.8 and 4.10 – 4.13. A higher level of agreement is shown by a lower score in this scale and results are reported by the domains as previously described.

Gaining knowledge

A comparison of year group responses found that year 2 students rated dissection (U=2054, p=.013) and techniques (U=2011, p=.007) significantly more valuable than did year 1 students for gaining anatomical knowledge. There was no significant difference found between the scores for prosection (U=2600, p=.737), (Table 4.7).

*Table 4.7 Comparison of mean ranks of year 1 and 2 responses to 'gaining knowledge' items for dissection (Diss), prosection (Pros) and techniques (Techs). Statistically significant results are indicated by *.*

Teaching method	Gaining knowledge	
	Y1	Y2
Diss	82.16	64.67*
Pros	75.96	73.61
Techs	82.65	63.96*

Based on this finding, when further analysed as individual year groups using Friedman's ANOVA, no significant differences were found between the methods. This is shown in Table 4.8.

Table 4.8 Comparison of teaching methods dissection, (Diss), prosection (Pros) and techniques (Techs) in 'gaining knowledge' domain. Mean rank scores for Friedman's ANOVA shown by individual year group.

Teaching method	Gaining Knowledge	
	Y1	Y2
Diss	2.02	1.98
Pros	1.92	2.15
Techs	2.06	1.88
X^2	1.17	3.32
p	.556	.190

Application

In analysis of responses in relation to the opportunity to apply knowledge, year 2 students were found to score practising techniques as significantly more valuable than year 1 students (U= 2280, p=.039) (Table 4.9).

*Table 4.9 Comparison of mean ranks of year 1 and 2 responses for dissection (Diss), prosection (Pros) and techniques (Techs) in 'application of knowledge' domain. Statistically significant results shown by *.*

Teaching method	Application of knowledge	
	Y1	Y2
Diss	76.09	73.43
Pros	79.26	68.85
Techs	79.64	68.30*

Enjoyment

A significant difference was found between the scores of the two year groups for enjoyment of practising techniques (U=1718, p<.001). Year 2 students rated practising techniques more positively than year 1 students did (Table 4.10).

*Table 4.10 Comparison of mean ranks of year 1 and 2 responses for dissection (Diss), prosection (Pros) and techniques (Techs) in 'enjoyment' domain. Statistically significant results shown by *.*

Teaching method	Enjoyment	
	Y1	Y2
Diss	72.02	79.30
Pros	78.15	70.46
Techs	85.98	59.16*

Assessment

The difference in scores for assessment between the year groups was found to be significant in response to the value of practising techniques (U=1979, p=.004). Year 2 students rated the method to hold a higher value than year 1 students (Table 4.11).

*Table 4.11 Comparison of mean ranks of year 1 and 2 responses for dissection (Diss), prosection (Pros) and techniques (Techs) in 'assessment' domain. Statistically significant results are shown by *.*

Teaching method	Assessment	
	Y1	Y2
Diss	79.35	68.72
Pros	77.79	70.98
Techs	83.01	63.44*

Learning process

No significant differences were found between the responses of year 1 and 2 students in this section for dissection, prosection, or techniques. (Table 4.12).

*Table 4.12 Comparison of mean ranks of year 1 and 2 responses for dissection (Diss), prosection (Pros) and techniques (Techs) in the 'learning process' domain. Statistically significant results are shown by *.*

Teaching method	Learning process	
	Y1	Y2
Diss	74.56	75.63
Pros	77.91	70.80
Techs	77.35	71.61

Year 2 students rated more positively than year 1 students in all domains, particularly in relation to practising clinical techniques in anatomy sessions.

4.3.4 Qualitative results

Thematic analysis of the free text data from the surveys identified four main themes: Student learning preferences, the positive impact of the sessions, barriers to learning, and ethics. These themes and their associated sub-themes are illustrated in Fig. 16 below, and will be reported in turn.

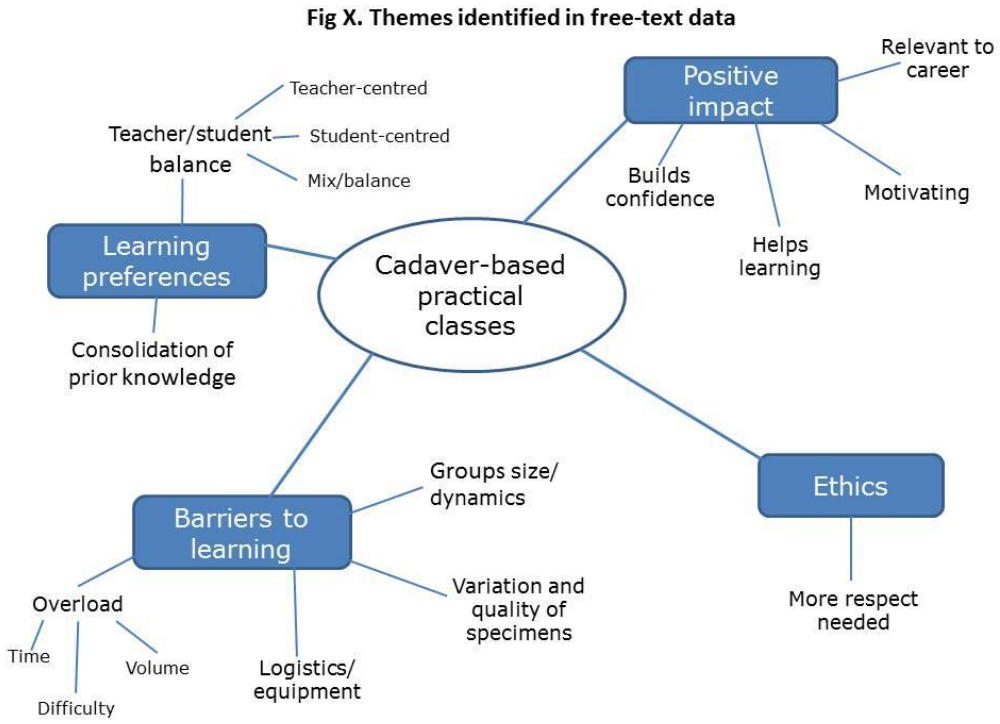


Figure 20. Themes identified in year 1 and 2 free text data

Theme 1: Student learning preferences

This theme illustrates students' preferences in learning within the dissection laboratory. The sub-themes identified were: consolidation of prior knowledge, and the balance between student and teacher-centred learning preferences. The latter included student led preferences, a preference for teacher-led styles and finding a balance between the two.

Consolidation of prior knowledge

This theme demonstrates how students valued the opportunity to apply theory to physical structures, thereby facilitating the consolidation of knowledge from other teaching sessions.

Q1: *"It is useful to apply the material delivered previously in lectures and I find that I can recall the information a lot better after having had cadaver anatomy following lectures."* [F2]

Moreover, having been introduced to the relevant anatomy prior to undertaking cadaver activities was important to the students in understanding what they were studying in the cadaver, and they felt that the practical classes became less useful without this prior knowledge.

Q2*: "Really helpful when we have done a lecture prior so we have a vague idea what we are looking at. I feel I get more from dissection when this is the case."* [F1]

Students commonly expected this prior knowledge to be delivered through preceding lectures, although some students referred to a self-directed approach, using books to establish basic anatomical knowledge. This difference in learning preference is illustrated in the following sub-themes.

Student/teacher balance

Teacher-centred comments were those describing a focus on the teacher as the source of information, either directly, or through the use of learning materials such as task sheets. This was a common theme within the free texts comments, with students feeling that there was not enough guidance in some practical sessions.

Q3: *"If not given enough guidance or opportunity to ask questions whilst dissecting then don't learn anything."* [F2]

Many of this type of comment reflected a need for verification, to be shown the 'right' way to do it. The students reported a lack of confidence in their own work, and a fear of failure in the sense of not having identified the structures necessary, reflecting a focus on the outcome rather than the process itself.

Q4: *"Difficult to know if what we do in dissection is correct without direct verification from lecturers etc – don't want to learn these wrong."* [F1]

However, some students enjoyed the 'hands-on' approach to learning tasks and reported the active process of handling the material themselves as an aid to learning. Comments suggest a balance to be found between teacher- and student-led activities during a session to enable students to carry out their own tasks under guidance in order to understand how to find structures and avoid feeling overwhelmed.

Q5: "*I find that I learn a lot more from dissecting the material myself as opposed to just seeing it in front of me*" [F2]

Q6: "*It is very useful when a staff member will go through a prepared specimen and name the structures before and after you do your own specimen dissection*" [F1]

Q7: "*It's really helpful to have staff present if you get stuck*" [F2]

Theme 2: Positive impact of sessions

Students value cadaver sessions and describe them as having a positive impact on their learning. The sub-themes identified

under this theme were 'relevance to career', 'motivating', 'builds confidence', and 'helps learning'.

Understanding the context adds value to the learning and is aided by the integration of clinical techniques into the teaching sessions. Many participant comments related to this aspect of cadaver classes.

Q8: "*Find the clinical techniques very useful to see how anatomy knowledge is relevant as a clinician*." [M1]

Students perceive learning in context to aid in recall of knowledge

Q9: "*The clinical integration is most helpful after doing normal cadaver dissection as it really helps the information stick as it is put into context when we get into practice*." [F1]

The perception that the sessions are preparation for 'real life' as a vet builds confidence alongside learning anatomy.

Q10: "*It's really good to practise surgical and clinical techniques on cadavers – helps improve confidence and learn what you are feeling for.*" [F1]

Contextual learning is motivating to students, encouraging engagement with not just the task at hand, but other aspects of the module perceived as relevant.

Q11: "*Some practical techniques that will be used as procedures in practice are really interesting as can relate module and its relevance to clinical situations*." [F1]

Cadaver sessions are described generally to have a positive impact on students learning, and were perceived to be enjoyable.

Q12: "*Really like it, really helps learning*" [F2]

Theme 3: Barriers to learning

In addition to the positive impact of cadaver classes, students identified factors perceived to have a negative impact on learning within the dissection laboratory. Sub-themes of this theme were: issues with group size or dynamics, quality of dissection specimens, logistical issues or issues with equipment, and overload.

Working in groups

Students reported issues with group sizes, commenting that groups were sometimes too large to be able to see demonstrated material clearly. Other issues under this theme were associated with the dynamics within a group, with

students reporting it difficult to participate when finding peers overbearing. This difficulty in working with others expressed by some students reflects the higher incidence of 'neutral' responses to the Likert items on peer learning and participation (Figure 18).

Q13: "*You don't always get the opportunity to join in if you are with pushy people.*" [F2]

This affects the small dissection groups of four students, but also the larger groups when studying prosections.

Q14: "*I find prosections can be intimidating to participate*." [F2]

Motivation can also be affected by group dynamics, particularly when dissecting, as group sizes are small. Students reported negative members of the group as having an adverse effect on learning.

Cadaver specimens

Specimens described as being of poor quality were mostly preserved dogs for dissection. Specimens were described as being 'smelly', 'too fat', and 'mouldy' resulting in a negative impact on learning. Other concerns raised in relation to specimens included those of a lack of validity, both to the live animal and to assessment.

Q15: "*Useful, however feels very different to the live animal*" [F2]

Q16: "*The assessment cadavers are not always easily comparable to the prosections we have been exposed to*."[F1]

Logistical/equipment issues

Access to screens when prosections or techniques were being demonstrated on camera was cited as a limitation when learning in the dissection laboratory, similarly students reported difficulty hearing in these situations, or that structures did not show up clearly on camera.

Overload

Students describe three types of overload leading to feeling overwhelmed – time, volume and difficulty of the task.

Time was reported as a limitation in two ways. For some classes it was felt that there was not enough time and students felt rushed. However, some classes allocated too much time to studying cadavers and the students became disinterested.

There was also difficulty in identifying the outcomes of the sessions from the task sheets and the cadaver, and report feeling 'lost in the anatomy'.

Q17: "*we get a little lost with what we are doing – only happens when we haven't yet digested the theory*."[F2]

If the dissection task was perceived to be difficult, or the task sheets complicated students reported a lack of motivation for the tasks.

Q18: "*Sometimes if it is a hard dissection it can become a bit negative*."[F2]

Theme 4: Ethics

This theme reflects some students concerns regarding the level of respect shown by some of their peers toward the cadaver materials used in practical classes. Students are conscious of the need to demonstrate respect when working with anatomical specimens, but also that more emphasis could be placed on encouraging professional attitudes toward the material.

Q19: "*everyone becomes so comfortable with the specimen that sometimes respect (or being gentle) can be lost. I think this is necessary for learning, but slightly negative*."[F1]

Q20: "*Respect for the cadavers could be further encouraged although it ultimately depends on the student."*[F2]

However, there were no comments expressing a desire to replace cadaver sessions, but a desire for more respect to be shown toward deceased animals. Comments in this theme support the quantitative data in highlighting the need to encourage more professional attitudes in dealing with cadavers.

4.3.5 Comparison of quantitative and qualitative results

Table 4.13 summarises the findings of the quantitative and qualitative aspects of the survey and includes themes elicited from free text responses alongside findings from analysis of Likert data.

Table 4.13 Comparison of responses in free-text and Likert data

Free text theme	Student comments	Likert responses
Learning preferences	Comments refer to using the sessions for consolidation of learning Student - teacher balance – fear of 'learning it wrong'	Complement qualitative data in that no one method was consistently rated above any other Not reflected in that the demonstration of prosections were not regarded as the most valuable method in gaining knowledge
Positive impact	Builds confidence Helps learning Find it motivating Find it interesting Value the opportunity to practise before 'doing it for real' Its relevant to their career	Complimented by quantitative data in that all methods were rated highly 89% of all students responded positively (agree or strongly agree) to finding dissection motivating, with 88% positive responses to prosection and 99% for practising techniques 97% of all students agreed or strongly agreed that dissection was relevant to their career, with 91% agreeing that prosection was relevant, and 99% agreed or strongly agreed that practising techniques was relevant.
Barriers to learning	Challenges with working in groups Poor quality cadavers Logistical issues Overload	Not supported by the Likert data in that the majority of students disagreed with the statement that cadaver practicals are a negative experience (3% of students agreed dissection was negative, 1% prosection and 2% techniques)
Ethics	Respect for cadavers should be further encouraged	Reflected to a degree in the quantitative analysis in that there were more 'neutral' responses to the respect item (Figure 19). However, overall responses were positive, with practising clinical skills rated as method most encouraging respect

Qualitative quotes from the survey data provide a more complete understanding of the positive responses demonstrated by the Likert data. However, the two datasets are divergent in the theme of 'barriers to learning'. Despite a number of themes emerging from the free text data indicating factors impacting negatively on their studies, Likert responses do not reflect this. Similarly, the fears expressed in the free text comments referring to 'getting it wrong' in dissection and the preference for being shown 'the right things' are not reflected in the quantitative data in that responses were overwhelmingly positive. However, statistical analysis did show that year 1 students perceived prosections, the most didactic method of practical teaching, to have more importance relative to the other methods in learning anatomy. This will be discussed in the following section.

4.4 Discussion

In investigating the perceptions of pre-clinical students studying anatomy at SVMS, this study's findings suggest that cadaver based practical classes are perceived by students to have a positive impact on their learning. Dissection, prosection and practical techniques were all rated highly by students in years 1 and 2 of the veterinary course.

Students appreciate different methods of delivery as is indicated by the fact that no one method was consistently rated more highly than any other across the learning themes. This reflects the work of Kerby et al. (2011), who measured how 'fit for purpose' medical students perceived methods of teaching anatomy to be. They found that different methods conferred different degrees of 'fitness for purpose' depending on the course aim. However, contrary to the results of the SVMS study, Kerby's results suggest that students perceive dissection to be the preferred method of teaching overall, as it was awarded the highest total of 'excellent' and 'good' fits. This finding echoes a previous study measuring the perceptions of anatomists, carried out by Patel and Moxham (2008). However, while these studies have included methods of teaching which employ applied anatomy such as living anatomy and radiological anatomy, they do not refer to the practice of teaching clinical skills and techniques. The integration of clinical information results in the inclusion of learning outcomes that are not anatomy based, and this may alter perception of the relative value placed on dissection as a learning activity. Furthermore, the two curricula have limited comparability due to the need for a new veterinary graduate to

be competent to work without supervision immediately upon completion of their degree. This is in contrast to the period of post-graduate supervision undertaken by a medical graduate.

4.4.1 Learning outcomes of cadaver practicals: knowledge outcomes

Practical classes are fundamental in the application of knowledge and the development of understanding through hands on experience. Tiberghien (2000) describes practical classes as helping students make the link between two domains of knowledge: The domain of observables, and the domain of ideas (Figure 21), and this model illustrates the fact that students need to be engaged in the theory of a subject when carrying out the practical tasks associated with it.

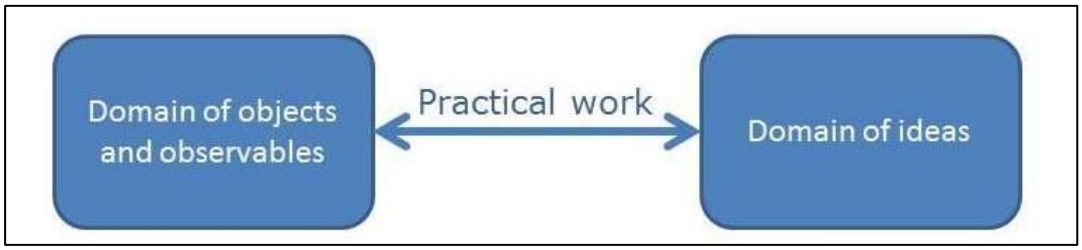


Figure 21. The linking of two domains by practical work

Practical classes serve to reinforce descriptions and principles delivered in lectures in such a way that they can be related to real life. They provide an illustration of the application of theoretical ideas and the opportunity to reinforce existing knowledge. This principle is reflected in the responses received in this study relating to the appreciation of the opportunity for consolidation of knowledge, and reports of the difficulties faced in dissection when material had not been previously covered in lectures.

It was not within the scope of this study to investigate student approaches to learning, however, comments relating to the opportunity for consolidation of knowledge imply that those students are employing a deep approach to learning as described by Marton and Säljö (1976). However, a study of a range of practical classes in a first-year veterinary curriculum in Dublin found that there were no correlations between practical classes involving cadavers and a deep approach to learning (Ryan et al., 2009). That there were also no correlations between the classes and a surface approach to learning either leads the author to suggest there may be a different type of learning taking place in practicals involving cadavers and live animals. Moreover, without information as to specific tasks that were carried out in the Dublin practical classes, or the assessment process associated with the

learning outcomes, it is difficult to draw meaningful conclusions from this aspect of the study.

4.4.2 Learning outcomes of cadaver practicals: professional skills

One factor shown to influence students' approach to learning is the perception of a task itself (Entwistle and Ramsden, 1983). In a study of Australian medical students, Azer and Eizenberg (2007) found that as students progressed from the first to second year of their course, they chose to favour dissection less as a resource for learning anatomy and instead relied more on textbooks. If student understanding of the outcomes of dissection is that they are based purely upon gaining anatomical knowledge, they may revert to using lectures and textbooks as a primary source for learning. However, other outcomes, important in developing skills and attitudes essential for a medical or veterinary practitioner should also be considered (Lempp, 2005, Böckers et al., 2010). Medical education studies have identified an appreciation of dissection practicals for providing the opportunity for teamwork, the application of practical skills, and preparation for clinical work (Granger, 2004, Lempp, 2005, Huitt et al., 2015). Similar themes were identified in analysis of comments from students at SVMS, and it is clear that practical classes are valued by veterinary students for fostering professional skills.

The manifestation of professional competencies within the cadaver laboratory has received little consideration within veterinary education, but human dissection has been identified as an opportunity to address emotions relating to death and dying (Dyer and Thorndike, 2000). Although the experience of dissection of an animal is less personal to that of dissecting a human cadaver, it remains a potentially stressful experience and as such the emotional impact of dissection sessions and the student experiences with their cadavers could be further explored. An attitude of 'detached concern', a balance of caring and detachment is required in veterinary as well as human medicine (Brannick et al., 2015). The results of this study show that respectful treatment of cadavers could be further encouraged in the dissection environment. The perception of the cadaver as an anatomical specimen rather than a once living pet is valuable in promoting objectivity in practice. However, desensitisation to the body to the degree of complete detachment is not necessarily appropriate to continue into a career in which empathy is of key importance. Therefore further investigation into students' relationships with cadavers could prove valuable in identifying opportunities to foster professional attitudes. A review of literature supporting

the importance of professional competences in the success of veterinary graduates by Cake et al. (2016) found comparatively little in the way of evidence to support the importance of competences such as empathy, professional behaviour and emotional intelligence. However, the authors of the review stress that the lack of evidence is due to a scarcity of research rather than a lack of importance in the veterinary profession. Furthermore, the research was carried out in the professional context of a new graduate, and the students surveyed for this research expressed the importance of respect and empathy in the context of the teaching environment, as is the focus of this thesis.

The use of cadavers for teaching purposes also raises the issues of moral and ethical use of animals. The need for hands-on work with animal cadavers has not been questioned in the results of this study, indicating that students believe their use to be necessary. However, students believe that respect could be further encouraged; something we can take forward into our teaching practice. It is noteworthy that students rated practicing clinical skills as the teaching method most encouraging respect of the material. A possible explanation for this could be because teaching is perceived to be more directly relevant to live animal scenarios, but further investigation would be pertinent to investigate the reason behind this view to further encourage the respect of all cadaver materials used in teaching. There is no doubt a moral question posed by the use of potentially healthy animals for teaching, and therefore the practice does provide opportunity to incorporate ethical issues into the veterinary professional skills curriculum.

4.4.3 Transition to HE

Recognising the importance of professional and practical skills, learning through practical experience and self-directed group work features heavily in the curriculum at SVMS, with less time allocated to the traditional lecture-intensive style of teaching. This approach is endorsed by Knowles (1970), who with his concept of andragogy describes adult learners as more independent and intrinsically motivated than child learners. However, Knowles' description of andragogy as dichotomous to pedagogy has been criticised for being too simplistic as many children can be motivated by curiosity and be independent in their learning and adults can be dependent on a teacher (Merriam, 2001, Yardley et al., 2012). Therefore, the need to support students through the transition to a different style of learning at veterinary school has been highlighted by previous work (Parkinson and StGeorge, 2003,

Mossop and Cobb, 2013). The free text responses from SVMS students in this study reflect this need for support, with comments from some students representing a desire for more direction and teacher-led activities. This illustrates the struggle that some students undergo in the transition between secondary and higher education. Moreover, a number of student responses in the theme of the student/teacher balance reflected a preoccupation with 'doing it right', and a need for verification from teaching staff. Veterinary students' over-reliance on staff for information was identified by Hall et al. (2013), and this is mirrored in comments made by SVMS students. However, reported fear of getting it wrong and the preference for being shown correct information was not reflected in the Likert responses, as these responses were overwhelmingly positive. But, statistical analysis of Likert data did show that year 1 students perceived prosections, the most didactic method of practical teaching, to be of more value in learning anatomy. This may, therefore, reflect that more of the responses relating to prosection as a more reliable technique for gaining knowledge were elicited from first-year students. However, this is not verifiable as free text comments were anonymised and frequency counts were not carried out. Thus, this hypothesis is not confirmed. Comments from both year groups pertaining to a need for guidance indicates a struggle to identify essential from non-essential knowledge, and this could add to the sense of feeling overwhelmed by the volume of material, a concern often reported in anatomy curricula (Soley and Kramer, 2001, Lempp, 2005, Mattick and Knight, 2007) and in this study of students at SVMS.

The desire to 'do it right' is indicative of a will to be able to replicate the material as presented, and a focus on the outcome rather than the process - principles associated with surface learning (Marton and Säljö, 1976). There were a number of responses referring to spot tests, in which prosections are used to test anatomical knowledge, and although not statistically significant, prosection as a teaching method received more 'agree' and 'strongly agree' responses to the statement that it is assessed. Similarly, assessment was the only domain in which practicing clinical skills was not rated as the most valuable method of learning. This may indicate that students are driven by the requirements of the assessment process, and as such it should be ensured that assessment is aligned with desired learning outcomes and does not encourage surface learning techniques such as memorisation of individual prosections (McLachlan, 2006).

Although magnitude coding was not carried out for this study, it can be observed from responses received from students that

first-year students seemed to emphasise the value of teacher-focused activities, whilst year 2 students commented more on student–centred learning and the balance between the two styles. This could be due to differences in the two groups of people surveyed due to factors such as personality or learning preferences, or it could suggest that as students progress through the course they become more willing to accept responsibility for their own learning and begin to develop independent learning skills. This phenomenon will be further investigated in a later study of 4th year students. The change from teacher to student focused learning is important in fostering deep learning as it enables students to build their own understanding through experience, which in turn provides experience upon which to build the next new topic (Parkinson and StGeorge, 2003).

4.4.4 Context in learning

Fostering deep learning in an anatomy curriculum can pose specific problems. Mattick and Knight (2007), in their study of factors facilitating high-quality learning in a medical programme, found that students perceived anatomy as distinct from other biomedical sciences in that it required learning material by rote. This suggests a perceived detachment of anatomy as subject, and a lack of understanding of its relevance to the curriculum and the medical profession. Introducing context, through clinical examples enhances the perceived relevance of anatomy, as reflected by free text responses in this SVMS study. Context in learning has been found to improve knowledge retention and recall (Baddeley and Godden, 1975, Finn et al., 2010), and the alignment of teaching to students' aspirations to become veterinary practitioners encourages the intention to gain understanding, and therefore the adoption of a deep approach to learning (Eizenberg, 1988). Other studies investigating approaches to learning in medical programs have found problem based anatomy curricula, in which anatomy is taught in a clinical context, is more likely to encourage a deep approach to learning (Dahle et al., 2002, Smith and Mathias, 2010, Ward, 2011). Encouraging a deep approach to learning and the clinical integration of anatomical concepts also ensures content is kept relevant and avoids unnecessary detail, which can overburden students and encourage surface learning (Cake, 2006).

4.4.5 Perceptions by year group

Overall, year 2 students rate classes more highly than year 1 students, indicating interest in practical learning does not

diminish, and that students clearly value practical experience as they advance through the course. Second-year students at SVMS have undertaken examinations, completed a broader range of modules and completed more extra-mural studies (EMS) placements[1] in comparison to first-year students, and this experience may alter their perspective of the requirements of the course. A broader experience of EMS studies may also explain the increase in the perceived value of practicing techniques in the course as students further realise the relevance of the tasks. It may also be the case that with experience, students' abilities and confidence increases, thereby influencing their assessment of practical sessions. However, it may also be true that differences in perception can be explained by innate differences in the groups. Further investigation into student perception and ability as they progress through the curriculum and apply their knowledge will be explored in a later study.

These results contrast the research conducted by Azer and Eizenberg (2007). Their results could reflect the realisation of the pressures of the medical course, and suggests a lack of alignment between dissection as a teaching method and the perceived demands of the course. With limited time in the course, students may find textbooks to be a more convenient way of learning material. It may also reflect a novelty value in dissection that is not sustained throughout the course. As no qualitative data was generated in Azer and Eizenberg's study, it is difficult to draw conclusions as to why students' perception of the importance of dissection changes as they progress through the course. The SVMS study focuses on student's experiences in the dissection laboratory, therefore comparisons between the studies is difficult as SVMS students were not asked about the importance of textbooks. Nevertheless, since year 2 students at SVMS view dissection as even more valuable than year 1 students, demonstrating a continued engagement with anatomy classes, it is unlikely the same phenomenon is occurring at SVMS. It is possible that Azer's study of medical students is not transferrable to veterinary students due to the difference in dissection practices. Authors of studies involving medical students report 8 to 10 students dissecting 1 human cadaver (Winkelmann et al., 2007), resulting in limited access for many students. This differs to veterinary dissection classes, in which students are typically grouped 4 to a cadaver, resulting in more students

[1] EMS are placements undertaken outside of curriculum teaching, providing students the opportunity to 'see practice' RCVS require pre-clinical students to complete 12 weeks of placements.

being able to access and visualise structures and therefore participate more actively in the dissection process. Active participation is also encouraged through the introduction of clinical skill based tasks at SVMS, and therefore, caution must be applied in comparing different teaching contexts as learning outcomes may differ.

In addition to the effect of integration of clinical skills, veterinary dissection courses should be distinguished from those in the medical curriculum by virtue of the need for veterinary schools to produce graduates that are able to perform surgery from the point of graduation. For this reason dissection classes and anatomy as a subject may well be perceived as more important than in a medical curriculum.

4.5 Limitations of the study

The results of this study should be interpreted acknowledging the limitations of Likert scales in that they indicate only order, and assumptions cannot be made that the differences between each rating is the same. This was acceptable for this particular investigation and appropriate statistical tests were used in the analysis of data. Further information could have been extracted from the data through more specific wording of the items. For example, distinguishing enjoyable from motivating and when asking about negative experiences.

The results of this study reflect a particular group of students at a particular point in time, therefore caution should be applied to generalisations made. Azer and Eizenberg (2007) suggest results can be skewed by the course material being studied at the time of completing the survey. They suggest that in their own research, students studying the nervous system of the head and neck struggle to visualise the associated structures and therefore this is reflected by a low appreciation of dissection at the time. Similar results have also been reported by others (Snelling et al., 2003, Winkelmann et al., 2007), Winkelmann measured the level of dissection activity over the course of a semester covering different anatomical modules and found that activity was highest during the limb module and lowest for head, neck and brain modules. However, there were no comments relating to the complexity of the head and neck made by students at SVMS, despite the survey being distributed to first-year students at the time at which they were studying neuroanatomy. It should, however, be considered that the fact that 1st year students spend more hours in the dissection laboratory alters their perception of the sessions.

A lower response rate was received by year 2 students, due to lower attendance for the practical class after which the survey was administered. It must be considered therefore, that the responses received were from the most motivated students, reflected in the more positive responses received from these students. The impact of clinical skills teaching should be considered. Students may have a more positive view of learning with cadavers generally, a response tendency known as the 'halo effect' (Bingham, 1939). Response bias may occur due to the respondents' perception of the need to answer favourably due to the manner in which the survey was administered (by a staff member), resulting in an acquiescent effect. It is also possible that students misunderstood the survey to be an opportunity to feed back to session deliverers, which may have influenced students' comments in areas of the survey such as when asking for negative aspects of teaching. The purpose of the study was explained to students prior to administration and thus this effect should be negligible.

Low alpha values on subsections of the survey makes interpretation of the individual domains difficult. Lastly, the generalisability of the study is limited as the survey was administered at a single institution and referred to a single curriculum and experiences of other curricula may vary.

4.6 Conclusion

This study highlights the importance of teaching using cadaveric material, and confirms that practical classes are well received overall. That there are few significant differences between perception of delivery methods signifies a balance of teaching methods that is appreciated as facilitating student learning, despite seemingly different outcomes. The demonstration of prosections is an efficient method of delivering information to students, whilst still utilising cadavers to illustrate 3-dimensional concepts. However, while at SVMS attempts are made to retain small groups of students, and to engage students through asking questions, demonstration remains largely a didactic approach. Dissection is more student–centred and involves employing manual dexterity skills and the ability to work in small groups, but can overwhelm and frustrate students if structures are not clear. Practicing clinical skills requires factual information to be interpreted and applied to a task, a higher level of learning according to Bloom's taxonomy. Claims that students need to have obtained and understood the knowledge before being able to apply it effectively are not supported in the present

study. It is clear however, that the practice of clinical skills has a positive influence on student learning, and that drive for understanding could impact all practical learning. The results of this study suggest the continuation of the delivery of a combination of teaching methods as this approach is motivating and educationally valuable. Practical classes provide opportunities for the consolidation of knowledge from other areas of teaching, delivering wider outcomes than just the acquisition of anatomical knowledge. The ethical considerations of using cadaveric material in teaching could be further explored during teaching delivery as it provides an opportunity to foster professional behaviours. The following chapter investigates if the perceptions held by students at SVMS are applicable in other veterinary education contexts.

5 Study 2. Perceptions of anatomy in different learning contexts

5.1 Introduction

Surveys carried out in Chapter 4 found that students highly value learning anatomy using cadaveric specimens, in particular they value learning clinical skills alongside anatomy teaching. The present study will build on Study 1 by investigating perceptions of anatomy teaching in different learning contexts.

The Royal College of Veterinary Surgeons (RCVS) Accreditation Standards document requires that new veterinary graduates have knowledge and understanding of the 'structure, function and behaviour of animals and their physiological and welfare needs'. However, veterinary institutions are free to design their own curricula to meet the standards required by the RCVS. Thus, there is variation in the content and delivery between each veterinary school. Anatomy remains a cornerstone of pre-clinical teaching and cadaver-based teaching practices continue to exist in the form of practical anatomy classes. Activities carried out in practical anatomy sessions include dissection, in which students participate in the dissection of a cadaver specimen, or the prosection-based demonstration of specimens to groups of students. It is common practice for pre-clinical veterinary training to consist of a combination of these two methods, and regardless of the teaching strategies used; classes are time, labour, and cost intensive. It is surprising, therefore, that the educational impact of cadaver teaching within the veterinary context has received little attention in the literature.

The teaching and learning environment was identified by Biggs as a situational factor in affecting student learning (Biggs, 2001), (see 2.1.1.1), and students' perceptions of the learning environment have been shown to influence students' approaches to studying (Trigwell and Prosser, 1991, Sadlo and Richardson, 2003). It can therefore be expected that students' perceptions of anatomy teaching may differ across courses depending on the quality of teaching, clarity of goals, workload and other contextual and academic factors. The present study is not concerned with the quality of teaching delivered in any given course, but to discover students' perceptions of anatomy, and to ascertain if attitudes differ between different learning contexts (Figure 22).

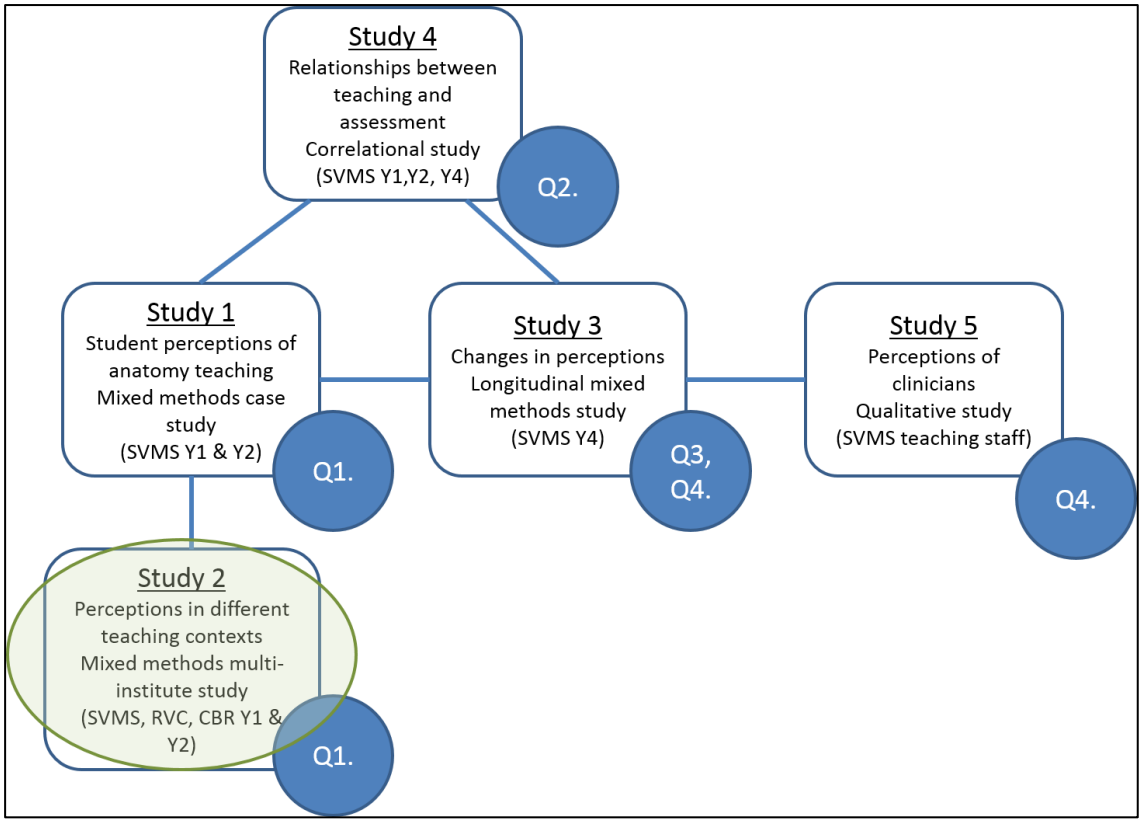


Figure 22. Map of studies in this thesis, study 2 highlighted. SMVS, School of Veterinary Medicine and Science; RVC, Royal Veterinary College; CBR Cambridge Vet School

This study will build upon the findings of Study 1, which demonstrate the positive attitudes held by students at SVMS toward practical anatomy teaching. Students here particularly valued the opportunities to practice clinical skills alongside learning anatomy in the dissection lab. Investigating perceptions of teaching in a different context will provide insight into students' views of the value of cadaver teaching more generally, and will indicate if there was an element of a 'halo effect' reflected in the responses of SVMS students.

Previous studies investigating perceptions of teaching methods have found students and anatomists in medical schools to believe the practice of dissection to be more valuable to their learning than prosections, lectures, Computer Assisted Learning (CAL), models and living and radiological anatomy (Patel and Moxham, 2008, Kerby et al., 2011). However, the results of the SVMS study showed no clear preference for dissection or prosection as methods of teaching, indicating value in mixed modalities of delivery. The present study will provide information as to whether the appreciation of a combination of teaching methods in the dissection room is a feature of veterinary undergraduates more widely.

A further finding of the original SVMS study was the increased positive perceptions held by second-year students in the course. As discussed as part of Study 1, this could be a feature of the lower response rate for the cohort, due to only the most motivated students being present at the time of distribution. The present study provides opportunity to investigate this further.

This further study builds on the findings of Study 1 by investigating perceptions of anatomy teaching across a range of learning contexts, which it is expected will paint a broader picture and produce results that are more generalisable. The purpose of the study is to examine the perceptions of anatomy teaching at three UK vet schools to determine whether differences in the design and delivery of the anatomy course influence attitudes to learning anatomy. In particular, this study aims to explore the following research questions:

1. What are veterinary students' opinions of the value of dissection and prosection in anatomy teaching?

2. Does the perceived value of cadaver-based activities differ in different learning contexts?

By gaining a better understanding of the factors influencing the ways in which students experience learning anatomy this study seeks to inform methods of teaching to improve learning quality and maximise the student learning experience.

5.1.1 Teaching contexts

The Royal Veterinary College (RVC), London operates a horizontally integrated systems-based curriculum, teaching veterinary basic sciences in years 1 and 2. In 2007, the 5-year veterinary program underwent review, resulting in a reduction in didactic teaching and dissection time, and increased emphasis on independent study. There are no anatomy lectures delivered to students thus practical sessions are the main source of anatomical teaching. Integrated structure and function tutorials run throughout years 1 and 2 which use live animals to demonstrate anatomy alongside cadaveric material. Cadaver based practical classes make use of fresh and preserved materials in demonstrations and student dissections. Students are informed in advance on the content of practical classes, are directed to relevant reading materials and are requested to prepare accordingly. As such, each practical class is delivered twice, to half a cohort at a time. Anatomy is assessed as part of the systems-based modules through essay and multiple-choice question (MCQ) papers. There is also an Integrated Structure and Function viva voce examination in which anatomy questions are

included. At the time of conducting this study cohort sizes for years one and two were 221 and 212 respectively.

The University of Cambridge's vet school employs a traditional curriculum whereby the basic veterinary sciences are taught in the pre-clinical years of teaching, years 1 and 2. Practical classes are monitored for attendance and consist of a combination of demonstrations and student dissections using fresh and preserved material. The Veterinary Anatomy and Physiology (VAP) module is delivered in year 1 of the course, and includes system-based teaching on locomotor, cardiovascular, nervous, respiratory, urinary and digestive systems. The reproductive system and central nervous system are covered in year 2 within the Veterinary Reproductive Biology (VRB) course and Neurobiology and Animal Behaviour (NAB) respectively. A Comparative Vertebrate Biology (CVB) course is also delivered in year 2 and includes anatomy of amphibians, reptiles, birds and fish. The anatomy of the head is delivered in the second year within this comparative module. Each biological system is taught through lectures and 'wet' practical classes, in which students dissect by region. Assessment is carried out using written and steeplechase formats, both containing short answer and MCQs. Essay questions are also used to assess content delivered in practical classes and lectures. Cohort sizes at the time of the study were 65 in year 1, and 72 in year 2.

The nature of the course and assessment at SVMS has been previously discussed, see 1.2.

5.2 Methods

5.2.1 Study design

An identical paper-based survey to that distributed in the original study of SVMS students (Appendix 3) was employed to gather data on perceptions of students studying at Cambridge and the RVC. An additional section was included in the questionnaires for external distribution, summarising the different teaching methods and including questions on the amount of experience the participants had with each method. This is included as Appendix 5.

5.2.2 Participants and data collection

Appropriate teaching staff were identified at each institution and were contacted via email to seek permission for the study, gather relevant information and to make arrangements for data collection.

Participants were recruited from the RVC 5-year D100 BVetMed course, the Cambridge 6-year D100 VetMB course and the SVMS 5-year D100 BVM BVS course, and in February 2013 the author personally distributed surveys to students studying at Cambridge and London. The spring term was selected as the most appropriate time for data collection from all schools to maintain consistency and ensure students were familiar with teaching and learning practices. Details of the specific teaching contexts and timing of data collection can be found in Table 5.1. Students at the RVC and Cambridge received an email from their teaching staff prior to their practical classes to prepare them for the upcoming request to participate in the study. Students were then verbally invited at the beginning of the class and at the end, at which time the surveys were distributed to all those present by the author.

Table 5.1 Times of survey administration at each school

Vet School	Year of study	Date	Practical class
RVC	1	18th and 19th February 2013	Sheep abdomen. Fresh whole sheep carcasses used to demonstrate abdominal anatomy to groups of students
	2	8th February 2013	Equine limb. Students dissect the limbs according to a written guide
Cambridge	1	5th February 2013	Lymphatics. Fresh and fixed material demonstrated to groups of students
	2	6th February 2013	Female anatomy. Fresh and fixed material from a range of species demonstrated to groups of students
SVMS	1	26th April 2012	Hindlimb innervation. Student dissection of fixed canine material
	2	24th May 2012	Comparative anatomy of the urinary system. Demonstration of fixed and fresh prosections

5.2.3 Quantitative and Qualitative Data Analysis

5.2.3.1 Descriptive data

Data were entered into SPSS version 21 and cleaned before median and mean scores were calculated. Mean values are reported in descriptive analysis to demonstrate the variation in responses, but were not used in statistical analysis. Charts were created in Excel to gain a visual representation of the results. For the new dataset, internal consistency of the domains created by combined Likert items was calculated using Cronbach's Alpha.

5.2.3.2 Statistical analysis

For statistical analysis, the negatively phrased question was reversed scored. Data were tested for normality using the Shapiro-Wilk test and values were found to be below 0.05, indicating a significant deviation from normal distribution. As the data were non-normally distributed, non-parametric analyses were performed. A Kruskall Wallis test was carried out to compare responses to the teaching methods dissection, prosection and techniques across the schools. Responses to 'dissection' received by RVC students were compared to those received by SVMS students and by Cambridge students. This was then repeated for responses to 'prosection'. *Post-hoc* Mann Whitney U analyses were carried out where statistically significant differences were found, to identify where differences lay. The Bonferroni correction was applied to adjust for the increased risk of type I error when making multiple statistical tests. Therefore, significance for these tests was defined as $p<.0167$.

To investigate the perceived value of teaching methods used within each school, a Wilcoxon signed rank test was used to compare the scores of dissection and prosection for each school individually. A Mann-Whitney U test was performed to investigate differences between responses from year 1 and year 2 students within each school. As these statistical tests are based on ranked data, ranks scores are reported. For all statistical analysis, significance was defined as $p<.05$.

5.2.3.3 Qualitative analysis

Analysis of the free text data was carried out manually using a thematic approach, as described by Braun and Clark (2006). Coding was an iterative process, using a hybrid of data-driven and a priori concept-driven codes derived from the analysis of the original SVMS study. Codes were then combined to form over-arching themes. One transcript was independently coded

by a second researcher to reduce experimenter bias before a process of comparison, review and refinement to produce the finalised coding structure defining the themes arising from the data.

In reporting free text responses, comments were numbered and coded as follows: S/C/R = school of study, 1/2 = year of study. E.g. Q1:S1 indicates a response from an SVMS first-year student, C2, a second-year Cambridge student, etc.

5.3 Results

5.3.1 Internal consistency

The internal consistency co-efficient scores for learning domains calculated by combined Likert items are included in Table 5.2.

Table 5.2 Internal consistency of items within a domain, calculated based on responses from all schools combined.

Items and domain	Cronbach's α
1-3, Gaining knowledge	.718
4-5, Application	.632
6-7, Enjoyment	.624
8-9, Assessment	.628
10-13, Learning process	.773

The survey yielded a total of 660 responses returned from participants resulting in response rates as detailed in Table 5.3.

Table 5.3 Response rates to questionnaire assessing perceptions of teaching methods. RVC, Royal Veterinary College; CBR, Cambridge Vet School; SVMS, School of Veterinary Medicine and Science.

School	Year of study	No. of participants	Response rate
RVC	1	205	96.7%
	2	178	80.5%
	Total	**383**	**88.5%**
CBR	1	64	98.5%
	2	64	88.9%
	Total	**128**	**93.4%**
SVMS	1	88	81.5%
	2	61	57.0%
	Total	**149**	**69.3%**

Responses to the additional question on students prior experience of teaching methods showed the majority of students studying at RVC and Cambridge had rarely or never carried out clinical skills on cadaver material. Teaching staff confirmed this. First-year RVC students were most familiar with prosections, and second-years with dissection. Most Cambridge students in first and in second year had regularly practised both teaching methods (Table 5.4). Due to the majority of students not practising clinical skills in the anatomy environment on a regular basis, practising techniques was excluded from analysis.

Table 5.4 Student responses to additional question relating to experience of dissection, prosection and clinical skills. % (n) of students and frequency of activity. RVC, Royal Veterinary College; CBR, Cambridge.

School and year of study (cohort size)	Teaching method	Experience of activity				
		Never	Once or twice	3 or 4 times	5 times or more	No response
RVC 1 (205)	D	0% (0)	10% (24)	82% (168)	6% (13)	0% (0)
	P	0% (0)	11% (22)	9% (19)	80% (164)	0% (0)
	T	64% (126)	18% (37)	4% (8)	3% (6)	0% (0)
RVC 2 (178)	D	1% (1)	1% (2)	0% (0)	98% (174)	1% (1)
	P	1% (1)	8% (15)	12% (22)	78% (138)	1% (1)
	T	76% (136)	35% (62)	3% (6)	1% (1)	0% (0)
CBR 1 (64)	D	0% (0)	0% (0)	0% (0)	100% (64)	0% (0)
	P	0% (0)	0% (0)	8% (5)	92% (59)	0% (0)
	T	66% (42)	27% (17)	3% (2)	5% (3)	0% (0)
CBR 2 (64)	D	0% (0)	0% (0)	0% (0)	100% (64)	0% (0)
	P	0% (0)	0% (0)	2% (1)	98% (63)	0% (0)
	T	28% (18)	58% (37)	11% (7)	3% (2)	0% (0)

5.3.2 Descriptive statistics and overall trends in data

Students in all three schools reported a high level of agreement to all but the negatively phrased question for both dissection- and prosection-based teaching practices. Table 5.5 indicates the measures of central tendency of responses for each school's cohort of students.

Table 5.5 Summary of responses to questionnaire assessing perceptions of teaching methods. RVC, Royal Veterinary College; CBR, Cambridge Vet School, SVMS, School of Veterinary Medicine and Science. D. Dissection; P, Prosection

Likert item	Teaching method	Mean scores (median)		
		RVC	CBR	SVMS
1. Helps me relate structure to function	D	1.5 (1)	1.7 (2)	1.8 (2)
	P	1.5 (1)	1.7 (2)	1.7 (2)
2. Aids in 3D appreciation of structures	D	1.1 (1)	1.1 (1)	1.4 (1)
	P	1.6 (1)	1.6 (2)	1.5 (1)
3. Improves my understanding	D	1.2 (1)	1.3 (1)	1.5 (1)
	P	1.5 (1)	1.4 (1)	1.4 (1)
4. Provides an opportunity to put theory into practice	D	1.4 (1)	1.6 (1)	1.6 (2)
	P	1.9 (2)	2.1 (2)	1.9 (2)
5. Is relevant to my career	D	1.2 (1)	1.3 (1)	1.4 (1)
	P	1.5 (1)	1.6 (1)	1.7 (2)
6. I found it interesting/motivating	D	1.2 (1)	1.4 (1)	1.8 (2)
	P	1.7 (2)	1.9 (2)	1.8 (2)
7. I found it to be a negative experience	D	4.6 (5)	4.6 (5)	4.5 (5)
	P	4.5 (5)	4.4 (5)	4.3 (4)
8. It is important because it is assessed in exams	D	1.9 (2)	2.1 (2)	1.6 (1)
	P	1.6 (2)	1.8 (2)	1.6 (1)
9. I found it useful preparation for exams	D	1.5 (1)	1.5 (1)	1.7 (2)
	P	1.5 (1)	1.5 (1)	1.6 (2)
10. It relates to other teaching sessions	D	1.3 (1)	1.2 (1)	1.5 (1)
	P	1.4 (1)	1.4 (1)	1.5 (1)
11. It promotes peer learning	D	1.5 (1)	1.4 (1)	1.7 (2)
	P	2.1 (2)	2.4 (2)	2.5 (2)
12. It provides the opportunity to ask questions	D	1.3 (1)	1.3 (1)	1.6 (1)
	P	1.7 (1)	1.8 (2)	1.7 (2)
13. It encourages respect for the material	D	1.9 (2)	2.2 (2)	2.2 (2)
	P	2.0 (2)	2.2 (2)	2.2 (2)

5.3.3 Perceptions across schools

When comparing responses from the schools, mean scores demonstrate that students from the RVC generally hold a more positive perception of practical anatomy teaching, particularly of dissection, than students from the other schools. Significant results were found in all areas of learning and a large number of these differences were found to be between RVC students and those studying at SVMS, with RVC students placing more value on dissection and prosection as teaching methods.

Cambridge students, when compared to SVMS students, felt more strongly that dissection related to the rest of their course (Likert item 10) and that it provided opportunities for peer learning (Likert item 11). SVMS students indicated more strongly than Cambridge participants that they felt dissection and prosection were assessed in the curriculum (Likert item 8). Figures 23 and 24 show the mean ranks scores for dissection and prosection by school, and full tables of results of the analysis can be found as Appendices 6 and 7.

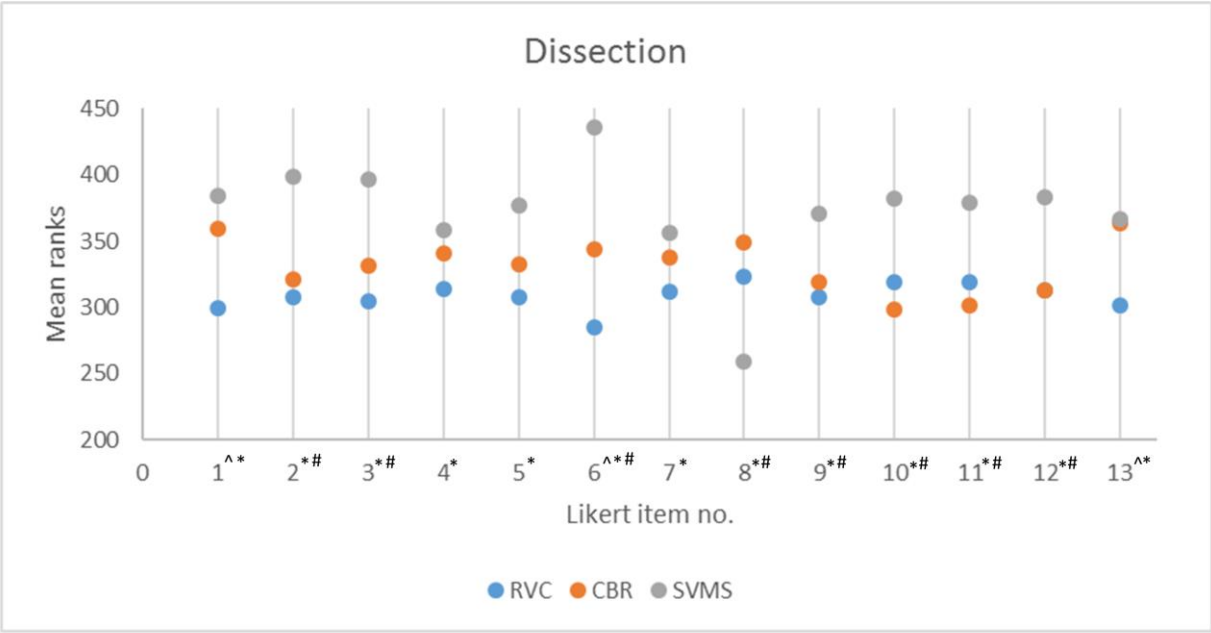


*Figure 23. Mean rank scores for dissection by school. Likert scale: 1, strongly agree - 5 strongly disagree. Therefore, a lower score represents higher value placed on the method. Significant differences found between RVC and Cambridge are indicated by *, between Cambridge and SVMS by #, and between Cambridge and RVC by ^.*

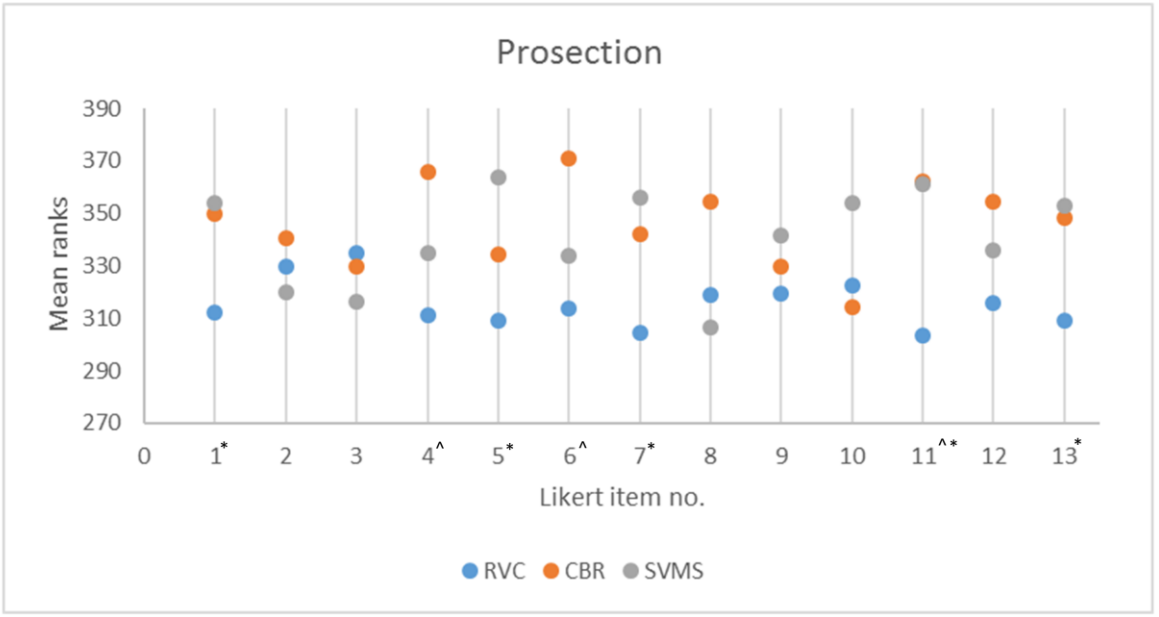


*Figure 24. Mean rank scores for demonstration of prosected specimens. Likert scale: 1, strongly agree - 5, strongly disagree. Therefore, a lower score represents higher perceived value. Significant differences found between RVC and Cambridge are indicated by *, between Cambridge and SVMS by #, and between Cambridge and RVC by ^.*

5.3.4 Teaching methods

When comparing the perceived value of teaching methods within each individual school, further differences were found in perceptions of teaching. Students at RVC rated dissection and prosection as valuable for different areas of teaching. Cambridge students demonstrated higher value placed on prosection compared to dissection as a teaching method, and SVMS students' scores reflected the smallest variation in perceptions of the two methods. The only areas of learning in which students agreed to a similar degree across all three schools, was that prosection is assessed in the curriculum, and that prosection encourages respect for the material. However, scores for the respect item were not different statistically. It was also indicated by students at all three schools that dissection promotes peer learning more so than the demonstration of prosections as an activity. Results of the analyses are included as shown in Table 5.6.

*Table 5.6 Comparison of scores for dissection and prosection by school. Statistically significant results are indicated by *, and have been colour coded where a statistically significant difference was found. Blue represents areas in which dissection was rated most highly, and yellow indicates where higher value was placed on prosection.*

Learning domain	Question number	RVC	CAMB	SVMS
Knowledge	1	Dissection* (*Z*=-2.31, *p*=.021)	Dissection (*Z*=-.259, *p*=.796)	Prosection (*Z*=-1.49, *p*=.137)
	2	Dissection* (Z=-12.00, p=.000)	Dissection* (*Z*=-6.63, *p*=.000)	Prosection* (*Z*=-2.35, *p*=.019)
	3	Prosection* (Z=-8.124, p=.000)	Prosection* (*Z*=-3.15, *p*=.002)	Dissection (*Z*=-1.40, *p*=.163)
Application	4	Dissection* (*Z*=-9.60, *p*=.000)	Prosection* (*Z*=-6.17, *p*=.000)	Dissection* (*Z*=-4.80, *p*=.000)
	5	Prosection* (*Z*=-9.34, *p*=.000)	Prosection* (*Z*=-4.66, *p*=.000)	Dissection* (*Z*=-4.22, *p*=.000)
Enjoyment	6	Prosection* (*Z*=-11.36, *p*=.009)	Prosection* (*Z*=-6.19, *p*=.000)	Dissection (*Z*=-1.49, *p*=.137)
	7	Dissection* (*Z*=-4.22, *p*=.000)	Prosection* (*Z*=-2.73, *p*=.006)	Prosection* (*Z*=-2.77, *p*=.006)
Assessment	8	Prosection* (*Z*=-5.62, *p*=.000)	Prosection (*Z*=-2.38, *p*=.017)	Prosection (*Z*=-0.88, *p*=.930)
	9	Dissection (*Z*=-1.77, *p*=.077)	Prosection (*Z*=-1.12, *p*=.264)	Prosection (*Z*=-1.40, *p*=.160)
Learning process	10	Prosection* (*Z*=-2.65, *p*=.008)	Prosection* (*Z*=-2.75, *p*=.006)	Dissection (*Z*=-.588, *p*=.556)
	11	Dissection* (*Z*=-10.54, *p*=.000)	Dissection* (*Z*=-7.72, *p*=.000)	Dissection* (*Z*=-6.686, *p*=.000)
	12	Dissection* (*Z*=-7.16, *p*=.000)	Dissection* (*Z*=-5.66, *p*=.000)	Prosection (*Z*=-1.31, *p*=.191)
	13	Prosection (*Z*=-1.83, *p*=.067)	Prosection (*Z*=-.705, *p*=.264)	Prosection (*Z*=-.591, *p*=.555)

5.3.5 Perceptions of first- and second-year students

There were few differences in perceptions between first- and second-year students. At SVMS, year 2 students rated dissection more highly than prosection for relating structure to function (Z=-3.32, p=.001) and a similar result was found for Cambridge students (Z=-3.46, p<.001). However, at RVC second-year students rated prosection more positively for the same item (Z=-3.79, p=.000). RVC showed the highest number of variations in opinions between year groups, with second-year students also rating prosection more highly for gaining understanding (Z=-4.17, p<.000) and for relevance to career (Z=-3.68, p<.000).

At RVC, patterns indicate a more positive perception held by first-year students toward dissection, rating it significantly higher than second-year students, finding it interesting (Z=-3.82, p<.000), and for its relation to the rest of the course (Z=-3.83, p<.000).

In all three schools surveyed, students in year 2 generally rated more positively than students in year 1. However, in many cases this was not shown to be statistically significant.

5.3.6 Free text data

Five overarching themes were identified in the data generated by the three schools, and these along with their constituent sub-themes are demonstrated in Figure 25. Further description and example quotations referring to the participants' school and year group are presented below.

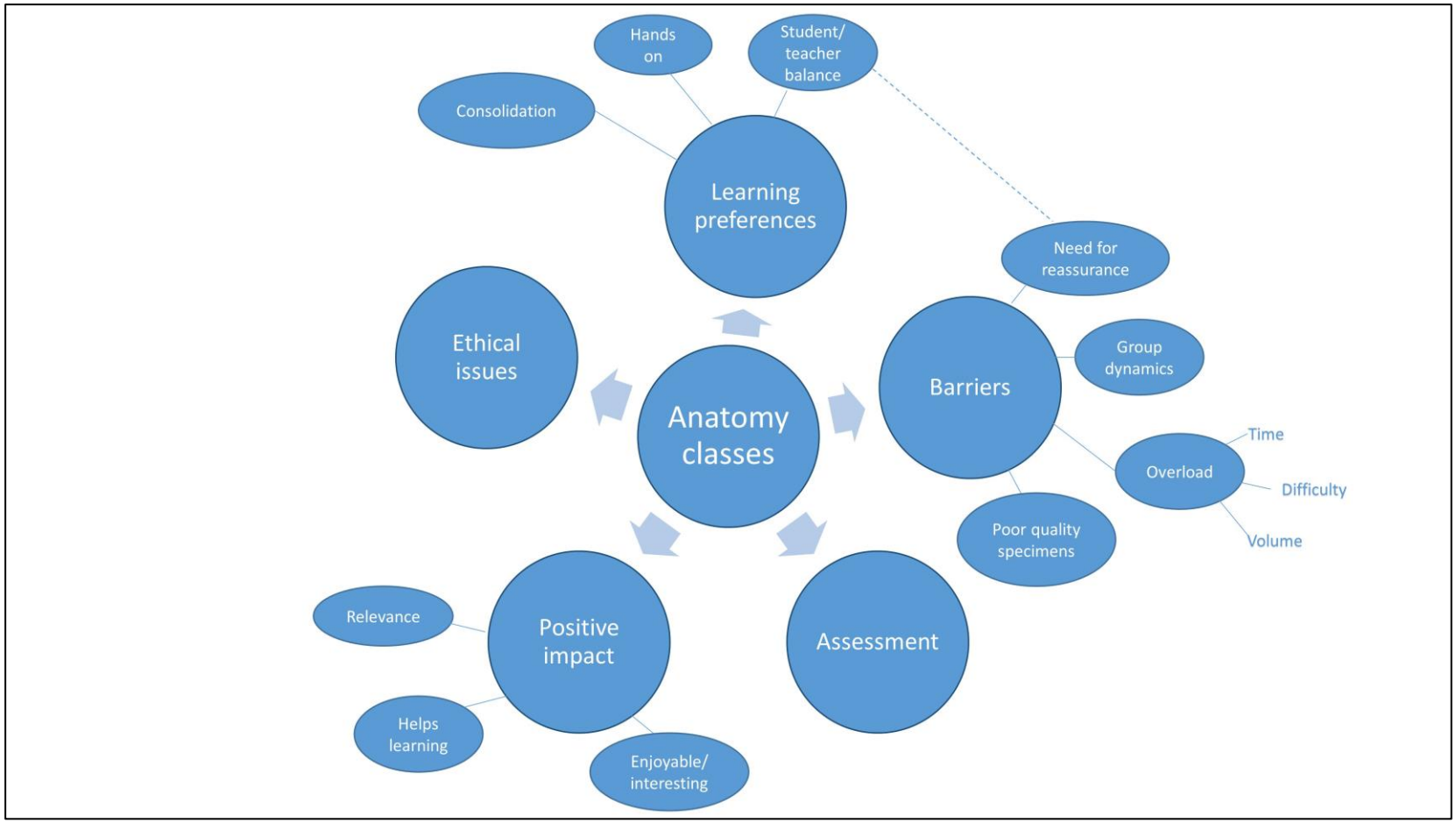


Figure 25. Thematic map of free text responses in 3 school

Theme 1: Learning preferences

This theme describes students' individual preferences in learning. The first sub-theme demonstrates preferences for either teacher-led or student-led learning, or a balance between the two. Students in all three schools stressed the need for guidance in practical sessions, demonstrating a reliance on teacher-led learning. Comments relating to teacher-led approaches largely reflect a desire for more demonstrators in practical classes, or emphasised the importance of there being enough demonstrators available during classes to answer questions. Other comments relating to teacher-led preferences referred to the value of good diagrams and task sheets as guidance.

Q1. "*I would like more instruction, clearer 'step by step'. More description of where to be looking exactly*" (S1)

Comments reflecting a student-led preference for learning included appreciating the opportunity for self-directed learning or small group work. The reported value of demonstrators as facilitators to guide students when they struggle illustrate a balance between teacher- and student-led approaches.

Q2. "*I find it really helpful to be able to talk through the anatomy in a small group and be able to ask for individual help from demonstrators if needed*" (C2)

RVC students however, repeatedly described how their own preparation was key in gaining the most benefit from a practical session, demonstrating a more student-led approach.

Q3. "*The more I prepare for the practicals the more I learn*" (R2)

The second sub-theme under the main theme of learning preferences refers to the benefit of using practical classes as an opportunity to consolidate or re-inforce existing knowledge. Students underlined the importance of receiving lectures in the subject matter prior to a practical class, viewing the practical classes as consolidation time.

Q4. "*It's useful, but significantly improved when the material that is being studied has already been covered in depth*" (C1)

The sub-theme entitled 'hands-on' reflects students describing preferences for learning anatomy practically, physically manipulating specimens. Further comments describe a disadvantage in teaching using prosections as being limited in the opportunities to touch and manipulate specimens.

Q5. "*Cannot touch/feel for yourself to help remember it*" (C1)

Different preferences for learning were demonstrated in the final sub-theme of clinical skills, with some students believing they would enjoy the opportunity to practice clinical techniques within anatomy practical classes and others believing they would not benefit from this type of learning.

Q6. "*Could do more of the clinical techniques, but no point as yet as we won't be using this until clinical years. Would prefer not to learn suturing (for example) in year 1 when we won't get to use it (and so will forget) until clinical years/EMS*" (R2)

Theme 2: Barriers to learning

Factors negatively affecting learning reported by students studying in all three schools included poor quality specimens and bad smells, and large group sizes affecting visibility and concentration. Students also reflected a lack of confidence in their knowledge and reported feeling overwhelmed.

The sub-theme overload reflects the number of ways students feel overwhelmed including sessions being too long, too short, too difficult, or there being too much to learn.

Q7. "*Sometimes in first year dissection sessions were very long often didn't take much away from just pure dissection*" (S2)

Q8. "*Sometimes very hard to find what you are looking for and easy to destroy things accidentally*" (C1)

Q9. "*I often feel there is too much to learn in one go*" (R1)

A number of comments reflect a feeling of being overwhelmed and the negative impact this has on learning. Students describe a lack of confidence and seek reassurance from staff. This sub-theme links to student/teacher balance.

Q10. "*Sessions are very useful when we are talked through the material. When we are not they can be frustrating, confusing and demoralising*" (R1)

Q11. "*The most useful sessions are when the lecturers/anatomists are around to explain things as you go along because vet school is one big self-doubt experience and it is so helpful to have someone there to confirm your thoughts or show your mistakes*!" (R2)

Large group sizes were described as a barrier to learning, and a negative effect was felt in both teaching practices of demonstrating prosection and student dissection with students reporting a loss of interest when groups are too big to see or hear what is being demonstrated.

Q12. "*Demonstration of prosections more useful when able to ask questions and dissection is more useful when in smaller groups*" (R1)

Group dynamics were also reported to be important in getting the most out of sessions. Problems arising from working in small groups included controlling or domineering group members, and peers expressing a lack of motivation.

Q13. "*You don't always get the opportunity to join in if you're with pushy people*" (S2)

Poor quality specimens is a sub-theme reflecting negative aspects in using cadavers such as the variation in how clearly structures can be presented, the validity of using the material, and the bad smell associated with the formalin-fixed specimens

Q14. "*I feel sometimes the experience isn't as helpful as it could be when we have poor specimens*" (R2)

Q15. "*If last group prosections can be damaged*" (S2)

Theme 3: Positive impact

Many students described the positive impact of the sessions. The responses were categorised into those referring to enhancing learning,

Q16. "*Normally the most helpful part of each module – only thing that always helps me understand the structure/functional anatomy*" (R2)

And those reflecting students' own experiences such as interest, enjoyment, or motivation.

Q17. "*Really enjoy them*" (S1)

SVMS students cite the relevance of the activities as positively influencing their learning and this emerged as a subtheme from the SVMS data.

Q18. "*I find the clinical techniques very useful to see how anatomy knowledge is relevant as a clinician*" (S1)

The small group environment that comes with dissection sessions is also valuable in gaining confidence, as is evidenced by the following quote:

Q19. "*I love working in small groups and feel more confident asking questions – very useful*" (R2)

Theme 4: Ethical considerations

Ethical concerns were also raised around the use of cadaveric material in teaching. First-year students in particular at the RVC reflected concerns about ethical sourcing and use of

specimens. A desire for more respect toward specimens was expressed by these students and SVMS students. Students from all three schools demonstrated a sadness at the need to use cadaveric specimens and the need for a level of detachment was highlighted. Students also expressed a desire for teaching staff to be well informed on the source of cadaveric materials and to share that information with students.

Q20. "*I feel the origins of the cadavers should always be known – the lecturers aren't always sure*" (R1)

Theme 5: Assessment

Students studying at all three schools demonstrate an intrinsic motivation to learn through dissection and prosections and indicate that assessment is not the focus for their learning in these sessions.

Q21. "*I find dissection/demonstration useful to learn anatomy and physiology and improve understanding, but not as direct prep specifically for exams*" (R1)

However, other comments demonstrate assessment as a driver for learning the material presented in anatomy classes.

Q22. "*We are often presented with pots to identify in exams therefore it is important we look at them and understand them in pracs*" (C2)

5.4 Discussion

In this study aiming to investigate students' perceptions of anatomy teaching across different learning contexts in the UK, students studying at the RVC were found to place a higher value on learning in the anatomy laboratory than students studying at Cambridge or SVMS. Results indicate that students in all three schools appreciate opportunities to participate in cadaver-based practical sessions, which emphasises the importance of teaching using cadaveric material in the vet school setting. Practical classes are perceived as most beneficial when used to reinforce and consolidate prior knowledge gained through lectures or self-directed learning methods.

A notable difference between the three institutions under study for this research is the cohort size. The statistical method used in the analysis allowed for this difference in participant numbers. The large cohort size at RVC is unlikely to impact student perceptions of practical classes due to the organisation of the course, i.e. half the cohort participating at

a time. This results in a practical class size comparable to that at SVMS. However, it cannot be assumed that the cohort size will not impact wider perceptions of teaching in the course, nor can it be discounted that high student numbers may result in students feeling required to work more independently. The evidence relating to impact of class size on achievement is inconclusive (Toth and Montagna, 2002). Moreover, Cambridge students reported problems with large group sizes when looking at demonstrated prosections, despite the smaller cohort size compared to the other schools. It is therefore unlikely to be the influencing factor in Cambridge participants assigning to prosection evaluations that are more positive than those for dissecting. In the case of practical teaching, it is likely the ratio of staff and teaching materials to student will have more of an effect than the overall cohort size. In the present study, staff numbers were not recorded, and staff-to-student ratios were variable depending on the type of practical and topic being delivered and thus meaningful comparisons between schools could not be drawn in this area.

The high value placed on anatomy classes by RVC students in relation to other schools and comments referring to student-led learning methods is interesting when considering the lecture-free learning environment employed by this particular school. Dissection and prosection were valued for different aspects of learning and students here felt more so than in other institutions that both these classes provide opportunities to ask questions. This, alongside the free text responses reinforcing the perceived value of these opportunities reflect an appreciation of the interactions with teaching staff to help in the interpretation and application of the knowledge gained from their preparatory activities. In comparison, Cambridge students, undertaking a more traditional course were more likely to evaluate the more didactic method of demonstrating prosections as more valuable in teaching anatomy.

RVC undergraduates are provided with information regarding the subject matter prior to the practical taking place, and are instructed to read around the topic area before attending class. As the transmission of information mostly occurs out of teaching hours, and class time is instead used for active learning, the method is similar to the inverted or flipped-classroom (FC) approach described by Bergmann and Sams (2012). Advantages of this approach include the capacity for students to learn at their own pace, and improving engagement through students taking responsibility for own learning (McLaughlin et al., 2014). In a study of veterinary students undertaking a professional skills course, Moffett and Mill (2014), found that students to prefer the flipped

classroom approach, rating it more positively than the traditional approach across a number of areas including more positive perceptions of teaching staff and increased confidence in tackling problems. Other studies into the flipped classroom style of teaching anatomy have similarly reported positive student perceptions (Mikkelsen, 2015, Park and Howell, 2015).

While perceptions have been found to be positive, investigations into FC model and its relationship to approaches to learning have so far proved inconclusive. Studies measuring approaches to learning using the Study Process Questionnaire (SPQ) (Biggs, 1979) have found the use of student-centred methods of teaching to have a positive influence on the use of deep approaches (Sivan et al., 2000, Wilson and Fowler, 2005), while others claim that traditional learning environments were more likely to promote a deep approach to learning (Struyven et al., 2003, Segers et al., 2006). However, these studies represent a variety of contexts and describe different self-directed activities employed, and as such may not be directly comparable. Furthermore, evidence of the impact of FC on approaches to learning anatomy is lacking and a search of Ovid Medline database returned no studies measuring approaches to learning in the context of a FC in anatomy teaching. It is clear, therefore, that further empirical evidence is needed before drawing conclusions on the impact of learner-centred techniques, as called for by Abeysekera and Dawson (2015) in their review of literature relating to the flipped classroom and motivation. Motivation is particularly pertinent in the case of the FC as the method relies on students carrying out pre-class preparatory work. If students are not motivated to carry out preliminary work, it may negatively affect group work in subsequent sessions, as was reflected by comments in present study pertaining successful group work arising from thorough preparation.

In the present study, some students described enjoying group work, but dysfunctional groups were also a factor in impeding learning. Conflict between individuals is likely to mirror disputes that occur in the workplace, and the ability to work with others is an essential skill to develop in veterinary undergraduates. Therefore, opportunities to develop collaborative working and strategies to manage conflict are valuable to students. However, while collaborative learning is conducive to adult learning, moving to more autonomous group working may be difficult for some secondary school leavers (Lowe and Cook, 2003). As such, it is important that as teachers we support and encourage students through the transitional period from secondary school to HE in order that they are able to develop professional competencies such as

teamwork and independent learning, as has been highlighted in previous work (Parkinson and StGeorge, 2003, Mossop and Cobb, 2013). The struggle in students' acceptance of an autonomous style of learning is reflected in a study of undergraduate medical students at the University of Edinburgh (Findlater et al., 2012). Findlater reports a strategy of 'supported self-directed learning' in a move from didactic teaching methods in the anatomy lab (demonstrations of prosections) to a student-centred, self-directed approach. In the new approach, students moved around stations containing prosections, models and radiographs guided by workbooks and facilitated by teaching staff. Students found it difficult to accept the new approach, with feedback containing complaints about teaching staff not doing enough teaching during the sessions. A lack of confidence in their own learning and an anxiety around self-direction demonstrated by students in the present study show the struggle some students face in the transitional stages of HE. Grow (1991) suggests that students advance through stages of self-direction, and it is argued that by providing structure to students in the early stages of self-direction teachers can help students move toward autonomy (Dynan et al., 2008).

Studies relating to the learner-centred teaching and performance in assessment have returned mixed results. Findlater's (2012) study found that the supported self-directed approach significantly improved students' examination performance, and suggests eventual improved engagement led to improved understanding. However, new lectures were introduced to supplement the self-directed approach in the lab, and more staff were enlisted to facilitate sessions. Therefore, it cannot be concluded that it was the self-directed approach alone that influenced students assessment scores. Moffett's (2014) study of veterinary students actually found that students studying course material using a lecture-based approach outperformed those participating in the FC version in a multiple-choice examination. Morton et al. (2017) argues that the inconsistency in study findings may be as a consequence of using assessments requiring low-level cognition as measures of effectiveness. In their study, Morton et al. categorised anatomy items by Bloom's taxonomy and found that the benefits of using a FC were better demonstrated when assessments requiring students to analyse content were used in measuring the effectiveness of the technique. This would suggest that pre-class activities requiring students to work independently may help in developing their ability to apply, analyse and evaluate material, cognitive processes higher up the taxonomy scale. It

follows then, that if we are to encourage students to work independently in order to develop higher order cognitive processes, the assessment formats used in the anatomy curriculum should allow students to showcase their abilities in these areas and not simply test recall.

Assessment performance was not considered for the present study, and assessment and perceptions of anatomy teaching are investigated in Chapter 7 in this thesis. However, assessment as a theme was evident in the qualitative data gathered, indicating assessment is an influencing factor in perceptions of learning. Likert results suggesting SVMS students felt more strongly than participants at other institutions that dissection, and to a lesser degree, prosection were related to assessment may be explained by the differing assessment formats within the schools. At SVMS practical examinations in years 1 and 2 can include the assessment of dissection technique and instrument handling. At the time of the study, RVC and Cambridge vet school did not practice this form of examination, and it may be that students recognise this as assessment of a direct learning outcome more readily than outcomes gained from the process of dissecting or looking at prosections. Differences in assessment practices have previously been raised as an issue when comparing teaching practices across different curricula (Winkelmann, 2007). Despite SVMS students believing dissection to be assessed, this did not seem to alter the perceived value of the teaching method overall, indicating a deeper motivation than learning simply for the purposes of assessment. Similarly, comments received by students at other schools indicate that assessment is not the main driver for learning anatomy.

When considering literature regarding the educational impact of a flipped classroom, it is important to note that the exact definition of FC teaching is unclear and it is likely that increased positive perception could be influenced by factors such as the introduction of interactive methods such as quizzes and other extra efforts made by teachers in redesigning their teaching. Ultimately, student perceptions and educational outcomes of FC will likely depend on the quality of pre-course materials and the in-class activities used (Jensen et al., 2015). RVC do not describe practising a FC approach, and practical anatomy classes are not directly designed to discuss ideas in the way described by some FC literature. Moreover, practical classes often encourage active learning regardless of activities carried out outside of the lab. However, the principle of learner-centred teaching remains, with the onus being on the students to attend practical classes prepared with a base level of knowledge and a want to develop this further.

Furthermore, RVC students were not alone in their desire to attend practical sessions feeling prepared. SVMS and Cambridge students also emphasised the importance of receiving the lecture before the practical class and allowing time for it to 'sink in'. However, reading through lecture material is not an active form of learning, and the comments imply that they are not reviewing material specifically in preparation for a class. Further investigation into students' preparation techniques would be valuable in understanding how to optimise student engagement with the material and support students transitioning to the higher education learning environment in which there is more emphasis on directing one's own learning.

It is clear from this research that students appreciate practical classes for the opportunities to consolidate their prior learning. Comments from students at all three schools illustrate that they are using the sessions to build upon and apply and 'make sense' of what they have been learning about. This suggests that practicals encourage the accumulation, digestion and organisation of subject knowledge. This highlights the importance of supporting students by designing activities in which they can actively construct knowledge to foster deep learning in anatomy.

5.5 Study limitations

While still rating dissection and prosection highly, SVMS students' attitudes were more neutral towards these teaching methods, and there were fewer significant differences found between the methods. The result of Study 1 carried out for this thesis show that practising clinical skills and techniques was rated more highly than both dissection and prosection for most areas of learning. As the responses for practising techniques were removed from the dataset in this analysis it is likely this may have affected the results as students may have answered differently without the context of this teaching method.

As is the case in all survey data collection, the results obtained during this study represent a snapshot in time. The responses obtained are expected to have been influenced by the time of distribution of the questionnaire. While efforts were made to ensure students were at a comparable point in their course, inevitably, differences in the structure of the courses mean that students had studied different modules and had completed a varying number of prosection- and dissection-

based practicals and this is likely to have influenced their perceptions.

When comparing different learning contexts, there are many varying factors likely influencing the results such as, the amount of time allocated to practical anatomy teaching, the point and order in which anatomy is included and assessed and the type of assessment used. Student numbers, student to staff ratio and student to cadaver ratio are also likely influences, as is the depth and breadth of the subject covered and the background of the tutors (e.g. clinical/non-clinical). Moreover, practical formats within the various school settings need to be evaluated in more detail before trends can be confidently identified. However, the findings of this wider study do support the findings of the investigation into SVMS student perceptions in recognising the value of cadaver practical classes in the first and second year of the veterinary program, and advocating the use of a combination of teaching methods in the dissection environment.

The findings show statistical differences between groups rather than causal relationships, and other factors such as differences in recruitment of students attracting different types of learners could be a factor when considering differences. Perceptions of learning are an important in evaluating educational curricula, but this study investigated only perceptions rather than educational outcome. Further investigation is required into the effects of learner centred teaching on learning anatomy. Nevertheless, students value practical sessions in anatomy to consolidate their knowledge, and through the appropriate design of activities encouraging the application of knowledge, a deep approach to learning can be encouraged in the dissection laboratory.

5.6 Conclusions

This study demonstrates that students value practical anatomy sessions as opportunities to apply and consolidate their existing knowledge. Furthermore, in-class activities should be designed to provide opportunities for consolidation, analysis and application of information and not the transmission of knowledge. While it is acknowledged that the RVC are not using FC per se, it could be that merely being explicit in the focus being on the student to prepare is enough extrinsic motivation to increase the perceived value of practical sessions for RVC students. It should however be noted that students can struggle to recognise what is relevant in the early stages of their course and in order to support students undertaking

independent learning practical classes should be appropriately staffed. Chapter 6 investigates if these issues continue into clinical years of study and if clinical students perceive their preclinical teaching to have been of value to their current studies.

6 Study 3. A longitudinal study into the perceptions of anatomy classes

6.1 Introduction

As described in the Chapters 4 and 5 of this thesis, practical anatomy classes are perceived by first and second year students to have a positive impact on their learning. Anatomy is traditionally taught as part of a basic science curriculum in years 1 and 2 of the veterinary degree course, as a foundation for clinical teaching delivered in later years. However, in the first study, students reported factors impeding their learning such as high workload and difficulties in learning the subject. Barriers such as these can lead to students adopting superficial learning techniques (Ryan et al., 2004, Parkinson et al., 2006) leading to a negative effect on long-term knowledge retention (Ward and Walker, 2008). An inability to recall and apply anatomical knowledge could leave students feeling unprepared for clinical placements.

Within the medical literature, concerns have been raised regarding the levels of anatomical knowledge of students taught through a clinically oriented curriculum (Older, 2004, Bergman et al., 2011). Literature on the current situation in the veterinary profession is lacking, although several authors have called for modernisation of the veterinary gross anatomy curriculum (Salazar, 2002, Ginneken and Vanthournout, 2005, Doherty and Jones, 2006). Furthermore, the need for veterinary graduates to be proficient in skills as described by the Day One Competences of the RCVS (RCVS, 2014) highlights the significance of relevant content taught within the veterinary curriculum.

The impact of the introduction of clinical educational tools such as ultrasound and radiography (Brown et al., 2012, Johnson et al., 2012), has been investigated and found to support traditional teaching methods. However, there is little empirical evidence on the continuing impact of teaching practices in anatomy. This study investigates the attitudes and opinions of students undertaking a clinically integrated veterinary degree course as they progress through the basic science modules through to clinical modules. Figure 26 demonstrates how study 3 fits into the research in this thesis.

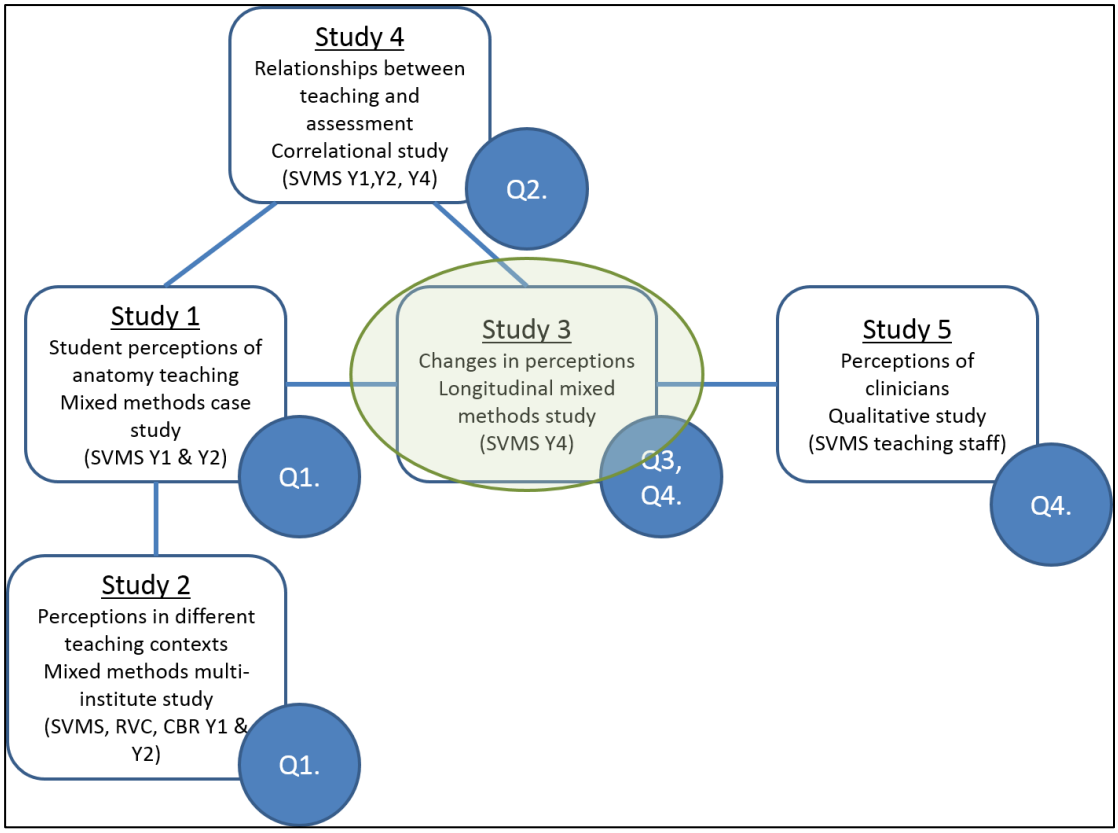


Figure 26. Map of studies in this thesis, study 3 highlighted. SMVS, School of Veterinary Medicine and Science; RVC, Royal Veterinary College; CBR Cambridge Vet School

In investigating the wider research questions of this thesis, this study aims to investigate the following research questions:

1. Do students' perceptions of methods of anatomy teaching change throughout the course?

2. Do students feel their anatomical knowledge is sufficient for clinical placements?

6.2 Methods

This study used a mixed methods approach using the previous survey design followed by student focus groups to follow up on issues arising from Study 1 and Study 3 survey data.

6.2.1 Survey design

In this longitudinal study, the cohort of students entering the course in 2010 were administered surveys as second year students in May 2012, and again as fourth years in March 2014. An identical questionnaire to that which the students had completed in year 2 of the course was created, in which the students were requested to answer the same statements

retrospectively about their anatomy classes in years 1 and 2. A brief explanation was provided to the students, and in addition to the original questionnaire, a further 5 Likert items were included. These questions related to year 4 teaching, and 3 further statements were regarding their expectations beyond graduation. These questions were chosen to reflect issues in the current literature and the objectives of the SVMS curriculum. The survey also included a request for volunteers to participate in subsequent focus groups and was piloted for clarity with year 5 students (n=3). Consequently, minor changes to wording were made and the final survey and additional information is included as Appendix 8.

The paper-based survey was distributed to the 2010 cohort of the 5-year full time BVM BVS course at the University of Nottingham, during a practical session in the spring term of their fourth year of study. This is the last term of teaching before entering into their final year of supervised clinical practice-based learning; therefore, they had completed all modules of formal study.

6.2.2 Analysis of survey data

Individual Likert item scores were summed according to the learning themes present in the survey; gaining knowledge, application of knowledge, enjoyment, assessment, and the overall learning process. Cronbach's coefficient alpha was used to assess the homogeneity of items within the domains.

Charts were created in Excel and data was entered into SPSS version 21 for statistical analysis. Friedman's ANOVA tests were used to compare responses between the different teaching methods of dissection, prosection and clinical techniques. Wilcoxon signed ranks tests were carried out to measure differences in responses between the first administration in year 2, to those in year 4. Significance was defined at $p < .05$.

Analysis of the free text data was carried out using a thematic approach. Due to the process of analysis of previous data carried out for this thesis, a naïve, inductive approach to the data was not possible, and as such a hybrid approach incorporating both an inductive approach and the use of a priori codes as a means of organising the data, as described by Fereday and Muir-Cochrane (2006).

6.2.3 Generation of focus group script

Survey responses were used to inform the contents of the focus group discussion guidelines. Initial questions were developed from the areas of learning used in the survey and

from themes arising from the free-text response data, and from this, a script was created. A pilot focus group was run with two postgraduate students who had graduated from the SVMS veterinary course the previous year. Changes to the script were subsequently made, including the sequencing of questions to facilitate flow of discussion. The final script is included as Appendix 9.

6.2.4 Focus group sampling

All students responding to the request for focus group participants were contacted with further information and asked to confirm attendance at the focus group on 26th March 2014. A self-selected sample of students was divided into two focus groups run simultaneously by the author and a second researcher, using the same script. Each consisted of 6 participants. Focus groups were audio recorded with students' written consent and students were informed that their data would be anonymised and confidential and that they had the right to withdraw at any time (Appendix 10). Food and drink were provided at the start of the meeting and students each received a £10 Amazon voucher as an expression of gratitude for participation.

6.2.5 Focus group data analysis

Focus group recordings were transcribed verbatim by a professional transcription service and imported into GSR NVivo10 for subsequent coding and analysis. As with the survey free-text responses, a hybrid approach of deductive and inductive methods was used in analysis of the qualitative data. Transcripts were continually referred back to and checked for accuracy throughout the process of developing a codebook (Appendix 11). A secondary researcher independently coded a transcript before a systematic comparison was carried out. Disagreements were few and discussed until consensus was reached.

6.3 Survey Results

6.3.1 Response rates

At the time of administration of the first survey in 2012, 61 surveys were returned from a cohort of 103 students (59%). Two years later, upon administration of the second survey, a total of 67 surveys were returned from year 4 students, representing 68% of the cohort. Of these, 27 were found to be completed by participants who had not completed the original version of the questionnaire two years prior. One student was

resitting in attendance at the time of the second administration of the survey, and two students had taken an authorised interruption of study in their third year of the course. Consequently, these three students were not part of the 2010 cohort during the first administration. The remaining 24 students were absent for the first administration for reasons unknown. Only students present for both administrations of the survey were included for paired comparison, resulting in a total of 40 surveys (43%).

Alpha values for the domains used in analysis have been previously reported (see 4.3.1).

6.3.2 Perceptions of second-year students

Full details of the results of the survey data obtained from year two students can be found in Chapter 4 in this thesis.

Second-year students reported a high level of agreement to all but the negatively phrased question with dissection, prosection and the demonstration of techniques all scoring highly as teaching methods (Figure 27).

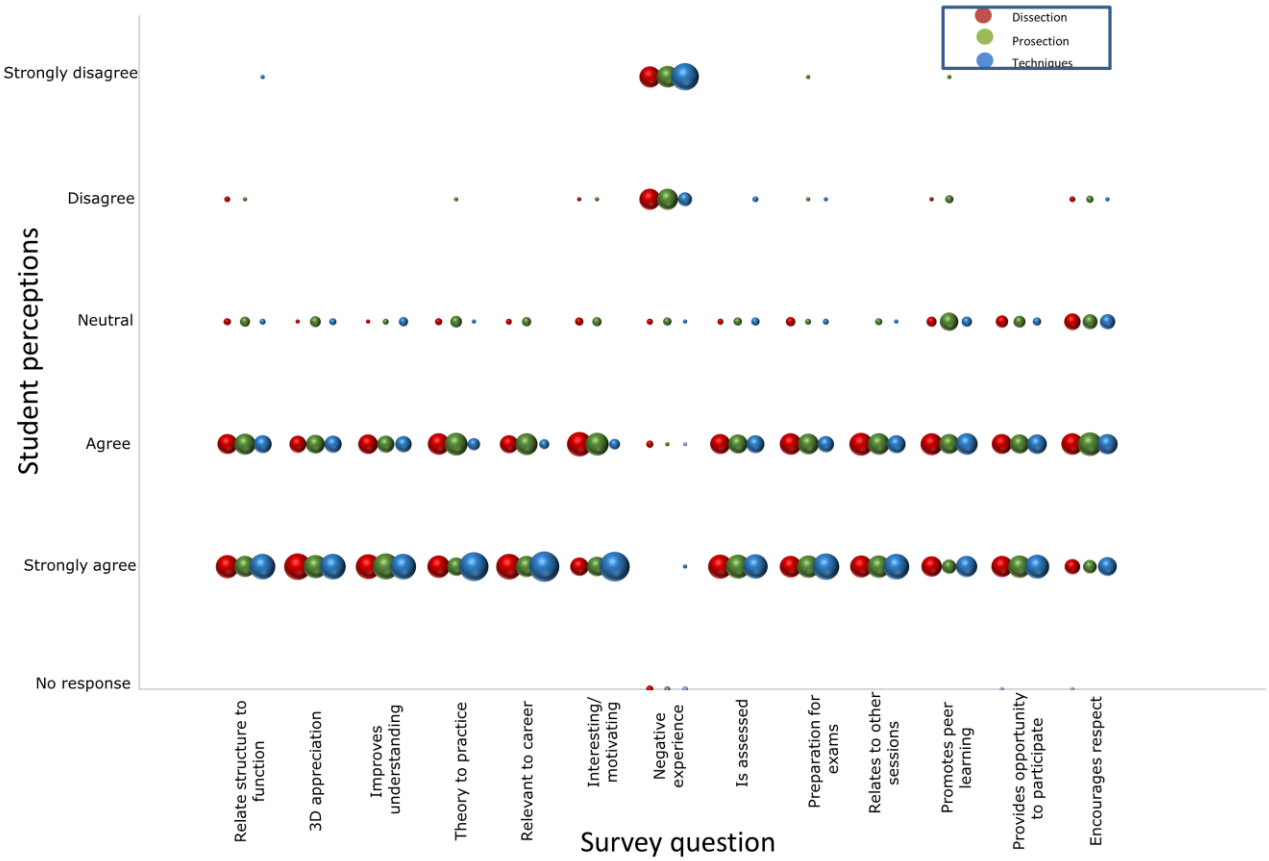


Figure 27. Perceptions of dissection, prosection and techniques, year 2.

Table 6.1 shows the mean rank scores for the three teaching methods as perceived by students in year 2. Practising clinical techniques was more highly rated than dissection or prosection in all teaching and learning themes. A comparison of responses to teaching methods found significant differences between teaching modalities in the areas of application (X2=21.44, p<.001), enjoyment (X2=31.66, p<.001), and learning (X2=21.44, p<.001).

*Table 6.1 Mean rank scores for dissection, prosection and practising techniques by learning domain, year 2 students. Significant differences between teaching methods are marked by *.*

Teaching method	**Mean ranks by area of learning**				
	Kn	**Ap**	**En**	**As**	**Le**
Diss	1.98	2.07	2.26	2.12	2.05
Pros	2.15	2.41	2.23	2.05	2.33
Techs	1.88	1.52*	1.51*	1.83	1.62*

6.3.3 Perceptions of fourth-year students

Perceptions of dissection, prosection and practising techniques as methods of teaching remain positive into fourth year. Figure 28 shows the majority of fourth-year students responded positively to all the methods of teaching with cadavers and practising techniques perceived to be particularly valuable in some areas. Statistical analysis of fourth year responses showed significant differences between methods of teaching in the areas of application, enjoyment, assessment and the learning process. Practical techniques was rated most positively in these areas, as is shown in Table 6.2

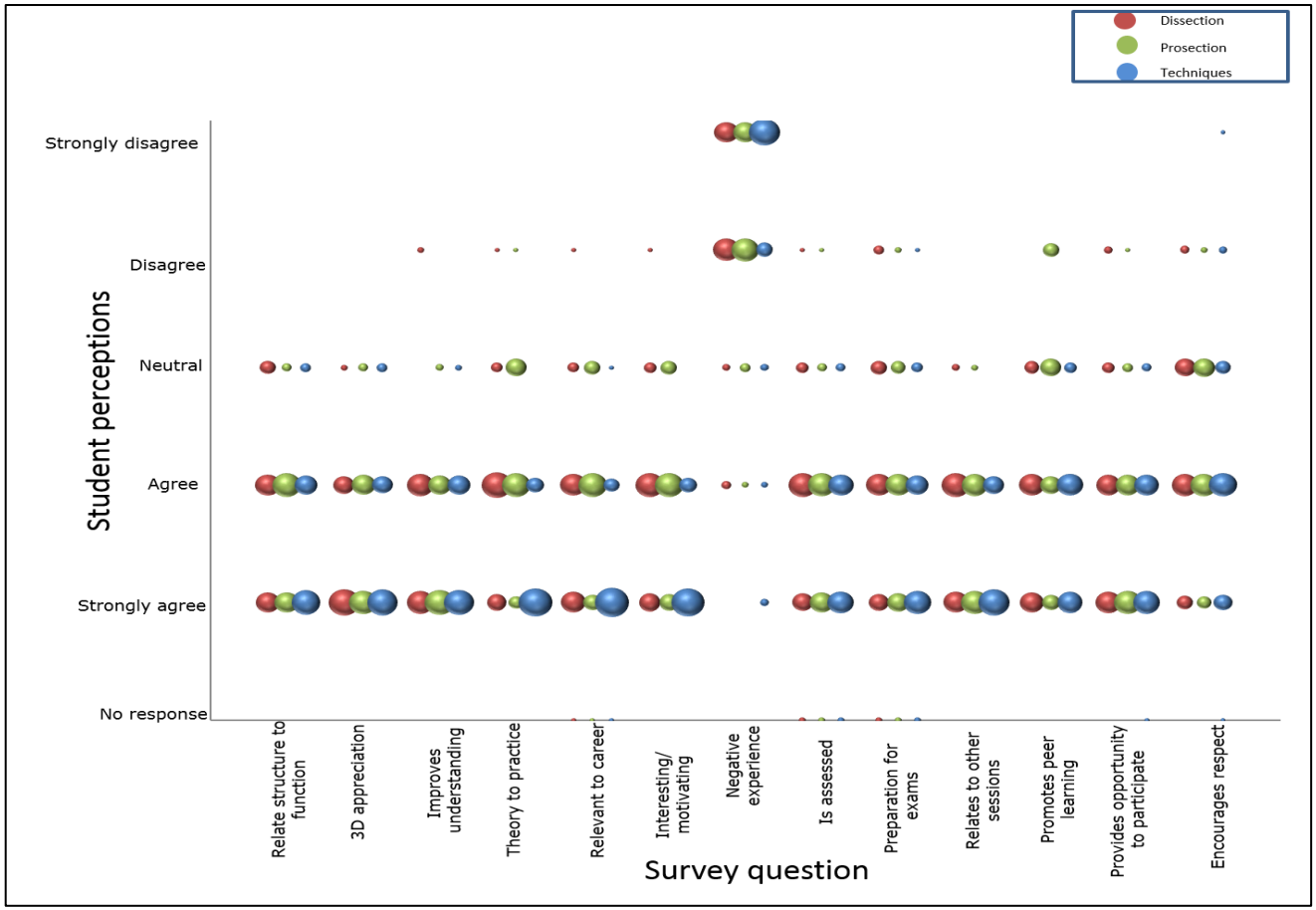


Figure 28. Perceptions of dissection, prosection, and clinical techniques, year 4.

*Table 6.2 Mean rank scores for dissection, prosection and practising techniques by area of learning, year 4 students. Significant differences between teaching methods, are marked by *. Diss, dissection; Pros, prosection; techs, clinical techniques. Kn, Knowledge domain; Ap, Application domain; En, Enjoyment domain; As, Assessment domain; Le, Learning domain.*

Teaching method	Mean ranks by area of learning				
	Kn	Ap	En	As	Le
Diss	2.09	2.13	2.21	2.26	2.04
Pros	2.08	2.60	2.27	1.97	2.33
Techs	1.83	1.27*	1.52*	1.77*	1.63*

6.3.4 Changes in perception between years 2 and 4

Statistical analysis of the responses showed a significant decrease in positive responses for dissection (Z=-2.43, p=.015) and prosection (Z=-3.42, p=.001) in the application of knowledge, as well as for dissection (Z=-2.09, p=.036) and prosection (Z=-2.45, p=.014) in the assessment of knowledge. In these areas, students placed more value on these methods in year 2 than they did in year 4. Table 6.3 reports the mean and median scores for each condition. However, practising clinical techniques was perceived to be equally valuable at the time of teaching and retrospectively, with no significant differences between the two administrations of the survey.

Table 6.3 Summary of mean (mode) scores for dissection, prosection, and techniques by year of study. Likert items: 1, strongly agree - 5, strongly disagree. Diss, dissection; Pros, prosection; techs, clinical techniques. Kn, Knowledge domain; Ap, Application domain; En, Enjoyment domain; As, Assessment domain; Le, Learning domain.

		Diss	**Pros**	**Techs**
Kn	Y2	4.43 (4)	4.45 (4)	4.23 (3)
	Y4	4.68 (5)	4.58 (4)	4.25 (4)
Ap	Y2	3.03 (3)	3.18 (3)	2.23 (2)
	Y4	3.58 (4)*	4.08 (4)*	2.33 (2)
En	Y2	3.48 (3)	3.13 (3)	2.30 (2)
	Y4	3.63 (4)	3.45 (4)	2.68 (2)
As	Y2	3.15 (3)	2.93 (3)	2.88 (2)
	Y4	3.62 (4)*	3.38 (4)*	3.13 (3)
Le	Y2	6.75 (7)	7.13 (8)	6.08 (6)
	Y4	7.35 (7)	7.85 (8)	6.20 (6)

6.3.5 Questions specific to year 4

Responses to questions about clinical studies are shown in Figure 29. All students believed anatomy to be an important part of the veterinary curriculum, with 22% of students agreeing and 78% strongly agreeing to the statement. The students largely disagree with the statement that anatomical knowledge was not required for fourth-year studies and they reported finding their learned knowledge useful for clinical extramural placements. However, 66% of students reported they had forgotten most of the anatomical knowledge they had learned in years 1 and 2 by the time they reached year 4, and 51% of students did not believe the anatomical topics were re-visited in year 4. Student responses indicated a belief that good anatomical knowledge is important in practice, with 24% of respondents agreeing and 75% strongly agreeing with the statement. However, 82% of those surveyed expected to look up anatomical information as and when it was needed in practice (Figure 30).

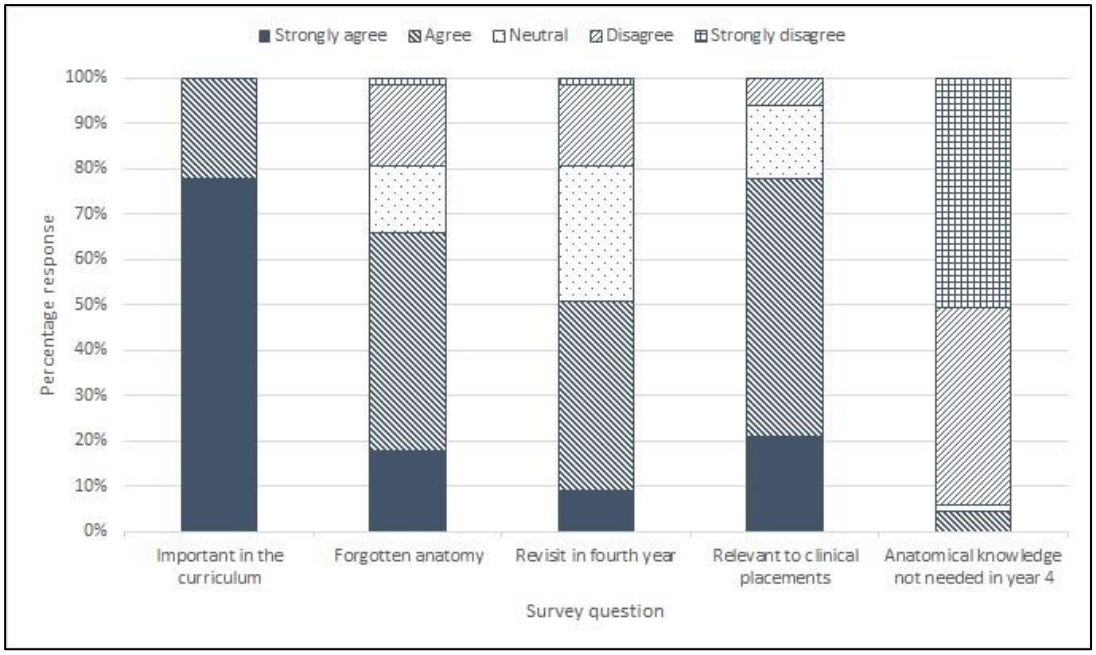


Figure 29. Responses of year 4 students regarding teaching in fourth year.

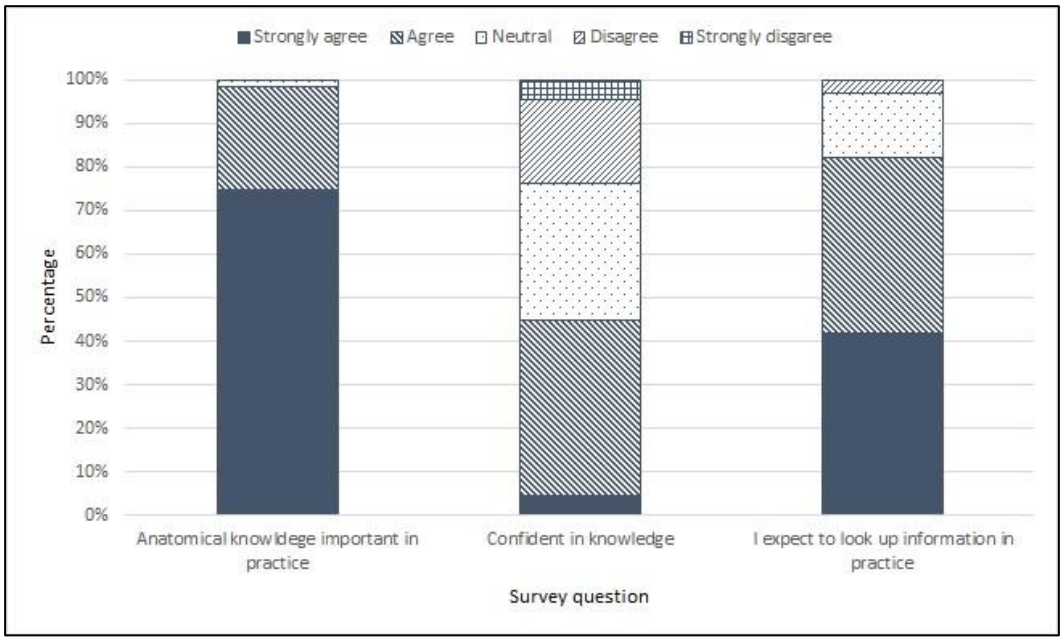


Figure 30. Year 4 student responses regarding post-graduation expectations.

6.4 Qualitative data

6.4.1 Free text survey responses

Four main themes were identified from the initial codes assigned to the free-text responses from second-year students. A further two themes were identified following analysis of fourth year responses. The main themes and example comments are shown in Table 6.4.

Table 6.4 Themes arising from free text comments

Theme (year of study)	Definition	Example comment
Positive impact (Y2 and Y4)	Positive comments reflecting enjoyment of practicals. Classes are useful or helpful to learning	"Couldn't pass Vet School without them. Makes lectures actually make sense." [Y2]
Barriers to learning (Y2 and Y4)	Negative aspects of classes that students feel hinder learning. Barriers include large group sizes, poor quality or validity of specimens, bad smells and difficulty of tasks	"When techniques have to be altered for cadaver material" [Y2]
Student/teacher balance (Y2 and Y4)	Demonstrates student preferences for either student-led learning techniques, teacher-led techniques or a balance between the two. Year 4 comments include those expressing a need to re-visit anatomical topics	"More time should be spent on demonstration before dissection as otherwise we don't know what we're looking for" [Y4]
Respect (Y2 and Y4)	Concerns regarding a lack of respect towards cadaveric material	"There should be more emphasis on respect for dissection material" [Y2]
Relevance (Y4)	The positive impact of an activity's relevance	"Much more enjoyable when made clinically relevant and practising actual techniques that would be used on live animals" [Y4]
Transition to clinical studies (Y4)	The change in motivation for learning	"Earlier in the course I think it is more about exams but now it is about learning to do it to become a good vet" [Y4]

6.4.2 Focus groups

Students' perceptions centred around 6 major topics: 1) Drivers for learning, 2) Barriers to learning, 3) Assessment of knowledge, 4) Learning at vet school, 5) The anatomy curriculum, 6) Ethics. A summary of the themes and their constituent sub-themes emerging from the analysis of the focus group data is shown in Figure 31. Each theme is presented with illustrations referred to by gender and focus group, for example M1 represents a male student from focus group 1, F2 a female from group 2 etc.

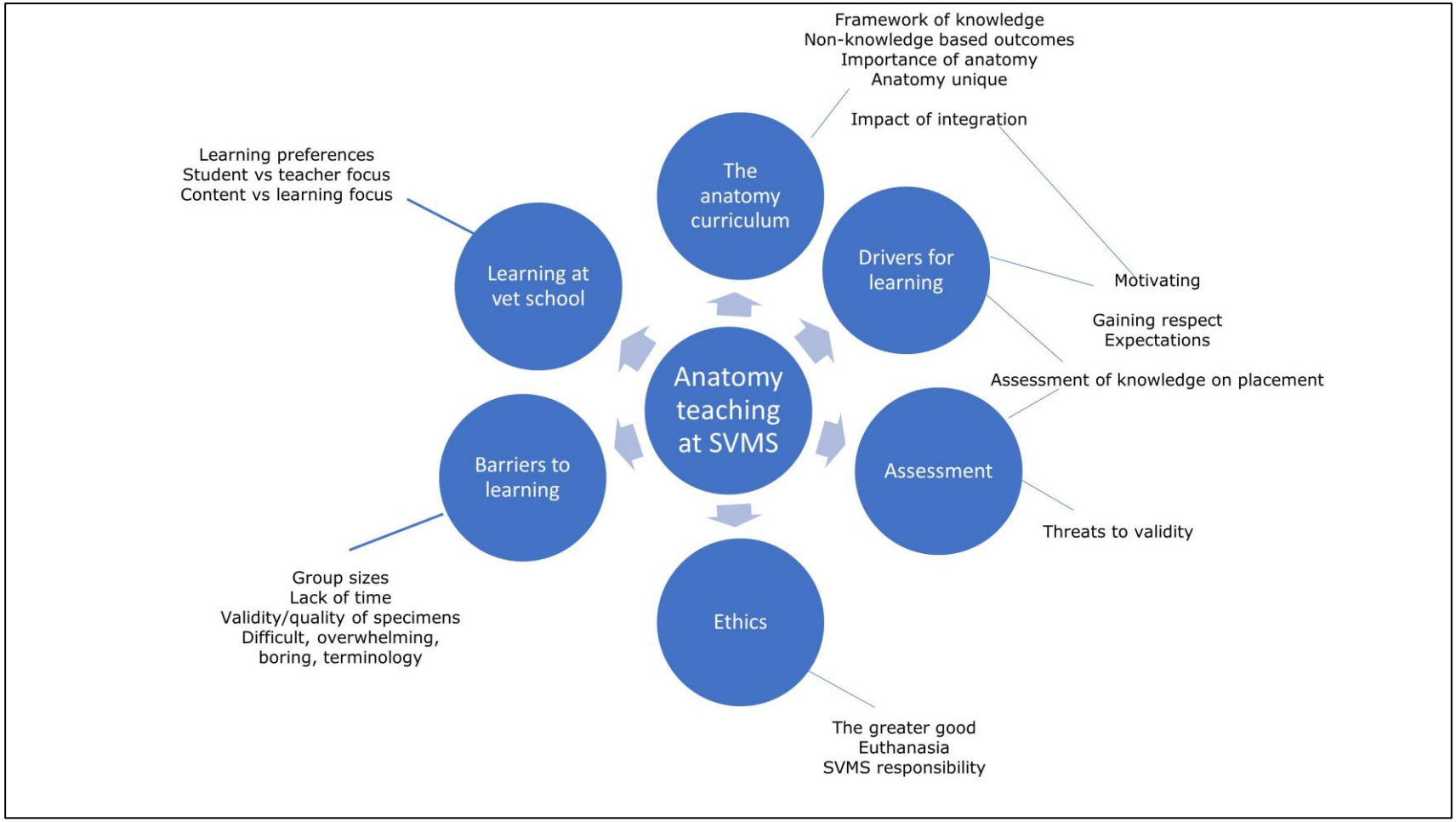


Figure 31. Thematic map of focus group data

Drivers for learning and motivating factors (Subthemes: Relevant material is motivating, gaining respect, Expectations, Assessment of knowledge on placement): Students described a number of intrinsic and extrinsic factors in driving their learning of anatomy. The relevance of the task at hand, gaining respect and expectations of others were found to be motivating. Students find tasks interesting and motivating and they enjoy learning anatomy if they can see the relevance of the task to their career or to clinical placements

Q1. "*I think it is also fun. I think sometimes in the vet course where we can just get so bogged down with just learning, and learning, and learning, that actually going back and doing something that's vaguely clinical makes you sort of think, 'Oh actually this is the reason I'm here. This is the reason I'm slogging through all these lectures and SDLs. It's because this is what I want to do at the end of it*." [F2]

Students also expressed a desire to gain respect through exercising their knowledge. They felt that they could impress their peers studying at other schools with their superior knowledge. They also felt they would be rewarded with more opportunities on placement if they were perceived to be a good student.

Q2. "*if in practice you see someone doing a chest drain or something and you go, 'Oh yeah. We did a practical on that', and then it's really useful there as well because people go, 'Oh you actually did a practical on this?' And you're like, 'Yeah. We did it to learn the anatomy', and they're always really surprised and then you get to do a lot more*." [F1]

Extrinsic factors motivating students to learn anatomy included the expectations of others. Students wanted to be prepared for questioning on clinical placements and rotations

Q3. "*There's a slight bit of worry now, when the vet goes 'what's this?' and I go 'I don't know, I'm going to have to look that up, sorry*.'" [F1]

The wider expectations of the school and profession were also influencing factors. However, the broad nature of requirements such as Day One Competences make it difficult to identify what is important.

Q4. "*I feel like in most of the modules you've been expected to already know the first module and then the second module is just carried on from that. That's kind of expected for you to have gone over that in your own time before the module*." [F2]

Q5. "*…to actually list everything they expect you to know, they could be there for days… You're expected to know everything*" [F2]

Assessment (Subthemes: Alignment, Validity): Students reported varying emphasis on anatomy between modular assessments. They expressed concerns that the assessment format does not always allow them to demonstrate their anatomical knowledge.

Q6. "*I think sometimes when they put pictures in the MCQ exams, it's sometimes difficult to answer them because you don't have the whole animal there. You don't know which way round it is or what's next to it, and sometimes I was sitting there looking at it going, 'I don't know what I'm seeing'*." [F2]

Barriers to learning (Subthemes: Group sizes, Lack of time, Validity/quality of specimens, Difficult, Overwhelming, Boring, Terminology): A number of threats to successful learning in the anatomy laboratory are described. Extrinsic factors such as large group sizes with not enough teaching staff and an apparent lack of time in the curriculum were perceived to have a negative impact on the student learning experience, as was the use of poor quality specimens in teaching.

Q7. "*When we were in our groups with our dogs, it sometimes took ages to have- If you were stuck on something, it would take ages for someone to be available to come and help you out, and then until you've got that person, you're sort of stuck. And I found that it made people in your group less interested in what you were trying to do because you'd start doing other things and going talking to other people*" [M2]

Factors relating to the subject of anatomy were also described by students as hindering their learning. Anatomy was recognised as a difficult topic to learn for a number of reasons. Students can feel overwhelmed by the volume of information, and anatomy as a standalone subject can be seen as vast and boring. The following quote demonstrates how anatomy can be seen as an exercise in the memorisation of unrelated factual information, making it difficult to learn:

Q8. "*It's there and then you learn it, whereas other things, it's more functional and kind of related. Whereas anatomy, it's kind of hard to make it sort of more personable. So it is harder to learn I think*." [F2]

Students also cited the Latin and Greek derived terminology used in anatomy as difficult to comprehend and remember. They felt that lectures on anatomical topics could be dry and boring and that the task of dissection can be onerous or

difficult due to the inability to identify structures. The following quote demonstrates how students can feel overwhelmed by anatomy

Q9. "*I think it's just a lot to take in. Initially when you do it, it is quite daunting with those classes because there's just so much there and when you're doing a certain body system, you don't know about any of the others until you get to them and it was quite daunting initially*." [F2]

Learning at Vet School (Subthemes: Learning preferences, student vs teacher focus, content vs learning focus, transition to HE): Subthemes in this theme illustrate wider issues around teaching and learning in the vet school environment. Individual learning preferences are described under the first sub-theme, including examples of textbooks and preferences for a 'hands on' approach to practical material.

Some students demonstrated a focus on teacher-led delivery such as lectures, and emphasised the importance of guidance. Others valued opportunities to work in groups and to direct their own learning, as is demonstrated in the following quote:

Q10*. "It's also good in the way that it's set up where you have four people per specimen, that you can work as a group to try and figure stuff out, whereas you might not know it on your own. Like if you don't know, someone else will know"* [F2]

There were also diverse comments relating to the outcomes of classes, with a number of comments reflecting a focus on meeting the individual objectives of a session. Others however, demonstrated a focus on understanding and transforming information.

Q11. "*I found that I could, instead of concentrating on minor things that I did in second year, I found it a lot easier to look at it in the bigger context and take more out of the session because I wasn't panicking as much about what I needed to get out of it*." [M2]

The sub-theme of transition to HE reflects the difficulties faced by the students in transitioning to a more independent style of learning. Participants discussed the insecurities around learning at vet school and a fear that they do not know enough. This student mirrors the lack of confidence in their own learning indicated by some students:

Q12. "*If you're doing something and you think it's right then you remember that, and the worst thing is remembering something that's wrong because it's unlikely that you'll then be corrected*" [F1]

The anatomy curriculum (Subthemes: Impact of integration, Framework of knowledge, Non-knowledge-based outcomes, Importance of anatomy, Anatomy as a unique subject): The sub-themes within this theme demonstrate the value placed on clinical integration in anatomy teaching, and also how students recognise their pre-clinical teaching in first and second year as a framework upon which to build in the clinical years of teaching. Within the first sub-theme, participants discuss how the introduction of clinical skills into the anatomy curriculum impacts learning. They describe how practising clinical techniques alongside anatomy helps learning and provides opportunities to reinforce their knowledge. This student describes how they feel learning in this way will benefit her in her career:

Q13. "*when we did all the ultrasound and stuff and that came specifically from ultrasound. That's how I learnt equine anatomy, but even if I don't have a theoretical knowledge of anatomy, like I couldn't tell you that it was this nerve running down here. I probably have a better working knowledge of anatomy that I would be able to apply to my career from the practicals where we've done techniques and stuff*." [F1]

Participants felt that their teaching was a framework to be built on in practice, but that anatomical knowledge is essential for their careers.

Q14. "*injecting to know where the nerves run and then to not hit those nerves is obviously very important, so something as simple as that, that knowledge. I think literally no-one could argue you don't need anatomical knowledge to be a vet*." [F1]

Comments made by some students indicate a perception that anatomy is in some ways different to other learning, and its standing as a traditional subject remains.

Q15. "*If nothing else, it's a rite of passage*" [F1]

Participants discussed how practical anatomy classes provide opportunities to build confidence and learn professional skills such as teamwork as well as the opportunity to develop practical skills

Q16. "*I think using the instruments helps as well because so many placements I've been on have commented on how confident I am with the instruments compared to the other students they've had and I think, and I think actually because we're using them from day-one, you don't really think about it anymore. You just pick them up*." [M2]

Ethics (Subthemes: The greater good, reason for euthanasia, SVMS responsibility): Participants felt that it is the school's

responsibility to ensure ethical sourcing of cadaveric material. They did not like to think animals had been euthanised primarily for use in their teaching. However, students were philosophical about the use of animals in teaching, with the observation of their use ultimately benefitting many more animals.

Q17. "*I also think that these animals have been put to sleep for a reason. They can't be rehomed or for any other behavioural reason or whatever, but they're kind of doing a service to us by helping us learn anatomy and structures and things. So in healthy animals, they will benefit from us hopefully in the future. So on the one hand their death is helping the future of their breed*" [F2]

6.5 Discussion

This study has demonstrated the value that students place on practical learning experiences in both pre-clinical and clinical stages of the veterinary course. Furthermore, embedding clinical skills alongside more traditional teaching practices within the dissection laboratory has proved enjoyable and motivating for this group of students. There are few changes in perception as students' progress through the course to clinical teaching. Anatomy is seen to be important in the role of a veterinary practitioner, and can still be seen as a rite of passage by some. Students in year 4 particularly valued the opportunity to develop clinical skills in conjunction with learning anatomy.

As teaching methods in the dissection environment, dissection, prosection, and clinical techniques are all perceived to have a positive impact on learning. Students enjoyed practising clinical techniques, a finding that has been reported in previous studies in human anatomy teaching (Dangerfield et al., 2000, Davis et al., 2014). In this study of students at SVMS, the opportunity to practice clinical skills was also appreciated for its relevance to the role as a veterinarian. Students found it to be the most motivating of the learning methods. Motivation to learn and participate in a task is known to positively correlate with deep approaches to learning (Fransson, 1977, Parkinson et al., 2006), and linking anatomical topics to clinical aspects of a program has been found to enhance learning and willingness to learn (Mills, 2003). As such it is important that we develop an interest by promoting the relevance of anatomical facts in such a way that nurtures the intrinsic motivation of our undergraduate students. There are longstanding concerns, however, regarding the cognitive load imposed on learners (Anderson

and Graham, 1980, May, 2008, Patel, 2009). Teaching methods that place additional demands on the learner increase the cognitive load, for example skills in image acquisition and ultrasound interpretation. However, while this has been found to be an issue in physical examination, it was concluded that learners were able to manage the cognitive load introduced by ultrasonography in anatomy teaching situations (Jamniczky et al., 2015). In the present study, students did not allude to such struggles in their comments, although it could be argued they are simply unaware of any additional cognitive demands. Because of the early introduction of these learning methods, they have no basis for comparison.

Compared to their perceptions in second year, students in fourth-year felt that dissection and prosection were less applicable to their career, and this supports findings of a longitudinal study of veterinary students carried out by Heath et al. (1996). In this Australian study, 92% of first-year respondents felt that anatomy was extremely relevant to their veterinary training. By fifth year and their second year of post-graduation work, students felt there were discrepancies between what was taught and what should be taught. Participants of the survey believed more emphasis should have been placed on the skills, knowledge, and techniques required for the practice of veterinary science and less emphasis on the basic sciences. However, this study was carried out several years ago, and before a review of the curriculum in question. It is also noteworthy that while anatomy is generally considered a basic science, Heath's report does not define the term and the study does not investigate perceptions of anatomical education specifically. It does, however, illustrate how perceptions can change with students' experiences. It may be the case that fifth-year students and graduates would have a more favourable perception of a vertically integrated curriculum that places more emphasis on skills and techniques.

The survey design used in this study did not invite students to select one particular method over another, and as such it should not be extrapolated that students would apportion scores similarly without the context of other teaching modalities. However, practising clinical techniques remains a highly valued teaching modality among fourth year students at SVMS, as is supported by the focus group discussions. Students cite the positive impact of the early introduction of clinical skills and relevance to their clinical studies and to clinical placements. This supports a study of Dutch medical students that found that clinical exposure (i.e., conveying the knowledge in context) to be the prime motivating factor for

studying anatomy (Bergman et al., 2013). Context in learning has been found to improve knowledge retention and recall (Finn et al., 2010), and is more likely to encourage a deep approach to learning (Smith and Mathias, 2010, Ward, 2011). A vertically integrated curriculum facilitates this learning by providing opportunities for contextual learning, promoting repetition of subject matter, and increasing time on task. However, also reflected in this study of SVMS students is the indication that students would like more time dedicated to anatomy teaching in fourth year, with focus group data suggesting a desire for revision of basic anatomy at the beginning of every clinical module. A review of medical education literature found that integration is often unidirectional in vertically integrated curricula, meaning that while clinical components are introduced in the early years of the program, the basic sciences are less commonly included in the clinical years, thus leading to a net loss of teaching time for anatomy (Prince et al., 2005, Whitcomb, 2006, Bergman et al., 2013). However, it has been suggested, that clinicians do deliver basic science teaching, but that it is perhaps more implicit and embedded in the context of teaching in later years (McCrorie, 2000). The nature of anatomy in clinical practice as a network of ready-packaged detailed knowledge has been described as encapsulation (Rikers et al., 2004).

Perceptions of unidirectionality in the curriculum highlights the importance of providing opportunity for self-study in the curriculum and effective signposting of relevant pre-clinical material. Furthermore, if the original delivery of material was clinically contextualised, this should enhance recall of the information (Schmidt and Moust, 2000). However, this may not be due to learning in the context of clinical situations having a cognitive advantage. It may be that the clinical context increases the commitment to learn underlying biomedical knowledge through driving a willingness to invest more effort in learning tasks presented through a clinical case (Koens, 2005). In addition, we should be arming students with the lifelong learning skills that enable them to recognise gaps in their knowledge and then source and critically review information. This is particularly pertinent considering that 82% of students surveyed for this study reported that they expect to look up anatomical information when they need it in practice. Some fourth year students recognised retrospectively their own focus on processes and assessment in pre-clinical years, demonstrating reflective skills that will be valuable to them as lifelong learners (Murdoch-Eaton and Whittle, 2012). However, they also reported a preference for teacher-led approaches to learning, supporting the views of Hall et al.

(2013) that students underuse the resources available to them and instead rely on instructors for information. Other studies have suggested this may be as a result of the high volume of information in the curriculum leaving students feeling overwhelmed (Ryan et al., 2004, Raidal and Volet, 2009).

Students in the present study felt that training in clinical techniques and using clinical veterinary equipment increased their confidence and their feelings of readiness for clinical studies and placements. This was supported by 77% of respondents agreeing that their teaching had helped them in clinical placements and this may explain the overwhelmingly positive response to the statements that anatomy is an important subject in the veterinary curriculum and important in practice. Furthermore, students recognise the importance of the subject, they are not necessarily motivated to learn it. In the study of Dutch medical students, the authors concluded that junior medical students were more likely to judge how important it is to study a subject based on how heavily it is assessed rather than how relevant the subject is to their career (Bergman et al., 2013). This further emphasises the importance of aligning assessment with the desired learning outcomes of the course, but threats to the validity of assessments have been highlighted in this study.

Drivers for learning such as assessment and instructor expectations feature in the comments of second- and fourth-year students in this study, indicating an extrinsic motivation that persists throughout the course. However, comments from fourth year students describe a desire to become a good veterinarian, reflecting a change to an intrinsic motivation for learning as undergraduates progress through the course. In relation to assessment, students' retrospective perceptions of dissection and prosection in the fourth year were lower than their perceptions in the second year. This result is perhaps unsurprising since students spend a limited number of hours in the dissection laboratory in year 3 and thus are not examined on anatomical concepts in this year of the course. At the time this study was carried out, fourth-year assessments had not begun. It was not within the scope of this particular study to consider assessment in relation to student attitudes, and the relationship between perceptions of learning anatomy and assessment is investigated further in Chapter 7 of this thesis.

6.6 Limitations

This study captures the perceptions of one cohort of students studying at one veterinary school in the UK and so caution

should be applied when generalising the results. Similarly, the questionnaire investigated perceptions at one moment in time after a practical class, which likely biased opinion based on the module under study at the time of administration of the surveys and focus groups. Response rates for paired analysis were limited by students' attendance in practical classes and by the flux of students entering and leaving year groups. Further information could have been garnered from distinguishing interesting from motivating in the questionnaire and subsequent analysis. Finally, alpha values were below .7 in some domains of the questionnaire and as such, summed data should be interpreted with caution.

6.7 Conclusions

This study supports others in this thesis in highlighting the value of cadaver practical classes throughout the veterinary undergraduate program. Students continue to recognise the importance of these classes and appreciate the opportunities to consolidate their learning. In particular, the introduction of clinical skills within the anatomy curriculum has a positive impact on students' perceptions of learning anatomy, with learners appreciating the relevance of the material covered in these sessions from pre-clinical through to clinical years. Anatomy is a mostly knowledge-based subject, but its application to clinical practice is significant and it can be taught through the introduction of clinical techniques early in the curriculum, allowing factual information to be contextualised and consolidated. It is therefore suggested that anatomy continues to be delivered using cadaver materials and a combination of traditional methods and clinical teaching. Moreover, further investigation into perceptions of multiple cohorts of students and the educational outcomes of anatomy teaching can further inform the veterinary anatomy curriculum. While perceptions of teaching provide useful information in evaluating a curriculum, the next level of evaluation according to Kirkpatrick is educational outcome (Kirkpatrick, 1996). Relationships between perceptions of anatomy teaching and educational outcome are investigated in the next chapter.

7 Study 4. Perceptions of teaching and its relationship to academic performance

1.1 Introduction

Research carried out for this thesis has found that students perceive practical anatomy classes to have a positive impact on their learning. Students in a range of contexts believe cadaver classes to be of value in their learning, and students undertaking clinical studies still value these sessions. The impact of assessment on learning is widely accepted as being profound, and the 'backwash effect' describes how the perceived demands of assessment drive learning (Tang and Biggs, 1996, Cilliers et al., 2010). This suggests that students may place more value on teaching methods that reflect their assessment experiences. A longitudinal study investigating student perceptions of teaching in a Canadian university found no relationship between perceptions and course achievement. The author of the Canadian study suggests that personal characteristics are more likely to be responsible for expressions of program satisfaction than achievement (Grayson, 2004). However, this study has limited generalisability to the SVMS context as the research was carried out in a large university where achievement was measured by Grade Point Average.

The aim of the study reported in this chapter is to investigate whether there are any relationships between perceptions of learning and assessment performance. The focus of this study therefore addresses research question 2:

Is there a relationship between perceptions of teaching and assessment?

Figure 32 shows the relationship of this study to the overall thesis questions.

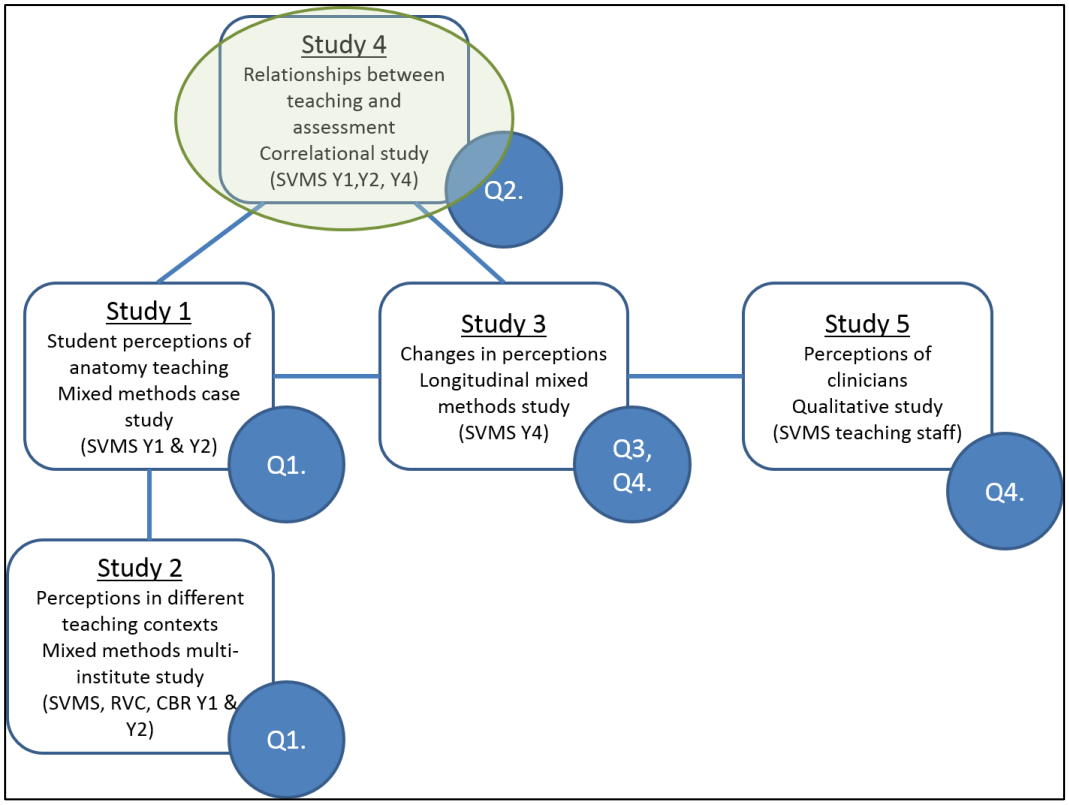


Figure 32. Map of studies in thesis, study 4 highlighted. SMVS, School of Veterinary Medicine and Science; RVC, Royal Veterinary College; CBR Cambridge Vet School

Surveys developed in studies 1 and 3 of this thesis gathered information regarding students' perceptions of three teaching modalities employed in the anatomy dissection facilities at SVMS; dissection, prosection and practising clinical techniques. The present study correlates survey data with assessment results to investigate relationships between perceptions and academic performance. Investigating the relationship between the perceived benefit of teaching methods and exam performance will facilitate a greater understanding of the impact of teaching methods on learning in the anatomy curriculum.

7.1 Methods

7.1.1 Study Design

The questionnaire employed in this study is included as Appendix 3. The 13-item Likert Scale questionnaire was employed to measure students' perceptions of the use of dissection, prosection and practising clinical techniques in anatomy teaching. The areas of learning investigated were gaining knowledge (Kn), applying knowledge (Ap), enjoyment of the tasks (En), the task's relationship to assessment (As) and the overall learning process (Le) (see section 4.2).

Students were asked the extent to which they agreed to each statement (1 = strongly agree, 5 = strongly disagree) in relation to each teaching method. As low survey scores reflect high agreement, for the purposes of this study data were reversed-scored before statistical analysis in SPSS to more accurately reflect the direction of correlations. Survey results assessing the perceived value of teaching methods were reviewed against selected summative assessment results of each first and second year participant for the academic year 2011-2012. The survey responses of the 2010 cohort of students were correlated against D14MSK module assessment delivered in summer 2014. This module was selected as the module with the most anatomically relevant content.

7.1.2 Participants

In the spring term of 2012 paper-based surveys were administered to two cohorts of students studying the 5-year D100 BVMBVS course; first-year students (2011 cohort) and second-year students (2010 cohort). Identical surveys were then re-distributed in the spring term of 2014 to the 2010 cohort of students during their fourth year of study. Cohorts, year of study and assessment point are shown in Table 7.1.

Table 7.1 Assessment data used in analysis. Time of assessment, cohort and year of study. YOE, year of entry

Assessment point	Student cohort	Year of study
June 2012	YOE 2010	Year 2
	YOE 2011	Year 1
June 2014	YOE 2010	Year 4

Permission for survey data to be correlated against assessment scores was obtained from participating students. Responses were linked to assessment results via an individual identification number to maintain anonymity. Students were invited to participate verbally, and consent was confirmed by signature using the consent form (Appendix 4).

7.1.3 Modules selected

The assessment papers and practical examination stations selected were those with large components of anatomically relevant questions. Three assessment formats were selected for investigation: Online MCQ, from which only anatomically

relevant questions were analysed, Spot Test and OSPE. Year group, module and assessment format selected for this study are shown in Table 7.2. Example questions are included.

Assessment papers examined content from the first-year systems-based modules Musculoskeletal System (D11MSK), Cardiorespiratory System (D11CRS), Neuroscience (D11NEU), and the second-year modules Gastrointestinal System (D12GIL) and Reproduction (D12REP). The year 4 Musculoskeletal module (D14MSK) was selected as the module with the most anatomically relevant material and was chosen for comparison with fourth-year data.

Table 7.2 Number of assessment questions selected in each module (% of total marks for paper). Module codes: MSK, musculoskeletal; CRS, cardiorespiratory; NEU, neuroscience; GIL, gastrointestinal; REP, reproduction.

Format	Year 1				Year 2			Year 4
	D11MSK	D11CRS	D11NEU	**Total**	D12GIL	D12REP	**Total**	D14MSK
MCQ e.g., What sequence correctly describes the drainage of the paranasal sinus of the horse to the nasal cavity? (Year 1 CRS)	108 (60)	62 (35)	111 (59)	**281** **(5)**	39 (22)	44 (44)	**83** **(83)**	**40** (63)
Spot test e.g., Examine the placental specimen. Identify the species from which it was obtained. Identify the regions marked A and B, (Year 2 REP)	72 (100)	87 (100)	66 (100)	**225** **(100)**	66 (100)	44 (100)	**110** **(100)**	
Total written	180	149	177	**506**	105	88	**193**	
OSPE e.g., Your task is to: Use ultrasound to obtain a transverse image of the mid metacarpal (cannon) region of an equine cadaver limb (Year 1)	3 stations				3 stations			

7.1.4 Data Analysis

The MCQ questions were selected for analysis based on the SVMS curriculum map. Selected questions assessed learning objectives meeting the criteria of mapping to gross anatomy as an embedded module in the curriculum, and being delivered through activities carried out in the dissection facilities, as per the module timetable. The number of questions selected for each module and year group is shown in Table 7.2.

7.1.4.1 Assessment data

Questions selected from MCQ assessments were categorised using Bloom's taxonomy of educational objectives to investigate if there may be stronger correlations associated with certain levels of the taxonomy. Similarly, for each of the questions selected for use in the study, the item's difficulty and differentiation values were recorded as described by Allen (2001). Each question is assigned a *P* score to represent the question's difficulty. A mean *P* value for the selected questions for each module was then calculated. The *P* score is calculated as:

$$P = \frac{No.of\ correct\ responses}{Total\ number\ of\ responses}$$

The larger the *P* value, the easier the question.

A question's ability to differentiate between students who are high performing and those who are not, is calculated as d using the following formula:

$$d = \frac{(U - L)}{n}$$

Where *U* equals the number of correct responses in the highest performing 27% of students in the paper overall, *L* equals the number of correct responses from the lowest performing 27% of students, and n equals 27% of the total number of students. A high *d*-value indicates a discriminating question. Low correlations (*d*< .25) indicate the question is not related to a good test score and thus is not discriminating.

7.1.4.2 Correlations with perceptions

The number of anatomy marks awarded for each MCQ assessment paper was summed and added to the spot test score for each student, resulting in a nominated percentage score for anatomy for each student. Scores were entered into the statistical package SPSS version 21. Non-parametric, Spearman's rank tests were used to measure the relationship

between perceptions of anatomy teaching and examination performance. Each survey item was scored from 1, strongly agree to 5, strongly disagree. For the purposes of this study, items were combined into their learning domain as previously described. Therefore, a domain encompassing two items would have a minimum score of 2 and a maximum of 10, a domain comprising three items' scale would run from 3 to 15 etc., with a lower score representing higher perceived value. The Bonferroni's correction was applied to multiple pairwise comparisons, thus significance was defined as $p<.0167$. Cronbach's Alpha was used to determine the homogeneity of items within the domains.

Individual OSPE stations were selected according to tasks completed in dissection laboratory-based classes. Selected stations were:

Year 1:

- 'Epidural Anaesthesia in the Ewe', taught in spinal cord structure class during neuroscience module.
- 'Dissection of Skin from Cadaver Material', taught in introduction to anatomy class, during musculoskeletal module.
- 'Synovial Fluid Aspiration from the Distal Interphalangeal Joint of a Horse', taught during bone and joint anatomy class during musculoskeletal module.

Year 2:

- 'Lambing', taught in parturition and dystocia class during reproduction module.
- 'Intramuscular Injection', taught in injection techniques class during endocrine and integument module.
- 'Clitoral Swab' taught in clinical exam of the female class during reproduction module

As OSPE examinations are designed to assess a student's ability to carry out a practical technique, only scores for practising clinical techniques were analysed with these examination results. As the OSPE assessment at the time of the study generated only a pass/fail mark, median Likert scores from the survey were calculated for practising techniques for two groups of students; those passing the examination station, and those failing. The scores for these two groups of students were then compared using a Mann Whitney U test. Significance was defined as $p<.05$.

7.2 Results

A total of 88 surveys were returned from a cohort of 98 first-year students (82%), 61 were returned from 103 second-years (59%), and 67 surveys were received from fourth-year students from a possible 98 (68%).

7.2.1 Assessment data

Alpha values for the learning domains used in the survey are reported in Table 4.5 (see 4.3.2). Cronbach's alpha values for year 1 and year 2 assessments were .917 and .797 respectively. Practical examination stations are reported individually.

Analysis of the MCQ anatomy questions used in this study found 364 (90.3%) of the assessment items were at Level 1 in Bloom's taxonomy, and are therefore testing recall. Level 2 questions testing understanding contributed 30 marks (7.4%), and the remaining 9 items (2.2%) were at Level 3, apply, and reserved for the year 4 module.

Difficulty and differentiation values for the MCQ module assessments are summarised in Table 7.3.

Table 7.3 Difficulty (p) and discrimination (d) values of anatomy questions and percentage of questions at levels 1, 2 and 3 of Bloom's taxonomy. SD = standard deviation. Key to modules: MSK, musculoskeletal; CRS, cardiorespiratory; NEU, neuroscience; GIL, gastrointestinal; REP, reproduction.

Year of study	Module	Mean *p* value (±SD)	Mean *d* value (±SD)	Bloom's taxonomy (%)		
				Level 1	Level 2	Level 3
1	D11MSK	.75 (±.24)	0.22 (±.16)	90.7	9.3	0
	D11CRS	.66 (±.28)	0.24 (±.16)	100	0	0
	D11NEU	.71 (±.24)	0.25 (±.18)	92.7	7.3	0
2	D12GIL	.67 (±.25)	0.18 (±.14)	89.7	10.3	0
	D12REP	.71 (±.26)	0.25 (±.19)	90.9	9	0
4	D14MSK	.71 (±.26)	0.20 (±.15)	67.5	10	22.5

7.2.2 Performance in assessment

Students generally performed well in anatomy related questions, with mean scores of 67% in year 1, and 64% for year 2. This compared to overall mean scores of 72% for year 1 and 71% for year 2. In year 4, students performed better in anatomy (71%) than in the module overall (69%), as is shown in Figure 33.

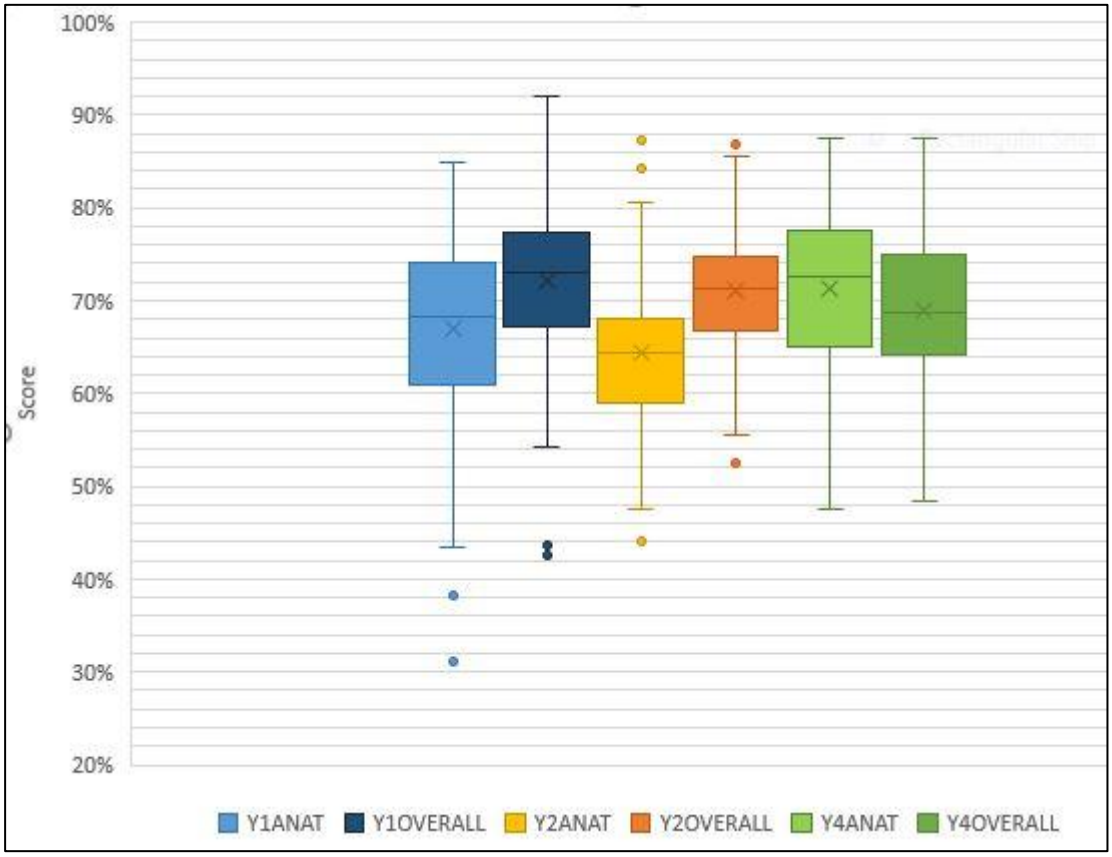


Figure 33. Box and whisker plot showing percentage scores for anatomy questions and overall year scores. X represents the mean scores, the horizontal lines the median. The box represents inter-quartile range and whiskers the actual range.

In anatomy, students scored the highest number of marks for the D11MSK and D14MSK modules (mean score 72.4% and 71.2%respectively). They performed less well in the D11CRS (mean 59.8%) and D12GIL modules (mean 63.1%) as demonstrated in Figure 34.

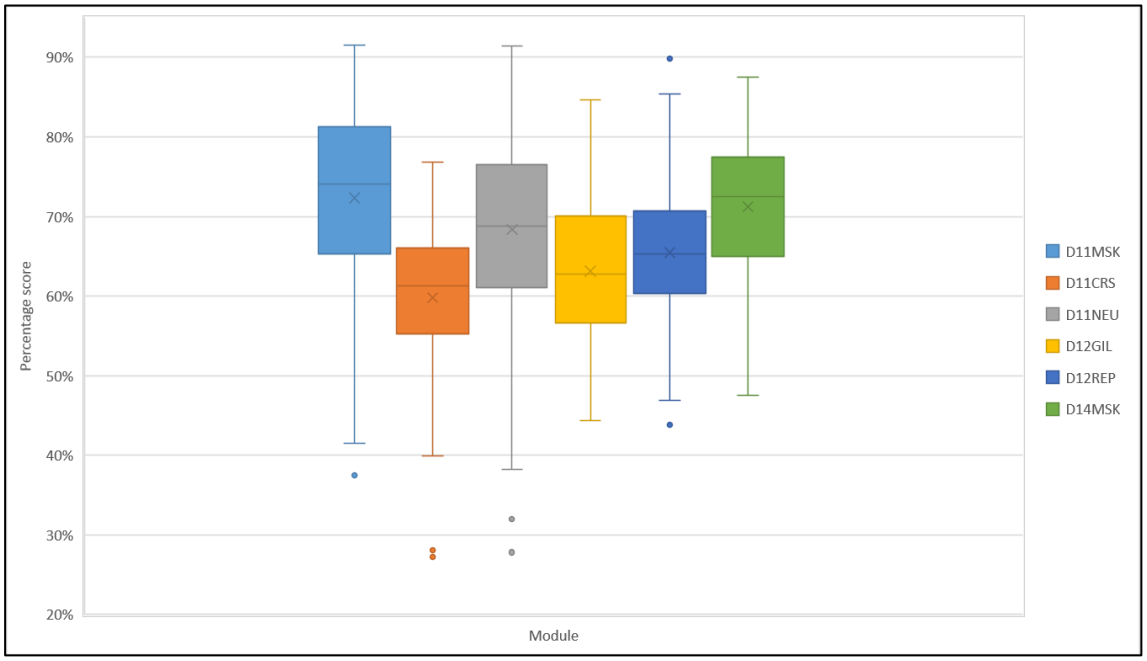


Figure 34. Attainment in anatomy questions, by module. X represents mean scores, horizontal lines the median. The box represents inter-quartile range and whiskers the actual range. Key to modules: D11MSK, year 1 musculoskeletal; D11CRS, year 1 cardiorespiratory; D11NEU, year 1 neuroscience; D12GIL, year 2 gastrointestinal; D12REP, year 2 reproduction; D14MSK, year 4 musculoskeletal.

7.2.3 Correlations between perceptions and performance

Full details of survey data measuring perceptions of year 1 and 2 students can be found in Chapter 4 of this thesis, and details of year 4 student data in Chapter 6. Table 7.4 shows the mean scores of survey responses for each teaching method, grouped to learning domain.

Table 7.4 Summary of survey responses grouped by domain. D, dissection; P, prosection; T, practising clinical techniques. Likert scale: 1, strongly agree – 5, strongly disagree, therefore a lower score means a higher level of agreement. Items were combined to learning domains of: Kn, knowledge; Ap, application; En, enjoyment; As, assessment; Le, learning process. Cohorts: 1st year, year of entry 2011; 2nd year, year of entry 2010; 4th year, year of entry 2010.

Domain (no. of items combined)	Year of study	Mean score (median)		
		D	P	T
Kn (3)	1	4.92 (5)	4.65 (5)	5.07 (5)
	2	4.31 (4)	4.62 (4)	4.26 (3)
	4	4.69 (5)	4.61 (4)	4.33 (4)
Ap (2)	1	3.01 (3)	3.67 (4)	2.55 (2)
	2	2.95 (3)	3.48 (4)	2.28 (2)
	4	3.56 (4)	4.14 (4)	2.39 (2)
En (2)	1	3.18 (3)	3.55 (3)	2.92 (3)
	2	3.36 (3)	3.31 (3)	2.41 (2)
	4	3.58 (4)	3.67 (4)	2.76 (2)
As (2)	1	3.41 (3)	3.25 (3)	3.57 (4)
	2	3.08 (3)	3.10 (3)	2.92 (2)
	4	3.89 (4)	3.55 (4)	3.17 (3)
Le (4)	1	6.98 (7)	7.81 (8)	6.77 (7)
	2	6.98 (7)	7.62 (8)	6.44 (6)
	4	7.37 (7)	7.97 (8)	6.59 (7)

7.2.3.1 Correlations with written assessments

There were no general trends in the data, with no correlations found between perceptions of teaching methods and overall anatomy performance. Similarly, there were no overall trends relating to a particular teaching method or assessment type. There were not found to be patterns in any aspects of teaching and assessment in some learning domains after correction for multiple pairwise comparisons had been applied. Table 7.5

shows results of analysis between perceptions of teaching methods and written assessments.

Table 7.5 Correlations between teaching methods and assessment. D, dissection; P, prosection; T, techniques. Kn, knowledge; Ap, application; En, enjoyment; As, assessment; Le, learning process.

			D	P	T
Year 1	Kn	*r*	.206	.096	-.044
		p	.054	.373	.681
	Ap	*r*	.058	.052	.061
		p	.593	.630	.571
	En	*r*	.114	.216	.237
		p	.290	.043	.026
	As	*r*	-.101	.093	-.058
		p	.350	.387	.591
	Le	*r*	.190	.169	.012
		p	.076	.116	.909
Year 2	Kn	*r*	-.058	.022	-.149
		p	.662	.866	.257
	Ap	*r*	-.072	.057	-.258
		p	.586	.664	.047
	En	*r*	.127	-.085	.021
		p	.335	.519	.872
	As	*r*	-.023	-.085	-.306
		p	.863	.519	.018
	Le	*r*	.092	.248	.057
		p	.484	.056	.663
Year 4	Kn	*r*	.086	-.066	-.084
		p	.491	.597	.502
	Ap	*r*	.151	-.064	.002
		p	.229	.611	.984
	En	*r*	.155	.141	.198
		p	.215	.258	.111
	As	*r*	.176	-.014	-.149
		p	.164	.916	.241
	Le	*r*	-.134	-.118	-.003
		p	.282	.347	.982

There were no significant results for correlations with dissection in any year group, and no relationships were found in the year 4 data.

7.2.3.2 Correlations with OSPE assessments

There were no overall patterns in the data when comparing those students passing OSPE stations and those failing (Table 7.6). However, there was a significant relationship found between students reporting practising techniques as particularly enjoyable and the year 1 epidural OSPE station (U=-2.75, p=.010). Mean ranks indicate students passing the station (mean rank 38.08) rated practising techniques as more valuable than those that failed the station (mean rank 51.22).

*Table 7.6 Comparisons between passing and failing OSPE candidates. Statistically significant results indicated by **

	OSPE station	Kn	Ap	En	As	Le
Year 1	Epidural	U=-.527, p=.598	U=-.924, p=.356	U=-2.574, p=.010*	U=-.209, p=.835	U=-.008, p=.993
	Skin dissection	U=-.828, p=.408	U=-.618, p=.537	U=-1.564, p=.118	U=-.416, p=.677	U=-.022, p=.982
	Joint aspiration	U=-.356, p=.722	U=-1.837, p=.066	U=-1.489, p=.136	U=-.708, p=.479	U=-.258, p=.796
Year 2	Lambing	U=-1.236, p=.217	U=-.607, p=.544	U=-.643, p=.520	U=-.561, p=.575	U=-.187, p=.851
	Intramuscular injection	All participants passed this station				
	Clitoral swab	U=-.593, p=.553	U=-1.421, p=.155	U=-.582, p=.561	U=-.661, p=.509	U=-.010, p=.992

7.3 Discussion

In investigating relationships between student perceptions and exam performance, the results of this study show no associations, suggesting that perceptions of anatomy practical teaching methods are unrelated to academic performance. This is likely due, in part, to the fact that as students rated all anatomy teaching highly, the spread of scores was limited. Therefore, correlations are less likely to be found. Studies

investigating the impact of educational interventions in anatomy have likewise found small or no significant differences between groups of students using different methods in anatomy teaching and that teaching approaches are often complimentary to one another (Codd and Choudhury, 2011, Griksaitis et al., 2012, Whillier and Lystad, 2013, Canty et al., 2015). Whilst it was not the intention of the present study to measure the impact of a particular intervention, and thus no experimental conditions were used, parallels can be drawn in the lack of significant differences between outcomes of different teaching methods, accounted for by some by the characteristic desire to succeed in high achieving students (Albanese, 2000). Veterinary students, like their medical counterparts, are typically high performers. As such, they may not be as strongly affected by educational interventions, and are able to compensate for variations in teaching methods through their own learning. In the case of students at SVMS, students are able to utilise the combination of teaching methods to suit their individual learning preferences and study styles. As such, this study goes further in supporting the findings of studies 1 and 3 in this thesis, in advocating a continued mix of teaching methods in anatomy.

It is widely accepted that assessment drives learning (Newble and Jaeger, 1983, Tait, 2005, Biggs and Tang, 2011), and the influence of assessment is such that if students perceive an assessment format to require the regurgitation of vast quantities of knowledge, they will resort to a surface approach to their studies; behaviour misaligned with desirable educational outcomes.

In a study of the impact of assessment on learning, Cobb (2013), found that students at SVMS perceived the MCQ questions used in online assessments to require knowledge of large quantities of information with insufficient time to prepare, and thus led to students adopting a surface approach to learning. MCQs may encourage students to assume a superficial approach to learning if the question relies on factual recall of information, the lowest, 'remember' level of Bloom's Taxonomy (Bloom, 1956).

Anatomy is a largely factual, content–heavy subject and possessing factual knowledge is traditionally considered an important quality in a veterinary professional and undergraduate student. Furthermore, memorisation of vocabulary in the context of the knowledge, interpretation and implementation of terminology is an important part of the learning process (Laurillard, 1979) and can even form part of a deep approach to learning (Entwistle and Ramsden, 1983).

Thinking processes must be based on underlying information, therefore, it is imperative basic factual knowledge is assessed in the curriculum. However, as well as memorising facts, students must be able to demonstrate understanding and an ability to apply their knowledge. Bloom's framework was not applied to the spot test items used in the present study, but a previous study by Blunt (not published) found this assessment format to overwhelmingly test recall, and written assessment questions in the present study were largely at Level 1. Despite a shift in the percentage of questions testing higher order outcomes through the academic years from first-year to fourth year in this study, this remains to be an area for improvement to ensure we encourage students to adopt a deep approach to learning anatomy. Furthermore, as anatomy is assessed early in the veterinary course, the assessment processes used have a formative role in guiding students' future learning. Therefore, there is a requirement to assess higher-order outcomes encouraging the ability to analyse and apply knowledge in meaningful ways relevant to the veterinary context and to provide students with meaningful feedback to promote learning (Martinez and Lipson, 1989).

It was not within the scope of this study to examine the relationship between assessment and approaches to learning and it is not known how students' perceptions of learning anatomy affects their approach to learning and methods of study. Therefore, further work in this area would be of value.

Students performed well in anatomy overall. However, questions that are too easy provide little or no information regarding a student's knowledge, and the mean *P* values in this study indicate that item difficulty could be improved when the effects of guessing multiple-choice answers are considered. Tavakol and Dennick suggest MCQ items should have a *d* value of 0.2-0.6 (Tavakol and Dennick, 2011). Mean d-values, while positive, were not particularly high, suggesting the items are not very effective at discriminating the strongest from the poorer students. Hopkins (1998), suggests *d* values of .30 and above as good. However, some items may be testing easy knowledge and have low discrimination, but still accurately measure essential knowledge. Further analysis at an individual item level will indicate if the students were able to guess these questions. The lack of discriminatory power of the data could be a contributing factor to the occurrence of so few correlations.

It is possible that the integrated nature of the assessment process may also have contributed to the lack of overall trends in the data. Anatomy is taught as an embedded module at

SVMS with the aim of integrating knowledge across topics to achieve cross-disciplinary understanding. As such, anatomical knowledge is assessed as part of the systems-based modular exams. Isolating anatomical items from these assessments is not only problematic, but negates the objective of assessing cross-disciplinary understanding. As a feature of the anatomy curriculum at SVMS and of this study, it is pertinent to discuss the nature of the integrated assessment format. One concern with the integrated approach to anatomy assessment is that the requisite cohesive understanding required necessitates students draw upon a broader knowledge-base than that needed for a specific anatomy assessment, and it has been argued that this can make it more difficult for students to achieve high assessment scores (Cavalieri, 2009). However, this theory is not supported by the results of the present study, in which students performed well in anatomical items. A further concern with this approach is the perception of students that integrated assessment can have a detrimental effect on their learning of disciplines such as anatomy if they believe they can pass an assessment without answering anatomy questions correctly, as was shown to be the case in a study of medical students (Bergman et al., 2013). These concerns are echoed by a review of medical schools in Australia and New Zealand (Craig et al., 2010). However, a content-heavy curriculum will inevitably drive students to choose which topics to learn, regardless of whether a subject is integrated or discipline specific. Furthermore, integrated assessment better reflects the integrated nature of anatomy in a clinical career.

Insufficient sampling of items can lead to construct under-representation as a threat to the validity of assessments (Downing and Haladyna, 2004). Item sampling is a known internal factor in potential sources of error in psychometric measurement reliability (Tavakol and Dennick, 2011). To ensure sufficient coverage of anatomical concepts in multidisciplinary assessments, Byram (2015) advocates using generalisability theory (G theory) to inform the number of anatomy items required for a reliable assessment of knowledge. Coefficient scores used in reliability analysis for this study did not highlight an area for concern, and analysis methods such as those described by Tavakol (2011) are valuable in developing reliable and valid assessments.

High-stakes summative assessment data were chosen for authenticity as the variable for analysis in this study as it was recognised that students may behave differently in a formative assessment setting with no consequences for progression. However, as summative assessments form part of the

curriculum in preparation for which students modify their behaviour in preparation for, irrespective of preferred methods of teaching, students will study using whatever methods are necessary to perform well. For this reason, ten Cate (2001) argues that a study design using an educational method as the independent variable and achievement in summative assessment as the dependent variable is too simplistic as the assessment will have an unknowable effect on the student. He advocates instead considering student behaviour as the dependent variable, or at least an intermediate variable. A study design incorporating student study activities and approaches to study would provide a richer picture of the impact of teaching methods on achievement in this study.

7.4 Limitations of the study

Relationships between Likert responses and assessment scores were difficult to isolate as responses to teaching methods were largely positive. Furthermore, the 5-point Likert scale used in this study was not sensitive enough to detect subtle variations in perceptions of teaching methods. However, scales of measurement such as the visual analogue scale and 7-point Likert would imply a degree of precision inappropriate for the research question. The low discriminatory power demonstrated by written items and the OSPE component scored as pass/fail led to difficulties in relating perceptions to academic outcome. Any comparisons across year groups should be made with caution due to the difference in the number of questions analysed for each year group. In particular, data from just one module was correlated with year four student's perceptions and there is no year 4 practical exam that could be used in this study. However, the focus of this study was to investigate the relationship of perceptions with assessment of students studying the anatomy curriculum in years 1 and 2. Year 4 data were included in the event of any key shifts in the data in light of the decrease in perceived value of dissection and prosection in fourth year. However, the perceived value of these teaching methods was unrelated to outcome in the D14MSK assessment.

Despite the longitudinal aspect and use of multiple cohorts in this study, it captures the perceptions of students at particular moments in time. Therefore, opinions are likely to be biased by the modules under study at the time of completion of the survey. There were also limitations surrounding the analysis of the assessment questions used. Firstly, because anatomy is distributed throughout the modular assessments, the number

of questions analysed from the written format do not necessarily constitute a representative sample from the anatomy curriculum as a whole. Secondly, the spot test examinations were analysed as complete papers, and as such it may be the case that not all of the questions were anatomically relevant. However, as the spots tests are designed using anatomical specimens as prompting material, it was considered appropriate to use assessment data as gathered by the School's examination office, as few questions would be unrelated to anatomy.

As discussed in Chapter 1 of this thesis (see section 4.3.5) there was a lack of triangulation in responses between quantitative and qualitative datasets from year 1 and 2 students. Negative comments regarding some aspects of practical anatomy teaching were not captured in the quantitative analysis and it may be that this information could have provided a more complete picture of relationships with assessment data. Alpha values for the summed learning domains were below .7 in some domains, and so summed data should be interpreted with caution.

Relationships between perceptions and assessment performance are reported using a combined assessment score. Analysis at the modular level provided no new information as there were no patterns present in the data and no strong correlations. This was also the case in individual analysis of assessment format. However, further information may be gleaned from multiple cohorts and qualitative data surrounding students' preparation for exams.

7.5 Conclusions

This study did not provide evidence of a relationship between students' perception of anatomy teaching and their attainment in assessment. Although a limited number of weak correlations were found, these were not consistent between year groups or for all teaching domains. It is therefore proposed that students will adopt a strategic approach to learning to ensure success in examinations, regardless of the value they place on teaching. This highlights the importance of assessing students in a manner that fosters deep learning and allows students to express their knowledge.

The findings of this study demonstrate a need to review the assessment of anatomy. Questions should test students underlying knowledge but also their understanding and ability to apply their knowledge. Clinician's perceptions of student's ability to apply their knowledge and understanding will be investigated in the next chapter.

8 Study 5. Perceptions of teaching clinicians

8.1 Introduction

Previous studies in this thesis have shown that students value practical anatomy teaching, in particular the opportunity to develop clinical skills alongside learning anatomy. Findings from Study 3 demonstrate students believe that anatomy is important for practice, but students had forgotten what they had learned in years 1 and 2 by the time they reached their year 4 teaching. Some students (24%), felt a lack of confidence in their current level of knowledge. This study aimed to investigate clinicians' perceptions of students' anatomical knowledge and the anatomy curriculum.

An outcomes-based curriculum is one designed with the emphasis on the product – the veterinary graduate – rather than the educational process (Harden, 1999b). It is the educational outcomes that define the curriculum content and therefore in order to deliver an effective curriculum the profession's expectations of new graduates in practice must be defined. The learning outcomes required of veterinary students are defined by the Royal College of Veterinary Surgeons, thus the curriculum at SVMS has been designed to meet the standards stipulated by the RCVS Day One Competences (RCVS, 2014). This expected standard of proficiency states that new graduates should understand the structure and function of animals comprehensively enough to be able to undertake their professional duties. This broad-ranging statement means that UK vet schools are required to produce vets that are omnicompetent, with the ability to practise in any area or on any species. This requires the utilisation of a wide variety of knowledge, skills, and attitudes. How much anatomical knowledge is required to reach this level of competence is a complex question to answer. The RCVS requirement is broad and open to interpretation, and required levels of anatomy knowledge are likely to vary greatly depending on the role of the graduate and with the with developments in veterinary practice.

The place of this study within the thesis is shown in Figure 37.

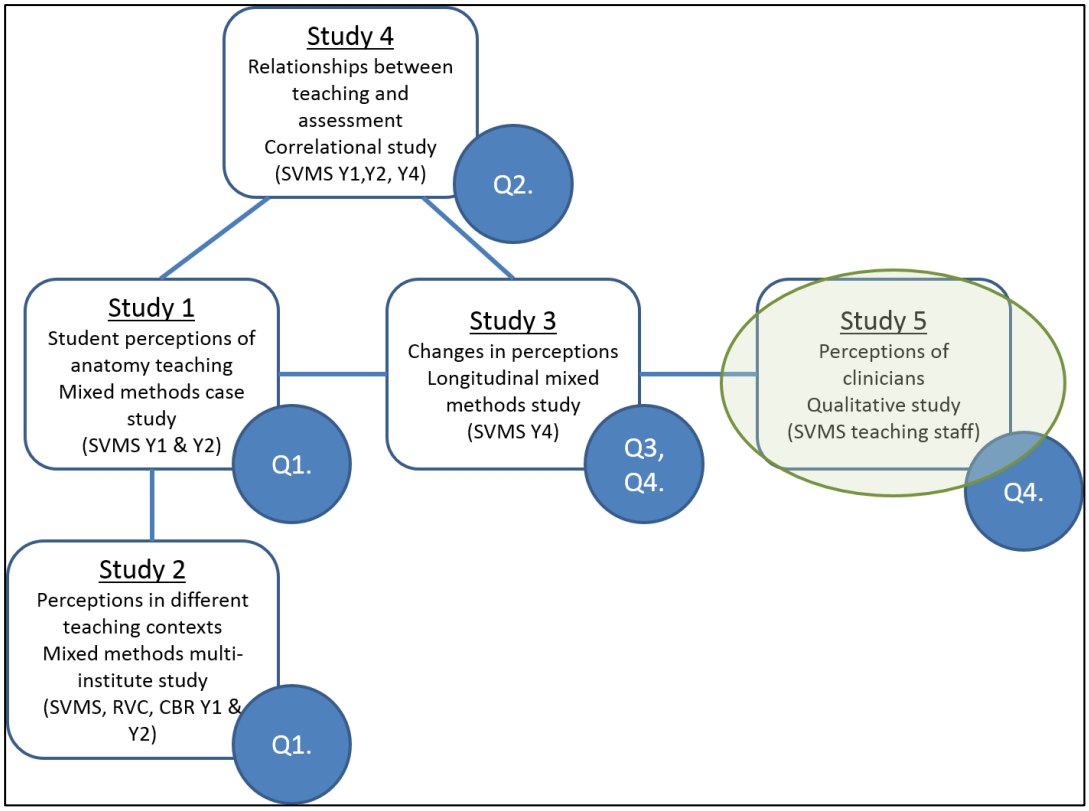


Figure 35. Map of studies within this thesis, study 5 highlighted. SVMS, School of Veterinary Medicine and Science; RVC, Royal Veterinary College; CBR Cambridge Vet School

To investigate the anatomy curriculum's effectiveness in preparing students for clinical placements, this chapter draws upon expert views garnered from qualitative research with clinicians supervising SVMS undergraduates in their final year of study. In particular, the study aims to answer the following research questions:

1. What are clinician's own experiences of learning anatomy?
2. What are clinician's expectations of final year students?
3. Is the SVMS anatomy curriculum aligned to meet the needs of a final year student?

8.2 Context

The structure of the 5-year course at SVMS is described in the introductory chapter of this thesis (see section 1.2). Anatomy is primarily delivered in the first two years of the course, and in the context of systems-based modules in year 4, it is re-visited in a clinical context. Year 5 of the course consist of intra-mural rotations (IMR) and includes 26 weeks of formal teaching comprising an introductory week, 9 weeks of small animal practice including referral practice, 8 weeks of farm animal practice, 6 weeks of equine practice and 2 weeks of

pathology. Students are supervised by practice and university staff.

This study was carried out in March and April 2015, at the time the students previously studied for this thesis were in their final year of teaching.

8.3 Methods

8.3.1 Study design

This study used interviews to explore topics informed by the current literature and themes arising from previous studies carried out for this thesis. A semi-structured interview script was prepared and piloted and is included as Appendix 12.

8.3.2 Sampling

A purposive sampling method was used to recruit participants as described by Patton (1990). Criteria for participation was that contributors should be a member of SVMS staff directly supervising SVMS students during their 5th year rotation placements, and a range of species and disciplines should be represented in the sample. As is consistent with sampling in qualitative studies, data collection continued until saturation was reached (i.e. no novel data discovered). The final sample included clinicians working across equine (n=2), farm (n=2) and small animal (n=4) practices and in a range of disciplines. The sample included clinicians working in general practice as well as specialists. Individuals were approached by invitation email including a brief description of the study. Follow up emails were sent to those who did not respond to the initial email (Appendix 13).

8.3.3 Data collection

Individual participants were interviewed face-to-face by the author at a mutually convenient time in March and April 2015, where upon participants were issued with information pertaining to the study and a consent form (Appendix 14).

8.3.4 Data handling and analysis

Interviews took between approximately 30 minutes to 1 hour, were audio recorded and were sent to a professional transcription service. The transcripts were then checked for accuracy upon return before being imported into the NVivo version 10 qualitative analysis software package for ease of electronic management. Data analysis followed a thematic approach as described by Braun and Clarke (2006). A hybrid method of inductive and deductive analysis was used through

the application of the a priori codes of pre-determined themes emerging from studies 1 and 3 carried out for this thesis. These were used alongside the identification of codes arising from inductive analysis. Collaborative coding of an interview transcript by a second researcher resulted in an iterative process of analysis until the coding structure was agreed. The codes were then grouped into overarching themes. The codebook created during the process is included as Appendix 15.

8.4 Results

8.4.1 Participant demographics

A total of 8 clinicians participated in the study, with all those nominated agreeing to participate. Demographics of the participants including disciplinary backgrounds are reported in Table 8.1.

Table 8.1 Interview participant demographics

Participant	Species	Discipline	Graduation
Vet 1 (male)	Equine	Surgery	Washington State, 1994
Vet 2 (male)	Farm	Health and production	Bristol, 2008
Vet 3 (female)	Equine	Medicine	RVC, 2000
Vet 4 (male)	Small animal	Neurology	Cambridge, 1991
Vet 5 (male)	Small animal	Medicine and oncology	RVC, 1999
Vet 6 (female)	Farm	Population medicine	Cambridge, 2008
Vet 7 (male)	Small animal	Diagnostic imaging	Bristol, 1983
Vet 8 (female)	Small animal	Surgery	Glasgow, 1985

8.4.2 Analysis of interview data

Five overarching themes were identified in the data: Learning differences, the subject of anatomy, teaching effectiveness, the spiral curriculum and changes in higher education. Table

8.2 summarises these themes and their constituent sub-themes.

Table 8.2 Themes and sub-themes in interview data

Theme	**Sub-themes**
Learning differences	Teaching methods Learning preferences Drivers for learning
The subject of anatomy	The role of anatomy Content of the anatomy curriculum
Teaching effectiveness	Teaching staff Student knowledge
Clinically integrated curriculum	Positive perceptions Challenges Balance between clinical and basic sciences
Changes in HE	Advances in online resources Student experience and fees

Theme 1: Learning at vet school

This theme includes the teaching methods in use when participants' were at vet school. The sub-theme of teaching methods is linked to the second sub-theme in this category; learning preferences. Different drivers for learning are also included in this theme.

The teaching methods sub-theme includes clinicians own experiences of teaching practises at vet school. Lectures, dissections and supervisions were described.

The sub-theme of learning preferences included clinicians' references to their own preferences when learning anatomy and they also recognised SVMS students as having their own individual learning differences needing to be provided for through different courses and teaching methods, increasing choice through delivering variety.

Q1. "*obviously evidently, some students will have different learning styles, different preferences, different ways they want to do things, and if everything is the same, there is no real choice*" [Vet 7]

Personal interest in a particular area or discipline was highlighted as a driver for learning, both in the interviewees own learning and in the motivation of SVMS students:

Q2. "*there's a cohort of students who are only interested in horses who come through who are so apparent from day one that they don't care and they're not that bothered about trying to make an effort for small animals*" [Vet 8]

Q3. "*they have no interest in equine and they know absolutely nothing*"

[Vet 1]

It was not only positive drivers that were highlighted in the discourse, as fear of humiliation was identified as a driver for learning by one clinician, who described how the fear of failure drove her to prepare for rotations:

Q4."*If you didn't know something about your case or the procedure you were going to do, we lived in constant fear but obviously we managed to get through our rotations so it was fine. I remember feeling a big pressure and I didn't want to let them down, let yourself down, and be in trouble if I didn't know anything. I made damn sure that I would know as much as I thought I could the next day, and as I say, in surgery if we didn't know something we were asked to leave*" [Vet 3]

However, other interviewees identified anxiety as a barrier to learning, believing that in stressful environments students may panic:

Q5. "*I don't quiz them in theatre because I think they're super-stressed and I don't want them to be scared of coming into theatre. So I will never stand there when they're already super-stressed and go, 'Right. What's the name of that? What's the name of that?', because I think that's just never going to work and they're going to hate it*" [Vet 8]

Theme 2: The subject of anatomy

Characteristics of anatomy are captured in this theme, including the content of an anatomy curriculum as the first sub-theme. Anatomy was acknowledged as a difficult subject to learn, presenting particular challenges in areas difficult to dissect and visualise in 3 dimensions. Equally, it was recognised to not always be a very interesting topic to learn, especially when the relevance of the material is not apparent. Nevertheless, clinicians in this study felt that anatomy has an important role to play as a subject in its own right, and its relevance to clinical practice is implicit. The role of anatomy forms the second sub-theme in this category and is illustrated by the following quote:

Q6. "*We all realised that we would need to know the structure of animals in order to do clinical work in order to do whatever we would go on to do, but there was nothing specific in the curriculum at that point in time to point that out*" [Vet 7]

Interviewees recall their time spent in the dissection room as students and describe the knowledge gained there as fundamental base knowledge upon which to build new knowledge and experiences throughout the rest of the course.

Q7. "*So you had your anatomy in first year. It's one of the first classes you took. Then it seemed like everything else built upon that. So like when you went and you took your surgery classes, they expected you to know all that anatomy. So if you didn't, you had to know it for your surgery courses and everything just kind of built up on that*" [Vet 1]

Q8. "*So it's not just the fact that if I'd known nothing I could have looked it up in a book and I would have been fine, but with the knowledge that I had, refreshing the knowledge*." [Vet 7]

Teaching anatomy that is clinically relevant was highlighted as being important, and something that interviewees felt was not always the case in their own learning, with the inclusion of irrelevant detail being a cause of frustration for some participants. There was also a perceived misalignment between what was delivered during their own learning and what is relevant to their practice.

Q9. "*The way we were taught, if you gave me a bone, I could tell you which leg it came from, which species and point out every bony prominence on it and what its name was, which I wouldn't be able to do now, but if I cut into a bit of a cow, I could describe the structures underneath even if I couldn't remember their names*" [Vet 2]

Participants were able to identify frequently occurring topics in their own area of practice and the associated regions of anatomy. They expressed a need for a core, or base level of knowledge to be able to apply to clinical situations. However, emphasis was more on understanding than detailed knowledge or the names of particular structures.

Q10. "*I'd like them to know that somewhere this region here which is a stifle, there are ligaments that are commonly damaged. I would want them to know that but I wouldn't want them to necessarily understand exactly where they originate and insert and stuff*." [Vet 8]

However, the relevance of a topic will depend on the species and area of work in which a new graduate will ultimately work,

and clear differences in the levels of knowledge required between the species arose from the interviews.

Q11. "*So the muscles of the lower limb of a dog I don't need to know and haven't known in a long period of time*" [Vet 5]

Q12. "*So being able to know the lower limb anatomy particularly, tendons, ligaments, joints, are super-important*" [Vet 3]

And a recognition that an attempt to teach the same level of detail across all domestic species can result in an overload of information in the course.

Q13. "*sometimes perhaps we teach rather more detail than perhaps people need to know but also we don't know what roles different people are going into and in different roles you need to know different amounts, therefore perhaps we have to teach the whole lot*" [Vet 7]

However, participants also described their personal experiences of directing their own learning post-qualification in order to perform their role, and emphasised that some things will only come through experience.

Q14. "*Even the final year students palpate animal's abdomen, dogs and cats abdomens, and say, 'I can't feel anything', but that's standard for vet students because they don't really realise what they should be feeling*" [Vet 5]

Theme 3: Effectiveness of teaching

This theme captures comments regarding levels of student knowledge and staff expectations. Discussions around who should deliver anatomy teaching highlighted the importance of clinical knowledge, with clinicians being observed to be best placed to provide context for anatomical facts and identify the material most relevant to students' careers.

Q15 "*To really link it to clinical process and some of our demonstrators were qualified vets and were the ones that you would prefer to ask questions of rather than the pure anatomists who- Well they couldn't give a clinical perspective*" [Vet 6]

Also highlighted was a distinct inconsistency in the understanding of the pre-clinical curriculum between clinicians involved in teaching anatomy and other subjects early in the course and those teaching primarily through rotation supervision.

Q16. "*I don't know really what anatomical teaching you even get, let alone what sort of standards*" [Vet 5]

Q17. "*I suppose it's a bit of a self-fulfilling prophecy because I know what I'm expecting them to have in Year 5 and so I tend to really hammer and labour that in Years 1 and 2 and 3*" [Vet 7]

Expectations among staff varied widely, with some clinicians expecting specific knowledge to be demonstrated by students on placement, and others placing less emphasis on anatomy knowledge.

Q18. "*They should know feet, they should know splint bones, they should know the carpus, they should know fetlock, they should know hock, they should know stifle. Necks a bit, backs a bit, but there's not a lot you can- You know what I mean? There's limited things for those, but certainly lower limb they should know. Again, elbow, shoulders, okay not so bad, but those lower limb stuff they should know*" [Vet 3]

Q19. "*As long as they know where to turn up and what time, that's generally good enough for me*" [Vet 5]

Unsurprisingly, those interviewed felt that they set reasonable expectations of final year students and methods such as trying to remember their own standard of knowledge at a similar stage and using the RCVS Day One Competences as frames of reference were described. There was disparity in believing whether or not students were meeting these expectations and a belief amongst some clinicians that the standard of anatomical knowledge is in decline. Both equine clinicians interviewed felt that students were not meeting the required standards of anatomical knowledge, but one clinician questioned whether expected standards of knowledge were too high in their field and another, small animal vet echoed this in reflection of their own experiences.

Q20. "*whether the small animal people find the same or whether that's not because more people are small animal inclined…maybe their expectations are different... Maybe ours are too high but I don't think they are in the majority of cases when it comes to the basic stuff, being able to know what the lower limb anatomy is and what bones and tendons you're looking at or palpating*". [Vet 3]

Q21. "*I remember having to- I remember particularly and it may have been due to our teachers- having to know equine anatomy pretty well, whereas I think less so of large animal species and less so for small animal species, but particularly equine anatomy seemed to stick in my head and I think that was because it was continually drilled into us*." [Vet 5]

A number of clinicians referred to the variation in the ability of different students and some showed concern regarding weaker students progressing through the course.

Q22. "*I think we do bring out the best in our good students. I think we've got a lot of average students like everywhere else but I just think some terrible ones are sneaking through*" [Vet 8]

Areas in which the students' knowledge is perceived to be particularly poor were identified, as well as areas in which skills and knowledge are stronger. Naturally, the knowledge and skillsets identified varied according to the interviewee's own speciality. However, there were seen to be problems with students' lack of basic knowledge by the time they reached their final year. This was attributed to issues with knowledge retention and a belief that students compartmentalise their learning.

Q23. "*The classic quote I got from a student was, 'Well we learned that in first year. You don't expect me to know that now do you?'*" [Vet 1]

There is, in many participants opinion, a struggle for the students in applying their knowledge in clinical situations, and recognising the significance of their knowledge.

Q24 "*so that they would know that the abomasum in a cow can displace and they would know where in the digestive tract the abomasum comes and what it's attached to and that sort of thing, but they can't always walk up to a cow and say, 'So it would displace from here to here and it would move this way and these structures would be pulling it back*" [Vet 2]

This lack of ability to apply knowledge can then go on to have further negative ramifications as they are unable to gain the trust of their superiors in clinical situations

Q25. "*and that's a genuine thing because no one trusts them. They're like, 'Well if you can't tell me where that is, then I'm not going to be letting you touch this animal. So sorry', and that's difficult because that's obviously not ideal either for learning but that's the perception*" [Vet 3]

It was however, the perception of many of the interviewees that it was their role, as mentors to the students to facilitate this transformation of knowledge by students on rotation, and that the experiences they undertake on placements will aid in the development of these skills. Similarly, EMS was highlighted as particularly valuable in developing competence in clinical situations.

Q26. "*So I think the final year sort of pulls that together and that's where I certainly think our role in final year teaching is, is to try and develop that reasoning ability*" [Vet 4]

There was also recognition of the 'use it or lose it' aspect in the retention of knowledge, with knowledge eroding with disuse.

Q27. "*They've forgotten some of those things, but that's not surprising. I've forgotten lots of those elsewhere that I don't do all the time*" [Vet 7]

Theme 4: The clinically integrated curriculum

Comments regarding the structure of the SVMS course are included in this theme, which includes advantages and challenges to teaching in a vertically integrated curriculum. The spiral, clinically integrated curriculum was perceived positively by those interviewed, believing the course structure provided students with opportunities to practise skills they will need in practice and for EMS placements. It was also believed to make the course more interesting. The point that a course such as this is staff, time, and resource intensive was also acknowledged.

However, there were concerns expressed about ensuring a healthy balance between the basic and clinical sciences with a risk of overloading the curriculum, and the practise of clinical techniques acting as a distraction from the foundation knowledge. It was also recognised that too much of a clinical focus could be a particular issue for those that ultimately decide not to practise veterinary medicine.

Q28. "*They come away all enthusiastic about that and be talking about it, but then by the time they get to fourth year, final year, they don't remember how to do that and they didn't learn the anatomy because they were so busy getting excited about the clinical stuff*" [Vet 8]

The need to ensure reintegration of the basic sciences later in the curriculum was also highlighted, and that without the sciences as foundation knowledge the course can become about training students to perform specific techniques

Q29. "*There's always a danger that you can trim that down too much and you end up not training a sort of open mind*" [Vet 6]

Theme 5: Changes in HE

The subthemes in this category reflect changes that have taken place in HE in recent years. Access to internet resources, changes in curriculum content and increased emphasis on the student experience are included. The improvement in online learning tools was perceived to be helpful to current students, but also the accessibility of information online in the present day means that detailed information can be accessed rather than memorised by students.

The second sub-theme under the over-arching theme of changes in HE is that of change in curriculum content. There has been a move away from detailed anatomy as a basic science, but there is more to cover in a modern curriculum due to advances in technologies and techniques in use in the veterinary profession

Q30. "*Well there certainly is more crammed into the curriculum because there is a lot more that you could know. So there are many more techniques and much more knowledge than when I was a boy and also I think to some extent what we've tended to do is perhaps cram a bit more stuff in.*" [Vet 7]

The rise in student numbers at SVMS was cited as a challenge in delivering practical teaching as the group sizes increase, reducing opportunities for the students to handle animals and practise techniques

Q31. "*I don't know why that doesn't come and again I don't know whether it's because in the practicals with the live animals there's so many of them that they don't all physically put their hands on, you know, think about it, or get the ophthalmoscope. I don't know. Or if we don't notice that there's someone. You can't make sure that everyone, do you know what I mean, to do it. I don't know. To do something. To use something. Because as I say, they are definitely bigger classes now*" [Vet 3]

There was a perception of students as consumers wanting a service was reflected in some comments. One interviewee empathised with the fee-paying student, suggesting we need to strive for them to receive a high quality education for their large sums of money

Q32. "*it makes the whole course relevant by thinking the right way and keeps them interested when they're paying us however many thousand pounds a year*." [Vet 2]

Others, however, expressed concerns that the idea of students as consumers has a negative impact on their education, and that by feeding their desire to 'know the answers' may affect their ability to interpret and apply knowledge

Q33. "*but I don't know if there's a difference again in they're consumers. They pay. I didn't have to pay my fees. They're expecting- I feel like they expect us to tell them everything. Fine but I can't sit the exams for them. That's what I tell them. 'We can try and help you and that's a two-way process. I can stand here and lecture you on a rotation and we can not do anything clinical again, but in order for you to pass your exams, there's got to be something from you as well.' I don't know if that's fair or not. I don't know if that's something that's changed. That's just as I say, all my opinions of randomness, but whether because they're a consumer, that they think we should do everything for them. I find them spoon-fed now and we were probably told we were spoon-fed as well. Yeah. I don't think they have any fear of anything because I think that there's lots of committees that help them and I know that there's a jolly good reason for that, but I don't feel that there's any fear-factor of failing*" [Vet 3]

Q34. "'*We need a wrap up. We need some time-released notes. We need to know the answers', whereas the advantage- Because the amount, the content, is there already, what I learnt, what they learnt, and that's covered in a different way. In my sessions, my SDL, my CR type sessions, it relates to application of that knowledge, but they're learning how to apply knowledge, not specific facts. They don't get that. They say, 'Oh you've got to wrap it up'. So I say, 'We've done it. You've just done it. Well done. You've done what you need to do.' 'Oh yeah but what are the answers?' 'It doesn't matter. It doesn't matter because you can look it up. You can look it up in a book. You will cover it again when we're in Year 4.' It doesn't matter. It's the process and they don't get that*." [Vet 7]

8.5 Discussion

Students in year 4 felt that vertical integration of clinical skills into the anatomy curriculum better prepared them for clinical placements. This study aimed to investigate clinicians' perceptions of year 5 SVMS students and their preparedness for IMR. The information regarding clinicians' own experiences of learning provide context for their perceptions. In addition, the inductive approach to the data in this study also raised some interesting considerations around teaching in a contemporary curriculum more generally.

It is a characteristic of a clinically applied, problem based learning curricula to focus on developing learning skills such as problem solving and self-directed learning. Yet, there are some anatomical topics in which veterinary graduates will require a comprehensive understanding in order to provide effective care of their patients, and the expansion of knowledge in the veterinary field makes it increasingly unrealistic to train omni-competent graduates. Advances in technology, particularly in imaging in the case of anatomy, drive the need to ensure content is applicable.

Establishing exactly how much anatomical knowledge a new graduate veterinary surgeon needs to master is not straightforward. The results of this study have shown the variation in perceptions of practising clinicians in what students entering their final year of study need to know. The clear differences in required levels of knowledge between species reflects the diverse requirements of the varying roles of a veterinary practitioner, and the need for entry level graduates to have omni-potential, if not to be omni-competent. In 2001 the RCVS stated the requirement for graduates to be omni-competent was 'unrealistic and fundamentally misguided'. Despite the substantial load in course content multi-species training brings, there is still a perceived need for training across all species (Dale, 2008). However, there is much debate about omni-competence and tracking in the veterinary curriculum (Halliwell, 1999, Radostits and Prescott, 2001, Walsh et al., 2009). Further work in this area can investigate whether narrowing the field of study reduces the content burden on veterinary undergraduates enough to justify the consequential restricted career options. This study highlights the importance of anatomy in equine practice, although it is through the study of the dog that the majority of practical teaching is carried out, reflecting the career choices of graduates rather than the relative significance of the topic.

This study found that expectations of knowledge are not just set by the requirements of the role, but by the clinicians themselves. There was disagreement about how much anatomy students in their final year of study should know, with expectations of students' knowledge and skills ranging from understanding specific anatomical regions to the general basic requirement of turning up ready to learn. The findings of study 4 indicate that students generally perform well in assessment of anatomical knowledge. This could suggest that some clinicians' expectations are unrealistic, or it could be a further indication that assessment practices are not aligned to the desired learning outcomes of the course.

Disparity in the expectations of teaching staff demonstrates the difficulty in defining the relevant content of anatomy curriculum, but also illustrates a subjectivity in relation to expected standards of students' knowledge. This may be influenced by factors such as familiarity with the school curriculum, but also by the benchmarks cited by the clinicians relating to how they set their expectations. Discrepancies in the expectations of students' knowledge is not unique to veterinary practice, and is reflected in a study carried out by Prince et al. (2005). In this medical school study, Prince found diversity in standards of anatomical knowledge set by anatomists, clinicians, new graduates, and fourth year students. It is suggested that insight into actual knowledge levels may be a contributing factor in the variations. These findings suggest the need to conduct further research into ascertaining whether students' anatomy knowledge is inadequate in particular areas, or if some clinicians over estimate the amount of knowledge students should have acquired by their final year of teaching.

Long term understanding of anatomy and the transformation of acquired knowledge is an area requiring further investigation. Medical education studies have found that students lose basic science knowledge throughout their training (Ward and Walker, 2008) (Smith and Mathias, 2011, Wilhelmsson et al., 2013). Ward and Walker (Ward and Walker, 2008) found that it was a student's approach to learning that was associated with long-term retention. This study found that students using a combination of study methods and deep processing were more likely to retain knowledge when compared to students using memorisation. This highlights the need to provide students with opportunities to practice deep approaches to learning in the curriculum, but also the importance of aligning assessment practices to discourage surface approaches. In a study of medical alumni, Smith (Smith and Mathias, 2011) found that students claimed to forget much of the anatomy they learned. However, the majority (56.9%) reported that anatomical knowledge they had forgotten came back easily with a small amount of study. Clinicians in the present research did not comment on whether student's knowledge had improved by the end of a rotation or if student's seemed to remember anatomy readily after study.

The clinicians interviewed for this study were unanimous in the view that students struggle to apply their knowledge to clinical situations, a problem reflected in other clinical curricula (Cottam, 1999, Waterston and Stewart, 2005b). This suggests a wider issue with the transformation of basic science knowledge. The clinical skills practiced alongside anatomy

teaching at SVMS, and integrated teaching methods such as problem-based and case-based learning are thought to support the process of knowledge transfer from basic science concepts to clinical problems (Norman and Schmidt, 1992, Schmidt and Rikers, 2007). The outcomes of this study support others in emphasising the role of workplace-based learning such as extramural placements (EMS) in a veterinary curriculum and its value in providing opportunity for students to transform theoretical knowledge into clinical practice and in gaining valuable practical experience (Magnier et al., 2011). It is this practical, working knowledge that was identified as most important, but sometimes lacking in our students and the concerns of the clinicians raised in the present study indicate there is clearly more that can be done to facilitate the process of transforming declarative basic science knowledge into procedural, clinically applicable understanding.

The lack of preparation for rotations shown by some students proved to be a source of frustration for some interviewees and was also reported to negatively affect students' learning experiences, further reflecting the work of Magnier (2011), whose study found that most students did not read the placement-related documentation before entering onto a rotation. Therefore, if this is something we expect of students, the implications of not doing so should be further emphasised to students.

Fears expressed in this study reflected how our role as educators might be in conflict with the expectations of the 'student consumer' and the clinicians interviewed in this study were conscious of the financial relationship the student has with the university. The perception among some clinicians is that the students expect a degree of 'spoon-feeding', or to play a passive role in their education as a consequence of their financial contribution. A lack of engagement with the learning process and an unwillingness to take responsibility for their own learning could foster surface approaches to learning and assessment among students, which is incongruous to the objectives of Higher Education in developing higher order skills and an enquiring mind. However, as Bryson suggests, teachers themselves have a role to play in facilitating students' engagement in the learning process, and attention should be paid to curriculum design, implementation and alignment between outcomes (Bryson and Hand, 2007). It cannot be discounted that staff perceptions of what students expect may differ from students' actual expectations; indeed, there is little evidence to support the view that contemporary students are more demanding. Furthermore, as reported in a recent press release (British Veterinary Association, 2016) the financial

challenges faced by veterinary undergraduates should not be over-looked as an external stress factor, compounding the pressure to pass the course. Engaging students as partners and extending discourse to foster good relationships can positively influence both teachers and students. Ramsden (2008) argues that we as educators have a role in shaping students' expectations. He emphasises the importance of managing expectations and endorses engaging students as partners through collaborations in teaching, course planning and improvement of quality. However, increasing emphasis on performance indicators such as NSS[2], TEF[3] and Unistats[4] intended to provide students with information and choice may inadvertently put pressure on teaching staff to opt for teaching and assessment methods that students enjoy, but are not particularly challenging to them. Thus, collaborating with undergraduates enables opportunities to respond to students views, but also to manage students' expectations in terms of their responsibilities in their own learning.

8.6 Limitations

The data for this study were collected over a six week period and therefore represent a snapshot of the views of the participants. The results therefore should not be assumed to be widely generalizable and the presence of the author as interviewer and a staff member may have impacted objectivity. Further, it may be the case that the SVMS course attracts a particular type of clinician. However, useful information has been garnered regarding perceptions in the context in which it was intended. The qualitative nature of the study necessitated a small sample size. A larger study would ascertain into whether differences in perceptions and expectations between species experts were a genuine phenomenon or specific to this study.

8.7 Conclusions

Despite the implementation of a more problem based, clinically integrated curriculum at SVMS, and the introduction of the practice of clinical skills into practical teaching,

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[2] National Student Survey. Intended to gather opinions from final-year undergraduate students about their experiences of their course. A copy of the questionnaire is included as Appendix 16

[3] Teaching Excellence Framework. A scheme designed to measure the quality of teaching at Higher Education Institutions (HEI) in England. A HEI is awarded gold, silver or bronze by a panel of experts based on evidence from a set of metrics assessed against ten criteria

[4] Formerly the Key Information Set (KIS). A website managed by the Higher Education Funding Council for England HEFCE containing data collected from HE providers and from NSS

traditional teaching methods used in the delivery of anatomy remain largely unchanged and previous studies in this thesis have shown these still to be valid today. However, the subject of anatomy is still thought to contain much irrelevant material and the application of taught knowledge continues to be an issue. Therefore, there is scope for further work on the use of anatomical information by the new graduate in order to inform the anatomy curriculum.

The disparity between the strong performance in anatomy assessment throughout the course and clinicians perceptions of students working knowledge of anatomy suggests review of assessment practices is required to better align assessment with the desired learning outcomes of a new veterinary graduate.

There is a clear need to find a balance between responding to students' needs whilst still developing open minded, independent thinkers with problem solving skills they can apply to life outside of university, and further work should be carried out to investigate students' perceptions of consumption in HE to see if the concerns raised in this research are founded. However, there is a need for us to be explicit in what we expect from students to ensure they are able to maximise their educational experience.

9 Discussion

9.1 Perceptions of anatomy in a modern veterinary curriculum

A discussion of the findings of each of the studies is provided at the end of each relevant chapter. This chapter summarises the main findings and limitations relating to each of the research questions set out in this thesis. The conclusions are then considered within the wider context of anatomical education and veterinary education more broadly.

9.1.1 How do students perceive practical anatomy classes? Part 1: Opinions of SVMS students

The results of study 1 demonstrated that cadaver-based anatomy classes have a positive impact on students' perceptions of learning. Students value a combination of teaching methods to reinforce their knowledge, but struggle to identify essential from non-essential knowledge. Therefore teaching staff need to support students in the transitional period from secondary to higher education and encourage learning methods that will prepare them as lifelong learners (Parkinson and StGeorge, 2003, Raidal and Volet, 2009).The inclusion of clinical teaching in the anatomy curriculum has a positive impact on students' perception of learning anatomy, promoting interest and re-enforcing the relevance of the mostly knowledge based subject. Delivering clinical examples alongside anatomical information also ensures content is kept relevant to the role of a veterinary graduate, reducing the burden of unnecessary details that can easily overwhelm students (Cake, 2006, May, 2008, Patel, 2009).

The results of this study do not support claims that the basic scientific knowledge needs to be mastered before students are able to effectively apply their knowledge. Activities involving clinical techniques alongside learning anatomy are well received by students. The higher value placed on teaching methods used in the anatomy laboratory by second-year students suggests that their learning experiences in this environment are aligned to the demands of assessment and EMS placements. The use of animals in teaching raises a moral question and highlights an area in which non-technical competencies required for a new veterinary graduate could be developed within the anatomy environment.

Care must be taken in the interpretation of these results as the data represent a snapshot of opinions directly after a

dissection class. It is therefore likely that the teaching session they had just completed and the material under study influence the results. Furthermore, the more positive responses held by second–year students could be attributed to fewer students attending the class, these being perhaps the most motivated students.

9.1.2 How do students perceive the teaching methods used in veterinary anatomy? Part 2: Opinions of RVC and Cambridge students

The findings of this multi-institutional study further support the use of cadaver-based teaching sessions as they were highly valued across the different learning contexts. Practical sessions are particularly valued for the opportunity to interact with teaching staff and consolidate prior learning. This was especially true of RVC students, who, in the absence of anatomy lectures, adopt a learner-centred approach to anatomy. This highlights the importance of practical classes that are well supported and utilise a combination of teaching methods. Furthermore, practical classes should include practical activities that provide opportunities for students to apply and transform their knowledge.

While RVC students appeared to appreciate the value of anatomy classes, particularly dissection classes, more than Cambridge and SVMS students, this study did not investigate the impact of students' perceptions on their learning. RVC participants were significantly more likely to rate prosection and dissection more highly for finding sessions interesting and motivating, and motivation is known to foster deep learning (Fransson, 1977, Parkinson et al., 2006). However, further investigation is required to establish whether motivation to learn leads to actual learning gains in this case.

Interpretations from this study are limited by the use of the existing data obtained in the study of SVMS students. Data pertaining to perceptions of clinical techniques was removed from the dataset and students may have responded regarding dissection and prosection differently without the context of practising techniques. There are a number of confounding variables that must be considered such as the point at which anatomy is delivered and assessed in these different learning contexts, differences in availability of staff and cadavers, and variations in the depth and breadth of topics. This study investigated perceptions of learning and not educational outcomes and therefore, further investigation into approaches, motivation and attainment would be valuable.

9.1.3 Do perceptions of teaching methods impact assessment performance?

No evidence was found to suggest a relationship between perceptions of teaching and attainment in assessment. It is suggested that teaching methods are complimentary to one another and that students adopt a strategic approach to learning, able to utilise teaching methods to suit their individual learning preferences.

Students performed well in anatomy overall, but analysis of assessment items revealed a need to improve the difficulty and discrimination values of these questions. Traditionally, assessment in the largely factual subject of anatomy has focused on testing the acquisition of lower-order learning outcomes. In modern curricula, teaching methods have been designed to meet the intended outcomes of integrating and applying anatomical knowledge. However, this constructive alignment in teaching should extend into examination practices through the use of assessment methods that encourage higher order cognitive skills. The influence of assessment on learning behaviour is such that it can have unintentional effects (Newble and Jaeger, 1983, Cilliers et al., 2012). Students will adopt surface approaches to learning if assessment methods are perceived to demand it (Cobb et al., 2013), and as anatomy is delivered primarily in the initial years of the veterinary curriculum, it has a formative role in guiding students' learning. Thus, summative assessment can be used in these early stages of the curriculum to direct students in learning practices that promote deeper learning.

A limitation of this study was the use of the pre-existing questionnaire designed to elicit rich information on perceptions of different aspects of teaching. When correlated with assessment scores, the data became granular and thus patterns difficult to identify. A more sensitive measurement scale may have extracted more detail in the largely positive responses, making relationships easier to identify.

A study design incorporating students' approaches to study and learning activities would provide valuable information on the impact of teaching methods on attainment in assessment.

9.1.4 How do perceptions of learning anatomy change during the veterinary course?

The high value placed on cadaver teaching practicals continued into the clinical years of teaching. Students in year 4 particularly appreciated the opportunities to practise clinical skills in conjunction with learning anatomy and find learning in

this way to be valuable to their clinical studies and placements. Students feel that anatomy is an important discipline in the veterinary curriculum, but raised concerns about the lack of time in the curriculum to revisit basic anatomical knowledge alongside the clinical curriculum in fourth year. Rather than being unidirectional, vertical integration should include continued anatomical learning, allowing students to reinforce their knowledge and encourage application of existing knowledge to new scenarios.

Students show evidence of intrinsic motivating factors once they reach clinical studies, and a desire to learn in order to become a 'good vet'. However, there is still a reliance on instructors to provide information, and this learning behaviour is incongruent with the objective to develop the skills of lifelong learning in our new veterinary graduates. Previous studies have indicated that the high volume of information students in a professional curriculum are exposed to can lead them to feeling overwhelmed and contribute to a reliance on teachers for guidance (Newble and Gordon, 1985, Ryan et al., 2004, Raidal and Volet, 2009).

There are limitations to this study. Firstly, the responses received in the survey represent a snapshot of opinions immediately after a single practical class, and are likely to be influenced by the experiences of that individual session. As will the timing of the focus group meeting. Secondly, the sample size was reduced for the paired comparison by reduced attendance in the fourth year class and by students changing year groups. Finally, the alpha scores for some of the grouped domains of the questionnaire and as such summed data should be used with caution.

Despite these limitations, this study highlights the positive perceptions of students toward learning anatomy through cadaver-based activities. In particular, the introduction of clinical techniques early in their learning is highly valued and appreciated into the clinical years of teaching. As the spiral curriculum introduces clinical scenarios earlier in the veterinary curriculum, and basic concepts should be reinforced in the clinical years of teaching to facilitate the consolidation and encapsulation of relevant knowledge.

9.1.5 Does the SVMS anatomy curriculum prepare students for clinical placements?

The findings of studies for this thesis show that students at SVMS perform well in anatomy assessment, but this is not reflected in the perceptions of some clinicians working with students in their final year on clinical placements. Clinicians

were unanimous in their view that students struggle to apply their existing knowledge to clinical scenarios.

The findings of this study emphasise the complexity of establishing a level of anatomical knowledge required of a new graduate veterinary surgeon. While recognising that omni-competence is unrealistic, the RCVS day one competences cover a broad range of species and disciplines. The diverse profession into which our new graduates enter is reflected in the varied range in opinion of the clinicians interviewed for this study. Results reflected considerable disparity among clinicians with regard to what students entering their final year of study need to know and to what level of detail. Some clinicians indicated a clear mismatch between their expectations and the level of knowledge demonstrated by students. The divergent levels of competence expected of a year 5 student further emphasises the difficulty in identifying an anatomy curriculum that is appropriate for the range of disciplines open to a new veterinary graduate.

Students' apparent inability to apply their knowledge to clinical scenarios is an area of concern for clinicians, although this transfer of knowledge can be facilitated through seeing practice under clinical supervision (Magnier et al., 2011). However, it is clear that more could be done to facilitate the transformation of declarative knowledge into the procedural knowledge required for placements.

The perceived incongruity between students' expectations of contemporary education and the objectives of HE in developing an enquiring mind has been highlighted as an area for further investigation. Furthermore, we as educators have a role in managing the expectations of our students.

Small sample sizes and non-random sampling limit the generalisability of the findings of this study, and the presence of the author as interviewer and staff member may have influenced participants' responses. A wider survey of teaching clinicians, informed by the results of this study would facilitate further investigation into potential knowledge gaps specific to species.

9.1.6 The impact of a clinically integrated anatomy curriculum at SVMS

Assessing the overall impact of the integration of clinical teaching into the anatomy curriculum at SVMS is challenging and cannot be measured by the studies in this thesis alone. However, the research has highlighted both the positive impact of teaching with cadavers, and areas in which the

teaching and assessment of anatomy can be further developed to help students develop and use knowledge effectively.

Cadaver practical classes are valued for the opportunities to consolidate pre-existing knowledge. Learner-centred preparation for anatomy classes can motivate students to maximise their laboratory experiences. However, in order to facilitate the transition to more learner-centred approaches, classes need to be well supported. Students particularly appreciate the opportunities to practice clinical skills alongside learning anatomy. Moreover, positive perceptions continue into the clinical years of the course. While students believed classes benefited their learning and thought that practising clinical skills helped them to apply anatomical knowledge, this was not reflected in many of the clinicians' perceptions. This study found no evidence that the integration of clinical teaching directly benefits students on clinical placements. However, the clinicians interviewed for this research were only working with SVMS students and further research with clinicians supervising students from a range of integrated and traditional curricula would be of value.

9.2 Implications of the research for teaching anatomy

Optimising anatomy education to focus on the knowledge and skills required of a new veterinary graduate is a complex issue. The findings of the studies within this thesis can be related to teaching veterinary anatomy within a contemporary veterinary curriculum by addressing questions in the following sections.

9.2.1 Why continue to deliver anatomy?

It has been argued that basic science knowledge is of little value to the practising clinician (Patel et al., 2000). However, Patel's study was carried out using think-aloud protocols, and this method which may miss the identification of the implicit, encapsulated knowledge (Rikers et al., 2004). However, the process of encapsulation needs to be supported by integrated teaching and exposure to clinical situations, and only the anatomy relevant to development of encapsulation concepts should be delivered (Schmidt and Rikers, 2007).

In a modern curriculum, there is not the time to teach anatomy for anatomy's sake or as a rite of passage. However, anatomy plays an important role in diagnosis, and the relationship between clinical features and disease. Furthermore, it serves as a theoretical framework for the

organisation of clinical knowledge (Woods et al., 2006). An understanding of normal structure and function of body systems and how they are interconnected is essential for understanding how disease manifests itself. Communication with clients and colleagues requires an understanding of, and ability to use anatomical terminology. Furthermore, with increasing access to imaging modalities such as ultrasound and endoscopy, anatomical knowledge is becoming increasingly significant in diagnostic imaging in first opinion practice. An appreciation of imaging is also important in enabling discussion with referral clinicians and in interpreting findings for clients. Students value opportunities to develop skills in using clinical instruments and relevant anatomical concepts are re-enforced simultaneously. Participants of the studies in this thesis considered anatomy to be an important part of a veterinary curriculum. However, there is a perceived need to reduce unnecessary detail.

9.2.2 When to deliver anatomy: Vertical integration and the spiral curriculum

Students participating in this research reported the negative impact of limited time revisiting basic sciences in the later years, suggesting that the bidirectional nature of vertical integration within the SVMS curriculum could be improved. Encapsulation of knowledge presents an issue in this context as the expert clinician may not express anatomy explicitly.

Students at SVMS did report to have forgotten learned anatomy, and some clinicians interviewed for this research felt that student's anatomical understanding was lacking. Retention of basic science knowledge is a long-standing issue within clinical curricula (Watt, 1987), (Swanson et al., 1996, D'Eon, 2006). Smith (Smith and Mathias, 2011) found half of medical students forgot anatomy but that this knowledge came back easily. Others report less pessimistic conclusions, (Custers, 2010) but similarly advise revisiting and reinforcing knowledge in order to improve retention. Accordingly, when students move into the later phase of the spiral curriculum they should be signposted to previous teaching on the topic and allow students the time for revision of the subject in hand. Studies for this research have suggested that students value opportunities in practical classes to clarify prior learning, thus a flipped classroom approach to sessions in clinical years can encourage students to revisit anatomical topics.

It is important however, that previous material is not just re-taught, but that understanding is deepened, through building on previous knowledge. As described by Harden (Harden

1999b, 1999) as topics are revisited, increasing levels of difficulty should be added with the new relating to previous knowledge, thus students' competence increases. This also emphasises the need to keep the early phase of learning general but relevant. This can be built upon with deeper, more specific knowledge to be taught by clinicians during later phases of the curriculum.

The struggle with the transfer of knowledge to clinical situations is a problem common to clinical curricula, and strategies such as early exposure to clinical problems have been suggested as part of a potential solution (Norman, 2009). However, the encapsulation of anatomical knowledge may only come through experience in the clinical setting, but can be supported by integrated teaching (Schmidt and Rikers, 2007). Furthermore, integrating teaching can help provide examples to students, but actual integration has to be accomplished by the students themselves (Goldman and Schroth, 2012).

An effective integrated curriculum relies on the collaboration of clinical and pre-clinical staff. This research suggests a disconnect between the deliverers of early years teachers and those teaching in the clinical years of the curriculum in some areas, highlighting a need for regular discourse between deliverers in the planning and review of teaching to ensure content is current and relevant.

9.2.3 What to deliver: An outcomes-based approach to teaching anatomy

As this research shows, students highly value the integration of clinically relevant skills and techniques alongside their anatomy teaching delivered as part of the outcomes-based educational approach used at SVMS. This style of curriculum has a focus on the competencies expected as a result of the educational process. Within the context of the veterinary curriculum, standards are stipulated by the RCVS (RCVS, 2014). However, RCVS requirements are necessarily broad due to the variety of career options available to a new veterinary graduate. This makes defining outcomes for an anatomy curriculum difficult.

It is important to consider the role of the anatomy curriculum within the wider veterinary context. Anatomical knowledge is a framework upon which to draw in clinical reasoning, it is not the role of a vet school to develop specialists in the subject. Students have found the clinical relevance of a topic to be a motivating factor in their learning in this study. Furthermore,

in an increasingly busy curriculum a focus on topics relevant to the clinician can reduce content overload by reducing unnecessary detail. The findings of this research did not support the concerns of high cognitive load relating to the delivery of practical techniques early in the veterinary/clinical course. However, careful consideration should be given to this balance of basic science knowledge and clinical practices. Clinical information can be used to provide a focus, and should not be an extra burden that distracts from the intended learning outcomes.

Anatomy is just one discipline within the veterinary curriculum and there are additional factors influencing the content and delivery which can lead to a lack of alignment. These included accrediting bodies such as the European Association of Establishments for Veterinary Education (EAEVE) and the American Veterinary Medical Association (AVMA), and the requirements and regulations of the wider University. Furthermore, changes in teaching staff can result in the widening gap between the intended and the delivered curriculum, known as curriculum drift. (Woods, 2015). Nevertheless, whilst we must be mindful of unintentional drift, content should not be static, as it must respond to changes in disease patterns and technologies to equip new graduates. A process of continuous review and curriculum mapping can tackle the issue of curriculum drift, and as stated previously, this should include clinical and non-clinical staff.

9.2.4 How to deliver anatomy: Teaching methods

This thesis focussed on teaching in the anatomy facilities at SVMS, and findings support the use of a combination of methods aligned to the ILOs. This enables students to utilise different methods to suit their individual learning preferences. Cadaver-based tasks are complimented by practical activities that provide students opportunities to practice interpretation as shown in Fig 38. This translation of information from one format to another increases 'time on task' and places learning in context. Furthermore, it provides opportunity for students to practice transfer, using knowledge acquired in one setting to understand a problem in another context (Norman, 2009).

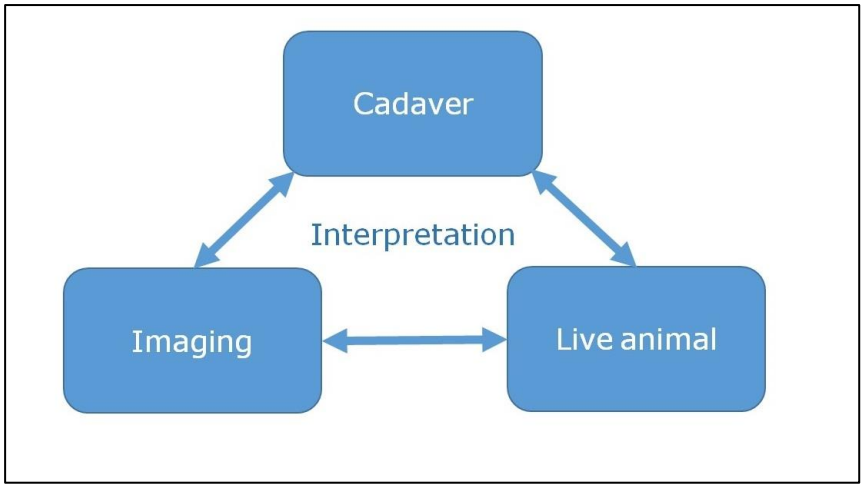

Figure 36. Interpretation of information through practical activities.

Previous studies have found that students struggle with the transition to a veterinary degree and find the intensity of the course stressful (Kogan et al., 2005, Sutton, 2007, Laakkonen and Nevgi, 2014). An overload of detailed anatomical information is widely reported in clinical education, (Lempp, 2005, Mattick and Knight, 2007). Therefore, regardless of teaching methods used, students need guidance in identifying relevant information and this was reflected in the findings of the present research. Moreover, findings of studies in this thesis reflect the value students place on the interactions with staff during anatomy practicals. Therefore, consideration must be given to staff: student ratios during these classes to ensure students can actively participate. Furthermore, findings of study 2 of this thesis suggest that students particularly value this active learning time for interpreting and applying knowledge gained from prior self-directed reading, in the flipped classroom style.

Beside knowledge-based learning outcomes, there are a number of additional outcomes such as the professional competencies associated with working in the dissection environment. While the body of evidence is weak regarding the importance of these skills in the veterinary profession (other than communication skills) (Cake et al., 2016), we can utilise opportunities within the context of the dissection room to foster respectful behaviour.

9.2.5 How to assess anatomical knowledge

The importance of assessing students in a manner that fosters deep learning and encourages the application of knowledge has been highlighted in this work. Possessing factual knowledge on which to base clinical decisions is an important outcome of an anatomy curriculum. However, testing lower-order outcomes can lead students to associate recall and

surface strategies with success in anatomy, and students should not perceive the memorisation of terms as the endpoint of their learning. Flawed item formats, items that are too easy, too hard, or non-discriminating all threaten the validity of assessments, as does inadequate sampling of the construct. Therefore, attention to the number of items and the cognitive levels tested is advised (Downing and Haladyna, 2004). The implementation of Blooms taxonomy and post assessment analysis can be useful tools in informing question writing. A focus on the explanation of clinical signs, detection of abnormalities and interpreting signs from clinical examinations rather than naming structures will aid in testing higher order learning outcomes. In a well-designed, constructively aligned curriculum, assessment items can reflect the integrated nature of the course by encouraging students to apply functional knowledge to explain clinical signs and symptoms. An approach in which higher order, functional anatomical knowledge is assessed as part of wider assessments of competence and performance at the 'shows how' and 'does' levels in Miller's pyramid of competence (Miller, 1990) is suggested. This approach may help bridge the apparent gap between the student successful in declarative anatomical knowledge in first-year and the final-year student struggling with procedural knowledge.

9.2.6 Who teaches anatomy

A collaborative teaching agenda supported by clinical and non-clinical teachers across all species can benefit curriculum alignment (CA). Defining the expected level of functional anatomical knowledge expected of our 5th year students will help align teaching. Furthermore, discussions regarding what should reasonably be kept in the UG curriculum and what can be left for post qualification can help reduce curriculum overload.

Regular curriculum reviews involving the input of teachers across all years of the curriculum can guide the content to deliver the relevant general anatomical knowledge required of pre-clinical teaching. This can then be built up upon in the spiral curriculum to include the more specific detail required of a year 5 student embarking on clinical intra-mural rotations (IMR). The inclusion of clinical concepts earlier in the curriculum should create time for the addition of relevant anatomical detail in year 4 teaching. A collaborative approach to curriculum review may aid in setting the expectations of clinicians teaching IMR students. Clinical teachers have a key role in the transformation of students from novice to professional, and IMRs provide a context in which is facilitated.

In a contemporary curriculum with an increased focus on the student experience, good teaching is no longer about the ability to just transmit knowledge. In order to support the learning of students, teachers need to develop teaching competencies such as those identified by Ramani and Leinster (Ramani and Leinster, 2008). Furthermore, there is evidence to suggest that academic development programmes can influence teacher behaviour and student's approach to learning (Gibbs and Coffey, 2004, Godfrey et al., 2004). Therefore, teachers should be trained in education, and furthermore, rewarded for good practice.

9.3 Recommendations

This research has explored perceptions of anatomy and its place in the veterinary curriculum. Based on the studies carried out for this thesis the following recommendations are suggested. These recommendations should be applicable to not just the SVMS curriculum, but to other veterinary curricula and indeed any curriculum delivering anatomy.

1. **Reduce content**
   A focus on functional anatomy and clinically relevant information will reduce the burden of unnecessary detail in the curriculum.

2. **Review assessment**
   Use an outcomes-based approach to assessment to encourage students to apply functional knowledge to clinical scenarios. This will test higher order learning outcomes and discourage rote learning.

3. **Increase opportunities to access anatomy in clinical years**
   Anatomy should be re-visited (not re-taught) in clinical years. This can be achieved through a flipped classroom approach in which students review basic anatomy before a clinically focussed class.

4. **Continue to use a blend of teaching methods**
   To deliver teaching through a combination of methods including teaching clinical skills alongside anatomy

5. **Develop professional competencies**
   Encourage respect for cadaveric teaching materials through reflective writing tasks, and assessing

professional attitudes in the context of anatomy teaching.

6. **Enhance transition to HE**
   Employ a progressive shift from a more supportive, teacher-focussed environment to independent learning. It is important to engage students in this process so that they don't become reliant on the teacher throughout the course.

7. **Encourage staff engagement in teaching and learning processes**
   Training in and dissemination of good practice in teaching, learning and assessment. Rewarding staff for good practice and encouraging discourse with students.

Based on these recommendations, further research should focus around the development of an outcomes-based curriculum with reduced content. Future work could investigate the application of cadaveric teaching to develop professional competencies and attitudes. Investigation into assessment of anatomy as measures of competence and for their predictive value of anatomical knowledge is recommended, as is the validation of authentic assessment such as in OSCE situations.

9.4 Conclusion

Anatomy is a traditional subject, but its place in the modern curriculum is changing. Students currently studying in higher education have instant access to vast amounts of information through the internet and therefore do not need to memorise it. However, to make sensible choices about the information they access they do need a level of understanding. In order to aid better understanding, the goal of anatomy teaching should be to foster deep learning. This can be achieved by reducing the burden of factual content and unnecessary detail, and by aligning assessment and teaching practices with the intended learning outcomes of the course.

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Appendices

Appendix 1: A level specifications relating to anatomy

Accrediting body and qualification	Module	Outcome
Edexcel A Level Biology	Exchange and transport	Know the structure of the heart, arteries, veins and capillaries
	Control systems	Know that the mammalian nervous system is composed of the central and peripheral nervous systems. ii Know the structure of the spinal cord. iii Know the location and main functions of: • the medulla oblongata – controls breathing and heart rate • cerebellum – controls balance and coordination of movement • cerebrum – initiates movement • hypothalamus – temperature regulation and osmoregulation. iv Know that the peripheral nervous system is divided into autonomic and voluntary systems. Know the structure of the human retina. Know the gross and microscopic structure of the mammalian kidney.
	Practical work assessed by teachers (pass/fail) Dissect an insect to show the structure of the gas exchange system.	
AQA A-level Biology	Gas Exchange	Adaptations of gas exchange surfaces, shown by gas exchange: in the tracheal system of an insect (tracheae, tracheoles and spiracles) across the gills of fish (gill lamellae and filaments including the counter-current principle The gross structure of the human gas exchange system limited to the alveoli, bronchioles, bronchi, trachea and lungs.

		Ventilation and the exchange of gases in the lungs. The mechanism of breathing to include the role of the diaphragm and the antagonistic interaction between the external and internal intercostal muscles in bringing about pressure changes in the thoracic cavity. The general pattern of blood circulation in a mammal. Names are required only of the coronary arteries and of the blood vessels entering and leaving the heart, lungs and kidneys. The gross structure of the human heart. Pressure and volume changes and associated valve movements during the cardiac cycle that maintain a unidirectional flow of blood. The structure of arteries, arterioles and veins in relation to their function. The structure of capillaries and the importance of capillary beds as exchange surfaces. The formation of tissue fluid and its return to the circulatory system. Muscles act in antagonistic pairs against an incompressible skeleton. Gross and microscopic structure of skeletal muscle The structure, location and general properties of slow and fast skeletal muscle fibres
	Opportunities for skills development Students could dissect mammalian lungs, the gas exchange system of a bony fish or of an insect Required practical 5: Dissection of animal or plant gas exchange system or mass transport system or of organ within such a system.	

OCR A-level Biology	Development of practical skills in biology	safe and ethical use of organisms to measure: (i) plant or animal responses (ii) physiological functions safe use of instruments for dissection of an animal or plant organ

	Exchange and transport	the structures and functions of the components of the mammalian gaseous exchange system To include the distribution and functions of cartilage, ciliated epithelium, goblet cells, smooth muscle and elastic fibres in the trachea, bronchi, bronchioles and alveoli. the mechanism of ventilation in mammals To include the function of the rib cage, intercostal muscles (internal and external) and diaphragm. the mechanisms of ventilation and gas exchange in bony fish and insects To include: • bony fish – changes in volume of the buccal cavity and the functions of the operculum, gill filaments and gill lamellae (gill plates); countercurrent flow • insects – spiracles, trachea, thoracic and abdominal movement to change body volume, exchange with tracheal fluid. the dissection, examination and drawing of the gaseous exchange system of a bony fish and/or insect trachea

	Transport in animals	the structure and functions of arteries, arterioles, capillaries, venules and veins To include the distribution of different tissues within the vessel walls. the external and internal structure of the mammalian heart (ii) the dissection, examination and drawing of the external and internal structure of the mammalian heart
	Classification and evolution	the different types of adaptations of organisms to their environment Anatomical, physiological and behavioural adaptations AND why organisms from different taxonomic groups may show similar anatomical features, including the marsupial mole and placental mole.
	Communication, homeostasis and energy	the structure and functions of the mammalian liver To include the gross structure and histology of the liver the structure, mechanisms of action and functions of the mammalian kidney the dissection, examination and drawing of the external and internal structure of the kidney the structure and functions of the adrenal glands Adrenal glands as an example of endocrine glands, to include the hormones secreted by the cortex and medulla and their functions. the organisation of the mammalian nervous system

		To include the structural organisation of the nervous system into the central and peripheral systems AND the functional organisation into the somatic and autonomic nervous systems. the structure of the human brain and the functions of its parts To include the gross structure of the human brain AND the functions of the cerebrum, cerebellum, medulla oblongata, hypothalamus and pituitary gland.
	Plant and animal responses	the structure of mammalian muscle and the mechanism of muscular contraction To include the structural and functional differences between skeletal, involuntary and cardiac muscle

Appendix 2: Concept note and ethical review

Research Projects Concept Note and Ethical Review

The 'Concept Note' should be completed for all research applications that are being developed. The 'Concept Note' should be submitted to the Research Directorate (chris.holland@nottingham.ac.uk) in the early stages of an applications development and prior to a full review being carried out by a member of the Research Directorate. An Ethical Review will be required for all applications. Please submit the completed form to Chris Holland for circulation to the Research Directorate and the Ethical Review Committee.

SVMS applicant name (indicate whether principal applicant or not):
Erica Gummery
Kate Cobb (supervisor)

Project Title:
Student Perception of Anatomy Teaching: is there a relationship between engagement and performance?

Funding (awarding agency and amount sought):
SVMS
Submission date:

Collaborators and Institutions involved:
RVC/Edinburgh

A) Please provide a one page outline of the project with a statement of why the work is important (novelty and timeliness), hypotheses (if any), objectives, experimental plan and techniques to be used.

This project aims to investigate the following:

(1) What activities are carried out within the dissection room and associated areas?
(2) How do first- and second-year veterinary students perceive the value of these tasks and activities?
(3) Is there a correlation between the perception of tasks carried out using cadaver material in these classes and performance in exams?

Methodology

In order to gather information on student views of dissection sessions and how they use them in the wider educational context I would like to ascertain:

(1) The range of individual activities carried out during classes in the dissection facilities. This information can be obtained from session plans and resource lists.
(2) Student perception of the time spent in the dissection lab. I intend to do this by using a Likert scale questionnaire covering topics such as those included in The Approaches and Study Skills Inventory for Students (ASSIST) (Entwistle, 1997). I plan to

distribute the survey to 1st and 2nd year students at two UK Veterinary Schools. Furthermore, I intend to obtain more detailed qualitative data using further interviews.

(3) I intend to compare the data of student perception of dissection with performance in anatomy assessment for participating students at the University of Nottingham. This would be through the use of data collected from exam marks of anatomy-related questions.

Relevance and contribution of this research to the area of study

At SVMS first- and second-year undergraduates dissect fixed tissue, practice clinical skills on fresh material, and are taught in small groups using prosections to present structures of anatomical import. I aim to establish how learning objectives are met using these methods and if other veterinary schools teach anatomy using similar methods and materials.

More detailed information gathered about what students value in practical dissection classes provides insight into how to utilise the time in order to motivate undergraduates in these sessions to best achieve the intended outcomes. The comparison of student perception across two different schools deepens understanding into how dissection teaching is perceived in different contexts.

The clinically integrated curriculum at SVMS demonstrates the clinical relevance of basic sciences such as anatomy; and a positive response to clinically related tasks in dissection classes would be expected. By studying the correlations between aspects of anatomy taught with a particularly clinical emphasis and the corresponding examination results we should gain a clearer picture as to the effects of this method of teaching. i.e. if the clinical relevance of the topic engages and motivates the student thereby improving performance in assessment, or if the clinical information distracts the student from the basic knowledge intended to be delivered.

B) Ethical information required:

For any clarification, please contact: richard.hammond@nottingham.ac.uk

1) Does this proposed project use animals or materials obtained from them? If yes go to Q2. If not go to Q9

NO

2) Is the proposed project to be carried out as part of an existing project licensed under the Animal Scientific Procedures Act? If yes go to Q 3. If not go to Q4

3) Does the proposed project require any modification of the content described in the current project licence that would require a project variation and therefore review by the Site Ethics Committee?
Go to Q7

4) Does the study use samples, or part of samples, obtained from the animals using an invasive procedure? If no go to Q 7. If yes go to Q5

5) This study must fall under the Veterinary Surgeons Act. What is the source of the animals or animal derived material to be used in the proposed study?
Go to Q6

6) Informed owner consent must be obtained prior to obtaining these samples – even for cadaver material or surplus from samples taken as part of the clinical investigation. Has the process for obtaining such consent been discussed with the veterinary practice/animal keeper?
Go to Q8

7) Does the proposed project involve modification of the behavior or routine of the animal(s)? If so please describe these modifications and the potential impacts on the animal(s) then go to Q13. If No go to Q 13.

8) Describe in detail the process by which samples are to be obtained – site, amount concurrent medication (e.g. sedation), restraint, clipping of fur etc. Go to Q 7

9) Does the proposed study involve obtaining information by questionnaire or interview?
If yes go to Q10. If no go to Q11
YES
*10) Have you read, understood and agree to abide with the Schools policy on data collection by questionnaire or interview? G:\School of Veterinary Medicine and Science\SVMS Information\Ethics.***YES**
If yes please go to Q13

11) Does the proposed study involve obtaining 'owned' information through a third party – eg searching practice records about clinical cases? If yes go to Q12 If no go to Q13

12) Have you read and understood the relevant sections of the 1998 Data protection act
http://www.opsi.gov.uk/Acts/Acts1998/ukpga_19980029_en_1 as they relate to your proposed work, understand the implications of the act and agree that the proposed study does not infringe provisions of the act? Yes or No.

13) END – no further information required a this stage.

Signature of Research Directorate Reviewer: …… Date:……

Signature of Ethical Review Committee Chairman: …… Date:…….

Appendix 3: Final Survey SVMS Y1 & Y2

Thank you for taking part in this study into veterinary anatomical education. The following questionnaire covers different aspects of your learning experience and includes three activities commonly carried out in the dissection lab: dissection, demonstration, and practising techniques. Please respond to the statements by marking the box that most reflects your experiences and feelings to the statements. Please add any comments not covered by the statements in the free text space at the end of each section.

Section 1 Gaining anatomical knowledge

Please rate how strongly you agree or disagree with each of the following statements relating to how cadaver material aids in your understanding of anatomy by placing a tick (✓) in **one** of the boxes for each statement.

Dissection of cadaver material

	Strongly Agree 1	Agree 2	Neutral 3	Disagree 4	Strongly Disagree 5
Helps me to relate structure to function					
Helps me with 3D appreciation of structures					
Improves my understanding of anatomy					

Demonstration of prosections

	Strongly Agree 1	Agree 2	Neutral 3	Disagree 4	Strongly Disagree 5
Helps me to relate structure to function					
Helps me with 3D appreciation of structures					
Improves my understanding of anatomy					

Practising clinical/practical techniques on cadaver material

	Strongly Agree 1	Agree 2	Neutral 3	Disagree 4	Strongly Disagree 5
Helps me to relate structure to function					
Helps me with 3D appreciation of structures					
Improves my understanding of anatomy					

Do you have any other comments regarding learning anatomy using cadaver specimens?

_____
_____
_____
_____
_____

Section 2 Application of anatomical knowledge

Please rate how strongly you agree or disagree with each of the following statements relating to the application of knowledge to veterinary skills using cadaver material by placing a tick (✓) in **one** of the boxes for each statement.

Dissection of cadaver material

	Strongly Agree 1	Agree 2	Neutral 3	Disagree 4	Strongly Disagree 5
Opportunity to put theory into practice					
Is relevant to my career					

Demonstration of prosections

	Strongly Agree 1	Agree 2	Neutral 3	Disagree 4	Strongly Disagree 5
Opportunity to put theory into practice					
Is relevant to my career					

Practising clinical/practical techniques on cadaver material

	Strongly Agree 1	Agree 2	Neutral 3	Disagree 4	Strongly Disagree 5
Opportunity to put theory into practice					
Is relevant to my career					

Do you have any other comments regarding application of knowledge using cadaver material?

_____
_____
_____
_____
_____

Section 3 Enjoyment

Please rate how strongly you agree or disagree with each of the following statements relating to enjoyment of classes using cadaver material by placing a tick (✓) in **one** of the boxes for each statement.

Dissection of cadaver material

	Strongly Agree 1	Agree 2	Neutral 3	Disagree 4	Strongly Disagree 5
I find it interesting/motivating					
I find it to be a negative experience					
Please comment as to what makes the experience negative					

Demonstration of prosections

	Strongly Agree 1	Agree 2	Neutral 3	Disagree 4	Strongly Disagree 5
I find it interesting/motivating					
I find it to be a negative experience					
Please comment as to what makes the experience negative					

Practising clinical/practical techniques on cadaver material

	Strongly Agree 1	Agree 2	Neutral 3	Disagree 4	Strongly Disagree 5
I find it interesting/motivating					
I find it to be a negative experience					
Please comment as to what makes the experience negative					

Do you have any other comments regarding your enjoyment of sessions utilising cadaver material?

_____
_____
_____
_____
_____

Section 4 Assessment

Please rate how strongly you agree or disagree with each of the following statements relating to assessment by placing a tick (✓) in **one** of the boxes for each statement.

Dissection of cadaver material

	Strongly Agree 1	Agree 2	Neutral 3	Disagree 4	Strongly Disagree 5
It is important because it is assessed in exams					
I find it useful preparation for exams					

Demonstration of prosections

	Strongly Agree 1	Agree 2	Neutral 3	Disagree 4	Strongly Disagree 5
It is important because it is assessed in exams					
I find it useful preparation for exams					

Practising clinical/practical techniques

	Strongly Agree 1	Agree 2	Neutral 3	Disagree 4	Strongly Disagree 5
It is important because it is assessed in exams					
I find it useful preparation for exams					

Do you have any other comments regarding assessment?

_____
_____
_____
_____
_____

Section 5 Learning process

Please rate how strongly you agree or disagree with each of the following statements relating to the learning process by placing a tick (✓) in **one** of the boxes for each statement.

Dissection of cadaver material

	Strongly Agree 1	Agree 2	Neutral 3	Disagree 4	Strongly Disagree 5
It relates to other teaching sessions					
It promotes peer learning					
It provides the opportunity to participate and ask questions					
It encourages respect for the material					

Demonstration of prosections

	Strongly Agree 1	Agree 2	Neutral 3	Disagree 4	Strongly Disagree 5
It relates to other teaching sessions					
It promotes peer learning					
It provides the opportunity to participate and ask questions					
It encourages respect for the material					

Practising clinical/practical techniques

	Strongly Agree 1	Agree 2	Neutral 3	Disagree 4	Strongly Disagree 5
It relates to other teaching sessions					
It promotes peer learning					
It provides the opportunity to participate and ask questions					
It encourages respect for the material					

Do you have any other comments regarding the learning process relating to cadaver material?

_____
_____
_____
_____
_____

Thank you for taking the time to complete the survey.

Appendix 4: Participant information and consent form

The University of Nottingham

School of Veterinary Medicine and Science

Participant Information and Consent Form

Thank you for volunteering to complete this questionnaire which is part of a study aiming to investigate student perception of cadaver based teaching for veterinary undergraduates

What you should know

- Completion of the questionnaire should take 5 – 10 minutes
- Participation in this study is completely voluntary and you are free to withdraw at any point.
- Data collected during this study is confidential and will be used solely for the purposes of educational research
- Providing your student number will help identify trends in data, however individual performance will not be recognised
- The study has been approved by the Nottingham University School of Veterinary Medicine and Science ethical review panel and I guarantee that good ethical conduct will be observed throughout as outlined in the 'Revised Ethical Guidelines for Educational Research (2004)' by the British Educational Research Association (BERA)
- You can contact me with any questions on 0115 9516 457 or at erica.gummery@nottingham.ac.uk

Please sign below to show that you have read and understood these conditions and agree to participate in the study.

I, _____, agree to take part in this study.

Signature: _____ Date: _____

Student I.D. number: _____

Appendix 5: Teaching method description and experience

Thank you for taking part in this study into veterinary anatomical education. The following questionnaire covers different aspects of your learning experience and includes three activities commonly carried out in the dissection lab: dissection, demonstration, and practising veterinary techniques. Please respond to the statements by marking the box that most reflects your experiences and feelings to the statements. Please add any comments not covered by the statements in the free text space at the end of each section.

Please note – for the purposes of this study:

'**Dissection**' is intended to mean the dissection of cadaver material carried out by the student either individually or in small groups

How often do you perform this activity?

I have never experienced this ☐

I have experienced this once or twice ☐

I have experienced this 3 or 4 times ☐

I have experienced this 5 times or more ☐

'**Demonstration of prosections'** refers to teaching whereby a demonstrator/lecturer will present material to the student in order to describe anatomy/physiology

How often do you perform this activity?

I have never experienced this ☐

I have experienced this once or twice ☐

I have experienced this 3 or 4 times ☐

I have experienced this 5 times or more ☐

'**Practising clinical/practical techniques**' denotes the use of cadaver material in performing practical veterinarian skills and includes such activities as ultrasound, endoscopy, suturing etc.

How often do you perform this activity?

I have never experienced this ☐

I have experienced this once or twice ☐

I have experienced this 3 or 4 times ☐

I have experienced this 5 times or more ☐

Appendix 6: Statistical analysis of responses across schools (Kruskall-Wallis test)

Dissection

Survey question	Vet school	Mean rank	X^2	*p*
1. Helps me relate structure to function	1	299.31	31.37	.000*
	2	349.24		
	3	384.12		
2. Aids in 3D appreciation of structures	1	307.36	63.54	.000*
	2	320.94		
	3	398.19		
3. Improves my understanding	1	304.38	45.35	.000*
	2	331.38		
	3	396.88		
4. Provides an opportunity to put theory into practice	1	313.62	8.74	.013*
	2	340.56		
	3	358.64		
5. Is relevant to my career	1	308.05	26.67	.000*
	2	332.97		
	3	376.84		
6. I found it interesting/motivating	1	284.98	102.65	.000*
	2	343.54		
	3	436.30		
7. I found it to be a negative experience (reversed)	1	311.65	9.149	.010*
	2	337.36		
	3	355.90		
8. It is important because it is assessed in exams	1	323.37	22.29	.000*
	2	348.95		
	3	259.09		
9. I found it useful preparation for exams	1	307.51	15.96	.000*
	2	319.54		
	3	371.07		
10. It relates to other teaching sessions	1	319.48	23.92	.000*
	2	298.09		
	3	382.53		
11. It promotes peer learning	1	319.61	17.83	.000*
	2	301.47		
	3	379.26		
12. It provides the opportunity to ask questions	1	312.64	22.85	.000*
	2	313.34		
	3	383.28		
13. It encourages respect for the material	1	301.36	20.08	.000*
	2	363.10		
	3	366.30		

Vet schools: 1, RVC; 2, CBR; 3, SVMS

Prosection

Survey question	Vet school	Mean rank	X^2	*p*
1. Helps me relate structure to function	1	312.08	9.05	.011*
	2	349.99		
	3	354.12		
2. Aids in 3D appreciation of structures	1	329.58	.999	.607
	2	340.33		
	3	319.98		
3. Improves my understanding	1	334.72	1.38	.502
	2	329.55		
	3	316.11		
4. Provides an opportunity to put theory into practice	1	310.88	9.82	.007*
	2	365.96		
	3	334.94		
5. Is relevant to my career	1	309.14	11.73	.003*
	2	334.37		
	3	363.61		
6. I found it interesting/motivating	1	313.91	11.28	.004*
	2	371.00		
	3	333.71		
7. I found it to be a negative experience (reversed)	1	304.32	12.22	.002*
	2	342.27		
	3	356.09		
8. It is important because it is assessed in exams	1	318.76	6.08	.048
	2	354.57		
	3	306.60		
9. I found it useful preparation for exams	1	319.53	1.88	.391
	2	329.62		
	3	341.37		
10. It relates to other teaching sessions	1	322.42	5.29	.071
	2	314.35		
	3	354.09		
11. It promotes peer learning	1	303.43	16.60	.000*
	2	362.35		
	3	361.21		
12. It provides the opportunity to ask questions	1	315.97	5.13	.077
	2	354.45		
	3	335.94		
13. It encourages respect for the material	1	309.15	8.69	.013*
	2	348.03		
	3	352.80		

Vet schools: 1, RVC; 2, CBR; 3, SVMS

Appendix 7: *Post-hoc* Mann Whitney U tests to identify differing perceptions between schools

Dissection

Survey question	Comparison and mean rank		*U*	*p*
1. Helps me relate structure to function	RVC 244.12	CBR 291.55	19961.50	.000*
	RVC 247.20	SVMS 314.66	21140.00	.000*
	CBR 132.19	SVMS 143.96	8664.00	.173
2. Aids in 3D appreciation of structures	RVC 253.35	CBR 263.94	23496.00	.164
	RVC 246.02	SVMS 319.15	20688.00	.000*
	CBR 121.50	SVMS 154.03	7296.00	.000*
3. Improves my understanding	RVC 250.70	CBR 271.87	22480.50	.037
	RVC 245.69	SVMS 320.00	20562.50	.000*
	CBR 124.00	SVMS 151.88	7616.50	.001*
4. Provides an opportunity to put theory into practice	RVC 249.46	CBR 269.78	22140.50	.117
	RVC 255.66	SVMS 292.50	24511.00	.004*
	CBR 134.28	SVMS 141.15	8918.00	.423
5. Is relevant to my career	RVC 249.27	CBR 268.14	22334	.062
	RVC 249.28	SVMS 305.10	22335.50	.000*
	CBR 128.83	SVMS 146.74	8233.00	.022
6. I found it interesting/motivating	RVC 244.49	CBR 290.45	20103.00	.000*
	RVC 232.49	SVMS 353.92	15508.50	.000*
	CBR 117.60	SVMS 157.39	6796.50	.000*
7. I found it to be a negative experience (reversed)	RVC 248.98	CBR 269.02	22222.50	.101
	RVC 253.17	SVMS 288.76	23815.00	.004*
	CBR 132.34	SVMS 140.14	8679.50	.345

8. It is important because it is assessed in exams	RVC 233.39	CBR 253.50	19662.50	.138
	RVC 267.99	SVMS 215.60	20950.00	.000*
	CBR 156.45	SVMS 118.49	6480.00	.000*
9. I found it useful preparation for exams	RVC 247.49	CBR 257.27	22814.00	.445
	RVC 246.02	SVMS 296.56	22266.50	.000*
	CBR 126.77	SVMS 149.51	7970.50	.008*
10. It relates to other teaching sessions	RVC 259.64	CBR 243.15	22867.50	.163
	RVC 251.34	SVMS 302.05	22859.00	.000*
	CBR 119.44	SVMS 154.99	7032.00	.000*
11. It promotes peer learning	RVC 258.99	CBR 245.08	23114.00	.287
	RVC 252.12	SVMS 300.03	23157.00	.000*
	CBR 120.89	SVMS 153.73	7218.00	.000*
12. It provides the opportunity to ask questions	RVC 255.30	CBR 256.11	24370.50	.946
	RVC 248.85	SVMS 305.46	21906.00	.000*
	CBR 121.73	SVMS 151.32	7326.00	.000*
13. It encourages respect for the material	RVC 242.62	CBR 289.76	19807.00	.001*
	RVC 249.24	SVMS 302.16	22320.00	.000*
	CBR 137.84	SVMS 138.14	9387.50	.974

Results marked with * indicate a statistically significant result after Bonferroni correction has been applied

Prosection

Survey question	Comparison and mean rank		MW-U	P
1. Helps me relate structure to function	RVC 247.06	CBR 26.58	21494.00	.027
	RVC 255.52	SVMS 289.18	24707.00	.011*
	CBR 137.91	SVMS 139.94	9396.50	.814
4. Provides an opportunity to put theory into practice	RVC 242.09	CBR 283.72	19880.00	.003*
	RVC 258.29	SVMS 278.48	26003.00	.136
	CBR 145.73	SVMS 131.46	8412.50	.109
5. Is relevant to my career	RVC 247.10	CBR 266.50	22034.50	.138
	RVC 250.54	SVMS 294.45	23325.50	.001*
	CBR 131.87	SVMS 144.15	8619.00	.155
6. I found it interesting/motivating	RVC 243.77	CBR 288.44	20103.50	.001*
	RVC 261.15	SVMS 276.63	26725.50	.239
	CBR 147.05	SVMS 132.08	8505.00	.076
7. I found it to be a negative experience (reversed)	RVC 242.45	CBR 272.35	20682.50	.022
	RVC 248.87	SVMS 290.02	23076.50	.002*
	CBR 133.42	SVMS 140.07	8810.00	.442
8. It is important because it is assessed in exams	RVC 241.45	CBR 268.98	20830.50	.040
	RVC 262.30	SVMS 252.55	26455.50	.456
	CBR 149.59	SVMS 129.04	8052.50	.019
11. It promotes peer learning	RVC 242.62	CBR 287.70	19943.00	.002*
	RVC 250.81	SVMS 297.78	23046.50	.001*
	CBR 139.16	SVMS 137.93	9388.00	.893

13. It encourages respect for the material	RVC 245.97	CBR 275.96	21214.50	.034
	RVC 253.18	SVMS 288.49	23945.00	.011*
	CBR 136.07	SVMS 137.81	9153.00	.847

Results marked with * indicate a statistically significant result after Bonferroni correction has been applied

Appendix 8: Year 4 survey

The University of Nottingham

School of Veterinary Medicine and Science

Participant Information and Consent Form

Thank you for volunteering to complete this questionnaire which is part of a study aiming to evaluate anatomy teaching in the veterinary curriculum.

What you should know

- Completion of the questionnaire should take approximately 5 minutes
- Participation in this study is completely voluntary and you are free to withdraw at any point
- Data collected during this study is confidential and will be used solely for the purposes of educational research
- Providing your student number will help to identify trends in data, however individual performance will not be documented
- The study has been approved by the Nottingham University School of Veterinary Medicine and Science ethical review panel and I guarantee that good ethical conduct will be observed throughout as outlined in the 'Revised Ethical Guidelines for Educational Research (2011)' by the British Educational Research Association (BERA)
- You can contact me with any questions on 0115 9516 457 or at erica.gummery@nottingham.ac.uk

Please sign below to show that you have read and understood these conditions and agree to participate in the study.

I, _____, agree to take part in this study.

Signature: _____ Date: _____

Student ID: _____

You may remember participating in a survey in 2nd year in which you gave your opinions on learning with cadaver material. As a continuation of this, I'd really appreciate your time in completing the similar survey below. The recently published results of the AVS survey reported that Nottingham students rated practical classes very highly, and we want to make sure the classes remain valuable to you. Thank you for your participation so far.

I'm asking for your help again now that you are two years older (and hopefully wiser) as I'm interested to see how and if your perspective has changed. Therefore, please respond to the statements by marking the box that most reflects your experiences and feelings to the statements. Please add any comments not covered by the statements in the free text space at the end of each section.

Please note – for the purposes of this study:

'**Dissection**' is intended to mean the dissection of cadaver material carried out by the student either individually or in small groups

'**Demonstration of prosections'** refers to teaching whereby a demonstrator/lecturer will present material to the student in order to describe anatomy/physiology

'**Practising clinical/practical techniques**' denotes the use of cadaver material in performing practical veterinarian skills and includes such activities as ultrasound, endoscopy, suturing etc.

Section 1 **Gaining anatomical knowledge**

Thinking back to your year 1 and 2 practical classes please rate how strongly you agree or disagree with each of the following statements relating to how cadaver material aids in your **understanding of anatomy** by placing a tick (✓) in **one** of the boxes for each statement.

Dissection of cadaver material

	Strongly Agree 1	Agree 2	Neutral 3	Disagree 4	Strongly Disagree 5
Helped me to relate structure to function					
Helped me with 3D appreciation of structures					
Improved my understanding of anatomy					

Demonstration of prosections

	Strongly Agree 1	Agree 2	Neutral 3	Disagree 4	Strongly Disagree 5
Helped me to relate structure to function					
Helped me with 3D appreciation of structures					
Improved my understanding of anatomy					

Practising clinical/practical techniques on cadaver material

	Strongly Agree 1	Agree 2	Neutral 3	Disagree 4	Strongly Disagree 5
Helped me to relate structure to function					
Helped me with 3D appreciation of structures					
Improved my understanding of anatomy					

Do you have any other comments regarding learning anatomy using cadaver specimens?

_____
_____
_____
_____
_____

Section 2 Application of anatomical knowledge

Thinking back to your year 1 and 2 practical classes, please rate how strongly you agree or disagree with each of the following statements relating to the **application of knowledge** to veterinary skills using cadaver material by placing a tick (✓) in **one** of the boxes for each statement.

Dissection of cadaver material

	Strongly Agree 1	Agree 2	Neutral 3	Disagree 4	Strongly Disagree 5
Opportunity to put theory into practice					
Is relevant to my career					

Demonstration of prosections

	Strongly Agree 1	Agree 2	Neutral 3	Disagree 4	Strongly Disagree 5
Opportunity to put theory into practice					
Is relevant to my career					

Practising clinical/practical techniques on cadaver material

	Strongly Agree 1	Agree 2	Neutral 3	Disagree 4	Strongly Disagree 5
Opportunity to put theory into practice					
Is relevant to my career					

Do you have any other comments regarding application of knowledge using cadaver material?

_____
_____
_____
_____

Section 3 Enjoyment

Thinking back to your year 1 and 2 practical classes, please rate how strongly you agree or disagree with each of the following statements relating to **enjoyment** of classes using cadaver material by placing a tick (✓) in **one** of the boxes for each statement.

Dissection of cadaver material

	Strongly Agree 1	Agree 2	Neutral 3	Disagree 4	Strongly Disagree 5
I found it interesting/motivating					
I found it to be a negative experience					
Please comment as to what made the experience negative					

Demonstration of prosections

	Strongly Agree 1	Agree 2	Neutral 3	Disagree 4	Strongly Disagree 5
I found it interesting/motivating					
I found it to be a negative experience					
Please comment as to what made the experience negative					

Practising clinical/practical techniques on cadaver material

	Strongly Agree 1	Agree 2	Neutral 3	Disagree 4	Strongly Disagree 5
I found it interesting/motivating					
I found it to be a negative experience					
Please comment as to what made the experience negative					

Do you have any other comments regarding your enjoyment of sessions utilising cadaver material?

_____
_____
_____
_____
_____

Section 4 Assessment

Thinking back to your year 1 and 2 practical classes, please rate how strongly you agree or disagree with each of the following statements relating to **assessment** by placing a tick (✓) in **one** of the boxes for each statement.

Dissection of cadaver material

	Strongly Agree 1	Agree 2	Neutral 3	Disagree 4	Strongly Disagree 5
It is important because it is assessed in exams					
I found it useful preparation for exams					

Demonstration of prosections

	Strongly Agree 1	Agree 2	Neutral 3	Disagree 4	Strongly Disagree 5
It is important because it is assessed in exams					
I found it useful preparation for exams					

Practising clinical/practical techniques

	Strongly Agree 1	Agree 2	Neutral 3	Disagree 4	Strongly Disagree 5
It is important because it is assessed in exams					
I found it useful preparation for exams					

Do you have any other comments regarding assessment?

_____
_____
_____
_____
_____

Section 5 Learning process

Thinking back to your year 1 and 2 practical classes, please rate how strongly you agree or disagree with each of the following statements relating to the **learning process** by placing a tick (✓) in **one** of the boxes for each statement.

Dissection of cadaver material

	Strongly Agree 1	Agree 2	Neutral 3	Disagree 4	Strongly Disagree 5
It relates to other teaching sessions					
It promotes peer learning					
It provides the opportunity to participate and ask questions					
It encourages respect for the material					

Demonstration of prosections

	Strongly Agree 1	Agree 2	Neutral 3	Disagree 4	Strongly Disagree 5
It relates to other teaching sessions					
It promotes peer learning					
It provides the opportunity to participate and ask questions					
It encourages respect for the material					

Practising clinical/practical techniques

	Strongly Agree 1	Agree 2	Neutral 3	Disagree 4	Strongly Disagree 5
It relates to other teaching sessions					
It promotes peer learning					
It provides the opportunity to participate and ask questions					
It encourages respect for the material					

Do you have any other comments regarding the learning process relating to cadaver material?

_____

_____

_____

Section 6 Year 4 teaching

Thinking about your current studies, please rate how strongly you agree or disagree with each of the following statements by placing a tick (✓) in **one** of the boxes for each statement.

	Strongly Agree 1	Agree 2	Neutral 3	Disagree 4	Strongly Disagree 5
I think anatomy is an important part of the veterinary curriculum					
I have forgotten most of the anatomy I learnt in the first two years of the course					
We re-visit anatomy in our year 4 teaching					
I have found the classes to be relevant to CEMS					
I have not needed anatomical knowledge in year 4					

Do you have any other comments regarding anatomy in year 4 of the curriculum?

_____
_____
_____
_____
_____

Section 7 Beyond graduation

Thinking about your future role as a clinician, please rate how strongly you agree or disagree with each of the following statements by placing a tick (✓) in **one** of the boxes for each statement.

	Strongly Agree 1	Agree 2	Neutral 3	Disagree 4	Strongly Disagree 5
I think that good anatomical knowledge will be important in practice					
I feel confident my knowledge of anatomy is sufficient for a job in practice					
I expect to look up anatomical information as and when I need it					

Do you have any other comments regarding anatomy beyond graduation?

_____
_____
_____
_____

Thank you for taking the time to complete this survey. I plan to run some focus groups next week, please add your name and contact e-mail address below if you would like to be included in the sessions and receive a £10 amazon voucher.

Name .....

E-mail .....

Appendix 9: Focus group script

Focus group script

Welcome and thank you for attending. Thank you for completing the questionnaire last week. This session today is a continuation of the questionnaire you completed. I will ask you some questions regarding your experiences of learning anatomy at vet school. Please answer openly and honestly.

Your contribution is vital to this project and as such I would like to encourage you to speak freely and for everyone to have an input. I will however ask that only one of you speak at a time for purposes of transcription. Your responses will be recorded by the tape recorder, but will not be used beyond completion of the transcription process. Anything said in this room is confidential and all data will be made anonymous after today.

Does anyone have any questions?

I will now ask you to sign the consent form to confirm that you understand the information provided to you, that you agree to take part in the research, and you recognise that you can withdraw at any time.

1. The results of the survey you completed in second year indicated that you enjoyed the cadaver practical classes – why do you think that is? What made them enjoyable?
    - Do you think practicing techniques helps you learn anatomy or just makes it more enjoyable?

2. Did you ever wonder where the material came from for the classes?
    - Were you aware that the dogs came from America?

3. What specifically can you remember about the classes in first and second year?
    - Do you think you remember the activities or the anatomy?

4. Was there much anatomy in year first and second year assessments would you say?

5. In your year 4 classes you have continued to practice some clinical and surgical techniques – do you think having done similar things previously has helped you this year or could you not really remember them?

6. Did you expect anatomical concepts to be covered again in year 4?
    - Would you say they have been?

7. Did you refer back to any anatomy notes from 1st / 2nd year during 4th year teaching?
    - If so, were these notes you'd made yourself?
    - Did you take any photographs in dissection classes?
    - Did you use other resources such as OVAM or the museum?

- Would you come to lunchtime anatomy revision sessions in fourth year?
- Is there anything else you would have found helpful in learning anatomy?

8. The last survey's results highlighted that you liked the demonstration of prosections because you know you were told the 'right' things, rather than doing it yourselves in case you learnt the 'wrong stuff'. Would you say this is still the case or has your perception changed?

9. Some other survey results now… The recently published AVS survey results show that for this school, anatomy as ranked the second best covered subject, and also the second worst. Why do you think this could be?

Moving on to thinking about the application of anatomical knowledge,

10. Would you say you've had to apply your anatomical knowledge during CEMS?

11. Would you say the vets you were working with knew a lot of anatomy?
    - Did they look up details?
    - Did they use anatomical terminology?

12. Are you happy to look up anatomical detail as and when you need it?
    - Is anatomical information easy to find?
    - In what scenario do you see yourself having to look up information?

13. Do you think it is important to learn anatomical detail at vet school?

And finally,

14. Anatomical knowledge is not specifically referred to in the RCVS day one competencies document, other than in the 'underpinning knowledge' section, which states that there is a requirement for an understanding of the structure and function of animals.

    - What do you think about this?

    - Is anatomy an assumed knowledge base?

Thank you for your comments today; and for all your help with the research so far.

Have a nice Easter and good luck with your exams!

Appendix 10: Focus group consent form

The University of Nottingham

School of Veterinary Medicine and Science

Participant Information and Consent Form for Focus Groups

Thank you for volunteering to participate in this focus group which is part of a study aiming to evaluate anatomy teaching in the veterinary curriculum.

What you should know

- Participation in this study is completely voluntary and you are free to withdraw at any point
- Data collected during this study is confidential and will be used solely for the purposes of educational research
- The discussion will be audio recorded but the recording will not be used beyond the transcription process
- The study has been approved by the Nottingham University School of Veterinary Medicine and Science ethical review panel and I guarantee that good ethical conduct will be observed throughout as outlined in the 'Revised Ethical Guidelines for Educational Research (2011)' by the British Educational Research Association (BERA)
- You can contact me with any questions on 0115 9516 457 or at erica.gummery@nottingham.ac.uk

Please sign below to show that you have read and understood these conditions and agree to participate in the study.

I, _____, agree to take part in this study.

Signature: _____ Date: _____

Appendix 11: Focus group codebook

	Code	Description
Negative aspects	Boring lectures	Ref to lectures not being interesting
	Difficult	Task of dissection being onerous, inability to identify structures
	Lack of time	In relation to revision of 1st and 2nd yr material
	Group sizes	Too many students, too few staff, or inability to see demonstration
	Knowledge retention	Lost a lot of anatomy since 1st and 2nd year
	Overwhelming	In terms of volume or complexity – feeling lost
	Slow	Refs to long time in DR due to timetabling or process
	Terminology	Refs to Latin/Greek being difficult
	Validity/quality of specimens	Poor quality specimens have negative effect on learning
Positive aspects	Assessment of knowledge on placements	Ref to being questioned by vets on placement
	Assumed knowledge	Expectations of school and profession on what they should know
	Gaining respect	Impress peers or vets on placement
Ethics	For the greater good	Use ultimately benefits many
	Not reason for euthanasia	More comfortable knowing not euthanised for teaching only
	SVMS responsibility	It is the school's responsibility to ensure ethical sourcing
Learning	Content vs learning	Focus on content LOs vs understanding/transforming information
	Insecurities	Not knowing enough, learning the wrong thing
	Learning prefs	Individual preferences in the use of learning resources
	Student vs teacher	Teacher led delivery or student directing their own learning
	Transition to HE	Different to anything done previously
Assessment	Alignment	Weighting of anatomy
	Validity	Methods of assessment

Anatomy curriculum	Unique subject	Ref to anything unique about learning anatomy
	Framework	A base on which to build in clinical years and in practice.
	Anatomy important	Essential for practice
	Non knowledge based outcomes	Confidence, professional skills e.g. teamwork, practical skills development
	Positive impact of early intro of skills	Provides context, enjoyable, helps learning and re-inforce knowledge and understanding

Appendix 12: Interview guide

Interview guide (semi-structured)

Introduction including greeting, purpose of study, thanks, consent, signposting, questions?

A bit about yourself:

- Firstly, please me a bit about your own background and training – current role etc

- Do you remember dissection classes from first and second year of your training?
  - Do you remember learning from prosections?
  - Did you practise any clinical skills in first and second year?

- Did you understand the relevance of anatomy when you were at vet school?
  - Did you think anatomy was important at the time of study?

- How much (as a percentage) of the anatomy you were taught would you say you use in your role?
  Which aspects are most important in your role?

- How good would you say your anatomical knowledge was when you graduated?
  - Were you confident in your knowledge?
  - Did you have to look up anatomical detail when you first started in practice?

- Has your anatomical understanding deepened since being in practice?

SVMS students:

- Do you ask students anatomy based questions when they are working with you?
  - Do you expect them to prepare for a clinic with you

    - Are students confident in their knowledge?

- Do students meet your expectations in terms of their anatomical understanding?
    - What are you expectations/how do you set expectations?

- Are there any areas of anatomy they are particularly weak in?

- Are there any areas of anatomy they are particularly strong in?

- Do students meet your expectations in their ability to relate anatomy to clinical cases?

- Do students meet your expectations in terms of competency in their practical skills?

Anatomy education:

- Do you think introducing clinical skills teaching early in the curriculum is a good thing?
    - Do you think it impacts on knowledge in the basic sciences?
    - Would you say you learnt more basic science content in your own training?

- Do you think there is a difference in graduate skill sets around the UK?

- Is this a good thing?

Closing is there anything else you would like to say that I haven't asked you about?

Appendix 13: Email requesting participants for the teaching staff interviews

Dear All,

For those of you that may not know me, I am a teaching associate here at the vet school, mostly demonstrating anatomy to first and second year students. I'm also working on an educational PhD, investigating the impact and effectiveness of anatomy teaching at SVMS.

I'm writing to invite you to participate in a one-off interview to investigate your views on the place of anatomy in the veterinary profession, and if our students on 5th year rotations are meeting your expectations with regard to their anatomical knowledge.

You have been selected as I would like to gather a range of opinions across species and specialities and the information you provide will inform a survey to investigate wider opinion on the topic.

The interview will take approx. 30 mins – 1 hour and I plan to run them during April. If you are over at SVMS during this time I can arrange a time to suit you, alternatively I can visit your place of practice if that is easier for you.

If you are able to participate please read the attached information form and please reply to this e-mail with your availability. You help would be greatly appreciated and your opinions will help inform teaching for future years!

Many thanks,

Erica

Appendix 14: Participant information and consent form for staff interviews

The University of Nottingham

School of Veterinary Medicine and Science

Participant Information and Consent Form for Interviews

Thank you for volunteering to participate in this interview which is part of a study aiming to evaluate the impact of anatomy teaching in the veterinary curriculum. These interviews aim to explore clinicians' perception of anatomy teaching if our students meet your expectations. This interview along with others will be used to inform a survey, and the information gathered will help inform anatomy teaching at SVMS.

What you should know

- Participation in this study is completely voluntary and you are free to withdraw at any point
- Data collected during this study is confidential and will be used solely for the purposes of educational research
- The discussion will be audio recorded but the recording will not be used beyond the transcription process
- The study has been approved by the Nottingham University School of Veterinary Medicine and Science ethical review panel and I guarantee that good ethical conduct will be observed throughout as outlined in the 'Revised Ethical Guidelines for Educational Research (2011)' by the British Educational Research Association (BERA)
- You can contact me with any questions on 0115 9516 457 or at erica.gummery@nottingham.ac.uk

Please sign below to show that you have read and understood these conditions and agree to participate in the study.

I, _____, agree to take part in this study.

Signature: _____ Date: _____

Appendix 15: Interview codebook

Code	Description
Advances in online resources	Accessibility of information online and improvement in online learning tools
American system	Supervised PG training and national exam
Anatomical regions that are important to know	
Anatomy a building block	Anatomy is a base for other knowledge
Anatomy difficult	
Anatomy uninteresting	
Areas in which the students do well	Comments on specific areas in which the students' knowledge and skills are strong
Areas in which the students don't do well	Areas in which students are reported as being weak
Assessment of anatomy	Anatomy exams
Balance between clinical and basic sciences in the spiral curriculum	Striking the right balance. Clinical material can distract from basic concepts. Staff/time intensive. D102 students. Including the basic sciences in later years
Compartmentalising	Students struggling to integrate knowledge from one module/year to another. Forgetting about a topic once they have passed the exam
Core knowledge	A base level of knowledge is required, including and overall anatomical picture
Day one competences	
Decline in students' knowledge	Students seem to be getting worse
Disconnect	Lack of ability to apply factual knowledge to real-life situations. Not being able to visualise what's going on
EMS	The role EMS plays in students gaining experience
Experience	Learn through experience. Somethings take practise
Fear	References to feeling scared on rounds, feeling under pressure to perform well in front of others, or getting into trouble for not knowing something References to not wanting to stress students
For anatomy's own sake	Learning anatomy as a subject in its own right. Just accepted that it must be learned
Frequently occurring veterinary issues	Need to know anatomy associated with common clinical cases

Gaining trust	If students don't display a basic level of knowledge, they don't gain the trust of others and will be given fewer responsibilities. Equally demonstration of competence promotes further opportunities to gain experience
Imaging	Anatomical knowledge needed for imaging
Knowledge of curriculum	Clinical staff members' (un)familiarity with early years teaching. Clinical staff feed into early years teaching
Knowledge retention	Knowledge erosion over time. In students and in practice. Forget information that is no longer relevant.
Learning preferences	Preferences for ways of learning exhibited by interviewees and recognition of different student preferences, including different courses
Level of detail	There is the potential for learning a lot of detail – much of it irrelevant
Look up information when required	Revision of/look up information before carrying out a specific procedure. Continuous self-directed learning and through experience. (but need the base knowledge)
Lost in detail	Overwhelmed by volume of detailed information and forget detail
Memorable experiences of anatomy	Memories of the anatomy lab and anatomy teaching
Modern curriculum busy	More information being crammed into curriculum
Omni competence	The requirement to teach to all specialities. What is relevant will depend on the role
Overload	Volume of information. Lack of time to learn it all
Perceptions of SVMS	How SVMS markets itself. Friendliness of staff and enthusiasm of students
Personal interest	Students' interests and intended career drive their learning
Positive perceptions of clinical integration	Positive impact of clinical integration including maintaining interest, providing opportunities to practise, and keeping the course relevant
Practical issues with teaching anatomy	Practicalities of teaching E.g. difficult to teach 3D concepts
Principles vs names	Knowing the names of structures is not as important as knowing what to expect and recognising what is significant
Purpose of HE	Not just about knowledge and skills, but wider purpose of HE
Purpose of rotations	Final year is about assimilating knowledge and transforming it into applied situations. Role of the clinician to facilitate process
Relevance implicit	Anatomy is intrinsically relevant and as such its relevance to practice was never pointed out in the traditional curriculum
Relevant anatomy	Clinically relevant anatomy most important. Relevant anatomy most interesting. Feeling that some anatomy will never be relevant
Rose-tinted glasses	Interviewees remembering their learning more positively than reality

Rote learning	References to learning by rote
Self-directed learning	Onus on learner to direct their own learning
Staff expectations	Expectations seem lower now.
Staff expectations	How teaching clinicians go about setting their expectations of students and what those expectations are
Student expectations	Students want answers to sessions, or not understanding the outcomes of sessions are sometimes about application and processes rather than facts. Students are fee payers.
Student numbers	Impact of high student numbers
Students not meeting expectations	
Students vary in ability	Good and poor students, comparisons with students from other schools
Teaching methods	Methods of teaching anatomy including lectures, practical classes, dissection, prosection, essay writing, supervisions, self-directed approaches
Transition to practise	Experiences of applying learning to real life situations
Weaker students getting through	Weak students still with us at the end of the course
Who teaches anatomy	Clinicians vs anatomists Unsuitable/unqualified people teaching

Appendix 16: NSS questionnaire

National Student Survey 2017 - Core Questionnaire

Scale:

Definitely agree

Mostly agree

Neither agree nor disagree

Mostly disagree

Definitely disagree

Not applicable

Questions:

The teaching on my course

1. Staff are good at explaining things.
2. Staff have made the subject interesting.
3. The course is intellectually stimulating.
4. My course has challenged me to achieve my best work.

Learning opportunities

5. My course has provided me with opportunities to explore ideas or concepts in depth.
6. My course has provided me with opportunities to bring information and ideas together from different topics.
7. My course has provided me with opportunities to apply what I have learnt.

Assessment and feedback

8. The criteria used in marking have been clear in advance.
9. Marking and assessment has been fair.
10. Feedback on my work has been timely.
11. I have received helpful comments on my work.

Academic support

12. I have been able to contact staff when I needed to.

13. I have received sufficient advice and guidance in relation to my course.

14. Good advice was available when I needed to make study choices on my course.

Organisation and management

15. The course is well organised and running smoothly.

16. The timetable works efficiently for me.

17. Any changes in the course or teaching have been communicated effectively.

Learning resources

18. The IT resources and facilities provided have supported my learning well.

19. The library resources (e.g. books, online services and learning spaces) have supported my learning well.

20. I have been able to access course-specific resources (e.g. equipment, facilities, software, collections) when I needed to.

Learning community

21. I feel part of a community of staff and students.

22. I have had the right opportunities to work with other students as part of my course.

Student voice

23. I have had the right opportunities to provide feedback on my course.

24. Staff value students' views and opinions about the course.

25. It is clear how students' feedback on the course has been acted on.

26. The students' union (association or guild) effectively represents students' academic interests.

Overall satisfaction

27. Overall, I am satisfied with the quality of the course.