UNIVERSITY OF SOUTHAMPTON

FACULTY OF LAW, ARTS AND SOCIAL SCIENCE

School of Education

Learning Anatomy at University: effectiveness, issues and implications for the future education of doctors.

By

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ABSTRACT

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LEARNING ANATOMY AT UNIVERSITY: EFFECTIVENESS, ISSUES AND IMPLICATIONS FOR THE FUTURE EDUCATION OF DOCTORS.

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This research study utilised an illuminative case study methodology to comprehend anatomy learning and application in medical education. Principles from phenomenography and grounded theory were adopted to seek perceptions and experiences of students, staff and alumni. The research methods included focus groups, questionnaires, observations, interviews and an approaches to learning inventory (ASSIST).Through progressive focusing on significant themes a model of learning and applying anatomy knowledge is proposed. The learning of anatomy is influenced by an individual's previous experiences and their perceptions of anatomy in context. Individuals adopt a deep, strategic or surface approach to learning, influenced by identified positive or negative factors. Perception that anatomy is relevant and other positive influences result in a deep approach being adopted and vice versa for a surface approach. A strategic approach is driven by the desire to perform in assessments. The approach to learning adopted has consequences, in that the adoption of a surface or strategic approach hinders the application of knowledge at a later point. A deep approach enables knowledge application through touch-mediated perception from examining human cadaveric specimens and is the preferred approach to learning anatomy as it enables an understanding of the three-dimensional form.

Anatomy learning occurs in three stages and the approach adopted reflects different levels of engagement in these stages. Application of knowledge occurs through situated learning where anatomical knowledge is restructured and through experience becomes encapsulated, enabling illness scripts to be applied in the clinical context.

To enable effective learning and application of anatomy the study recommends that:

- Clinical content and application of knowledge be increased in the early years of medical education and that anatomy education continues throughout undergraduate and postgraduate training.
- Anatomy education includes the use of human cadaveric specimens.
- Assessment should be appropriate for anatomy education and promote a deep approach.

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ii. Author's Declaration

I, CLAIRE FRANCE SMITH,

declare that the thesis entitled

Learning Anatomy at University: effectiveness, issues and implications for the future education of doctors.

and the work presented in the thesis are both my own, and have been generated by me as the result of my own original research. I confirm that:

- this work was done wholly or mainly while in candidature for a research degree at this University;
- where any part of this thesis has previously been submitted for a degree or any other qualification at this University or any other institution, this has been clearly stated;
- where I have consulted the published work of others, this is always clearly attributed;
- where I have quoted from the work of others, the source is always given. With the exception of such quotations, this thesis is entirely my own work;
- I have acknowledged all main sources of help;
- where the thesis is based on work done by myself jointly with others, I have made clear exactly what was done by others and what I have contributed myself;
- parts of this work have been published as:
    - Smith, C. & Mathias, H. (2007) 'An Investigation Into Medical Students' Approaches to Anatomy Learning in a Systems-Based Prosection Course', *Journal of Clinical Anatomy*, 20: 843-848.
    - Smith, C. & Mathias, H. (2007) 'Educational philosophies on learning anatomy', *Journal of Anatomy*, 210: 774.
    - Smith, C. & Mathias, H. (2007) 'Medical students' approaches to learning anatomy: quantitative and qualitative reflections', *Journal of Clinical Anatomy*, 20: 471.
    - Smith, C. (2006) 'Letter to the Editor', *Journal of Clinical Anatomy*, 19: 780-781.

Signed: ......CSmith...

Date:............16th June 2008...

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Thank you.

iv. Abbreviations

ADD: Anatomy Deficit Disorder
ADLIMS: Adelaide Diagnostic Learning Inventory Medical Students
ANOVA: Analysis of Variance
ASGBI: Anatomical Society of Great Britain and Ireland
ASI: Approaches Studying Inventory
ASSIST: Approaches to Study Skills Inventory
BM: Bachelor of Medicine
BMA: British Medical Association
BMBS: Bachelor of Medicine, Bachelor of Surgery
BMJ: British Medical Journal
CAL: Computer Assisted Learning
CD ROMS: Compact Disc Read Only Memory
CLAS: Centre for Learning Anatomical Sciences
COREC: Central Office for Research Ethics Committees
CPQ: Course Perception Questionnaire
CT: Computer Tomography
DR: Dissecting Room
EMQ: Extended Matching Questions
FCAT: Federative Committee on Anatomical Terminology
FRCA: Fellowship of the Royal College of Anaesthetists
GMC: General Medical Council
H&S: Health and Safety
HIV: Human Immunodeficiency Virus
HTA: Human Tissue Act
ISS: Information Systems Services
JT: Jonckheere-Terpstra
KV: Key Views
KW: Kruskal Wallis
MB: Medical Bachelor
MCQ: Multiple Choice Questions
MEDIS: Medical Information System
MRCS: Membership of the Royal College of Surgeons

MRCPsych: Membership of the Royal College of Psychiatrists
MRI: Magnetic Resonance Imaging
MV: Multiple Views
NHS: National Health Service
OSCE: Objectively Structured Clinical Examination
OSPE: Objectively Structured Practical Examination
PBL: Problem Based Learning
PET: Positron Emission Tomography
PGCE: Post Graduate Certificate of Education
PIS: Participant Information Sheet
PRHO: Pre Registration House Officers
QAA: Quality Assurance Agency
RAE: Research Assessment Exercise
RASI: Revised Approaches to Studying Inventory
RCSE: Royal College of Surgeons of England
RSH: Royal South Hampshire Hospital
SGH: Southampton General Hospital
SPSS: Statistical Package for the Social Sciences
SOLO: Structure of Observed Learning Outcomes
SSU: Student Selected Units
SV: Single Views
TDNet: Teldan Network
UK: United Kingdom

1 Chapter 1. Introduction

1.1 Overview

The aim of this thesis is to narrate the research project, Learning Anatomy at University: effectiveness, issues and implications for the future education of doctors. This thesis is divided into eight chapters. The introduction chapter sets the scene, examining the history and current state of anatomy education and explains the rationale behind the study. The second chapter is a literature review exploring the literature central to what is already known on the subject of anatomy education, medical education and educational theory. Chapter three explores the methodology for the study and study design. Chapters four, five, six and seven provide details of the research activities and the results obtained. At each stage these chapters bring together a working theory of learning and applying anatomy. Chapter eight discusses the conclusions, theory and recommendations produced from the research work.

My background is as an anatomist with clinical experience as an operating department assistant. I learnt anatomy as an Anatomical Sciences undergraduate and worked as a dissector and demonstrator in a London medical school. I then studied for a PGCE and this began my interest into pedagogical issues in the discipline of anatomy. I continued teaching anatomy in a medical school setting and at the time of writing hold a Senior Teaching Fellow position at the School of Medicine, University of Southampton.

At this point is it imperative to define what is meant by anatomy. Anatomy can be simply defined as the study of the structure of the living organism. However, a more complex definition is required for the context of this research. For medical education it is the study of the human form and encompasses various sub-sections: gross anatomy, surface anatomy, histology, neuroanatomy and radiographic anatomy. For this investigation the term anatomy refers to all of the subsections. However, the project's emphasis is on the study of gross anatomy (macroscopic).

Anatomical education is unique for many reasons and is based on a turbulent past, as described later, the pressures of which have meant that some very fundamental pedagogical concepts were overlooked, for example, how students are learning and applying anatomy. Medical education today and hence anatomy education has common aims as to what medical students and doctors in practice should achieve. This study sets out to investigate how these aims might be achieved; the processes and experiences of learning and applying anatomy. This study provides a deeper understanding as to how students learn and apply anatomy and how the teaching and learning experience can be enhanced to enable effective learning and clinical application. As recently stated:

> The single most desirable improvement in anatomy teaching would probably be in the field of evaluation. The question we must answer concerns which method of teaching about the structure of the body produces the most effective clinicians. (McLachlan & Patten 2006)

This statement however assumes an understanding of the processes and approaches to anatomy learning which currently does not exist. We first have to understand these processes from a variety of perspectives. It is from this understanding that a theory on anatomy learning can be developed.

I began this research study by exploring the history and current setting of anatomy education. A concise account is provided in this introduction chapter to place the study into context. Further information sources can be found listed in the Bibliography.

1.2 The History and Evolution of Anatomy Education

1.2.1 History of anatomy

The study of anatomy is believed to have started in the Stone Age with cave paintings of body structures. Over time, anatomy had been influenced by various notable figures such as Aristotle, who in 384-322 B.C. began the discovery of the human body by dissection. Galen in 129-199 A.D. continued dissecting and discovering animal anatomy. Galen wrote anatomical texts which became standard for many years, although many parts we now know to be incorrect. It has been proposed that due to the beliefs and influences of the Catholic Church anatomy development was halted (Bouchet 1996), until the twelfth century when a medical faculty was established in Bologna. Following this, the use of anatomy dissecting increased again and with it so did the teaching of anatomy. Drawings from Leonardo da Vinci (1452-1519), who himself dissected over 30 cadavers (Bouchet 1996), were used in teaching anatomy, although they were more a mixture of accurate drawings and art. Andreas Vesalius (1514-1564) published his seven-volume *De humani corporis de fabrica* (On the Structure of the Human Body), in which he carefully integrated text and drawings made from his observations of dissections and helped set anatomy on a new course toward a more scientific method (Anderhuber 1996). Accompanying the textbooks were fine woodcuts depicting human bodies at various stages of dissection (Dyer & Thorndike 2000), illustrating the need to retain what had been shown during dissection.

With the rise of surgical therapy, anatomy dissection grew. William Harvey (1578-1657) taught anatomy by dissection in the 'Padua' style lecture theatres (refer to section 1.3.3.1). Padua theatres used an observation style of teaching where students could watch and gain limited experience (McLachlan & Patten 2006). This style of demonstration of structures continues into the present day.

Anatomy lectures were combined with popular public demonstrations and dissections, and by the early 1800s there were many anatomy theatres around the country. Anatomy lectures gave a fleeting view of the human form and dissections allowed individuals to discover these structures for themselves. Observation soon became thought of as a lower standard activity. There was no focus on the method of teaching, because there were other concerns, such as where the next cadaver was coming from. Anatomy schools in Paris were reporting a plentiful body supply and rich medical students started to head to Paris to study (Richardson 1976). This was a concern for the British government who wanted to maintain the status and funding of medicine. With the turning of public opinion against the use of cadavers and grave robbing at an all time high, legislation was required to control the use of human bodies for anatomical study.

The Anatomy Act of 1832 (Office of Public Sector Information 2008) granted licences to allow the study of human cadavers, and a bequeathal system was arranged. In order to try and turn public opinion, medical schools were required to pay for burial expenses (Richardson 2000). The Act was redefined in 1983, and more recently in 2006 the Human Tissue Act has superseded the Anatomy Act (Office of Public Sector Information 2006).

Teaching remained in the same style of dissections and lectures. Students used anatomy textbooks which gave descriptions of the structures to be found on dissections (referred to as Dissection manuals). One of the most famous books is Gray's Anatomy, named after Sir Henry Gray who studied at St. George's Hospital Medical School in the 1840s (Elsevier 2006). This book is still seen as the cornerstone of anatomical knowledge today. Other anatomical texts also developed, for example Quain's Anatomy, which laid the foundations for anatomy textbooks of today. At this point anatomy was studied topographically, so that each region was studied in turn. Because of this arrangement many textbooks (with the exception of Gray's Anatomy, which until the 39th edition was arranged in systems) were and continue to be organised in the same fashion.

1.2.2 Evolution of anatomy in the 20th Century

With the advent of radiological examination, microscopy and computer generated images, the ways of viewing the human body, diagnosing and treating disease have changed dramatically, yet the methods of teaching anatomy appear still to have a hold on the past. In the 1960s some medical schools moved to the use of prosections (professional dissections), so that students could get on and study structures without spending the hours involved in dissection. The decision to do so was influenced by a number of factors including the decrease in available curricular time, an increase in student numbers and a belief that spending hours finding the structure for yourself did not aid the learning process. If the structure was already dissected by a professional dissector then many students could appreciate its structure and relationships. The debate as to whether anatomy should be taught using dissection or prosection continues today and is explored in the literature review.

It has only been in the past fifty years that anatomists have started to question the learning activities used and this is reflected by the dates of publications in the literature section. Justifications such as 'this is the way our fathers learnt anatomy, this is the way we will learn anatomy' are still prominent. In particular there is a belief that dissection is a rite of passage for many medical students. The result is that historical components remain in anatomy teaching but their role is not understood.

Anatomy as mentioned was always taught in a topographical style (arm, leg, thorax, etc) and one of the recent major changes in anatomy education was brought about as a result of the recommendations made in Tomorrow's Doctors (General Medical Council 2003). The report recommended that medical education should be taught in terms of systems of the human body, for example the cardiovascular system. There is an early example of a system approach being adopted in the 18th century before Abrahams Colles suggested the topographical approach (Monkhouse & Farrell 1999). Many medical schools now teach anatomy in a system-based approach, where each human body system is studied in turn, for example the nervous system. More recently, the GMC has published 'Good Medical Practice' which outlines the values and skills on which good practice are founded (Good Medical Practice 2006).

1.2.3 Brief history and development of anatomy in the medical curriculum

From the early days of medical faculties, such as the one in Bologna, there has been an ever increasing rise in the number of medical students (Bouchet 1996).Basic scie nce disciplines were arranged in a 'Flexnerian' curriculum model where students learned the basic science facts in the first two years (pre-clinical) and were then expected to apply these facts in the later third to fifth years (clinical years). Anatomy was taught in regions (topographical) and, until the 1890s, anatomy dissection was completed in blocks of six weeks. Cadavers would be unusable during their decomposition but the invention of formalin embalming by Von Hoffman (Bouchet 1996) meant that anatomy dissection would now be spread more evenly across the first two years (Parker 2002).

Disciplines, such as anatomy or physiology, were seen as separate entities, in that they were studied separately and students' knowledge was thus compartmentalised. The content was considerable and students were expected to know the majority of the human body inside out with little clinical relevance.

The post-Flexnerian curriculum model was developed with an emphasis on understanding the mechanisms of disease and how basic science relates to clinical practice. Compounded by Tomorrow's Doctors (General Medical Council 2003), anatomy teaching was forced to shift its place and style in the medical curriculum. There was a rationalisation of the material taught and hence the publishing of the Anatomical Society's guidelines on the core curriculum (Dyball et al. 2003), which was further refined in 2007 (McHanwell et al. 2007). Anatomy, as well as other disciplines, embraced new technologies which are able to either support or enhance the curriculum, for example the intranet and educational CD ROMs. Teaching in the medical curriculum developed from the 1900s from didactic teaching towards student-centred teaching as the result of an increased understanding of the process of learning.

Development of medical practice reflects a shift in the paradigm from the acquisition of knowledge and facts to the doctor being an analyst and synergist - the life-long learning physician. This is also a reflection in the change in patients, with the National Health Service (NHS) being patient-centred. Doctors of today and tomorrow are very different from those of their forefathers and hence it is important not to only understand the learning process, but also its application in the clinical context.

Only in the past ten years have radical changes started to occur in medical education, mostly in the form of Problem Based Learning (PBL) and the use of Computer Assisted Learning (CAL). But there is still no firm comprehension as to how students learn and apply anatomy as a subject. Hence the importance of this study is to ascertain how in the 21st Century medical students learn anatomy and how it is applied to clinical practice.

1.2.4 History of the University of Southampton medical school

The Hartley Institution, out of which the University of Southampton developed, was mainly a product of the industrial revolution; it grew out of the need for education and also from the pursuit of scholars for enjoyment. Between 1885 and 1893 it became known as a university college and the buildings continued to expand back to the city walls. In 1919 the decision was taken to move to Highfield, where the University is based now. The University gained its charter in 1952 (Patterson 1962) and the medical school took its first cohort of medical students in 1971.

The medical course first commenced with 40 students on a five year Bachelor of Medicine course, which remains today. Information collected for the 1975 GMC visit shows that the main teaching hospitals used for undergraduate teaching were Southampton General Hospital (SGH) and the Royal South Hampshire Hospital (RSH). The Boldrewood campus was built by the early 1970s and was the site for teaching for the first and second year of the course and the associated administration, with hospitals used for the later years' teaching. By 1975 student intake numbers had increased to just over a hundred. Two hundred and twenty students were admitted to the first year in 2007.

The curriculum will now be explored along its historical lines to enable understanding of its current structure and what changes have occurred. With reference to Figure 1 it is clear that the initial curriculum is course specific and divided into three terms per academic year. The first two years are termed 'pre-clinical' years and the later years 'clinical'. As described previously this is a very common curricular structure for the 1970s. The assessment is through the primary BM examination at the end of the first year, the intermediate part 1 and 2 being at the end of the second and third years, respectively, and the final BM at the end of the fifth year before pre-registration for one year. Unusual for the time, the curriculum included a 4th year Study in Depth and a running thread of sociology through the early years. It also gave early medical contact in the pre-clinical years, a feature that was very new to medical curricula. While it was traditional in having separate discipline courses, e.g. anatomy, it also had systems courses where a body system was studied with all the disciplines involved. These features made the curriculum very different from longstanding medical schools of the time.

In 1990 the first two years of the curriculum were revised to incorporate a systems-based style of teaching, so that each body system would be covered in turn. This modified curriculum included the following courses in order:

1. Foundation course
2. Cardiopulmonary course
3. Locomotor course
4. Nervous systems course
5. Endocrine, renal and reproductive systems course
6. Gasto Intestinal and lymphoreticular course.

1.3 Anatomy Education Today

1.3.1 Introduction

The focus of this study is on anatomy education in medical education. In referring to undergraduate study, in 2007 there were 32 medical schools in the UK. All offered a five year course with varying degree titles (Hon MB, BMBS, and BM), 14 medical schools provide a four year graduate entry course and 11 provide a six year foundation course. All but one, the Peninsular Medical School, teach anatomy using human cadaveric specimens in one way or another. Financial and space pressures have meant that some medical schools source their bodies ready processed (embalmed) from other medical schools, for example, St. Georges Hospital Medical School supplies Brighton Medical School. Postgraduate anatomy education is focused within certain specialities (e.g. surgery) and the membership of professional colleges (e.g. The Royal College of Surgeons of England).

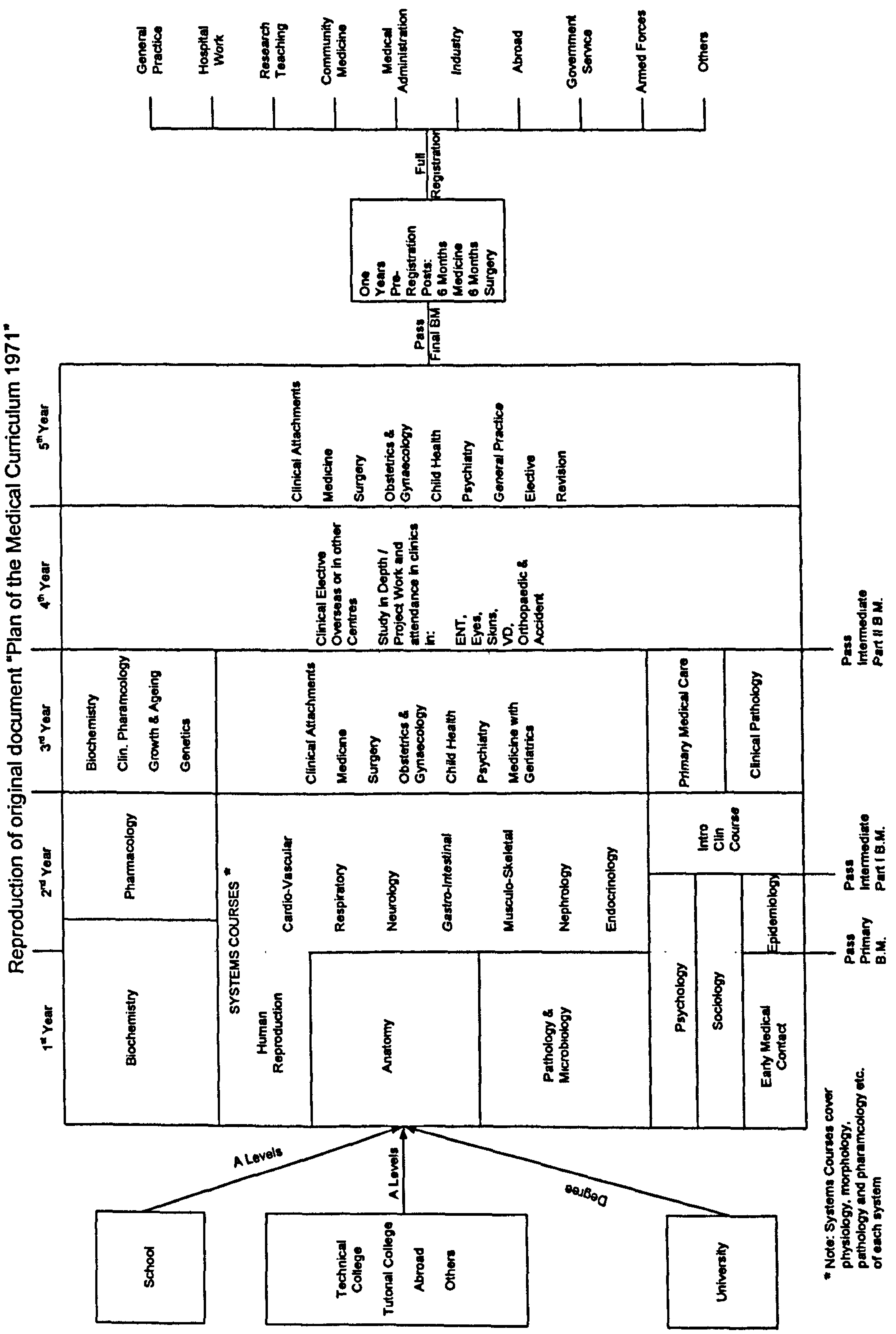


Figure 1. The initial Southampton BM 5 Curriculum in 1971 (Reproduction of original)

Anyone involved in the study, diagnosis and treatment of the human body will at some point study the human form. This includes (not an exhaustive list) dentists, physiotherapists, occupational therapists, radiographers, nurses, podiatrists, forensic anthropologists, sport therapists, chiropractors, osteopaths and paramedics. The level of detail and the emphasis often varies according to profession, but the learning activities remain the same. This study seeks to generalise the findings to all students who learn anatomy and, where relevant, has drawn on literature regarding anatomy education from these professions.

Since the beginning of the 21st century anatomy education has been in the media spotlight for three main reasons: firstly, the retention of organ parts; secondly, for a new medical school opening for the first time without using cadavers; and, thirdly, the public Von Hagen's exhibition and television series. Figure 2 shows an example seen at the public exhibition. These three factors have heightened the public's awareness of anatomy education and together with concern and interest from within the profession have intensified the focus on anatomy education. This section will examine how anatomy is taught today. I first explore anatomy teaching in the curriculum and then the learning activities which students studying anatomy could be engaged in.

1.3.2 Curriculum

Within the traditional medical curriculum each discipline was seen and taught as a separate entity. There has since been a move towards a systems approach in medical education where a body system is studied in turn, e.g. the nervous system. This change was to encourage integration of knowledge from different disciplines, so that the human body was seen as one living system. However, many medical schools (including Southampton) retained traditional topographical elements, because some parts of the body do not fit into a system, for example the regional anatomy of the neck.

More recently some medical schools have moved to problem or case-based curricula. These may be categorised together as they are both focused on

Figure 2. Günter von Hagen's late 20th century plastinated imitation of Valverde's Bartholomew-like écorché. (Moore & Brown 2004)

the outcome of medical education - becoming a doctor. Therefore the training reflects the role and activities of a doctor from the start and to a greater extent is student centred. This means that the emphasis and responsibility for the learning are placed on the student. There is considerable variation into how anatomy is taught within problem or case-based curricular. In some institutions (including the BM 4 course at Southampton), anatomy is taught within a system while at other institutions anatomy is confined to the specific anatomy of the case scenario. In 2002 it was reported that 57% of anatomy curricula in the UK were systems-based (Heylings 2002) with the remaining 43% being half traditional and half problem or case-based.

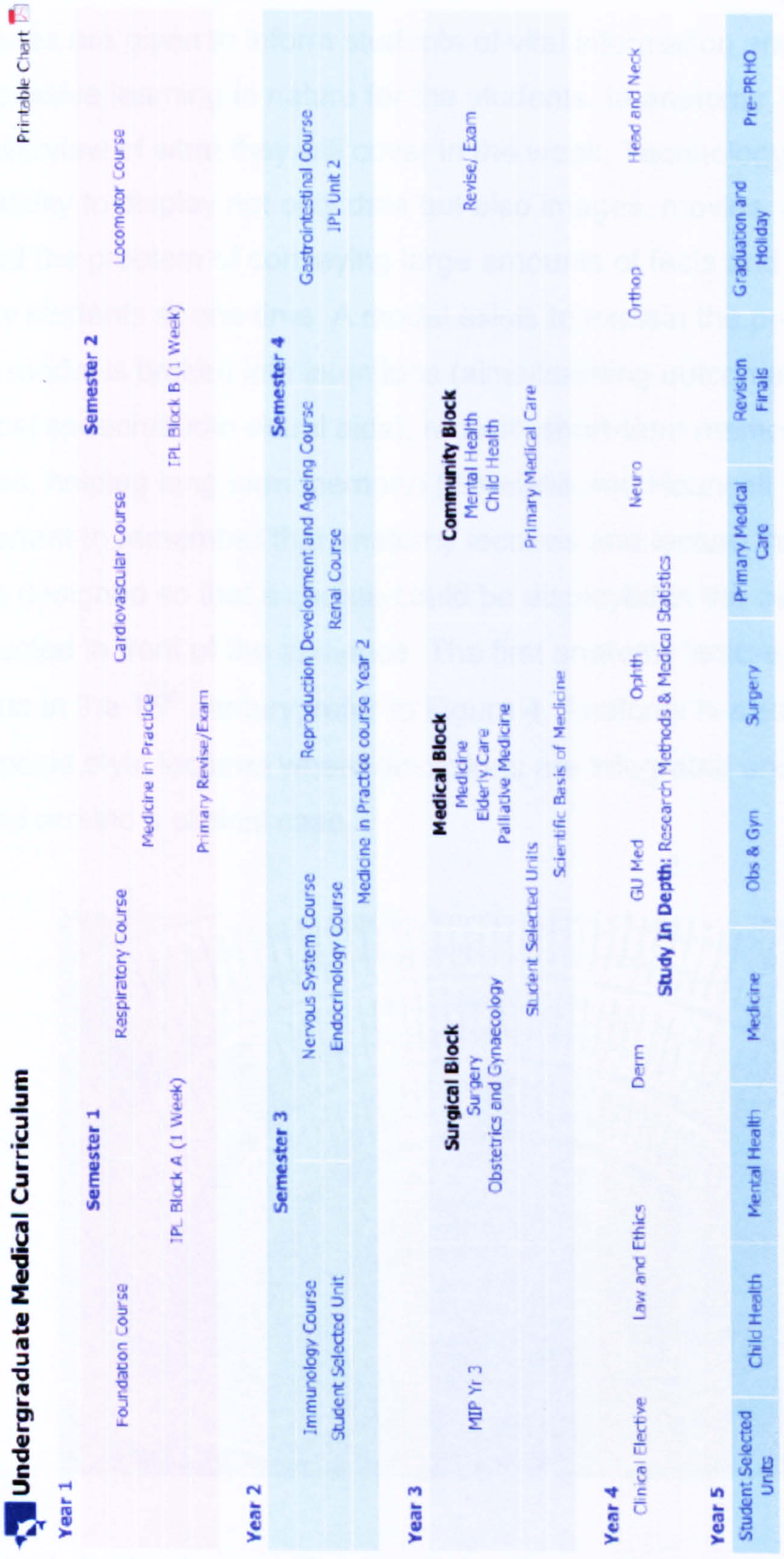
At the time this research took place, the University of Southampton appeared 21st overall in the UK and joint 3rd for medicine in the UK Times Higher ratings (The Times 2005), with Oxford and Cambridge being first and second, respectively. Southampton offers a BM five year course which is systems based and a BM four year course for graduate entry which is case based.

The BM five year course (BM 5) selects a wide range of students, including school-leavers, mature students, graduate students and overseas students. In 2002 the university gained the opportunity to develop a graduate entry course (BM 4) as part of a national agenda to widen access into medicine. The students study systems case-based topics for the first two years and then join the BM 5 course in year 3 and 5. The BM 5 curriculum is detailed in Figure 3.

1.3.3 Learning activities

Anatomy teaching at undergraduate level occurs predominantly within timetabled sessions in the first two years of the course and forms part of the formal curriculum, with teaching taking place in university or hospital premises. This is common in many institutions today, although a spiral approach (where themes and strands are continually evolving as students move through a curriculum) is becoming adopted by more schools with the belief that the amount of, and approach to anatomy changes over the time of the course and that anatomy education in the curriculum should reflect this. Anatomy learning also occurs as self-directed study, as well as parts of anatomy forming the hidden/informal curriculum. No research to date has explored anatomy learning outside of the formal curriculum.

At postgraduate level anatomy teaching is less formalised and occurs in the clinical context. Some postgraduate specialities, for example surgery, have specific training programmes which encompass anatomy. Various teaching methods are utilised in teaching anatomy. These include lectures, practicals, tutorials and Computer Assisted Learning (CAL). In the following paragraphs they will be described in more detail.


Undergraduate Medical Curriculum

Printable Chart

Year 1

Semester 1

Foundation Course

Respiratory Course

Cardiovascular Course

Semester 2

Locomotor Course

IPL Block A (1 Week)

Medicine in Practice

IPL Block B (1 Week)

Primary Revise/Exam

Year 2

Semester 3

Immunology Course

Nervous System Course

Reproduction Development and Ageing Course

Semester 4

Gastrointestinal Course

Student Selected Unit

Endocrinology Course

Renal Course

IPL Unit 2

Medicine in Practice course Year 2

Year 3

MIP Yr 3

Surgical Block
Surgery
Obstetrics and Gynaecology

Medical Block
Medicine
Elderly Care
Palliative Medicine

Community Block
Mental Health
Child Health

Revise/ Exam

Student Selected Units

Primary Medical Care

Scientific Basis of Medicine

Year 4

Clinical Elective

Law and Ethics

Derm

GU Med

Ophth

Neuro

Orthop

Head and Neck

Study In Depth: Research Methods & Medical Statistics

Year 5

Student Selected Units	Child Health	Mental Health	Medicine	Obs & Gyn	Surgery	Primary Medical Care	Revision Finals	Graduation and Holiday	Pre-PRHO

Figure 3.The 2005 curriculum map
(University of Southampton 2006)

1.3.3.1 Lectures

Lectures are given to inform students of vital information and concepts; they are passive learning in nature for the students. In anatomy, lectures are often an overview of what they will cover in the week. Technology in lectures has the ability to display not only data but also images, movies, etc., which have eased the problem of conveying large amounts of facts and concepts to many students at one time. A model exists to explain the process of lecturing. This model is broken into intentions (aims/learning outcomes), transmission (verbal speech/audio visual aids), receipt (short-term memory), and output (notes, helping long term memory) (Entwistle and Hounsell 1975). It is important to remember that anatomy lectures and lecture theatres in history were designed so that a corpse could be displayed in the centre and dissected in front of the audience. The first anatomy lecture theatre was in Padua in the 15th century, refer to Figure 4. Anatomy is also taught in symposia style lectures where disciplines are integrated and the topic is based around a clinical case.

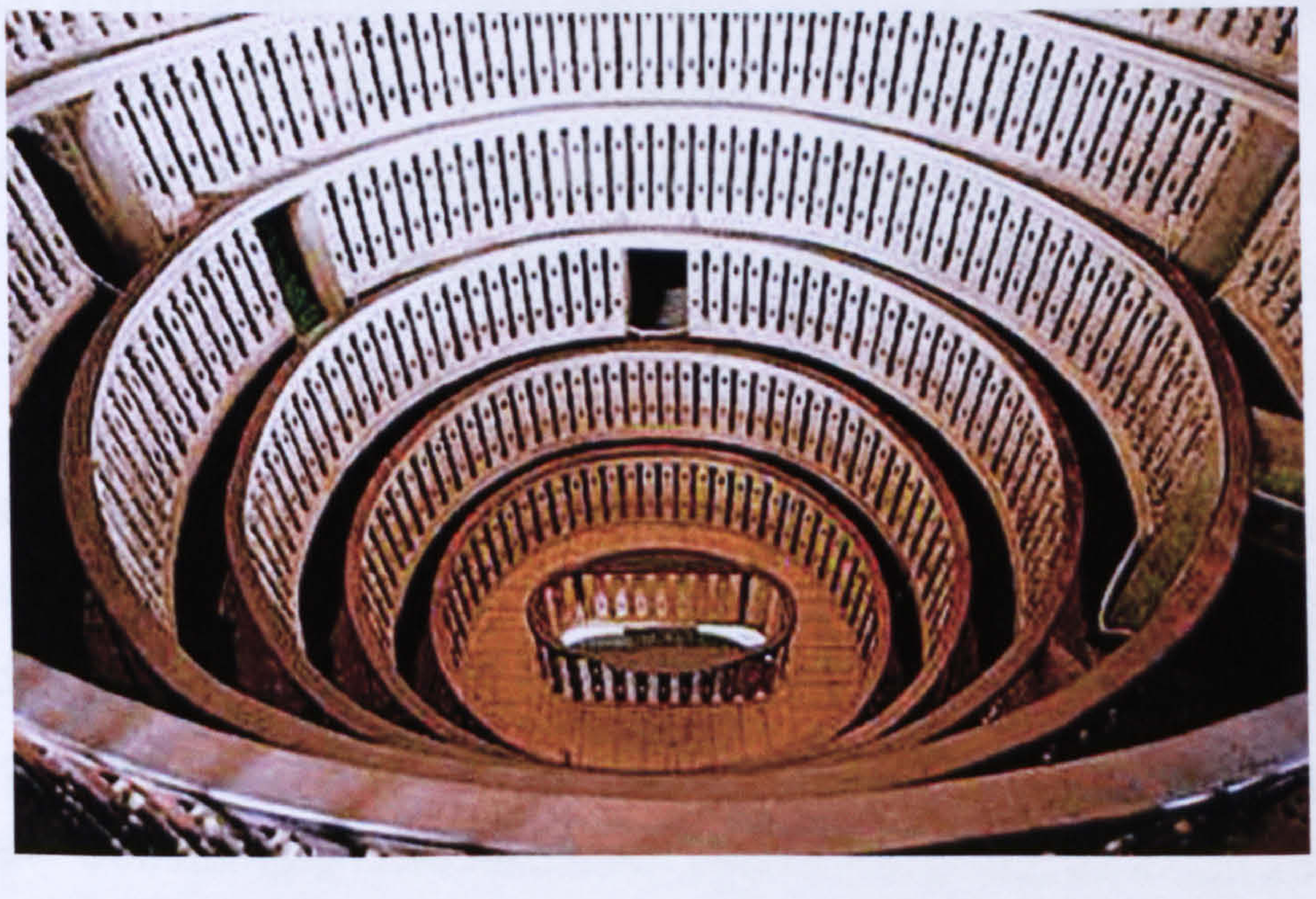


Figure 4. Padua Lecture Theatre (DK Images 2008)

1.3.3.2 Practicals

A practical denotes an area of learning that is 'hands on'. It may be in the form of an experiment, such as recording breath sounds; it may be a demonstration on how to do venepuncture; it may be a set of tasks to complete through a microscope. A practical is generally run with equipment and involves active learning. In anatomy, practicals involve the study of a human cadaver in the Dissecting Room (DR). They occur under the Human Tissue Act and operate under strict Health and Safety guidelines. The aim of practicals is described as:

> 1. To teach manual and observation skills relevant to the subject
> 2. To improve understanding of the methods used within scientific enquiry
> 3. To develop problem solving skills
> 4. To nurture professional attitudes.
>
> (Ramsden 2003)

Student activities in the DR take two main forms: Dissection and Prosection and are described in more detail in Chapter 2.

In anatomy the first stark observation on entering the teaching practical is that by its nature it contains human cadavers, some whole, some in parts, some donated a long time ago, and some recently donated. It is not possible to escape from the fact that these cadavers were people that lived, breathed, laughed and cried like all of us. They actively chose to donate their body for the education of others, a gift that is indescribable and priceless. It is not surprising that it is so important to elucidate how students are learning from this gift.

There has been a decrease in the numbers of cadavers received by anatomy departments, from 670 in 2001 to 600 in 2005 (Department of Health 2006; Macleod 2006). This has partly been due to an increase in the types of cases not being accepted (such as mild dementia) under health and safety guidelines. Southampton has also been part of this trend, although 25-30 donations are accepted each year. At the time of writing Southampton has acquired 712 donated bodies in total.

1.3.3.3 Tutorials or small group teaching

It is understood that teaching in small groups offers many benefits. It seeks to provide a good student-to-teacher ratio in a relaxed but educationally safe environment. Tutorials aim to:

1. The development of communication skills
2. The development of intellectual and professional competencies
3. The personal growth of the students. (Gibbs & Habeshaw 1998)

These aims are very much reflected in the placing of tutorials in anatomy teaching, in particular at Southampton where they allow active participation, face to face contact and purposeful activity. Students in anatomy use tutorials for different reasons; some to seek confirmation and some to further develop their understanding. Students should seek not only to develop academic understanding, but also higher level intellectual skills, such as reasoning, problem solving and the development of attitudes and interpersonal skills, such as listening and speaking.

1.3.3.4 Computer Assisted Leaning

The aim behind CAL is that it should provide a learning environment which permits intensive and relevant engagement with the subject matter. It should be individualised and self-paced, allowing immediate access to large amounts of data. CAL also enables students to test their understanding and provides expert guidance where required (Ramsden 2003). CAL is utilised in anatomy education for a number of reasons. It offers flexibility in learning modalities that may include text, images and videos. Its use in anatomy varies considerably across institutions; some have invested heavily in CAL in terms of finance and time, either through commercial products or by developing in-house products.

1.3.3.5 Assessment

Assessment in anatomy is varied and it is not clear what constitutes assessment in anatomy in UK medical schools. Examples of the assessment methods have been noted (Heylings 2002) but there has been no discussion as to the reasoning behind their use in anatomy. Written questions follow the ideas of medical education as a whole and may be presented in the form of essays, short notes, extended matching questions (EMQ), projects, case reports or multiple choice questions (MCQ), all of which are used as tools to assess the level of knowledge and understanding the student has reached.

Assessments of anatomy practical sessions vary according to the nature of the practical and the assessment of the curriculum as a whole. In anatomy, a 'spotter' examination may be used to assess a student's knowledge. This involves a series of pins placed in specimens where students have a limited period of time to identify the structure or feature (its blood supply, innervations, embryological origin, etc.) and record the answer.

Traditionally, viva or oral examinations have been used in anatomy to assess knowledge and understanding. In traditional courses some students have a weekly viva, however viva have recently come under criticism as they are not anonymous and thus may be biased, resulting in many schools eliminating this assessment tool. The exception is the Royal College of Surgeons whose membership exam has a viva component which contains anatomy.

1.3.3.6 Southampton Medical School anatomy learning activities

Anatomy learning activities in the BM 4 and 5 courses involve lectures, symposia, DR practicals, histology practicals and tutorials, similar to many other UK medical schools and other disciplines that learn anatomy, e.g. dentistry. Lectures in anatomy at the University of Southampton vary and reflect the personality and learning experiences of the lecturer. Some lectures are 'chalk and talk', stemmed from the belief that staff need to impart knowledge to the student. Other lecturers provide an overview or key concepts for discussion, with the belief that the textbooks will provide the details. Others lectures contain clinical context or activities to engage students. What students gain from the lectures does vary but they are an important part of the student's life and learning of anatomy. As an average for a systems course, each student has 20 hours of timetabled anatomy activity with four hours of this dedicated to lecture time.

At Southampton, students participate in practicals in the form of their DR Sessions and Histology practicals, which cover approximately 15 hours per course (approximately 10 and 5 hours, respectively). Year 1 and 2 students work on mainly prosected embalmed specimens with many additional resources, such as body slices, whole cadavers, plastinated specimens,

specimens in pots, bones, imaging and surface anatomy. The style of prosections is not unique to Southampton, however prosections are not used by all medical schools as some place greater emphasis on students dissecting. Students use handbooks to guide them around each table and specimen. For example, an extract taken from the urinary course book:

> A general dissection of the urogenital system is provided for you to examine when you have studied the whole of this class: if you can find and identify the structures detailed below and answer the questions, you are studying at an appropriate level...
> On the prosection study:
> -the kidneys in situ and find the 12th rib. Which muscles are posterior relations of the kidneys? Which nerves lie posterior to the kidneys and what do they supply?
> -the renal vessels and ureters at the renal hilus and trace the ureters to the pelvis
> -the relationships between the bladder, ureters, ducti deferentes, seminal vesicles and prostate. (Smith 2007)

Practicals exist as they are recognised to enhance learning through the active learning of three-dimensional information and touch-mediated perception discussed in Chapter 2. For example, students work on not only identifying structures, but also relationships, blood and nerve supply, fascial arrangement, etc. They also experience texture which gives the learning a real third-dimension. Third and fourth year students can experience a different element to the practical as they dissect areas for their own research projects. The practical DR experience is discussed later in the literature review on anatomy, and this reflects the variety of knowledge, skills and attitudes that can be captured in a single teaching session.

The structure of anatomy tutorials at Southampton varies according to the lecturer: some use the session as a mini lecture, some for peer teaching, some use a Socratic questioning approach, some to revise and some to give new information. They all allow a specific contact point with a member of the anatomy staff and account for approximately three staff-student contact hours of the course. However, students are not receiving teacher-led sessions all of the time and it is important to consider how they learn in their own time. Students receive various tasks which require self-direction, such as reading lecture notes, studying a computer assisted learning package or visiting the library. Southampton, like many other UK medical schools, uses a variety of commercial products available to students in the DR and home grown products that are course and content specific on the university intranet (MEDIS). These include lecture notes, learning packages, test yourself tests and supplementary material. Some medical schools have heavily invested in CAL as either a replacement for human specimens or as an adjunct to teaching.

Assessment of anatomy at Southampton occurs through discipline-integrated MCQ, essays, short notes, in-course assignments and problem solving questions (similar to other medical schools) in end of semester assessments and BM examinations. Specifically, anatomy is assessed at the end of each semester with a spotter examination involving 30/40 spots each with an A and B part. The students have one minute per station.

1.4 Rationale

The rationale driving this research project involves two factors: anatomy learning and the application of anatomy knowledge. Anatomy is unique because students are encountering new words and concepts, as with most subjects, but there is an extra dimension to their learning - the visual, tactile and three-dimensional component. Students have to articulate complex images and visual patterns in their own head in order to truly comprehend the three-dimensional nature of the human form. A component of anatomy learning is the human cadaver and it is not fully understood how learning activities that involve human cadavers enable understanding.

It has been noted that students' knowledge of anatomy is deplorable (Monkhouse 1992) and has resulted in an increase in litigation (Ellis 2002). The underlying cause of why this problem has arisen is unclear, however it is affecting patients. Medical students not only have to acquire anatomy knowledge but they also have to apply it in the clinical context to prevent, diagnose, treat and manage disease. Anatomy knowledge and application are linked and a better understanding of this phenomenon would enable effective training for doctors of the future.

It may be best to start by looking at the end result. The aim of medical education is to produce competent 'undifferentiated' clinical doctors fit to perform Good Medical Practice (General Medical Council 2006). A noteworthy point made by the GMC is:

> We can be certain that the doctors of tomorrow will be applying knowledge and deploying skills which are at present unforeseen. (General Medical Council 1993)

With this in mind anatomy education should not only teach the academic knowledge graduates require, but also the skills graduates require in applying knowledge and communicating. This involves successful lifelong learning, and critical evaluation of new concepts. For example, anatomical language is the basis of medical language that clinicians use to communicate diagnostic details. Thus the learning of anatomy encompasses the anatomical facts and the terminology, but they are useless unless successful communication can occur. In the example of the dissection experience, students also learn skills in handling and using surgical instruments or in the example of dissection and prosections, students can also learn to appreciate the three-dimensional nature of the human form, the anatomical relationships and the feel of structures such as arteries.

There is a general agreement about what medical education should provide as the end result, but there is much controversy as to how best to achieve it. In the case of anatomy, there has been a strong hold on the methods used in the past, being taught the way our forefathers were taught. There has been debate over the best learning activity but a lack of understanding of how anatomy is learnt and applied in practice. The issues within anatomy education have not been explored from a variety of perspectives. We must understand the students' perceptions and learning processes in anatomy and correlate these with educational principles to make a judgement on how best to teach anatomy. There has been little research into how anatomy knowledge is transformed into practice and in the training of medical doctors; this is important.

Neither has there been an in-depth look at the issues in anatomy education from student and staff perspectives and approaches. Hence the first stage of this project is to explore and evaluate these issues and then make comparisons.

It is intended that this study, along with others, will contribute to the development of knowledge and understanding about learning and teaching in the medical curriculum, and that the theory and recommendations arising from this research are used to implement desirable changes and inform future practice.

2 Chapter 2. Literature Review

2.1 Introduction

I used the question 'what are the current research theories and evidence on anatomy education?' to guide the focus of the literature review. I initially performed a web-based search on anatomy education. I used a variety of terms, for example, anatomy education, anatomical education, anatomy learning and anatomy teaching. The relatively little amount of research on learning anatomy resulted in a broadening of the search to include learning in higher education. I used the references in the initial papers to expand the search and then adopted a system of searching for elements under several terms, e.g. learning approaches or approaches to learning. The articles were then retrieved from a variety of sources (University of Southampton library, the internet, interlibrary loan and the British Library). Articles were read and a review was written. The article details were then added to Reference Manager 11^{TM}. Any additional references found in the article were then retrieved and documented in the same format.

The literature searching method adopted occurred continuously throughout the study in order to maintain an up-to-date view of the literature over time. I created overall literature summaries that were used to guide the formation of the research questions and the research focus throughout the study. The production of literature summaries also helped corroborate the literature searching method.

I established key journals and subscribed to them to enable up-to-date and easy access to papers. Papers relating to anatomy education were generally published in the following journals: Journal of Anatomy, Clinical Anatomy, Anatomical Record part A and B (New Anatomist) and Medical Education. Information published in relation to specific areas, for example learning, was drawn from a variety of journals including Academic Medicine, British Journal of Educational Psychology and Higher Education. This study has not been bounded by discipline and integrates many areas to explore anatomy learning in the context of medical education.

2.1.1 Context of the study

The study sought to investigate anatomy education within medical education. The Tomorrow's Doctors report made recommendations to ensure that students acquire the appropriate knowledge, skills and attitudes (General Medical Council 2003). Later the GMC published Good Medical Practice (2007) which set out the principles and values on which good practice is founded. Since the initial report in 1993, literature on medical education has focused on: curriculum, selection, teaching methods, student experience, assessment and postgraduate training.

In exploring the curriculum some researchers have called for changes in the emphasis of the curriculum, for example Fowell & Bligh (2001) echo the shift from faculty-centred to student-centred learning and recognise that assessment drives learning, and that changes need to be made in the curriculum to reflect this. Such calls have been more recently supported by the drive for an outcome-focused curriculum (Newble et al. 2005). Curriculum research based at Southampton comparing the Southampton curriculum with a Problem-Based Learning (PBL) curriculum not in the UK examined students' motivations and approaches to learning. The results showed that students at Southampton, at entry, did not seek to reproduce information but did so later on in the course (Coles 1985a). These results reflect not only the curriculum at Southampton at the time but also the education students had experienced previously. It was shown that the approaches of students varied across the years at Southampton but were stable in the PBL course. Students in the third year at Southampton showed a shift towards a deep approach to that similar on the PBL course. The study referred to the curriculum in general, although Coles' thesis provides some varied comments from students about anatomy, including:

> I enjoy anatomy.
> All I could remember about anatomy is hours in the DR.
> I suppose my total for the week would be about 10 hours.

> In the evening I'd read Snell, I'd read chunks of it and try to repeat it to myself.
> Anatomy was overwhelming. (Coles 1985b)

Such comments reflect the perception of anatomy at the time and this is reflected in the literature from this time on anatomy education. I was interested to see if these results and perceptions would emerge in this study, some twenty years later.

I explored literature on other disciplines within medical education as several disciplines share common elements with anatomy. Pathology is a close relation to anatomy in that the teaching of pathology to medical students traditionally occurred through autopsies, and therefore forms the only other point at which students are faced with a corpse. Burton (2003) discussed the effects of the GMC's recommendations and concluded that while autopsy teaching was declining, it remained having a multifactorial role in providing students with knowledge and attitudes for practice in the 21st century.

Other professionals, e.g. physiotherapists, also learn anatomy and I explored the literature to see if any professional group had explored learning anatomy in a different context. Frequently students studying for other professions are taught anatomy in the same way as medical students. It is however important to elucidate if the issues described in the literature on anatomy are specific to anatomy as a discipline or to anatomy as part of a medical curriculum. Exploring work produced from different professional groups confirmed that the majority of issues are part of the discipline rather than being institution-specific.

The majority of literature on anatomy education and other professions reflects the focus of debate over the use of prosection or dissection as a better learning activity. With physiotherapists in mind it was stated that dissection was "a slow and tedious way of teaching and learning" (Alexander 1970). Further studies explored the recall of anatomy knowledge, showing no difference when physiotherapy students were offered a dissection course, a computer course or both (Bukowski 2002). Other research reports that the single most recommended teaching method for an anatomy course was by dissection (Latman & Lanier 2001). Differences between professions will place different emphasis on various parts of the learning content, relevance and approach. Some institutions used foundation programmes where anatomy is taught to a range of students from different professions (Mitchell & McCrorie 2004). Links can be drawn between dental and medical education, for example research exploring dental anatomy education has explored web based anatomy tutorials, reflecting that students who completed the tutorials adopted a deep approach to learning (Durham 2005).

2.2 Anatomy Education

Having reviewed the history of anatomy and the Southampton curriculum (section 1.2 & 1.3), I explore in depth the literature on anatomy education. A large amount of the literature on anatomy education explores the history, issues and the debate over which method, prosection or dissection, is considered to be better. Understanding the issues within the discipline as a whole is important in enabling understanding of the parts and processes of anatomy learning as they are related. I therefore first explore the issues in anatomy education followed by the experiences and teaching activities of the DR.

2.2.1 Issues in anatomy education

I have categorised issues in anatomy education into the following: the anatomy department and anatomy in the medical curriculum. The issues affect the student learning experience and are influenced by political, managerial or other strategic decisions.

2.2.1.1 Anatomy department

Anatomists have had notoriety in history but now have a varied role in teaching, research and curriculum management. The literature reflects concern over the ability to recruit anatomists (Cahill & Leonard 1999; Dyer & Thorndike 2000). This has resulted in a "greying anatomy faculty" (Topp 2004), with some departments hiring anatomists without training or experience (Cottam 1999). Anatomists are also retiring and not being replaced (Dyer & Thorndike 2000). However, it has been reported that clinicians have moved into the anatomists' domain, as they seek new experiences and want to help develop the doctors of the future (Colgan & Anderson 2002). Anatomists have been described under two headings, traditionalist and modernist (Patel & Moxham 2006). However, these descriptions are not substantiated with criteria and do little to understand the real composition of anatomists in the United Kingdom (Smith 2006). Anatomy as a profession, how it is perceived and where its future lies is governed to an extent by the composition and beliefs of anatomists today. Therefore when considering the student experience the composition and views of the anatomy faculty must also be explored.

Some anatomy departments have posts referred to as demonstratorships. These limited academic posts, which may be full or part time, have been filled by qualified doctors training for surgical specialities. These posts offer the individual time to learn/relearn anatomy and confirm this knowledge through teaching. These individuals provide students with personal contact with someone who has experienced medical school and the clinical setting (Hanna & Tang 2005). Nonetheless, issues with the quality of dissecting, teaching and knowledge have varied, and the expense and changes to the Royal College of Surgeons Exams resulted in a decline of demonstrator posts (Lockwood & Roberts 2007). The educational value of such posts has received support from students, staff and representing bodies (Lockwood & Roberts 2007; White, Edmonds & Fraser 2007), including the Royal College of Surgeons, to reinstate demonstratorships (Royal College of Surgeons of England 2007).

Anatomy departments have a varied role reflected by their titles: Anatomy, Anatomy and Cell Biology, Anatomy and Reproductive Biology, Neurobiology and Anatomy to name but a few (Carlson 1999).They are also expensive - "There is no doubt that today dissecting room teaching is unpopular with our masters, the university administrators" (Ellis 2001). Justification and expense go hand in hand, so it is not surprising that over time anatomy departments have had to justify themselves. This is best stated by Jones:

> It is incumbent on anatomists to draw up a balance sheet between the economic costs (of dissection) and the academic benefits stemming from it. (Jones 1997)

This is the case regardless of which teaching method is preferred. However, with such little evidence in support of each teaching method it is surprising that anatomy departments are funded at all, and this reflects the need for evidence on how students learn anatomy. Literature relating to the comparative costs of dissection , prosection and computer-based learning have reflected that in converting from a dissection course the set up cost for a computer-based course is around £320k and for a prosection course around £190k, but that maintenance costs would increase 90% for a prosection course but only 3% for a computer-based course (Pratten 2007).

2.2.1.2 Anatomy in the medical curriculum

As already described there are a variety of medical curricula in the UK and around the world. However, three main types emerge: traditional, system and problem based. The types of curricula have a preference for particular forms of anatomy teaching. For example, a traditional curriculum is associated with dissection (Nnodim 1997).

Curricular time devoted to anatomy has been significantly reduced (Holla et al. 1999; Paalman 2000). This is thought to be the result of increasing the breadth of the curriculum (Hanna & Tang 2005). The reduction has been seen as detrimental, "Anatomy may be falling but it's not supine yet" (Sritharan 2005). The reduction in time has had an impact on the teaching methods adopted. In many cases laboratory time, in particular dissection time, was removed. Faculties felt that the reduction in time needed to be addressed - "reduced dissection lab time must be supplemented with CAL programmes" (Paalman 2000). Despite suggestions, for example 300 hours (Fitzgerald 1992), there is no known optimal time that should be devoted to anatomy, and every university has its own time allocation. Some surveys have tried to quantify the decrease in time in relation to knowledge. For example, in 1998 students' results were compared between a traditional course with 384 anatomy hours to a systems course with 183 hours. The results showed that students in the systems course performed worse (McKeown et al. 2003). Anatomy needs to be reasonably represented in terms of curricular time but surely the quality of the learning experience is more important than the hours devoted to it?

As time for anatomy within the curriculum has been reduced, the learning outcomes have been adjusted, reducing the content. Reduction in content was compounded by pruning as a result of the GMC recommendations (General Medical Council 2003) but some authors have felt this has left a black hole which has been referred to as ADD (Anatomy Deficit Disorder) (Reidenberg & Laitman 2002). The Anatomical Societies of Great Britain and Ireland developed a core curriculum (Dyball et al. 2003) to determine the level of knowledge students should master. Clinicians and trainees themselves acknowledged that they had a lack of knowledge, and this lack of knowledge has been shown to be a factor in the rise of malpractice (Ellis 2002; Older 2006). In a survey which questioned 162 clinicians, 61% said students' knowledge was inadequate (Waterston & Stewart 2005). A study using different panels to judge items on an anatomy test of fourth year students found that by the panel's standards 64% of students would have failed the test, reflecting that many students did not know enough anatomy (Prince et al. 2005). Another study found from 156 senior medical students that only 33% felt their knowledge was safe for clinical practice (Blyth & Insull 2006). It is unknown if graduates of Southampton feel the same. It is difficult to quantify what level of knowledge would be considered safe for clinical practice. However, the recognition of the problem has led to the attitude "lack of knowledge is no longer the trainee's fault" (Ramsey 2005).

2.2.2 Experiences and learning activities in the Dissecting Room

The dissecting room, or DR as it is more commonly known, has been described as adopting this faceless abbreviation (Francis & Lewis 2001) and is predominantly the focal point of anatomy learning activities. Encompassed in learning anatomy is the language of medicine. Anatomical terminology is the basis and in many ways the entirety of the language of medicine.

Anatomical language is used to: (1) locate, (2) name, (3) describe, (4) classify, (5) conceptualize, and (6) relate structures (FICAT 1999). It is also necessary to describe the deviation from the norm in terms of pathology, and to measure the effectiveness of treatment (Aziz et al. 2002). It has been estimated that students learn approximately 10,000 new terms in their first year (Cahill & Dalley 1990). The need to become proficient in a new language quickly presents an area of difficulty for first year medical students (Zucconi, Guelfguant & Solounias 2002). The grasping of this new language enables understanding and unambiguous communication. It remains to be explored how students perceive the learning of anatomy language and what approach they adopt to do so.

The human body is not universally the same and understanding anatomical variation is part of understanding the human form. Anatomical variation is described as follows:

> In anatomy, normality embraces a range of morphologies and includes those that are most common and others called variations which are less frequent but not considered abnormal. (Willan & Humpherson 1999)

Anatomical variation is seen in the DR as students experience many specimens and are therefore exposed to natural variability (Hanna & Freeston 2002; Zucconi, Guelfguant & Solounias 2002). Such variation is best demonstrated through prosections (Topp 2004). Variation ranges from subtle to remarkable and encompasses variations due to embryology, age changes, lifestyle and disease. Variability is often removed from most textbooks as they concentrate on the 'norm'. This leads to a potentially dangerous situation that if students are not somehow exposed to the reality of the existence of natural variation they potentially put patients at risk; at a low level wasting money by ordering unnecessary tests and at the extreme causing the death of a patient (misdiagnosis and malpractice).

In exploring learning in the DR it is possible to divide the literature into two main facets: the emotional experience and the learning activities.

2.2.2.1 Emotional experience

The harsh reality of the dissecting room is death. This point is echoed in the literature in that the first patient students see is dead (Aziz et al. 2002; Bourguet, Whitter & Taslitz 1997; Coulehan et al. 1995). The cadaver presents a patient who has experienced life and death (Aziz & Mckenzie 1999). This factor forces students to confront the issue of death and it is unanimously understood that:

> Students' confrontation with a cadaver triggers different emotional reactions. (Arraez-Aybar, Casado-Morales & Castano-Collado 2004)

The student's previous experiences have to be taken into account before it is possible to comprehend the effects of the anatomy cadaver on the student, and their experiences of medical education. It has been proposed that students experience the dissecting room from either a non-personal (biological) point of view or a personal (emotionally involved) point of view (Dyer & Thorndike 2000). The majority of research has focused on the detrimental effect of stress caused by this experience, as described by Evans and Fitzgibbon:

> Cause of stress is from the mechanics of touching, cutting and in effect mutilating dead human bodies, but also because of the emotional and philosophical questions provoked. (Evans & Fitzgibbon 1992)

The element of stress is important to explore as it may affect the quality of student learning and "it is important that learning is minimally impaired" (Druce & Johnson 1994). Common detrimental effects include fears and dreams. It has been reported that 46% of students reported varying fears on entering the dissection room. The most frequent fear (38%) being the reoccurrence of visual images (Abu-Hijleh et al. 1997). Also reported is that 91% of students thought that the dissecting room had a horrible smell and that 62% had a fear of contracting a disease or infection (Abu-Hijleh et al. 1997). This last fact may be a result of the date of the paper, lack of knowledge of the transmission of certain diseases, e.g. HIV, and the effectiveness of the embalming chemicals. Abu-Hijelh et. al's results are supported by Arraez-Aybar, Casado-Morales & Castano-Collado (2004) but Arraez-Aybar et al. also reported that anxiety dropped off by the third practical session. If anxiety and fear quickly disappear is the experience detrimental at all?

Some students reported that the exposure to the DR caused disturbing dreams, for example:

> In another dream, he was dissecting his own body and had replaced his phrenic nerve with dental floss. He repeatedly described seeing through the face of a pretty woman to her bones and muscles underneath. (Finkelstein & Mathers 1990)

This degree of trauma caused Finklestein and Mathers to suggest that the stress students are experiencing is similar to post-traumatic stress (Finkelstein & Mathers 1990). Helping students deal and cope with these stresses is important. This was first reflected by Penney, whose results showed that 64% of students felt unprepared for the experience (Penny 1985).

The results of more recent studies, particularly in the UK, suggest that experiences and attitudes have changed, focusing on the positive effects of the dissecting room. Students view the DR as an exciting experience with only 2% showing high stress levels (McGarvey et al. 2001) and that the experience is largely positive (O'Carrol et al. 2002). More useful than producing percentages of stressed students is what can be done to help students. Coping has been described as important for future practice:

> Anatomy lab may be compared to subsequent clinical encounters because it asks that a student concentrate on data collection and simultaneously deal with disturbing thoughts and feeling. (Finkelstein & Mathers 1990)

It has been suggested that anatomy education has a role to play in preparing students for death in the clinical context (Tschernig, Schlaud & Pabst 2000). It was proposed that students formulate basic rules for behaviours and attitudes towards patients from their experiences of the dissecting room (Gustavson 1988). Practical help in the form of a lecture based on the corpse before seeing it was found to be helpful by 72% of students (Tschernig, Schlaud & Pabst 2000). This is supported by another study allowing a preliminary visit to the DR (Heyns 2007).

The longer term aspect is to understand more about the experiences and consider factors which support students in the design of the course or setting. The only study to address the emotional impact in a more qualitative way asked 29 students at a traditional style medical school about their experiences by using one to one interviews. The majority of students found dissection fascinating and were more scared of fainting than actually seeing a dead body (Lempp 2005).

Humanistic values and the dissecting room have been explored as the DR offers the opportunity for many values to be considered and developed, for example inter-professional respect, responsibility, confidentiality, self-policing and interpersonal skills (Pawlina & Lachman 2004). The concept of detachment concern and the DR has also been explored (Dickinson et al. 1997). More recently, detachment concern has been described as a process, that as the cadaver loses its divine proportions, so the student progressively denies its former humanity until it becomes a 'thing' (Francis & Lewis 2001). This is very true when first confronted with a whole cadaver as it is very real and causes thoughts of death. However, getting out a cubital fossa is getting out a 'thing'; there are no associations with it. These reports all show the experience has had an effect on the student in transforming them as a person.

2.2.2.2 Learning activities

The two main types of learning activities in the DR, dissection and prosection, have attracted the majority of published papers in anatomy education and is a debate fuelled by many factors involving external confinements and personal beliefs. The crux of the debate is whether to dissect or not. In 1957 the GMC changed their guidelines so that medical schools could choose either not to dissect the whole body or not to dissect at all and hence the debate began (Utting & Willan 1995). It might be presumed that concluding this debate would be a clear case of weighing up the pros and cons, but this debate is entangled in personal beliefs, history and politics and has been for many years. This has led to many papers being published but few containing any evidence as reflected in the quote below:

> In general, academics are unable to produce hard facts about the value of the dissected body in medical education. (Parker 2002)

I will explore the literature related to each learning activity. Many literature pieces refer the reader to the place of dissection in history, for example:

> Dissection of the dead human body has been central to medical education since the renaissance. (Parker 2002)
> Time honoured, dating back to the renaissance. (Nnodim 1990)
> So after five centuries, in which human dissection has been used as a teaching method, is it now to be lightly abandoned? (Ellis 2001)
> The time honoured method of discovery. (Cahill 2000)
> The experience of dissection connects the contemporary student with his/her ancestors. (Aziz & Mckenzie 1999)

There is an underlying tone in most of these papers conveying 'how dare you question this time honoured tradition and have respect for it', for example:

> Are we wrong in feeling that the study of anatomy by dissection should be an obligation for the future generations of physicians, just as it has been in what we may call the enlightened past? Should it not demand our awe and respect? (Cahill, Leonard & Weiglein 2002)

This is obviously a sensitive subject and many do respect it. The respect is there but would it not gain more respect if its process as a teaching method was better understood?

This time honoured method also has a hidden prestige about it, and thus there is an element of prejudice affecting other methods that are often considered inferior. This might perhaps come from the notion that anyone could observe a public dissection, but only the experienced can dissect! There is also an amount of perceived medical secrecy (Lempp 2005) about dissection, thus giving it the enigma that only those in the secret medical profession perform it. Also encompassed in this is the notion of ritual transformation that occurs through the process of dissection (Dickinson et al. 1997; Lempp 2005) and that it is the most universally recognised step in becoming a doctor (Dyer & Thorndike 2000). This may have arisen as dissection was a defining point between the lay person and the medical practitioner. However, in today's medical world there are many defining factors and this is not necessarily the case.

Support for dissection is common and Cahill & Dalley (1990) state that students who dissect do better, but today we know that other research has shown this not to be the case:

> Many anatomists are adamant that dissection is the best way to learn anatomy, although there is little hard evidence for this. In fact many studies have shown medical students who learn anatomy by prosection and audiovisuals perform just as well in anatomy examinations as those who learn by dissection. (Parker 2002)

Some studies have rated dissection from the student perspective. In one study students rated dissection 2.1 on a scale of 1-5 (indicating 'essential' to 'waste of time', respectively), suggesting the presence of some doubt about its effectiveness and yet registering an understanding of its importance (Dinsmore, Daugherty & Zeitz 1999). Pawlina and Lachman argued that denying a medical student the privilege to dissect is undeserved (Pawlina & Lachman 2004). Thus it may not be giving them education, just a privilege. The idea of obligation is supported by Cahill et al:

> Medical students have a moral obligation to study anatomy by dissection; anything less is of questionable educational merit and may ultimately undermine the trusting relationship of future patients. (Cahill & Leonard 1997)

However, others have questioned whether such arguments are supported by any real evidence as to the educational benefit:

> The education benefits of cadaver dissection, even its indispensability, are almost universally agreed upon by faculties in anatomy and in a number of clinical disciplines. Yet it is difficult to find objective evidence of the educational benefits of cadaver dissection. (Rosse 1995)

From anatomists' perspectives (119 from Europe and 35 from the UK), 69% said they favoured the use of dissection of human cadavers over other methods (Patel & Moxham 2006). This conclusion may, however, be flawed because the representation of the population questioned is not revealed in the publication. It is also not shown how the respondents taught and their experience with all methods mentioned. Winklemann reviewed the evidence on dissection and dating from 1965 found 14 papers which were classed as truly experimental and criticised various pitfalls of those cases (Winklemann

2007).This paper really emphasises the point of a lack of evidence to back up many of the comments in the debate.

I dissected as an undergraduate and further worked as a prosector. To immerse myself within the context of the debate I carried out a dissection with the aim of concentrating on and documenting the process, rather than the anatomy. I choose the foot as an area I am least familiar with to simulate how a student would feel with limited knowledge. I documented the process and after 45 minutes of dissection a window had been made in the sole of the foot. The first and second layer of muscles had been displayed and reflected (see Figure 7). The process is well summed up by Cahill and Dalley in that dissection is a continuum or a progressive sequence of changing events as the dissection moves plane (Cahill & Dalley 1990). I made recordings of the process, for example, "I have cut a muscle fibre so it means I must work more superficial and pick through the fat and facia". The series of photos in Figures 5-7 illustrate the process.

Figure 5. The foot prior to dissection

Figure 6. The window made in the skin

Figure 7. The dissected muscle

As shown in the dissection I used fine motor skills to manoeuvre instruments. The ability of students to use instruments has been debated. The acquisition of surgical skills is a later part of postgraduate training and clinical skills courses deal with those skills that need to be mastered at undergraduate level. However, researchers have argued that manual dexterity skills are important aims in anatomy teaching (Ellis 2001) and that dissection is important in allowing students to develop respect for surgical instruments (Monkhouse 1992; Mutyala & Cahill 1996; Newell 1995). From the dissection I confirmed that the experience was heavily reliant on manual skills. These skills made the dissection successful and quick but are very much related to the cadaver. A doctor would not grasp a chunk of skin and pull in one hand, whilst a scalpel runs point and back, point and back on a real patient. Such experience may heighten students' clinical skills in general, but it is best left to the clinical skills and surgical departments to correctly teach students these techniques. There is an obvious benefit to dissection for students that are interested in surgery.

An interesting issue for dissection is raised by Jones (1997) and concerns students that do their best to bypass dissection: so how many are there and are they deficient in anatomical knowledge? This is an important consideration in institutions that only provide dissection, especially as most of higher education teaching is non-compulsory. The suggestion that many students do their best to bypass dissection highlights that for some students the experience, environment and/or method of teaching is not working. My personal experience is that in some cases only one student (in a group of 10) is actually dissecting. Other students may be engaged in the task but some students are left out and remove themselves from dissection practicals.

Prosection by its nature implies that specimens have been professionally prepared to show various structures. Prosected specimens can be used again and again as they are not destroyed by the dissecting process. For example at Southampton a prosection from Cadaver no. 99 donated in the late 1970s has been used for over 30 years in the pelvic/reproductive teaching, enabling the study of this region for over 4,000 students.

It has been suggested that dissections could be replaced by simple prosections (McWhorter & Forester 2004). A study of 546 students revealed that 64% of students found prosections helpful, compared to 55% of students that found dissection helpful. However, when asked if they would like to completely replace dissection with prosection, 86.7% said no. So while students preferred prosection, they did not want to lose the dissection part, but why? What is it offering to them? (Leong 1999). Supporting that students preferred prosection a study showed that 60.5% of students preferred prosection as a method after being exposed to both styles (Dinsmore, Daugherty & Zeitz 1999). In comparing examination results the prosection group performed better (Nnodim 1990). Nnodim revisited these students five years later for a true or false spotter and oral exam. The results showed that students who studied using prosections performed better on the oral examination and were guessing less in the spotter, thus supporting the notion that prosection is not only more superior in the immediate but also in the longer goals of medical education (Nnodim, Ohanaka & Osuji 1996). What is it about prosections that aids learning? Miller suggests that it is related to how students learn spatial relationships and that in terms of gestalt principles the basic patterns of collinearity and symmetry are remembered, thus prosection is better as many of the unimportant bits have been taken away leaving a clearer picture (Miller 2000).

These studies suggest that prosection is an effective learning tool and can reduce the time required to complete a course. In the same way as I carried out a dissection I explored several prosected feet and documented the process (Figures 8-12). I explored the prosections, each having been prosected to varying anatomical levels. The prosections were easy to manipulate and the skin and fascia had been removed so it was possible to look directly at the muscles. It was possible to feel the specimens and pull the tendons to see which parts were moving. The following quote is from the transcript of my audio recording:

> After finding flexor digitorium longus and brevis I swap specimens and look for the same things, I find them, but this specimen allows me to reflect these muscles to see the lumbricals. Excitedly I can see nerves and blood vessels which I refer back to the handbook to identify. I go to another specimen which has been dissected to show the blood supply in more detail. I have not used any instruments and I have very quickly got down to the small detail of the foot muscles.

Studying the prosections took a lot less time than dissection (about a quarter) and I felt that I had learnt and seen more. However, I did not feel a bond with the specimen and I had not gained an understanding of the fascia but I felt that the learning had been more complete.

The process of learning from prosections does remove by its nature certain components of anatomy, e.g. the superficial facia and associated vessels and nerves (Nnodim 1990). However, it remains unclear as to the clinical relevance of this or how it affects students' learning. These structures are important to surgical specialists where specialist training would explore them.

A potential downfall of a study which showed that students preferred prosection (Leong 1999) was in the description of what students were doing with prosections. They were being used to demonstrate on; hence a potentially active learning setting was turned into a passive one. This might have been why the students preferred it, but also wanted an element of dissection to remain.

Prosection has been described as an educational 'half way house' (Jones 1997). Statements like this reflect the possible lack of understanding of the real process of prosection and dissection as again they are not supported by any evidence and only act to oppose the other notion.

Figure 8. Selection of prosected specimens

Figure 9. Detail of prosection 1

Figure 10. Detail of prosection 2

Figure 11. Detail of prosection 3

Figure 12. High definition of prosection 4

It has been documented that with the decrease in the number of hours allotted to anatomy many schools have gone from a full body dissection to only specific regions being dissected, the rest of the study involving varying amounts of prosections (Arroyo-Jimenez et al. 2005; Dinsmore, Daugherty & Zeitz 1999). This type of approach appears to be very flexible, allowing students to experience more, but such a multi-method approach still requires the evidence and understanding of each method so that they can be more effectively utilised for students' learning.

Interestingly, while authors have argued that prosection is better than dissection only one author has argued for the total abandonment of cadavers

(McLachlan et al. 2004). This decision is important because it is seen as controversial but as the first student cohort had not yet graduated it is not possible to explore the outcomes. Table 1 summarises from the literature the pros and cons associated with the dissection-prosection debate.

Element	Dissection	Prosection
Appreciation of three-dimensional form	Yes	Yes
Variant anatomy	Yes	Yes to a greater extent
Hands on (touch-mediated perception)	Yes to a greater extent	Yes
Anatomical vocabulary	Yes	Yes
Development of fine motor skills	Yes	No
Patterns and form are not immediately apparent	No	Yes
Develop problem solving skills	Yes	No
Time consuming	Yes	No
Sense of discovery	Yes to a greater extent	Yes
Good at showing small detail of nerves etc	No	Yes
Material can be reused	No	Yes
Public expects it	Yes	No
Shortage of cadavers. High student: cadaver ratio	Yes	No
Anxiety and emotional disturbance	Possible to a greater extent	Possible
Staff intensive	Yes	Yes

Table 1. Elements associated with prosection and dissection

Apart from dissection and prosection other methods offer students the opportunity to examine the human form. These include: plastination, museums, computer-assisted learning, imaging and living anatomy. Each will be briefly discussed.

Plastination involves fixed specimens and was thrust into the public eye by Dr. Gunther von Hagen's exhibition "Body Worlds" in 2000. However, plastination first arrived in 1977 and hence has been used in anatomy teaching for many years. Plastination may offer educational benefits in the ways in which textbooks and computers may not (Cohn 2002). Plastinated specimens in particular serve an important role at Southampton in demonstrating structures easily damaged or delicate, thus many students can appreciate them without wasting cadaveric material. They are also used to preserve specimens which show anatomical variation so that many students can benefit from them.

While many medical schools have anatomy museums or anatomy/pathology museums, they are rarely discussed in the literature, except for the use of learning activities devised around stations in museums (Ganguly et al. 2003).

The advancement of technologies in the world has undoubtedly had its effect on learning anatomy in the 21st Century. It has been argued that anatomy, out of all biomedical science disciplines, is likely to benefit the most (Rosse 1995). This idea is linked to the belief that computers can aid students in understanding the three-dimensional nature of the body. However, computers could not replace the spatial awareness gained from exploring a human cadaver. One major advantage of e-learning and CAL is that it is not limited to the laboratory and may be accessed from anywhere at any time, giving students greater freedom in their learning (Nieder & Nagy 2002). Web usage has also been correlated to examination success (Rizzolo, Aden & Stewart 2002). This is an important feature of e-learning and CAL in that it is not restricted to common time constraints and students can use it when it suits their learning. The downside of commercial CAL has been explored in that the content may not match the curriculum (Van Sint Jan et al. 2003).

Imaging technologies have advanced substantially in recent years, with availability increasing and cost decreasing. This leads to a viable adjunct for anatomy teaching; after all it is the way many clinicians see the human form. It has been suggested that the increase in the use of PET, MRI, CT, etc., has acted to reduce the amount of rote memorisation and the use of dissection (Aziz et al. 2002). Studies that have investigated student ability in imaging anatomy have shown that students perform better when imaging anatomy is linked to sectional anatomy on plastinated specimens (Barros et al. 2001). The importance of student exposure to radiological anatomy is best written as "It prepares them for clinical years" (Reidy et al. 1978) and enables them to view the human form from a different perspective. This is important, as doctors in practice are using their anatomical knowledge every time they examine an X-ray. Studies have shown that the teaching of radiology varies across UK medical schools (Mitchell & Williams 2002).

Living anatomy has been part of anatomy education since its beginnings. It is how the physician will first see the patient prior to any investigations and a great deal can be established from examining living anatomy. It prepares students for dealing with the physical signs of abnormality (Rosse 1978). It has been stated that Pre Registration House Officers (PRHO) encounter anatomy in two modalities, living and imaging (McLachlan et al. 2004a). Transferring the understanding of anatomy gained from the dissected cadaver to the living body remains a challenge (Rosse 1995).

From the literature presented two main conclusions can be drawn. The first is that the prosection/dissection debate is not comparing like with like and many studies have failed to address this. The second conclusion is that the actual learning process and perceptions of anatomy from the student's point of view have often failed to be recognised. A limited amount is therefore known about the process and abilities involved in learning anatomy and the approaches students utilise.

2.3 Learning

With limited research on learning anatomy to draw on I explored the literature on learning theories, particularly in the higher education setting. Generic information on learning and teaching in higher education can be found in books such as "Teaching for Quality Learning at University" (Biggs 2003), "Understanding Learning and Teaching" (Prosser & Trigwell 1999) and "Rethinking University Teaching" (Laurillard 2002). A main theory on learning, phenomenography, developed by Marton based on work with others, is where the learner's perspective defines what is learned (Biggs 2003). This study relates to the phenomenography theory, because for anatomy it is the doing (perceptions and approaches) that creates the knowledge and the ability to use it. The study draws deeply however on one learning concept - 'Approaches to Learning'.

In higher education the aim of learning is generally described as the development of understanding. But what is understanding? I interpret understanding in the context of this study as the bringing together of all the pieces of knowledge to form one in a way that can be addressed from any angle. Cohesion of facts occurs and there are active links with their meaning and relationships. The SOLO taxonomy (Structure of the Observed Learning Outcomes) provides a way of describing the learner's understanding (Biggs 2003). Five levels determine the level of complexity of a task (Prestructural, Unistructural, Multistructural, Relational and Extended abstract). Knowledge is the object of understanding and involves propositional, functional, procedural and conditional knowledge (Biggs 2003).

In the next sections I examine broadly the notion of approach to learning, adopting an approach and influences that affect approaches to learning. I then focus on specific case studies and refine what is already understood about learning anatomy.

2.3.1 Approach to learning

An approach can be defined as a way of dealing with something. An approach to learning is dealing with the learning process or how an individual is going about their learning. As with many things, an approach denotes that there is more than one and Approaches to Learning Inventories (ASI) have been developed to classify and conceptualise an individual's approach to learning. This is based on the early work of Marton & Saljo (1976), who distinguished between the 'deep' and 'surface' approaches as they are commonly described. Fransson (1977) demonstrated that the approach taken by a learner was dependent on perceived relevance and anxiety. The relevance and importance of learning approaches are described as:

> The approach students adopt appears to be an important factor in determining both the quantity and quality of their learning. (Newble & Entwistle 1986)

Around the same time as Marton and Saljo were working on approaches to learning, Biggs published the 3P (Presage-Process-Product) model illustrating learning approaches (refer to Figure 13 redrawn from Biggs (2003)).

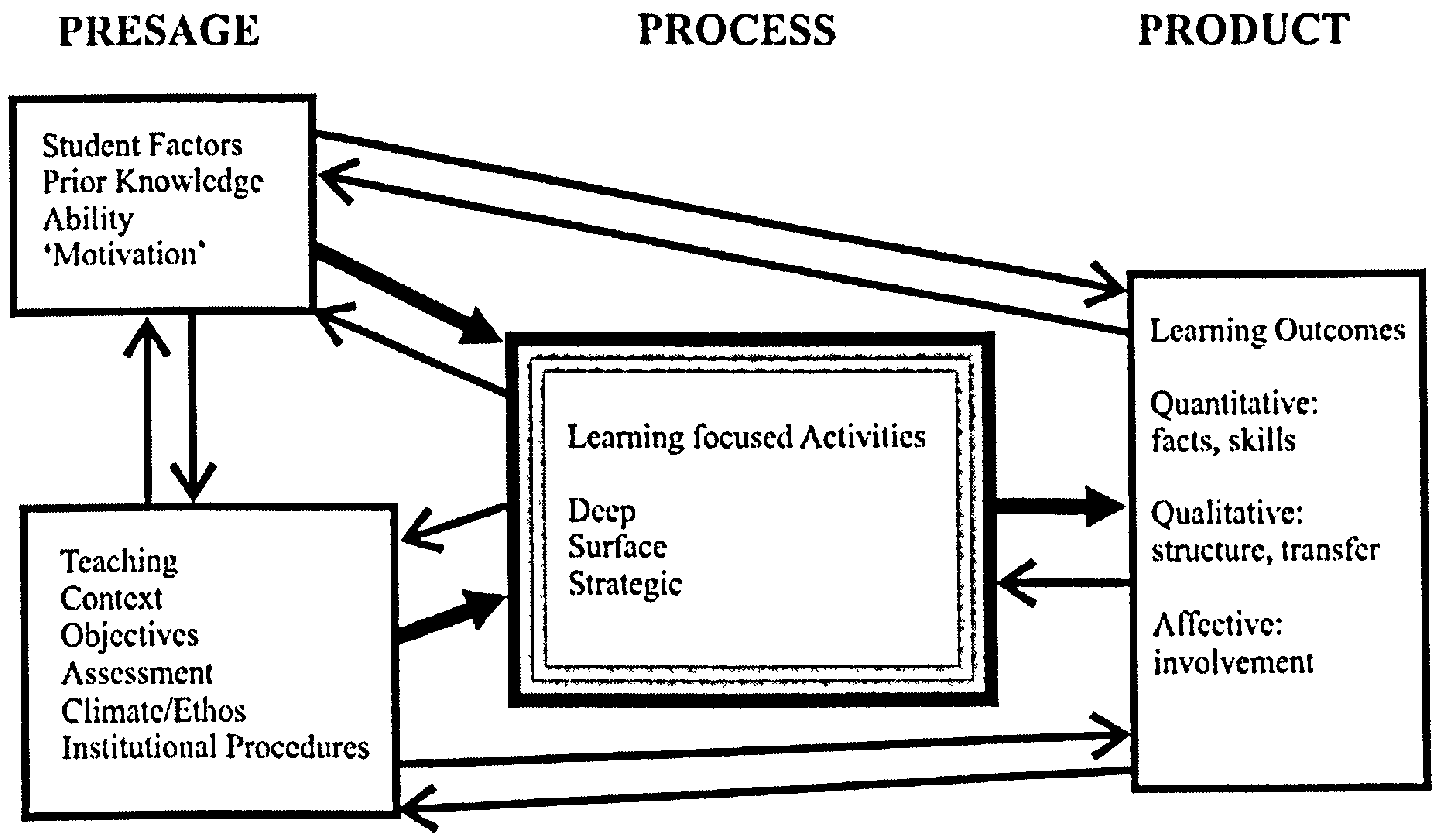


Figure 13. Biggs' 3P Model

Each of the approaches will now be described in turn.

2.3.1.1 Surface approach

Students who adopt a surface approach also adopt rote learning (Entwistle & Smith 2002), where the focus is on memorisation of information and ideas in isolation (Newble & Entwistle 1986). Students who adopt a surface approach are motivated by the fear of failure (Newble & Entwistle 1986). It has been shown that students using this approach may be classed under a sub-category of active or passive depending on the degree of involvement and effort shown by the student (Fransson 1977), hence the surface approach does not mean 'lazy'. Students who adopt an active surface approach may spend considerable time and energy investing in this approach. These students may appear very successful if the assessment reflects surface learning, however their understanding will be considerably limited (Newble & Entwistle 1986). Students who are passive in this approach are rarely successful and often are withdrawn from the course of study. A surface approach is also a limited approach offering few opportunities for development.

Anatomy as a discipline may present the issue of approach as a problem to students early and often. MacLaren explored the surface approach in relation to anatomy, and questioned whether first year medical students studying anatomy were more likely to adopt surface approaches when compared to theology students. Results showed that 71% of medical students adopted a surface approach, compared to 62% of theology students (MacLaren 2005). MacLaren's study also examined the use of mnemonics in anatomy, which are numerous and often unprintable! An example could be 'Say Grace Before Tea', marking the insertions of the Sartorius, Gracillis and Semi Tendinous muscles. These mnemonics are found everywhere and are used to aid memorisation of facts. It is claimed that anatomy learning has two problems: firstly, that students perceive anatomy learning to be memorisation based, and secondly, that the learning process is as important as the learning itself (Miller et al. 2002).

2.3.1.2 Deep approach

The deep approach arises from the individual wanting to engage in the task in a meaningful way (Biggs 2003). "The fundamental characteristic of the deep approach is the intention to understand the material or subject" (Newble & Entwistle 1986). In a deep approach students are motivated by their interest in the subject or by its vocational relevance (Newble & Clarke 1986). Involved in the deep approach, students use previous knowledge and experience and examine evidence of a new concept (Newble & Entwistle 1986). It has also been shown that a deep approach may occur in two ways: operation learning and comprehension learning (Pask 1976).

The operation learner uses a series of steps, with attention on facts or procedure (this may make them adopt a surface approach in short bursts) (Newble & Clarke 1986). This type of deep approach has been shown to be more common in science-based disciplines, which includes medicine. The comprehension learner uses a broad focus and is concerned with ideas and interconnections (Newble & Entwistle 1986). Through investigating case studies, a fine-grained view of the deep approach within a longitudinal nature was revealed and few students showed marked changes in their deep approach (McCune & Entwistle 2000).

Students who adopt a deep approach have been shown to spend more time on independent study (Svensson 1977) and reflects the individual's interest in the subject material (Newble & Entwistle 1986). The use of a deep approach is related to high quality learning outcomes (Trigwell & Prosser 1991). Nevertheless, in medical education a deep approach has not been positively correlated with assessment success suggesting that assessment did not require a deep approach (Newble et al. 1988).

2.3.1.3 Strategic approach

Students who adopt a strategic approach are influenced by the context; they can be quite difficult to distinguish because they will use whatever approach they perceive will get them high grades (Newble & Entwistle 1986). The students therefore need to have versatility to use each approach as appropriate (Newble & Clarke 1986). The level of understanding these students achieve has been shown to be incomplete but is dependent on the type of assessments within the course.

Figure 14 is redrawn from Newble & Entwistle (1986) and summarises the characteristics of the three main approaches to learning. What is significant about the concept of approach to learning is that it takes into account a variety of factors and influences which might lead to a student adopting a particular approach to learning. These include relatively stable attributes of the learner (e.g. learning style preferences, personality, motivational characteristics, etc) and factors which depend on how students perceive and interpret the context of the learning in relation to their ambitions. The notion of learning approaches relates to the constructivist view of learning in which learners construct meaning from their interactions with the world rather than reacting to stimuli in relatively predetermined ways (Biggs 2003). While certain contextual factors, such as the perception of assessment and workload can promote particular approaches to learning, learning approaches are not necessarily stable attributes of the learner. Approaches to learning can therefore change depending on the circumstances, for example a student may adopt a deep approach in a subject where they have a strong intrinsic interest but may adopt a surface approach in another subject where they just wish to pass the assessment.

Approaches to learning must not be confused with learning style, as is sometimes the case in the literature. A style of learning is believed to be a personality trait and a relatively stable characteristic of the learner where the student acts in a predictable way to a learning task. There is still much debate as to the nature and nomenclature of learning styles and their dimensions. There may be some natural cross over in the theories of learning styles and learning approaches. Students may have a preference for a style or approach but this may not be realised in practice depending on the context and circumstances (Biggs 2003). However, it is acknowledged that students approach their studies in different ways and that their approach is influenced by a number of factors. Approaches to learning is a much more inclusive and more powerful concept than that of learning styles as it takes into account a wide range of factors, including learning style preferences, in providing a framework for understanding the ways in which students go about their learning in natural settings. It is for this reason that learning approaches are adopted for investigation in this study.

2.3.2 Adopting an approach

Learners in higher education have experience. This experience affects the way in which they look at their learning and the way in which they approach it. More specifically, they bring particular perceptions to bear to their learning and develop conceptions of their knowledge and understanding. These two facets are discussed next.

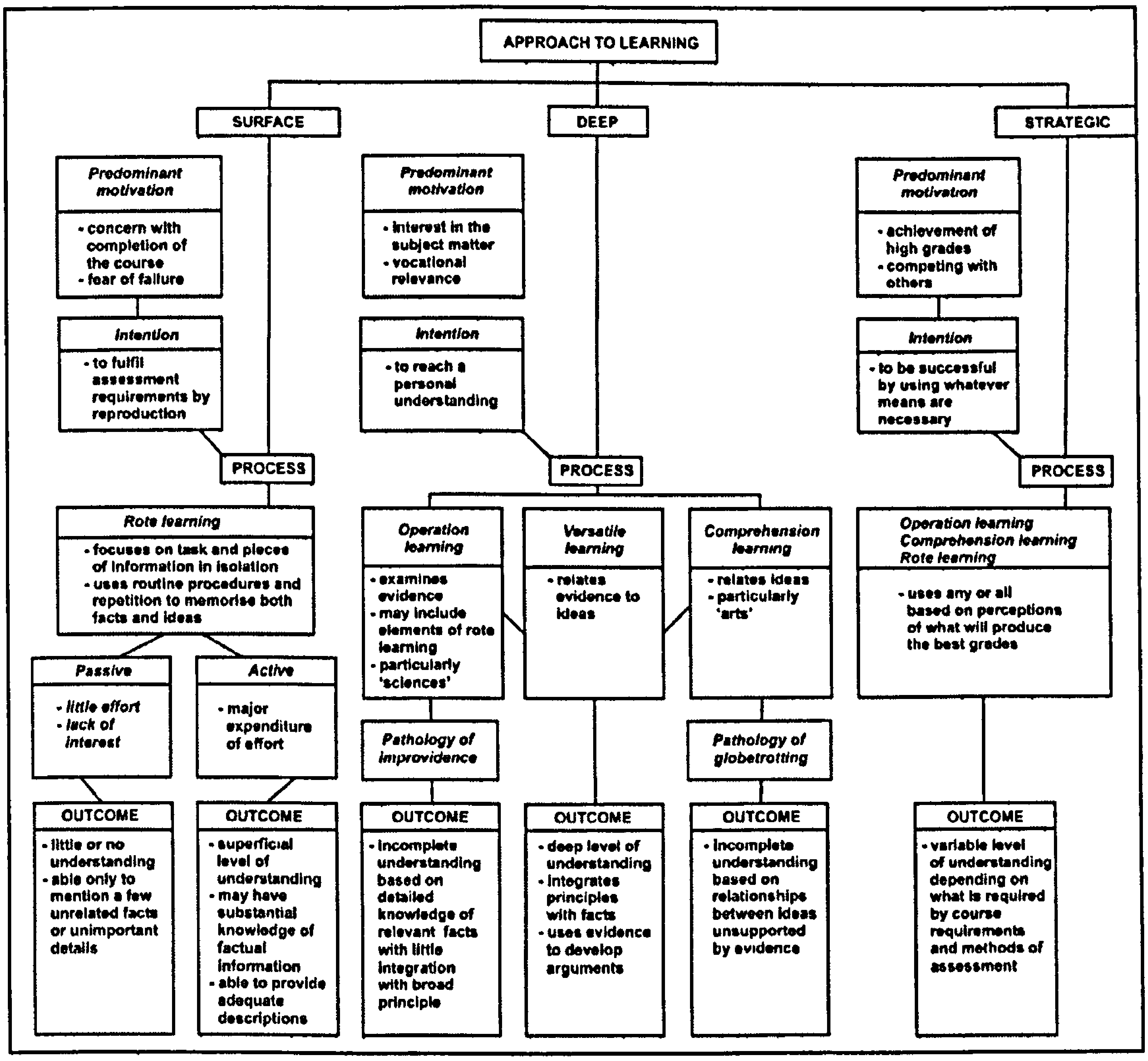


Figure 14. Approaches to learning (Newble & Entwistle 1986)

2.3.2.1 Perception

Perception is a way of perceiving and interpreting something. In the case of the student it is the learning task. Students' perceptions are in turn related to how they approach their learning (Prosser & Trigwell 1999). As Marton, Hounsell and Entwistle (1997) describe:

> An important finding is that students' approach to learning is not wholly a characteristic of the individual student, and reflects, in part, their response to their perception of the learning environment. (Marton, Hounsell & Entwistle 1997)

In particular, the Course Perception Questionnaire (CPQ) developed by Ramsden & Entwistle (1981) was adopted in research that demonstrated links between perception and approach (Meyer & Parsons 1989; Richardson, Gamborg & Hammerberg 2005). The Course Perception Questionnaire takes into account how students perceive many factors about their course, the teaching, the relevance, the workload, etc., which are all possible influences on students' approaches to learning. The Course Perception Questionnaire was considered too general for use in this study hence it was decided to use a more detailed anatomy-specific questionnaire.

2.3.2.2 Conceptions

The notion of conception and its links with approaches to learning was first described by Marton & Saljo (1976). A concept is an abstract notion and a conception being the individual's indentation of the concept or the consequence of the individual's perception.

In adopting an approach there appears to be a major distinction between whether the learning is seen as requiring the reproduction of information (i.e. a surface approach) or the transformation of it (i.e. a deep approach) (Entwistle & Entwistle 1991). This is a very real implication in how students perceive what the curriculum is requiring of them and hence " the perception and the approach to learning are intrinsically linked" (Trigwell & Prosser 1991).

2.3.3 Influences

The influences on student learning are numerous and the term 'learning pathologies' has been applied as a generic phrase for the problems associated with learning. Some of the influences which affect understanding are represented in Figure 15.

The overall perception of the academic environment is discussed by Entwistle & Tait (1990). They discuss one aspect of influence that is very important in medical education, relevance, and that the more students perceive the learning as relevant the more they adopt a deep approach (Entwistle & Tait 1990). It is important to note that a significant amount of the student's learning may take place outside of timetabled activities, so some influences may not be known. Some influences come from previous experience and may be embedded in the student's study habits. However,

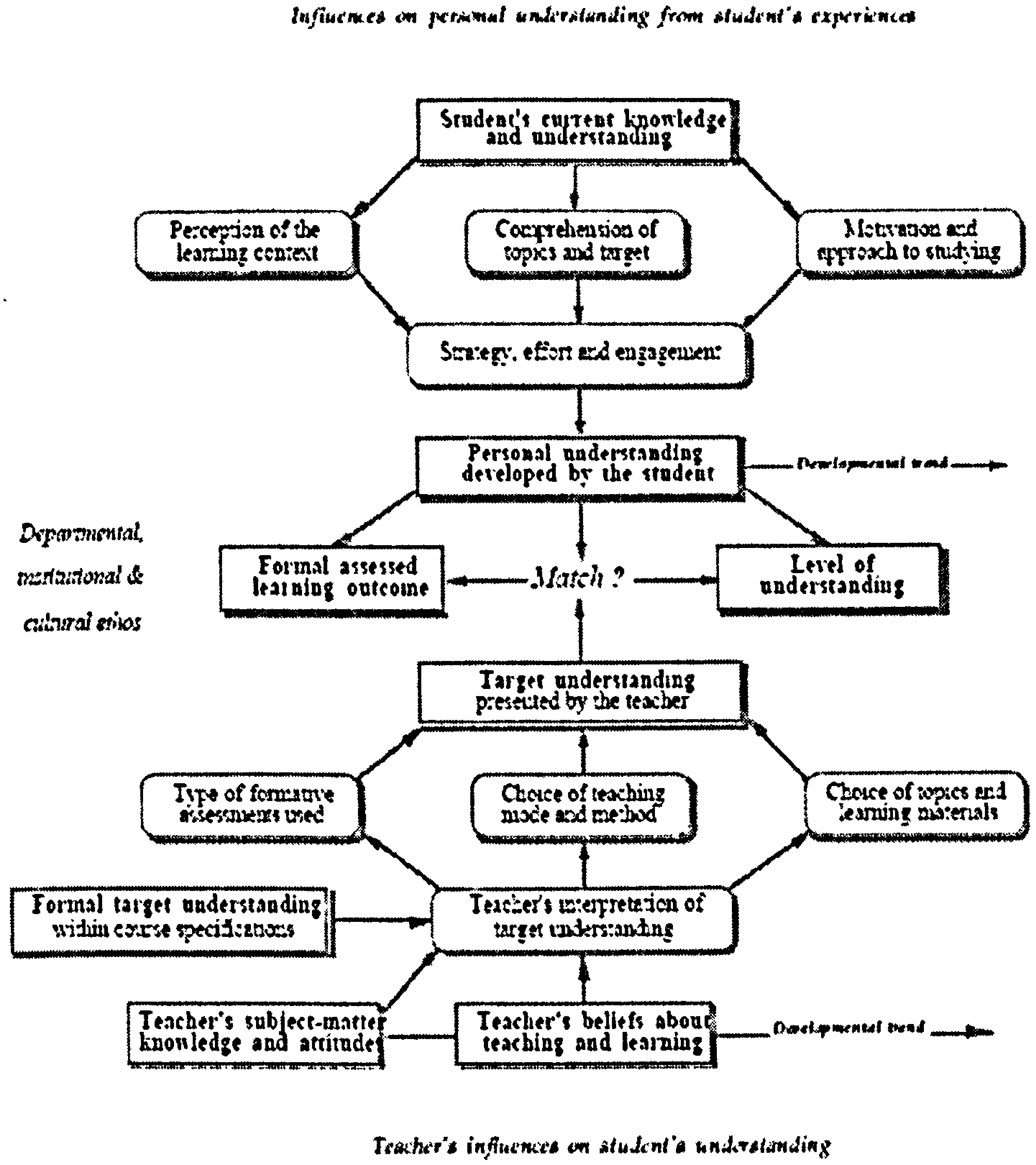


Figure 15. A concept map of some influences on understanding (Entwistle & Smith 2002)

some we do know about. As Newble and Entwistle describe, there are three influences: the teaching, the department and the student. It is also noted that some influences are stable whilst others vary (Newble & Entwistle 1986). Generic influences identified from the literature, namely, workload, assessment and demographics, are discussed below. It remains to be explored if anatomy education has some specific influences that affect learning. The term learning pathologies (Newble et al. 1988) has been adopted to mean things that hinder learning; these are not always the same as the influences.

2.3.3.1 Workload

Workload has an influence on how students approach their learning. Disciplines that exhibited high scores on a reproducing element were associated with a high workload (Ramsden & Entwistle 1981). Students who are overburdened are more likely to adopt an unfavourable approach to learning and adopt rote memorisation which was correlated with poor assessment performance (Chambers E 1992; Entwistle & Tait 1990). With time pressures in the curriculum it is not surprising that there is research into alternative schedules or different paced learning. For example, students' anatomy scores from those who attended a slow paced course achieved the best results (Elizondo-omana et al. 2006).

2.3.3.2 Assessment

Assessment has been shown to affect motivation and also approaches to learning:

> Without doubt the assessment system is the most potent factor for influencing student learning behaviours. (Elton & Laurillard 1979)

For example, assessments that were factually driven (e.g. multiple choice) pushed students towards a more surface approach, compared to an essay structure which encouraged a deep approach (Thomas 1986). Assessment often brings about anxiousness and students who reported being anxious were more likely to adopt a surface approach (Fransson 1977). Performance in assessments is also likely to affect students' general attitudes and approaches to studying. This may be in a positive or negative way. Considering the volume of published articles on dissection and prosection, the assessment of anatomy appears to be a forgotten side issue.
Multiple choice questions (MCQ) and their use in anatomy have been explored and support for them includes their high reliability and validity (Chakravarty et al. 2005; Nnodim 1992). Other studies have suggested MCQ to be too narrow and do not examine the depth of anatomical knowledge obtained by students as they test inert, non-contextual and vicariously-experienced facts (Cahill, Leonard & Weiglein 2002). Objective Structured Practical Examinations (OSPE) can be used to test a variety of knowledge and skills. They vary in station number and time for completion. Anatomy

assessment often occurs in the form of a spotter which is a version of an OSPE. It involves a number of stations at which students have to identify structures or they are asked a question regarding a structure, and may involve any learning resource (specimens, models, X-rays, etc). There is little if any research exploring their assessment effectiveness.

2.3.3.3 Demographics

Various associations have been identified in relation to the approaches to learning adopted. In particular, gender and age of students have been explored in the medical school setting. The association between learning approach and gender convey that female students scored slightly lower on extrinsic motivation yet in years 3 and 5 they scored highly in fear of failure, using the Approaches to Studying Inventory 1983 (Clarke 1986). Male students and school leavers demonstrated a higher surface approach (Mattick & Bligh 2004). In comparing the age of students with their approach to learning, studies revealed that there was a decline in the achievement motivation score and an increase in meaning orientation in older students (Clarke 1986; Richardson, Gamborg & Hammerberg 2005).

2.3.4 Approach to learning case studies

A study investigating a PBL curriculum used in Australia revealed that students perceived successful learning of anatomy as hard work, involving various combinations of memorisation, understanding and visualisations (Pandey & Zimitat 2007). This study used Structure of Observed Learning Outcomes (SOLO) ratings to relate students' written work to their ASI (surface or deep) scores. Three qualitative questions were asked and students' views of successful approaches (activities) to learning anatomy can be seen in Table 2.

Approach (activities)	No. of students (n=99)
Attendance and preparation	12
Time on task/hard work	51
Constant revision	30
Interest	10
Note taking, drawing	5
Using specimens	9
Discussion with others	7
Good memory or memorising, rote learning	39
Visualising	29
Understanding	36

Table 2. Student views of successful approaches to learning anatomy (Pandey & Zimitat 2007)

The approaches to learning scores showed that 63% of students had high deep approach scores and there was a negative correlation between surface scores and examinations results (Pandey 2005). The study concluded:

> The study of anatomy is problematic for students. It involves the knowledge of structures of the parts of the body, their physical organisation, function and structural and functional relationships with each other. The first challenge many students face is an overwhelming amount of new terminology and a number of anatomical structures that at one level, need to know before they can even communicate with their peers and tutors. Memorisation is one strategy used to overcome this hurdle. (Pandey 2005)

Pandey's statement may be partly true; however in real life anatomy is much more multifaceted, as students are dealing with a new environment, a new way of learning, death, touch-mediated perception, etc. What is not clear is how these facets affect student approaches to learning and how this changes as students move through the years. A noteworthy point is that this study was carried out in 2003, involving only 97 students and did not distinguish the strategic approach. It was also carried out in the last year of a traditional regional based course in Australia and as such is very different to Southampton's curriculum and ethos, and provides little generalisability to the system-based curricula of medical schools in the UK. Research in other health professions has demonstrated that students who adopted a strategic approach did better in assessments than students who adopted a deep approach (Mansouri et al. 2006).

The Approaches to Study Skills Inventory (ASSIST) has been adopted in a variety of settings. Repeatedly the findings have shown a negative correlation between examination results and students adopting a surface approach (Mayya, Rao & Ramnarayan 2004; Reid, Duvall & Evans 2007; Shankar et al. 2006).

2.3.5 Multi-dimensional understanding of the organisation of the human body

A key aspect of anatomy learning lies in the fact that patients are three-dimensional human beings. Many authors acknowledge that anatomy learning involves the generation of three-dimensional mental images (Willan & Humpherson 1999). However, this fact is often stated but not explored or really understood. More precisely, three-dimensional understanding involves spatial ability described as:

> The ability to perceive, retain and recognise or reproduce three-dimensional objects in their correct proportions when they are rotated in space, translated, juxtapositioned, projected, sectioned, re-assembled, inverted, re-orientated or verbally described. (Rochford 1985)

There is an ability to identify, retain and reproduce three-dimensional images, thus it has to be variable and possibly measurable (Garg et al. 1999). Three-dimensional learning requires perception of pattern and form, and imagery. The more complex the visual image, the more difficult the reconstruction and the higher the error rate (Marks 2000). Miller further adds that the recognition of complex shapes is slower than easier shapes (Miller 2000). The practical implications of this are numerous and it could be conceived that all students starting out on their anatomy journey should start with simple line drawings of features and progress onto complex three-dimensional images.

Rochford carried out experiments measuring geometric spatial ability in second year medical students using a variety of exercises. Students were then tracked through assessments and it was shown that students who had persistent deficits on the exercises scored significantly lower marks in the practical examinations (Rochford 1985). An experiment by Garg et al. using a randomised, single blind controlled study, in which 49 students were exposed to either multiple views (MV) or single views (SV) of the carpel bones on a computer programme, revealed no significant differences. Thus the authors proposed that key views (KV) are remembered and then interpreted in the brain (Garg et al. 1999). Later it was found that if information was presented in a oblique view the student synthesised it by rotating back to a KV of front or back, and that MV were only beneficial to students with good spatial ability (Garg et al. 2002). It is proposed that simple imagery acquired early in training will aid the underlying basic visual patterns, which will be internalised by students and will aid more complex images later in training (Miller 2000). It has been documented that the student's preference for highly complex images increases with increased exposure, illustrating the adaptive nature of the student's learning (Vitz 1966). Under the notion of dimensional anatomy, it is described that anatomical information can be classified as spatial (the actual anatomical entities) and symbolic (the descriptions, relationships and concepts) (Rosse 1995). It would appear to be a difficult task to break up anatomical understanding into these two domains, because in practice they should be synonymous with each other. This idea of anatomy understanding having components is further described as propositional knowledge and process knowledge, and that process knowledge must be learned where it can be applied, i.e. in clinical context (McLachlan et al. 2004a).

Practical ideas for reinforcing the three-dimensional nature of anatomy have been stated, one being that reconstructing the dissection in plasticine or wax is an even better way of impressing on the mind the deposition of various structures (Lockhart 1927). Looking back at anatomical history and illustration it is clear that even earlier drawings by Aristotle in 384 B.C (Calkins, Franciosi & Kolesari 1999) were done in a way as to best represent the three-dimensional nature of the structures encountered. Studying such a drawing would have been very useful to the learner considering the problems with cadavers at that time. Many medical schools (including Southampton) use a variety of commercially available plastic models to help students orientate difficult three-dimensional areas, for example the ventricles of the brain.

One aspect of spatial ability which has not been explored is why some students have a good spatial ability and others do not (Garg et al. 2002) Spatial ability's importance is somewhat curriculum specific as referred to by Rochford (1985), who described that only half of the assessments students are exposed to test this ability. Today the assessments that involve spatial ability are probably much less than in 1985 but it would be advantageous to find ways of identifying those students lacking spatial ability and help them develop.

In comparing the various literatures, it should be noted that there is a divergence of the use of the term 'three-dimensional'. Some authors have used three-dimensional to describe what is really many two-dimensional images put together, thus the viewer may be able to rotate around these images, but they are still two dimensional. This issue does affect the results presented in the research papers as some may not be comparing like with like.

2.3.6 Touch-mediated perception

A key part in the dissection/prosection debate and hence part of learning anatomy on cadaveric specimens is that the reinforcement of understanding of the human form is believed to occur through pathways involved in visual, auditory and tactile senses (Marks 1996). The most tangible evidence of touch-mediated perception can be seen in the carer and receiver (the examination or treatment of a patient using a clinician's hands), and that this journey starts in the dissection laboratory (Aziz et al. 2002). I have used touch-mediated perception in both the dissection and prosection examples.

In the opposing view, it has been suggested that if touch-mediated perception is to be best developed, then fixed cadaveric bodies of the DR are not the place and that unfixed animals would be better (Hubbell et al. 2002). However, this argument may be invalid as soft fixing of human tissue/ cadaver is now being adopted by medical schools. This method of fixing allows flexibility at joints and is particularly useful in postgraduate training (Groscurth et al. 2001).

2.3.7 Group learning

An aspect of anatomy learning which has not been linked into students' approaches, but is cited in literature related to anatomy education, is group learning. The dissecting room environment has been described to facilitate group learning as a bonding occurs because the groups are experiencing the same distress (Coulehan et al. 1995). The concept of team working experienced in the DR was shown by students as a useful prerequisite for working in ward teams (Lempp 2005).

Encompassed in group working is the act of peer teaching. This has been examined and students responded well to it (Yeager 1996). The concept of peer teaching is important as it acknowledges that teaching aids the development of understanding and fosters many other professional skills, while at the same time bonding the group (Krych et al. 2005). Embedded in peer teaching is the notion that you have to understand it to teach it. '*Qui Docet Discet*'- "those who teach learn". It is therefore not surprising that students who had experienced peer teaching performed significantly better than those who had not in two multiple choice papers and a practical test (Nnodim 1997).

An understanding of what anatomy learning involves has begun to emerge. A few studies have suggested links between education theory and anatomy learning. Research has suggested that teaching methods may not be so important, but more how the learning is placed:

> Contextual learning as an active processes of information acquisition and mental consolidation that couples cognitive demand with experimental discovery in a contextual...Cognitive demand includes the necessary memorisation of vast and detailed nomenclature of anatomy, while experimental discovery involves the coordination of cognitive knowledge to direct observations of the physical aspects of anatomy. The consolidation of cognitive and experimental information into useful meaning constructs

> depends largely on the context of the environment in which these processes are occurring. (Clough & Lehr 1996)

This important description serves to link the theory of learning to educational practices and offers some insight into the rest of the learning process.

The literature to date has enabled an understanding of the development and history of anatomy education and has revealed many aspects which need further research. The key issues missing are the perceptions of and hence approaches students take to learning anatomy in a UK medical school, and the process of their anatomy learning. The need for multi-modal evidence is clear for understanding and implementing successful anatomy learning from both the student and teacher perspectives.

2.4 Application of Knowledge into Professional Practice

The aim of medical education is to produce doctors fit for practice. For medical students, acquiring anatomical knowledge is not enough. The concern over rising litigation as a result of a lack of anatomy knowledge (Ellis 2002) also suggests a lack of the individual's ability to apply the knowledge. I explored the literature on the application of anatomy in practice but found very little so I broaden my search to examine research on the principles of knowledge application in medicine.

As previously described, knowledge involves propositional, functional, procedural and conditional knowledge (Biggs 2003). The procedural and conditional knowledge are related to the application of knowledge in the diagnosis and management of a patient. Two shifts in knowledge restructuring have been identified: the transforming of knowledge to encapsulation and then how the knowledge is applied through illness scripts in clinical practice.

2.4.1 Transforming knowledge

Medical students already have experience and knowledge of medicine which begins in their childhood (Boshuizen et al. 1995). The transformation of knowledge marks a distinction between the novice and the expert. Medical students when they enter training are novices and at various stages throughout undergraduate and postgraduate training they become experts. Students acquire knowledge - 'knowledge expansion' (Schmidt & Rikers 2007) and begin to transform it as they integrate it, beginning to form a network of understanding. As students progress they go through an intermediate phase which involves a detailed knowledge of the basic sciences.

Expert knowledge structures represent an illness script (Schmidt & Boshuizen 1993). It is suggested that during undergraduate medical training, medical students acquire elaborate causal networks explaining the cause of a disease. However, as this knowledge is experienced in the clinical setting the networks become 'encapsulated' (Boshuizen & Schmidt 1992; Schmidt & Boshuizen 1993). Encapsulation represents the simplifying of networks that can be easily accessed. Encapsulation is defined as:

> The subsuming or 'packaging' of lower-level, detailed concepts and their inter-relations, under a smaller number of higher-level concepts with the same explanatory power. (Schmidt & Rikers 2007)

Application of knowledge after encapsulation requires less detailed basic science knowledge; however experts remain better or faster at using biomedical knowledge (Schmidt & Rikers 2007). It has also been shown that experts use an extensive array of biomedical knowledge (Lesgold 2001). The transformation of knowledge occurs in situated learning (Maudsley & Strivens 2000) where it is proposed that novices learn to apply technical knowledge within clinical decisions. This makes the learning 'real' which is highly motivational (Maudsley & Strivens 2000).

2.4.2 Application of knowledge

The notion of 'illness script' has been proposed to represent how clinicians deal with a problem, the general components of the illness and their interrelationships (Feltovich & Barrows 1984). An illness script contains three component parts: enabling conditions, faults and consequences. For example, enabling conditions might be hereditary factors, faults are the malfunction, e.g. inadequate nutrient supply, and consequences are the signs and symptoms such as a rash or cough. Importantly, "Basic sciences (anatomy etc) are constraints on how the pieces can be put together" (Feltovich & Barrows 1984). It has been suggested that if presented with a case where no knowledge has been acquired, the clinician reverts back to casual networks and 'regresses' (Schmidt & Boshuizen 1993). Feltovich and Barrows (1984) highlight the importance of anatomy in clinical practice and the need to understand anatomy learning as the quality of learning has implications for future clinical practice. An example of an illness script is as follows:

> 55 year old man, pain deep in the abdomen, the pain is worse on sitting painful, frequent and difficult micturition, soft, enlarged prostate.

The student or clinician has to work through the anatomical structures in the abdomen, their nerve supply and the presentation of any associated pain. The muscles used in sitting. The structures involved in micturition (three parts of the urethra, the nerve supply, the sphincters, the storage of urine in the bladder, etc). The prostrate (its structures, lobes, nerve and blood supply). This leads to the hypothesis focusing on not just the prostrate but other organs in the abdomen. In encapsulated knowledge, restructuring is the result of prolonged experience of knowledge application, so that an experienced clinician will arrive quickly at "enlargement of the median lobe of the prostrate causing renal retention" (Boshuizen et al. 1995).

Illness scripts exist at various levels and may relate to previous patients. An illness script reflects that declarative 'propositional' knowledge structures have formed into a concept enabling a higher level of efficiency and practicality (Boshuizen & Schmidt 1992). It is unclear how anatomy knowledge is transformed to enable the application of illness scripts.

The literature confirms the rationale of this study, to explore how anatomy knowledge is learnt and applied in the clinical context. The literature provided me with an understanding of what was already known on the research problem. I referred back constantly to the literature throughout the study and the findings from the literature search presented informed the subsequent research questions.

3 Chapter 3. Research Questions and Methodology

3.1 Research Questions

This chapter begins by establishing the main research questions. Following on from the detailed research questions, I ask how these would be best investigated. Generic validity and reliability of the study are then discussed, followed by ethical considerations. This chapter closes with an overview of the methods adopted and detailed research plans.

I used initial questions (what is the history of anatomy education and what are the current research theories and evidence on anatomy education?) to guide me when investigating the history of anatomy and the literature on anatomy education. The questions facilitated understanding of the research problem and have been discussed in the previous chapters.

Informed by the history and literature on anatomy education I formulated two questions to guide the preliminary research activities:

- Are there particular issues within anatomy education which students and staff rate as important to them?
- What are the feelings and experiences of people involved in anatomy around the UK?

The conclusions drawn from the history, literature and preliminary activities were used to construct two main questions to ascertain the effectiveness, issues and implications related to learning anatomy:

1. How do students learn anatomy?

2. How does anatomy education prepare doctors in practice?

The two main questions were then sub-divided into the following to guide the research activities:

Sub questions 1: Anatomy learning

- What are medical students' perceptions of anatomy?
- How are medical students approaching anatomy learning?
- What is involved in the learning process?
- What affects and influences the learning of anatomy?
- How are medical students applying their anatomy knowledge?

Sub questions 2: Relevance in practice and reflections on anatomy education

- In hindsight, what were alumni experiences of anatomy education?
- What factors influenced alumni's learning?
- Did alumni's experiences influence their career and how?
- How do alumni use their anatomy knowledge?
- How did alumni re-learn and transform their knowledge?
- Having experienced medical education, what, if anything, would alumni change about their anatomical education?

3.2 Methodological Stance

3.2.1 Introduction

In order to investigate the research questions, several methodologies were considered. The lack of previous research reported in the literature on the understanding of learning anatomy led me to adopt an exploratory approach in this study as there was little to build upon. The University of Southampton Medical School was adopted as a case study to comprehend anatomy education.

The history of anatomy, briefly considered in the introduction chapter, and the review of the literature highlighted the need to understand the learning experience from students' and other stakeholders' perspectives (e.g. in terms of the teaching and the professional application of anatomy in the clinical context). To enable this understanding I adopted a naturalistic case study method. I felt this was appropriate as I sought to explore perspectives from both coded data and direct interpretation (Stake 1995). I was particularly influenced by principles adapted from illuminative research and progressive focusing, phenomenography and grounded theory. I will discuss each of these in relation to the study in more detail later.

I interpreted the definition of case study research in the context of this study to investigate a group and a phenomenon (Bassey 1999). In exploring literature on case study research an element central to this study is boldly described as "the public world is positivist; and the private world is interpretive" (Bassey 1999). Thus I felt that to understand anatomy learning I needed to ensure that the methods I adopted reflected the quote's two components. I was particularly interested in understanding student, staff and alumni's perceptions and experiences of learning anatomy and hence I have placed greater emphasis on the interpretive element of case study research methodology.

3.2.2 Illuminative research and progressive focusing

Illuminative (or evaluation) research seeks to describe and interpret an educational programme. Within evaluation research two concepts are proposed: the instructional system and the learning milieu (Parlett & Hamilton 1977a) which are similar to the components described by Bassey (1999) previously. In understanding anatomy education these are important as the instructional system is the medical curriculum or the learning model (the public world). I interpreted the learned milieu to be the interactions, processes and the variables that occur in the learning setting (the private world). The research strategy associated with illuminative research encompasses observations, interviews and questionnaires, usually in three stages, namely, to observe, enquire further and explain (Parlett & Hamilton 1977a). I felt this approach was well suited to this study as I began from a broad base of issues identified in the literature review and preliminary work. I then focused on issues which appeared significant in relation to the learning of anatomy using 'progressive focusing'.

The process of 'progressive focusing' (Parlett & Hamilton 1977a) involves reducing the breadth of the study and following emerging issues. Thus at each stage of the research significant issues were identified, interpreted and conceptualised by using data corroboration or 'triangulation' (Parlett & Hamilton 1977a). The progressive focusing resulted in a series of working hypotheses or provisional theories which contributed to developing a working model for anatomy learning. At each stage of the research the aim was to focus on and further refine significant issues and working hypotheses in order to achieve a deeper conceptual understanding of learning and applying anatomy. The notion of progressive focusing is supported by others researchers and may be succinctly defined as:

> Progressive focusing has two analytically distinct components. First, over time the research problem is developed or transformed, and eventually its scope is clarified and delimited and its internal structure explored. (Hammersley & Atkinson 1983)

3.2.3 Phenomenography

I felt elements of phenomenography would enable me to gain an insight from the students' perspective of how they related to the phenomena of learning anatomy. Phenomenography is defined as the analysis and description of everyday life (Abercrombie, Hill & Turner 2000) and has its roots in research investigating student learning (Goteborg University 2005). Phenomenography attempts to capture experience in a naturalistic way and aims to avoid imposing preconceived ideas and beliefs on the data. As such it shares a similar perspective with the approaches adopted in anthropology, grounded theory and participant observation which are also utilised in this study. However, unlike its methodological relatives phenomenography tends to record experiences 'second order' through the use of interviews (Trigwell 2000).

I applied some of the principles of phenomenography in this study. In particular the phenomenographical approach guided activities such as interviews to enable different experiences to be understood and characterised in the context of anatomy, allowing categories and comparisons to be formed. These categories are referred to as the 'outcome space' (Marton 1992) and I have used this as a place for further analysis within the results sections. It is within the outcome spaces that I was able to capture experiences and assign meaning to them.

In reviewing the literature on learning I considered that phenomenography would also allow me to take into account perceptions, ideas and experiences which students bring to learning anatomy. These might have a significant bearing on how anatomy learning was approached and experienced. Saljo commented that the aim of phenomenography was "... as an attempt to scrutinise and understand human learning..." (Saljo 1979). In attempting to understand anatomy learning I drew on the belief that the experience of learning can be described as a relationship existing between the subject and the object being experienced. How we experience things and give meaning to them can be influenced by our past experience, context and intention. If, as is suggested, it is not possible to deal with an object (e.g. anatomy) without experiencing it or conceptualising it in some way, then any of the subjects (e.g. students, staff, professionals) form a relationship with it. Thus there are many ties between the object and the subject. Some of these may have occurred before students ventured into higher education and these initial strands of experience may have an influence on this relationship and thus the way students deal or approach the phenomena.

In justifying phenomenography as a methodology to use for this study, I consider it is best summed up as:

> In higher education, we are generally intending to encourage the development of conceptual understanding in students, so a method which so vividly portrays differing conceptualisations must have direct relevance to learning and teaching. (Entwistle 1997)

3.2.4 Grounded theory

In order to understand anatomy learning it is necessary to translate the findings of this study through a set of concepts to define and explain it (Silverman 2005). To produce such theory the data were derived from various perspectives and from a mixture of methods. This study utilised selected principles from Grounded Theory. Grounded Theory is described as:

> A grounded theory is one that is inductively derived from the study of the phenomenon it represents. That is, it is discovered, developed and provisionally verified through systematic data collection and analysis of data pertaining to that phenomenon. Therefore, data collection, analysis, and theory stand in reciprocal relationship with each other. One does not begin with a theory, then prove it. Rather, one begins with an area of study and what is relevant to that area is allowed to emerge. (Strauss & Corbin 1990)

To follow the principle of letting theory emerge, the data from various perspectives and from the associated research activities produced themes which illuminated the data at the stages of the research. The themes were refined to generate a working theory, which was developed as subsequent data emerged. This relates to the progressive focusing and illuminative approach which in many ways facilitated the emerging themes and permitted refinement. The principle of constant comparison enables data from the start of the research to be compared across perspectives, time and through a range of methods (Cohen, Manion & Morrison 2001). The principle of constant comparison was utilised in the theory development to integrate data from various perspectives and different methods.

Grounded theory attempts to initially develop categories, saturate them and link the relevance, and then develop them into a framework with relevance to the outside setting (Glaser & Strauss 1999). Once the categories (groups of concepts) (Strauss & Corbin 1990) had emerged I ensured 'saturation' with appropriate examples that demonstrated their relevance. The categories were then worked into themes in the context of the research setting and to the wider setting of anatomy in medical education. This process shares common features, already explained, with illuminative research. A noted possible constraint of adopting a case study is the issue generalisability. However, I perceived that by utilising the principles of grounded theory I could produce a framework that had relevance outside of the research setting.

3.3 Validity and Reliability

3.3.1 Introduction

I acknowledge my role as a researcher, in that I am part of the world I am researching and I cannot be completely objective. It is the meaning that subjects give to data and inferences drawn from the data that are important - 'fidelity'. Agar claimed that in qualitative data collection, the intensive personal involvement and in-depth responses of individuals secures a sufficient level of validity and reliability (Agar 1993). This claim however is contested by Silverman (2002), in that there must be more rigorous notions of validity and reliability. Validity and reliability are now discussed in the context of this research.

3.3.2 Validity

Cohen et al. explain that validity in its earliest form was based on the view that it was essential that the measuring device measured what it was supposed to (Cohen, Manion & Morrison 2001). I agree with this and understood validity to imply 'truth'. Complete validity is impossible, and I interpreted for this study that validity should be seen as a matter of degree rather than as an absolute (Gronland 1981). Validity places certainty and confidence in the results. I hence explored a number of elements which would help increase the validity of the research. These included the appropriateness of the overall methodological framework, literature searching, the sampling strategies and methods adopted.

Descriptive validity is associated with the initial stages of the research (Winter 2005). To enhance the validity of the initial stages of this study I used a broad literature search. The search encompassed the discipline of anatomy, the context of learning and medical education. This ensured that the aims of the study reflected the literature and the possible depth and breadth of the study. While some researchers have further categorised validity, I use the two terms internal and external validity in the context of this study.

I understood internal validity as the demonstration that the explanation of the issue was sustained by the data. The problem of anecdotalism (Silverman 2005) was addressed by adopting triangulation. A way of increasing internal validity is through triangulation. Triangulation tries to overcome elements which may have been missed or overlooked by a particular method, also explained by Torrance (2002) as cross checking. The illuminative approach adopted seeks not to use only one method in isolation, and by viewing the research problem from a variety of views provides an aspect of triangulation (Stake 1995). Triangulation was achieved through four elements. Firstly, several views of the same phenomena were examined. Secondly, four methods (focus groups, observation, questionnaire and interviews) were used (methodological triangulation) (Cohen, Manion & Morrison 2001). Thirdly, the cross-sectional study design allowed the developing nature of the curriculum and learning journey to be explored, aiding space triangulation by exploring more than one subculture (Cohen, Manion & Morrison 2001). Investigator triangulation (Stake 1995) was established in elements which were open to greater subjectivity and my supervisor or colleagues acted to ensure that the same conclusions were drawn.

External validity I understood to be the degree to which the results could be generalised to the wider population. In this case the wider population was other medical schools and other students learning anatomy. To enable the results of this study to be of application to another environment, the working model or theory needed to be transferable. Generalisability was enhanced as I considered the selection, setting, history and constructs (Cohen, Manion & Morrison 2001) in relation to the research setting. I selected the case of Southampton University for a number of reasons: its convenience, its reputation in medicine, its curriculum and selection of students (which shares many common elements with other UK medical schools) and in my role as a member of academic staff. The setting of anatomy in terms of environment and content is representative of many medical schools where anatomy is taught in a system-based method, with prosection and dissection predominantly in the first two years of a five year programme. I considered the literature on anatomy education in general and specific to the setting, and felt that the case selected presented only a few minor unique elements. I considered exploring anatomy learning across a range of students but felt that in order to make the conclusions transferable the focus needed to be on undergraduate medical students.

Generalisability within this study is also supported by the appropriate adoption of sampling strategies and methods which could be applied to another setting. To further develop generalisability and to explore if there were other issues not documented in the literature on anatomy education, I designed the preliminary work to include the seeking of views from the stakeholder's perspective both at the University of Southampton and at other medical school institutions.

3.3.3 Reliability

Reliability is the consistency of the results. I improved the reliability through two elements: equivalence and internal consistency.

Equivalence in the study was enhanced through inter-rater reliability (Cohen, Manion & Morrison 2001). Inter-rater reliability was adopted in the same form as investigator triangulation to ensure that another researcher (e.g. supervisor or colleague) reached the same conclusions from focus group and interview data.

Internal consistency judges the reliability of the instruments used (Trochim 2006). In quantitative elements this was achieved by performing Cronbach's Alpha tests. Cronbach's Alpha measures the reliability of a scale, and whether the items used are measuring the same thing and are comparable (Bland & Altman 1997). Cronbach's Alpha was performed using Statistics Package for the Social Sciences (SPSS). The co-efficient values illustrated in

Table 3 demonstrate a high degree of consistency (Bland & Altman 1997). The values for the ASSIST inventory support findings from other studies (Entwistle 2006).

Research Activity		Co-efficient value
Assist Inventory	Overall	0.7
	Deep Approach	0.8
	Strategic Approach	0.9
	Surface Approach	0.8
Student Questionnaire		0.6
Alumni Questionnaire		0.8

Table 3. Cronbach's Alpha co-efficient

In qualitative activities internal consistency was improved by adopting a structured format of focus groups, observations and interviews. In addition different participants from the same group were asked the same key questions.

I also sought to improve the reliability in the study by examining my own biases and experiences as a potential issue. I aimed to minimise bias by acknowledging my own presence in the research and took practical steps to minimise any bias and increase the trustworthiness (Seale 1999) of the study. I felt it was important where possible, as described by Husserl, to "put the world into brackets" (Cohen, Manion & Morrison 2001). This bracketing requires renunciation of assumptions so that descriptions of the phenomena produced are as objective as possible (Ashworth & Lucas 1998). Bracketing enabled me to be aware and hopefully free of my usual perceptions of the area under investigation. I performed bracketing in my research field notes when analysing data from focus groups and interviews. For an example of bracketing in an interview transcript refer to Appendix U. My own experience of learning and teaching anatomy helped me to show empathy to a variety of views expressed in this study. However, I aimed to remain open-minded at all times to all the facets and opinions expressed within this project.

Another area for potential bias was my employment by the University of Southampton. I aimed to ensure bias was mitigated by conducting the research in an open manner. For example, when inviting stakeholders to participate I explained that the study was a postgraduate research study and reiterated that data would be treated as confidential and anonymous.

3.4 Ethics

3.4.1 Introduction

Ethical concerns in this project were referred initially through two 'Ethics Committees' in the School of Medicine and the School of Education. Due to the research subject and the participants potentially being employees of the NHS, the research was referred to Central Office for Research Ethics Committees (COREC) for ethical approval.

The possible issues arose from two points. Firstly medical students and possibly staff and alumni are considered to be employed by the NHS, and any research involving such participants requires COREC approval. Secondly, the context of the subject was a consideration. The anatomy laboratory environment operates within strict laws and guidelines and this study had to work within these. The nature of the context may be sensitive to potential participants and therefore procedures had to be in place to deal with these.

3.4.2 Ethical considerations

It was essential that key ethical issues were addressed. In considering the potential problems that might occur I decided that these would be overcome if the information I collected was treated as confidential and that anonymity was preserved at all times.

The nature of the research suited informed consent. Thus:

> Participants should know that their involvement is voluntary at all times, and they should receive a thorough explanation beforehand of the benefits, rights, risks, and dangers involved as a consequence of their participation in the research project. (Frankfort-Nachmias & Nachmias 1992)

I ensured that participants who had given consent also had the right to refuse to take part or to withdraw at any point in time without prejudice to the participant. A copy of the consent form and Participant Information Sheet (PIS) can be seen in Appendix B.

In defining Informed Consent, I followed four elements: 1. competence, 2. voluntarism, 3. full information, and 4. comprehension (Diener & Crandall 2003).

1. Potential participants of this study were adults, either as students or staff within UK universities or a National Health Service trust, and it was thus decided that their level of competence was sufficient to participate.

2. Potential participants were invited to take part having been informed as to the nature, form and commitment of the research in a voluntary manner.

3.I defined full information as the provision of as much information as possible and not withholding information that may influence the decision to participate. However, it was impossible for me to inform participants of absolutely every aspect of the research without harming the validity of the research (Wilkinson 2001). For example, I did not inform the alumni group of the results obtained from the student perspective.

4. Once participants were fully informed I felt it was highly important for the participants also to comprehend the nature of the research and have the opportunity to discuss any concerns, and if they felt necessary to withdraw from the project without prejudice.

I will now explain how I interpreted anonymity and confidentiality within this research context. I decided that all participants should be anonymous where possible in that they could not be identified from the information they provided. I fulfilled this obligation by participants being allocated a letter and number in a coding system. However, participants were informed that if they agreed to face-to-face interviews, total anonymity would obviously not be possible. In this case, all information received was treated as confidential.

Confidentiality was achieved by a coding strategy and confidential data were securely stored and if necessary appropriately disposed of. Data presented on the research topic had any elements which might compromise confidentially removed. For example, I have not reported the job titles or institutions of staff involved in this research. I am grateful for all information provided by participants and I ensured that the dignity, privacy and interests of the participants were respected at all times.

Ethics approval was obtained from the NHS Southampton and South West Hampshire Research Ethics Committees (B), dated 7th December 2005, REC reference number: 05Q1704/147 (refer to Appendix C for a copy of the approval letter). Registration and approval subsequently followed from the University Research Governance office. Within the conditions set out by Ethics Approval and Indemnity, I ensured that all aspects of the Data Protection Act 1998 were adhered to.

All activities for the study were considered under Standard Operating Procedures and Health and Safety regulations where appropriate for that year. I have complied with the Anatomy Act of 1984 and from September 2004 the Human Tissue Act of 2004.

3.5 Study Design

3.5.1 Introduction

Based on the research questions and the assumptions underpinning them (ontological reasoning), the study was designed to explore how students were learning and applying anatomy and how doctors in practice learned and were using their anatomy. Based on the methodology described previously this research case study was designed to facilitate the illuminative, phenomenographical and grounded theory assumptions. Activities were designed to allow for progressive focusing, theory development and constant comparison of the data, representing a concurrent transformative strategy (Creswell 2003), in that the methodology guided the research activities and involved triangulation of qualitative and quantitative data.

The study sought to explore perspectives and experiences from three main groups of participants:

- Medical Students at the University of Southampton
- Staff within University of Southampton Medical School and at other medical school institutions
- Alumni of University of Southampton Medical School.

In order to investigate each perspective a mixture of methods informed by the methodological framework was adopted. The suitability of these methods is discussed in turn. Comprehensive features and organisation of methods when applied to a participant group are addressed in subsequent chapters. The methods adopted are brought together through grounded theory at the end of each chapter in a working model of learning anatomy. The methods employed are summarised in Figure 16.

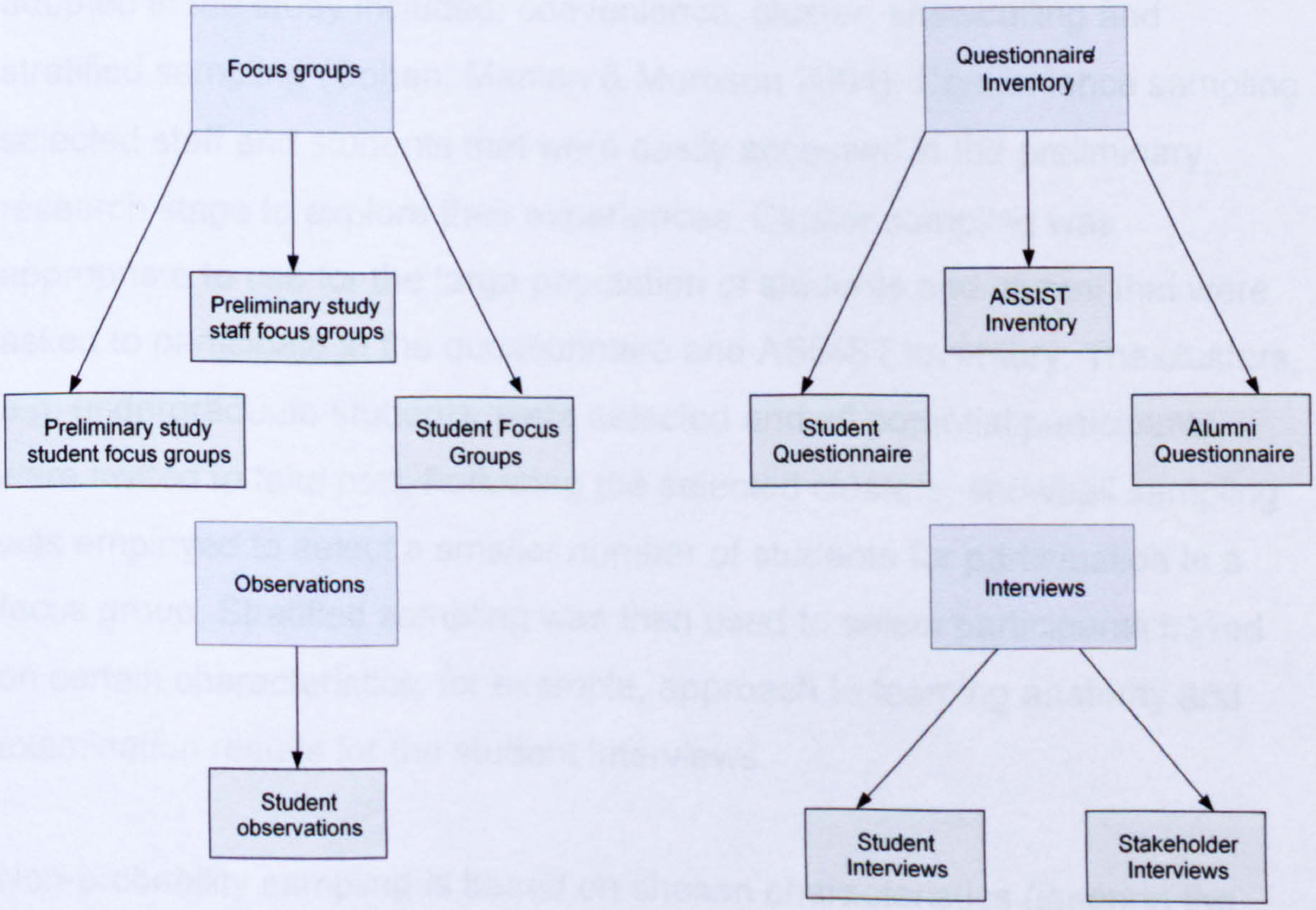


Figure 16. Research methods adopted

3.5.2 Sampling

A sample is a portion or subset of a larger group called a population (Fink 2003), with the best sample being representative of the population characteristics. I utilised sampling strategies as appropriate to meet specific purposes, for example to improve the validity and reliability of the study by allowing for the required breadth and depth of the issues being investigated. Kumar suggests that:

> Advantages of selecting a sample is that it saves time as well as financial and human resources, however the disadvantage is that you do not find out the facts of the whole population, you estimate or predict them. (Kumar 1996)

There are two types of sampling: probability sampling (random) and non-probability sampling (purposive) (Cohen, Manion & Morrison 2001).

Probability sampling implies that every member of the population has a known non-zero probability of being chosen, therefore eliminating subjectivity. Probability sampling has less risk of bias but cannot be entirely bias free. Such sampling promotes generalisability. Probability sampling adopted in the study included: convenience, cluster, snowballing and stratified sampling (Cohen, Manion & Morrison 2001). Convenience sampling selected staff and students that were easily accessed in the preliminary research stage to explore their experiences. Cluster sampling was appropriate to use for the large population of students and alumni that were asked to participate in the questionnaire and ASSIST inventory. The clusters, e.g. undergraduate students, were selected and all potential participants were invited to take part. Following the selected clusters, snowball sampling was employed to select a smaller number of students for participation in a focus group. Stratified sampling was then used to select participants based on certain characteristics, for example, approach to learning anatomy and examination results for the student interviews.

Non-probability sampling is based on chosen characteristics (ignoring the wider population) to represent an element, hence some individuals and not others may be chosen. In this study non-probability sampling included extreme and criterion sampling (Patton 2002). Extreme sampling identified students who had specifically high or low examination results in anatomy to be included in interview. Criterion sampling enabled me to select stakeholders based on their job role to be invited for interview.

The sampling strategies adopted reflected the illuminative and progressive nature of the study. For example, the sampling strategy adopted for the student questionnaire reflected a broad probability sampling strategy. As the study progressed purposive sampling was adopted to allow for refinement in the student interviews. Table 4 shows the sampling strategies adopted.

Classification	Activity
Probability (Convenience)	Staff and Student preliminary focus groups
Probability (Cluster)	Student and Alumni questionnaire
Probability (Snowballing)	Student Focus groups
Probability (Stratified)	Student interviews based on their approach to learning anatomy and examination success
Non Probability (Extreme)	Student interviews based on high or low examination marks
Non Probability (Criterion)	Stakeholder interviews based on their job title

Table 4. Sampling strategies adopted

I judged that an emphasis on the trade-off between breadth and depth was my main consideration for determining the sample size. Table 5 details the participant numbers.

Participants	Average time taken	Activity	Number of potential participants	Actual number
Student	45 minutes	Focus group	20	9
Staff	45 minutes	Focus group	7	5
Stakeholders	60 minutes	Interview	15	13
Students	45 minutes	Observation	70	30
Students	30 minutes	On-line questionnaire and ASSIST inventory	1075	297
	60 minutes	Focus group	92	25
	40 minutes	Interview	92	17
Alumni	30 minutes	On-line questionnaire	Unknown*	140

Table 5. Participant activity and number

* This number is unknown because the email addresses provided by the Alumni office may not have been active and the Wessex Deanery sent the email on my behalf to postgraduates registered with them, hence I was not able to deduce a potential number.

3.5.3 Focus groups methodology

The purpose of a focus group is to listen and gather information, and to understand how people feel and think about an issue (Krueger 2000). This purpose was suitable to explore students' and staff experiences of anatomy education. I used a focus group so that I could establish in a quick and easy way participant perspectives and areas to subsequently develop through further research activities. Participants were selected because they had certain common characteristics that related to the topic of the focus group. I created a relaxed and open environment that encouraged participants to interact and share perspectives on anatomy education. The groups ideally contained six to eight participants with a moderator (Krueger 2000).

I adopted focus groups as a method in the preliminary work to help orientate myself and to gain an understanding of the main issues from two perspectives, staff and student. In the process of progressive focusing, focus groups were subsequently carried out to develop themes and gather feedback from previous activities from a series of perspectives (Cohen, Manion & Morrison 2001). The subsequent focus groups aimed to explore the themes developed from the ASSIST inventory and student questionnaire.

Focus groups were designed to a multiple category structure (Krueger 2000). A multiple category structure in this study involved sequential and simultaneous focus groups so that comparisons could be made between the staff and student groups' perspectives and experiences in the preliminary study. Subsequent focus groups were organised by year of study hence making it possible to compare student experiences across the years. Focus groups followed a sequential order: the welcome, the overview of the topic, ground rules, the questions, conclusions and any other comments or questions. A guide sheet was constructed for each participant group. A questioning route was established (Krueger 2000) to construct questions which would stimulate discussion and were open-ended (refer to Appendix D for an example).

For all focus groups I acted as a moderator and listened attentively and sensitively, trying to understand the participants' perspectives while showing signs of respect and interest in their lives (Krueger 2000). I investigated and where appropriate utilised various techniques to aid the session. For example, the pause and probe and the echoing technique – "does anyone see it differently? Are there other points of view?" I decided to record the focus group for later analysis by using a Sanyo ™ Dictaphone on a conference setting and permission was always sought for this. The administration of each focus group was such that participants were welcomed, the project was explained and consent was sought. Students who participated in focus groups were offered a book token as gratitude for their time and involvement.

After the focus group I completed my field notes and the recording was transferred to computer. In line with Data Protection, the files were then securely stored (password protected) on computer hard drive and CD-ROM for the duration of 15 years. I transcribed the focus groups verbatim and used bracketing where required. The transcripts were then coded on paper identifying initial codes and line by line codes (Charmaz 2003). The codes were then formed into clusters. This approach enabled the working model of learning anatomy to reflect grounded theory and themes were identified as they emerged.

3.5.4 Observation methodology

Observation was selected to enable a better understanding of the case (Stake 1995) and, as previously described, is a method associated with illuminative research (Parlett & Hamilton 1977a), along with many other research approaches. I aimed to observe the learning experience in the DR, an environment in which I have worked as a teacher but one in which I had not previously researched or observed the learning experience. My teaching

experience in the setting had provided me from the teacher's perspective a limited understanding of the learning experience. A purposive and structured approach was required to investigate the DR learning environment.
Data gathered from observations included information on the following: the physical setting, programme setting, the human setting and the interactional setting (Cohen, Manion & Morrison 2001). In this case study these elements are reflected as the DR environment, anatomy teaching in the curriculum, and the students working and interacting. The types of interactions, formal interactions and informal interactions, may be experienced by the observer (Patton 2002). In particular I aimed to observe the relationships between the environment, the learning activities and the process of learning.

I adopted a form of semi-structured observation to capture the elements that I felt were needed for subsequent work, but which still allowed for unexpected aspects to be observed (Cohen, Manion & Morrison 2001). I was aware that structured observations would not uncover the underlying meaning (Parlett & Hamilton 1977b) but I used the method to gain a better understanding of the setting and to inform subsequent activities. As part of structured observation, I performed event sampling, when a line or tick is made against an activity (e.g. student opened book) and instantaneous sampling, where the events are recorded in chronological order.

In addition to the above structured recording, handwritten note observations were made. The structured observations and my field notes were analysed through categorical indexing (Mason 2002) or coding to produce an overview of the activities and interactions in the setting.

3.5.5 Questionnaire methodology

Questionnaires were adopted as a method as they were suitable in the overall research framework (Parlett & Hamilton 1977a) to enable a large amount of qualitative and quantitative data to be gathered. The questionnaires facilitated the progressive focusing nature of the study, allowing earlier elements to be tested and refined, and for developing further areas for in-depth investigation. I designed two questionnaires in this study: Student and Alumni.

The student questionnaire included participants from both medical courses and all student years to allow all perspectives to be explored. A pre-designed element (ASSIST inventory) was presented to students before the questionnaire to ascertain students' approaches to learning anatomy. The rationale for the ASSIST inventory is discussed later. However, to not confuse students the format of the ASSIST inventory was maintained throughout the subsequent questionnaire. The ASSIST inventory (Appendix G) used a five point Likert scale.

The utilisation of a questionnaire and inventory reflects that the study needed to quantify data in some way and this would not be possible if the questionnaire contained only open-ended questions. As a result, the questions were designed to fit into such a Likert scale that would give a range of suitable responses. The student questionnaire (Appendix H) was designed so that several comparisons could be made between demographics, such as year of study, and comparisons between students' approaches to learning and their experiences in anatomy.

The alumni questionnaire was designed to explore alumni experiences of learning anatomy and how they were using anatomy. The successful deployment of the student questionnaire confirmed the suitability of an online Likert scale questionnaire; hence in some parts the same Likert scale format was used. The alumni questionnaire also contained open-ended questions to allow participants to respond in greater depth to specific aspects (Appendix I). The questionnaire design allowed for comparisons of: year of graduation, current job and experience of anatomy education. I ensured that the questions flowed and were sequential (Cohen, Manion & Morrison 2001; Foddy 2001). Piloting the questions helped me to ensure that they were asking what they were supposed to. This involved pilot testing by non-anatomy post-holders within the department.

Initial development of the questionnaires was largely determined by advice sought from academics that had recently conducted an online questionnaire, and the online service provided by the University. I used 'Perception' Question Mark^{TM} software, an interface for online questionnaires. Several development meetings were held with both MEDIS and ISS (the Medical School IT department and Southampton University central IT body, respectively). I performed several tests on the questionnaires once they were established on the questionnaire data servers that checked for accuracy, spelling, readability and access. These tests involved me, my supervisor and five members of the department. Once the tests were completed and any problems resolved, the test results were downloaded off the servers to check the format of the download and if everything had been recorded correctly. The organisational details for the student questionnaire and the alumni questionnaire are described later.

Potential drawbacks of the questionnaire method were considered. Non-response to the questionnaire might affect the validity of the method (Cohen, Manion & Morrison 2001). However, triangulation from the previous focus groups, observations and subsequent interviews ensured that the results obtained were reasonably representative. Questionnaires may also be viewed as impersonal (Parlett & Hamilton 1977a). Progressive focusing using focus groups and interviews helped to overcome this.

3.5.6 Approaches to studying inventories

As the student questionnaire utilised the ASSIST Inventory, I feel that discussion is necessary to justify its inclusion. As described in the literature (section 2.3.1) an approach to learning is how the individual is going about their learning and this is classified into three approaches - deep, surface and strategic. Approaches to Studying Inventories (ASI) are used to identify an individual's approach to learning. An approach to learning can be accepted as stable, as an habitual response to learning situations which a student commonly meets, yet also variable in response to the teaching, learning environments and assessment demands in a specific course or on a particular occasion (Entwistle 1997).

The original ASI was composed of 64 items which were grouped into 16 subscales. The revised ASI (RASI) was developed by Entwistle and McCune, and it contained 52 items in 13 subscales (Entwistle 2006).The RASI has been used several times, for example by Duff in 2004 to investigate management education (Duff 2004). Duff also cites the RASI as being used by Sadler-Smith, and Waugh and Adison in 1996 and 1998, respectively. It is also worth noting that the ASI has been successfully used in subjects perceived to have a reputation for remembering things, such as accounting (Spencer 2003). The ASI has successfully been used on a variety of numbers of students from small numbers to 2208 in one piece of research (Entwistle & Tait 1990). It should be noted that an ASI failed to discriminate between students in some countries which raises the possible notion that the ASI used in the UK is only suitable for the UK.

The “Enhancing Teaching and Learning” project brought together the various parts of the ASI and RASI to make the ASSIST Inventory. The ASSIST inventory has been successfully adopted by many researchers, including research in medical education in the UK (Reid, Duvall & Evans 2007). What is important is that the ASI generally has been utilised by many, showing that context, influences and experiences may change but students' approaches to learning still fall within the same three categories.

The reliability of the ASSIST inventory has been shown to provide internal consistency by obtaining >0.7 co-efficient from Cronbach's Alpha tests (Entwistle 2006). The co-efficient for the ASSIST inventory in this study (section 3.3.3) supports that it is reliable at measuring approaches to learning. Permission was obtained from Professor Entwistle, University of Edinburgh, to use the ASSIST inventory and add in the word 'anatomy' where applicable.

3.5.7 Interview methodology

Within the overall methodological framework interviews serve as an important method for gaining an understanding from the experiences and interpretations of others. In order to comprehend the learning of anatomy, interviews were adopted to explore elements in depth and from a variety of selected perspectives or from those whose position makes their viewpoint noteworthy (Parlett & Hamilton 1977a). I held the view that the interviews had to be a personable encounter and structured to reflect the aims of the study, but not so tightly structured that they ignored potentially important information. I viewed interviews as not only information transfer, but also transaction and possible sharing of features. This aspect is the reason behind not choosing other methods such as online or telephone interviews.

I organised the interviews in a semi-structured format so that comparisons could be made between participants in a group whilst allowing for unexpected issues to also be freely discussed. This created a fluid and flexible format (Mason 2002). Gaps may occur in this technique; however I used a guide sheet to help overcome this. Interviews followed the pattern of introduction, questions, discussion and conclusions. The interviews continued until saturation or natural closure was reached. This varied from 40 minutes to two hours. The recordings were transferred to computer at the next available opportunity and were later transcribed verbatim. I also recorded my initial thoughts as field notes for further exploration.

The transcripts were coded using free nodes for content (words) and meaning. Bracketing notes were added to the transcripts to detail my own perceptions and experiences which might possibly influence my interpretation, and a short summary of the page was displayed. Delimiting occurred in the form of a diagrammatic representation of the codes which illustrated the component parts of the experience. The delimiting process (Barnard, McCosker & Gerber 1999) allowed me to suspend any preconceived perspective and report in a clear manner the experiences that students had reconstituted from the real experience in the process of a structured interview. Delimiting also allowed any repetitive data to be eliminated (Patton 2002). Clusters were formed from codes which were related to a label (cluster), e.g. deep approach (Moustakas 1994). The clusters represented the core themes of the experience. Meaning and context were deduced from the clusters (thematizing) to produce outcome spaces.

I considered the validity of interviews and whether there was potential for bias. Foddy refers to this in relation to symbolic interaction theory (Foddy 2001). I have differing relationships with the participants, e.g. in the student example as a lecturer, academic tutor or pastoral role. I therefore decided that during the introduction to the interview that participants were aware of the purpose, nature and ethics governing the study.

3.5.8 Study plan

Transferring the theoretical framework into action, the exploratory case study was designed over two stages outlined in Figure 17.
Stage 1 encompassed the preliminary study involving student and staff perspectives.
Stage 2 was a cross-sectional 'main' study of students and alumni groups.

The study was designed to follow the illuminative framework by first conducting an 'observe' phase, represented in this study as Stage 1. Given the relatively little amount of literature on learning anatomy, Stage 1 aimed to elucidate issues and experiences within anatomy education from a variety of perspectives. The 'enquire further' phase occurred in Stage 2 with refining of the student perspectives. This was required to explore in depth students' perceptions, approaches, experiences and application of anatomy. The 'explain' phase occurred in Stage 2 in the form of the alumni questionnaire. This allowed for verification of Stage 2 and enabled the application and consequence of experiences to be understood.

The flow lines represented in Figure 17 illustrate the progressive focusing routes. The themes identified for progressive focusing have been illustrated in this thesis to show the research pathway (Figures: 19, 20, 21, 23 and 24). The adoption of Grounded Theory within the methodological framework was enabled because the theory emerged from the data when the issues were identified. The theory was further refined and developed as the study progressed.

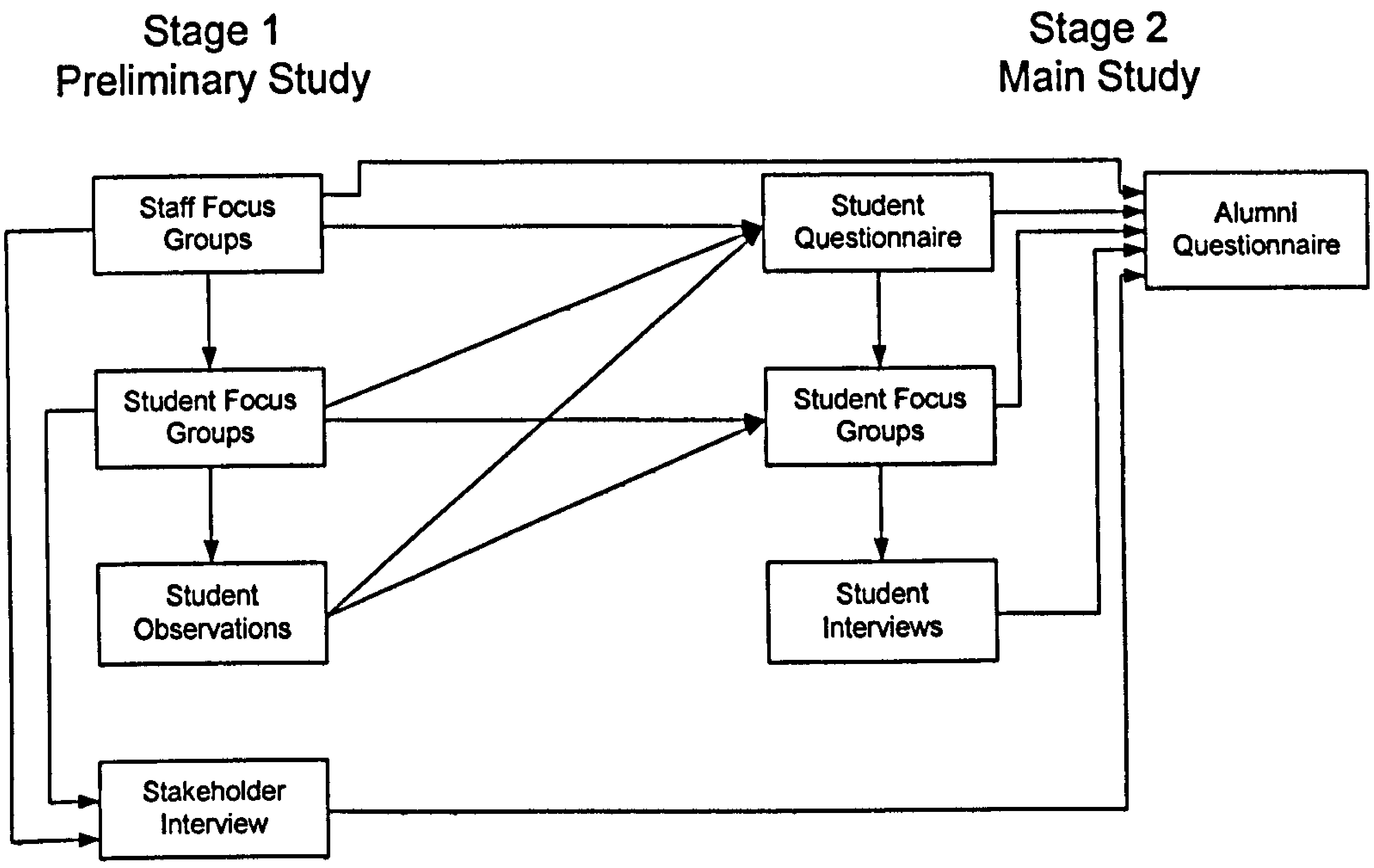


Figure 17. The two research stages and the flow of progressive focusing

4 Chapter 4. Preliminary Study: Identifying the Issues within Anatomy Education

4.1 Introduction

The initial stages of the research consisted of a series of exploratory activities designed to identify key issues that students, staff and other stakeholders had in relation to anatomy education. Focus groups, interviews and student observation methods were utilised. The outcomes of this initial work were analysed and examined in relation to the literature. A number of themes were identified for further investigation using progressive focusing to establish the next stage of the research.

4.2 Focus Groups

Focus groups were adopted to comprehend the key issues and concerns in relation to anatomy from staff and student perspectives. The focus groups were selected and designed to be relatively quick, free flowing and participant led. All seven members of the department's academic staff were invited to participate and five attended. The students were sampled through convenience sampling. Twenty students (second year BM 5) were asked to participate as they were in my academic tutorial group. Thirteen students responded and nine attended.

A written plan was developed, piloted and administered for each perspective (i.e. staff and students), which included open-ended questions (Appendix D). An information sheet for research participants provided information on the project's aims, participants' roles and a consent form (Appendix B). Focus groups took place in seminar rooms arranged to facilitate discussion.

Two staff focus groups were held, one with a group of three and one with two participants, to establish which issues were important to them. Initially, a brainstorm was carried out to aid the focus of the session. It appeared effective as the participants' thoughts flowed relatively freely. Each key area brought up by participants was then discussed in turn. Two student focus groups comprising of five and four second year BM 5 students were conducted. It emerged from the student groups that they believed that their answers were limited to only two years' experience and that their views might change as they entered a more clinically-orientated year.

4.2.1 Results

The results from the focus groups were not subjected to detailed analysis as the issues needed to be quickly established and structured into subsequent research activities. Therefore a summary of the issues raised through analysis of the transcripts is reported.

4.2.1.1 Staff

The focus groups formed of members from the anatomy department's academic staff revealed issues supported by the literature. In describing what they felt were important issues in anatomy education, they were all in agreement that curriculum content, teaching methods and students were important factors. Each point will now be taken in turn and discussed.

- Content

Curriculum content appeared to remain an issue despite the publication of the core curriculum (Dyball et al. 2003). This is perhaps intrinsically linked to curricular time in a belief that the more there is to teach, the more time required and the stronger the dominance of anatomy within the curriculum. It was not clear from the discussions which particular parts of the content were of concern. There seemed to be no debate as to the order in which the contents should be taught.

- Teaching Methods

It was felt that Southampton offered a wide variety of teaching and learning methods and that they all had their advantages and disadvantages. The discussion did not go into much more detail. It was often expressed that teaching needed to be clinically linked and that this should underpin the course content.

- Students

Student engagement and motivation appeared a concern for some members of staff, although all staff acknowledged that the students gave the impression that they would like to be taught, as highlighted in the following quote:

> I think quite a lot of the students expect to be spoon feed. I think that in tutorials it can be quite hard because you have the students that have done the work before hand and the students that haven't done anything and getting a balance so that you keep both parties interested can be quite difficult. (Lecturer in anatomy)

It was wondered whether this had always been the case, or a symptom of contemporary education. Staff felt that students were driven by assessment which resulted in rote learning. Some assessment methods used in anatomy, such as spotter and EMQ/MCQ, were felt to test isolated pieces of knowledge, reflecting the view of other literature (Nnodim 1992).

- Future

Anatomists believed anatomy was an integral part of medicine and would remain so, although in what form in the future remained uncertain. A few commented on anatomy departments merging and a shortage of staff. Some staff felt that anatomy departments needed to be more flexible, having held on to traditional concepts for too long.

4.2.1.2 Students

Second year students were asked questions which aimed to promote discussion about why they felt they were learning anatomy, how they were going about learning anatomy and what things hindered this process. Discussion flowed freely and the following key areas emerged.

- Learning process

When asking students: "What is important to you when learning anatomy?" many answers reflected practical concerns of learning anatomy. Some students stated that they learned by seeing, others by doing, for example:

> Seeing and being in the DR, being able to pull things around and have a good look, you can see where its coming from, where its going to and what its related to. (Year 1 student)

Most were keen to confirm their knowledge and understanding. Students liked the 'test-yourself' quizzes and spotters, as this student describes:

> The test yourself are helpful as they are from the specimens and if your not sure, you can take them over to the specimen and check. (Year 1 student)

As a general view, staff perceived that students were exam driven; this may be true to some extent. However staff may not have appreciated that students were seeking confirmation and reassurance through these processes.

- Relevance

When students were asked why they felt they were learning anatomy, some students immediately responded with clinical examples. Most students seemed sure about anatomy's purpose. Some had difficulty with this and a few students had already decided they were not going to be surgeons and felt they did not need to know anatomy as explained by the student below:

> I have kind of given up with anatomy and I said to myself, I am not going to become a surgeon, so its not important to me, I get by for the spotters. (Year 1 student)

It was only when prompted by colleagues, for example "you have to understand where a drug might work on", that the purpose of understanding anatomy became clearer to them. It was not known how many other students had this attitude toward anatomy. Many students commented that clinical aspects helped their motivation; for example, if they had a lecture about liver disease it made them want to find out what the liver looked like and how it functioned.

- Learning Pathologies

In reference to the literature on learning pathologies and influences on learning (section 2.3.3), I was keen to explore what aspects hindered students' learning of anatomy. Time, amount of material and the three-dimensional nature of the subject were prominent aspects from the student's perspective, as highlighted in the quote below:

> The biggest problem I have had in anatomy is the 3D idea of it. Its very much if you can't get to terms with the 3D nature of it, you can't see how it all related and all fits together. (Year 2 student)

Students also remarked that they were learning how to learn, especially when it came to assessments.

- Attitudes

Students were concerned that they might be judged negatively by the profession if they had not dissected. Students were curious about anatomy at other medical schools. Students were shocked that some doctors at other institutions would not have used cadavers prior to qualification. I informed students that Student Selected Units (SSU) in dissection was an option in the third year of their course. This discussion allowed students to open up and they shared how important the experience of human cadavers was to them.

4.2.2 Discussion

The focus groups revealed a disparity (more than I would have expected) between the concerns of the students and the staff, and an apparent lack of understanding by staff as to what the students were experiencing, particularly in comprehending how students learn, and how they used and perceived anatomy education. Supported by literature, the findings were applied in the construction of subsequent stages of the research.

The focus groups helped to gain an idea of the perceptions, experiences and concerns of the staff and students at Southampton. I felt it was important to explore the students' perceptions further through a variety of activities. In particular, I was interested in the learning environment of the DR and the process of learning anatomy. I therefore planned to conduct some observations within this setting.

Some of the issues raised by staff reflected the literature and I held the opinion that there was no further need to explore these. However, some aspects, such as the influences staff have on the curriculum and students' learning, I planned to explore through in-depth interviews with a variety of stakeholders.

4.3 Observations

The focus groups emphasised the need to explore further how students were conducting their anatomy learning. I felt that observing students in the learning environment of the DR would facilitate this. The aim was to describe the types of learning activities and how students were going about the tasks, possibly categorising and plotting a system of the activities used. All students in their first and second year had anatomy practicals in the dissecting room. I observed a selection from both year groups so that any differences which might be a result of students' experience could be observed.

I waited until the first year students were experiencing their second session (skeleton and muscle). The second years were studying anatomy in the nervous system course (head and neck 1). Observation of both groups was arranged by selecting a DR session in the timetable. As described in the methodology section (3.5.4), a semi-structured format was used. This comprised a structured recording sheet and a free notes sheet (Appendix E).

4.3.1 Results

- Semi-Structured recording

To begin with I noted the environment details, e.g. six students around station one. I also noted what each student appeared to be doing and how they moved through the practical class, e.g. studied specimen, referred to handbook and then touched muscles on specimen. I tried to note as much as I could about the entire experience.

- Structured recording

Using a structured scoring sheet, activities were recorded as they happened to a particular student. Five students from each class were observed in this way. A typical recording included the following: studied class boards, discuss with colleagues, examined specimen visually, referred to book, examined the specimen with finger, made note on book, discussed with colleagues, etc. Refer to Figure 18 for a picture illustrating students working in the Dissecting Room.

Figure 18. Students working in the Dissecting Room

4.3.2 Discussion

The results for the observations were not highly analysed. The activity was used as a tool to generate a broad understanding of the student activities in the DR environment. Briefly, the students were guided by their handbook and there was evidence that students had completed work before the practical, for example in the form of highlighting text. The system of learning activities varied immensely. Some students worked on their own, in groups, some touched and explored the specimens, and some observed. It is unclear why students were working in a particular way and what was achieved by each activity. Conclusions from this activity cannot be easily deduced; however they raised key areas (involvement with specimens, system of learning, group work, planning, engagement, etc) for which further investigation was necessary.

Having observed students in the DR I decided to revisit from personal experience learning in the DR environment. I placed myself as much as I could in the student situation and underwent a dissection and prosection practical as previously reported in section 2.2.2.2. From this experience I judged that the practical nature of exploring specimens required further investigation as a defining aspect of anatomy education – the element which has driven the debate over human cadaver use, mainly based on historical use but not on evidence.

4.4 Stakeholder Interviews

As part of the initial work of exploring and identifying significant issues relating to anatomy education, I felt that it was important to look further than the university and consult with a range of other relevant individuals from other institutions and professional bodies. I also had in mind that the curriculum was likely to have an impact on how students approached their learning of anatomy and talking to those involved in delivering anatomy in different curriculum contexts might indicate the extent to which issues and concerns varied. I called this wider group the 'stakeholders'. Included in this group were also those in the university who had some bearing on the curriculum and the teaching of anatomy.

The stakeholder group was divided into internal (those within the University of Southampton) and external. They were all identified because of their professional role. The internal group had two subdivisions: those that taught anatomy and those that influenced the curriculum. All potential participants were individually emailed explaining the purpose of the study, why they had been selected, and the nature and time of participation.

In order to protect participants' anonymity their exact job roles will not be disclosed, instead where applicable to provide context a broad job role will be used, e.g. lecturer. The participants from the external group included four anatomists at external institutions who taught anatomy within a medical school. They all had other roles within their institution, e.g. departmental head, and roles outside of their institution in professional bodies related to medicine and anatomy. Members of internal group were selected based on their job role and this included anatomists, those responsible for the curriculum and academics who taught other subjects within the medical curriculum. It included professionals who were also alumni of the medical school. In total 14 interviews took place (5 external, 9 internal). However, one interview recording became corrupt and had to be removed from the study.

4.4.1 Interview details

I used a semi-structured interview format to allow participants to freely discuss their experiences and perceptions of anatomy education based around a series of generic questions and a few specific to the individual's role. The interview schedule was divided up into five clusters: history, today, teaching, learning, and future (refer to Appendix J for an example). The history section was designed as an introduction so that I could understand the background of the participant. The 'today' section was designed to explore participants' current roles and perceptions of anatomy education in their institutions. Teaching and learning focused on participants' experiences of teaching anatomy to medical and other students.

One internal participant was concerned that they could not be truthful in participating as they perceived a conflict of interest. I discussed this with my supervisor and the participant was given the interview questions and reassured that any issues discussed would not be linked to their job role. The participant declined the interview.

4.4.2 Results

The interviews were transcribed verbatim from the audio recording into Microsoft Word and were subjected to initial coding. It was felt that it was not necessary to further analyse these into more detailed clusters. The principal findings are based on 13 interviews.
Principal findings:

1. Staff experiences of being a student were very similar to one another (all except two studied a variety of degrees at various universities).
2. As supported by the literature, there have been several common trends in anatomy education which have affected different institutions and staff (for example, a decrease in curricular time).
3. Stakeholders' perceptions of students were different across universities and staff. However, all recognised similar problems with the cohorts of medical students today compared to the past.
4. Debate was occurring over whether there was a difference in standards of graduates and whether it mattered.
5. The preference for various teaching methods/styles was largely reflective of that individual's experience and personality. No common or superior style or type was found.
6. Despite this study referring to medicine, many medical schools catered for other disciplines and these presented similar issues, thus confirming they were specific to anatomy as a whole, not just anatomy in medicine.

7. There were varying degrees of understanding of student learning experiences.
8. The outlook for the future had some common elements and some specific to institutions.

Each principal finding will now be addressed in turn, although it is difficult to separate the issues as many are interlinked and affect each other.

4.4.2.1 Staff experiences of being a student and learning anatomy

I wanted to gain an overview of the routes people took into anatomy. Some came through basic sciences in related fields (embryology, comparative anatomy), and some through deciding not to continue with clinical practice. Overall there was a feeling of being part of a traditional system in anatomy, detail-driven with dissection (as reflected in section 2.2.1). Participants' knowledge of anatomy was assessed mostly by vivas. Participants also observed that the condition under which anatomy was taught was different in the past, e.g. no gloves were used – "bits would get under your nails" (lecturer in anatomy). This is a reflection of the increase in health and safety awareness. In many cases it involved practices which would be considered unethical today.

Stakeholders reported that as students they initially found anatomy interesting but remembered the hard work involved. They also reported that at the time it was stressful and humiliating: stressful because of the dissecting, due to the emotional and internal need to prove yourself; humiliating in the mechanisms and manner of the teaching and assessment, in particular frequent vivas (often weekly). Anatomists explained that they could visualise the body without using specimens.

4.4.2.2 Common trends in anatomy education

The history and literature review chapters have explored the various reported issues in anatomy education and these were very much reflected in the staff focus group and also in the stakeholders' responses about the course at a given institution.

Many highlighted the worsening staff-student ratio which had resulted from several pressures. The numbers of medical students had increased as a result of government guidelines to increase the number of doctors. This had been mostly though increasing places on medicine courses and through the development of the new graduate entry programmes. This had also been coupled with an increase in the numbers of other students using the anatomy departments. At the same time, the number of faculty staff had either remained the same or decreased, a phenomenon described as the 'greying anatomy department' (Topp 2004). Staff (lecturers) commented that this had led to knowing fewer students personally. Staff (lecturers) reported their concern over the decrease in anatomy demonstrator posts, reflecting the literature (section 2.2.1.1).

Curriculum changes as a result of the General Medical Council (1993) Tomorrow's Doctors report forced some schools more than others to reduce the detail of their curricula and move to systems-based teaching. There appears to have been an acceptance of the detailed pruning but there was also a concern as to whether the level of detail was too low. This view is reflected in the literature as being referred to as ADD (Anatomy Deficit Disorder) (Reidenberg & Laitman 2002). As previously discussed, the move to systems-based teaching possibly left gaps and topics that did not fit within a system, and hence small pockets of regional anatomy remained in curricula, e.g. the neck.

Anatomy within many medical curricula had moved towards a semester-based teaching timetable, although the effect appeared to be negligible on the amount of anatomy taught. Several more traditional institutions noted a decrease in the time allotted to anatomy when other disciplines, e.g. communication, were brought into the curriculum. This created the perception of the discipline being further squeezed. The issue of assessment and its importance were also raised. It was felt by lecturers that if the requirement to pass anatomy assessments were weakened then students would not put the effort and time into the subject and they would not appreciate its importance in clinical practice.

A common trend which has affected institutions and compounds the above issues is the Research Assessment Exercise (RAE). Anatomy staff felt it had been forced upon them and had affected many decisions regarding the anatomy department, which may have been at the expense of resource, time, space, etc.

4.4.2.3 Stakeholders' perceptions of students' perceptions

It was clearly acknowledged that students of today were different to those of some years ago, but how this affected medicine and anatomy remained unclear and was very much hearsay. At Southampton, I was interested to look through old data and photographs, and it was clear that there had been some demographic changes in the student population echoed elsewhere (British Medical Association 2004). There has become a greater diversity of students from the 'white faced male' to the multicultural and more gender varied. Pre- and post-16 education has also changed significantly and participants all felt that students today came with less knowledge and ability that those before them. The following quote from one participant illustrates a staff's experience of students: "The complaints we get - they want all of the lecture written out, specimens labelled, handbooks - they want us to write an anatomy text-book" (lecturer and course director). Participants felt that students preferred to be increasingly 'spoon fed'.

4.4.2.4 Standards of graduates

When questioned about the standards of graduates, there was a mixed response from stakeholders. However, an important distinction was made between knowing the anatomy having learnt it from a book and being able to use it on a cadaver or patient. If students had passed a level of examination did their level of anatomy knowledge matter? The answer would be 'no' if they could practise safely. However, many stakeholders were aware of the rising litigation claims caused by a lack of anatomical knowledge so there had to be a deficit that mattered. One reason put forward for the increase in postgraduate anatomy was this deficit and the fear from the professional colleges of litigation (dean).

4.4.2.5 Preference over teaching method/style

The preference over a certain teaching style and method was very much related to the individual's own learning experience and personality. There was a distinction made between focusing on the content of the teaching session and focusing on the process, and that this shift occurred when you were confident in the material to turn it around in terms of process - a move from didactic teaching to facilitation.

A variety of methods and styles were discussed. This included small group teaching which teachers preferred as they were able to relate to students, giving them the chance to ask questions and be part of discussion. They all acknowledged the limitations of this style of teaching due to staff numbers. Most were very much in favour of making teaching relevant to clinical practice where possible. An area of common agreement was the notion of providing students with a foundation (simple principles, building blocks) in language and information; if they had a solid foundation they could build on it.

4.4.2.6 Other courses and disciplines

It was interesting to discuss the experiences of other disciplines. In physiology, for example, the students perceived it as concept-based and most students appeared to manage it better than anatomy. It is likely that the perception of the amount of anatomical detail and the spatial aspect are the two main factors which hinder anatomy learning specifically. The majority of anatomy departments taught paramedical courses to some extent. Medicine (apart from anatomy degrees) remained the course with the largest component of anatomy. Participants (lecturers) felt that paramedical students experienced the same teaching as medical students and had similar problems with anatomy.

4.4.2.7 Understanding of a student's learning

There was a general opinion that in providing the foundations of anatomy, deep learning may occur more dominantly later on in the course or in clinical practice. It was raised by lecturers as a possibility that students of the same approach tend to group and work together, especially in DR sessions.

4.4.2.8 Outlook for the future

From the wider perspective it was felt that the future of medical education was very much dependent on political decisions (lecturers and course directors). It was questioned if anatomy would or could get to the level of virtual reality, which would dramatically change how it was taught. This has been referred to as a drive to make anatomy less dirty and more sterile. It was suggested that while many university courses might become distance run, medicine and anatomy would stay as site-based. Many participants were concerned about the detrimental effect the RAE might have on things like funding and staff numbers, which would cause problems for medical education as a whole and anatomy specifically. In some geographical areas this might result (from lecturers' perspectives) in merging or sharing anatomy schools especially where there were staff shortages. In the extreme this might cause private anatomy schools to make a comeback as businesses rather than university departments. However, some felt that due to the legal threats through litigation cases anatomy would be making a return for the future (dean). This was especially felt true of postgraduate anatomy. It was hoped that the professional colleges and universities would reinstate demonstrator posts within postgraduate education (lecturers).

4.4.3 Discussion

The stakeholder interviews appeared successful in describing participants' experiences and perceptions of anatomy education. The trends described were reflected in the literature and did not warrant further exploration. Common aspects were experienced across other universities and other students learning anatomy which help promote the generalisability of this study. One issue that required further focus was student engagement and this was noted for further investigation.

4.5 Conclusions From The Preliminary Study

In this section the findings of the preliminary work will be summarised and discussed with a view to indicating what key themes and issues emerged as a basis for further investigation in the later work.

Figure 19 summarises the main themes emerging from the preliminary work and the initial plan devised for exploring these in more depth. The student perspective and experience were particularly important in understanding the process of student learning, especially perceived relevance of learning and factors which affected the ways in which students went about their learning. It seemed appropriate to use a questionnaire for part of the next stage as this could potentially capture the experiences of a much larger number of students. In addition, it would also be possible to attach one of the established approaches to learning inventories with the aim of characterising students' learning approaches in a more precise way. Focus groups were considered for exploring some themes in greater depth (e.g. planning and learning activities), and for following up and corroborating the outcomes of the questionnaire and inventory.

It was decided not to follow up the stakeholder interviews as it was unclear what significant new evidence would emerge from further work, and there was need to focus on the student learning theme within the time available for the research. However, some of the themes (e.g. graduate standards) could be pursued through an alumni questionnaire which would also capture the experiences of professionals who were likely to have something interesting and relevant to say about their experiences of anatomy learning and how it was applied in professional practice.

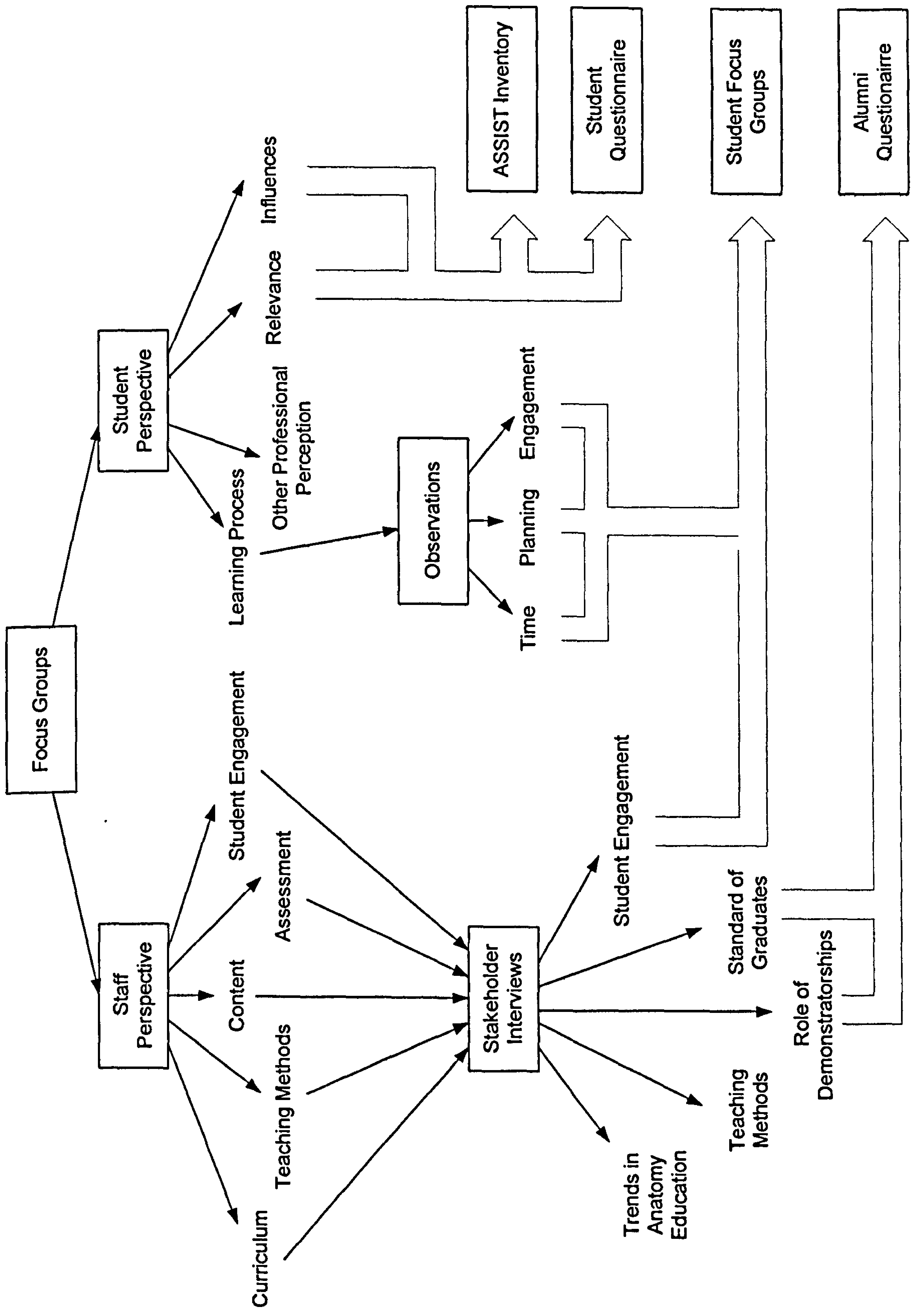


Figure 19. Illustration of themes mapped out from preliminary research activities in this chapter and the progressive focusing themes

4.5.1 Working model of anatomy learning

From the literature and the results of the focus groups, observations and stakeholder interviews I was beginning to understand what was important in anatomy education. The following points represent key findings of this initial exploratory work.

- The issues described in the literature are representative of the issues experienced by staff at both the University of Southampton and at other institutions (e.g. political influences, historical aspects, changes in student attitudes and demographics).
- There was an increasing level of concern regarding students' ability and preparation for higher education from the 5-18 education system.
- Students learn anatomy through a variety of activities including the DR. Students are guided by their handbooks and work to a system which reflects various levels of engagement and activities based upon seeing and doing. Confirmation of learning is important to students.
- Various influences, both positive and negative, affect students' learning of anatomy. Relevance helps with students' motivation whilst the large volume of information and spatial nature of the subject appear to present challenges or even hinder motivation and learning.
- A greater than expected mismatch between student and staff perspectives which may reflect the lack of research and evidence base available on understanding anatomy learning.
- Many anatomy departments also teach anatomy in similar ways to many paramedical groups. These students' experiences reflect similar issues as those for medical students.

I found the activities that were based around the use of human cadavers to be of interest for further work as some students highly explored the specimens whilst others just watched and I wondered how this exploration (or lack of it) mapped onto understanding anatomy. This is also supported by the lack of evidence and understanding in the literature of the use of the human cadaver in relation to students' learning of anatomy.

There was closure for a few lines of enquiry at this stage. I chose to focus on medical education and did not explore anatomy learning in other disciplines because the literature and stakeholder interviews supported that anatomy learning in other disciplines was similar to medical education. Neither did I seek to further explore teaching methods used in anatomy for two reasons. Firstly there is literature describing common teaching methods (e.g. lectures) and, secondly, I felt the emphasis needed to be on understanding the learning process.

5 Chapter 5. Student Approaches and Experiences of Learning Anatomy.

5.1 Introduction

I used the literature and preliminary activities to formulate more specific research questions. The themes I identified for further exploration were:

- Students approaches to learning anatomy
- Influences that affect anatomy learning
- Relevance and application of anatomy.

I felt it was essential to broaden participation and seek the experiences of more students involved in both BM 4 and 5 courses. I therefore choose to use an approach to learning inventory (ASSIST) and a questionnaire to answer the following research questions:

Sub-questions 1. Anatomy learning

- What are medical students' perceptions of anatomy?
- How are medical students approaching anatomy learning?
- What is involved in the learning process?
- What affects and influences the learning of anatomy?
- How are medical students applying their anatomy knowledge?

This chapter answers these questions using quantitative methods within the illuminative case study framework.

5.2 Organisation

The rationale behind the inventory and questionnaire has already been discussed in section 3.5.6. The main aim for their application was to classify students' approaches to learning anatomy and capture students' experiences of the learning process as part of a broad investigation which would then lead onto progressive focusing on significant issues. The ASSIST Inventory (Appendix G) and the questionnaire (Appendix H) were combined into one online activity. The questionnaire was designed to contain six clusters in which several statements were presented and required a Likert scale response. The clusters were selected as themes for confirmation or development from the literature and preliminary study. The rationale for each cluster is briefly described.

- Cluster 1. 'The activities students prefer to do to learn anatomy' was selected to confirm the findings of the focus groups from a wider perspective.
- Cluster 2. 'Students' experiences and feelings about working on cadavers' had been highlighted in the literature and focus groups to show a variety of responses. The experience might affect learning so I aimed to establish students' experiences within the sample.
- Cluster 3. 'The problems students encountered in learning anatomy' had not been explored in the literature. Several possible problems were discussed in the focus groups and this cluster would allow for a more general view and possibly classification of these problems.
- Cluster 4. 'How students currently use their anatomy knowledge' was selected because relevance was discussed by students in the focus groups and it remained unclear how they were applying their anatomy knowledge so further investigate was necessary.
- Cluster 5. 'Students' overall perceptions of anatomy' was selected as with little of the literature representing the student perspectives I was keen to explore students overall perspectives of anatomy so I could explore if students' perceptions and experiences were linked.
- Cluster 6. A few questions specific to either the early or later years of the course. These where chosen to reflect the level and application of anatomy and would enable comparison to reflect the journey of learning anatomy as the course develops.

The ASSIST inventory and the questionnaire were constructed in Question Mark Perception^{TM} and were subjected to several stages of pilot testing before the activity was available to students at https://www.som.soton.ac.uk/learn/anatomicalsciences/qmark/default.htm. On the 10th March 2006 students on the BM 4 and 5 courses (all years, 1075 students) were emailed an invitation to take part in this study (44 emails were returned as undeliverable). A written invitation letter was also sent to all students. A reminder email was sent on the 20th March 2006. Due to the nature of the 4th and 5th year vacation breaks the questionnaire remained live until the 24 April 2006, with a final email reminder sent five days before. Students were required to log in using their university username and password. Students then reached a page that contained the Participant Information Sheet (PIS) and consent forms with options to be selected for involvement in future focus groups. Students were then guided through the ASSIST inventory pages followed by the questionnaire. At the end of the survey students came to a thank you and conclusion page. Students who had fully completed the questionnaire were entered into a prize draw for book tokens. To avoid any potential claims of bias an academic member of staff not involved in this study selected winners through a random number generator at www.random.org.

Data were removed from the server and students who had selected the option of feedback were exported into a separate file and their ASSIST scores were calculated. Each of these students received an email with an introduction as to what the ASSIST inventory was, their scores with an explanation, and some advice on study skills.

5.3 Results

As indicated above, the activity contained two parts: the ASSIST inventory and the Anatomy Questionnaire. Data were extracted from the servers and imported into Statistical Package for Social Sciences ™ (SPSS). The data were cleaned to ensure correct formatting. Any entry which was incomplete was deleted. Table 6 provides details of the sample for the ASSIST Inventory and Questionnaire. The sample contained nineteen students from a potential 79 (24.1%) from the BM 4 course and 243 from a potential 996 (24.4%) from the BM 5 course. Overall the sample contained 44 mature students and 24 overseas students.

Research Activity	Number of students who completed	Number of incomplete entries withdrawn	Final Sample	Gender Ratio
ASSIST Inventory	317	54	263 (24.4%)	94 (39%) Male 149 (61%) Female
Questionnaire	297	41	256 (23.8%)	95 (38%) Male 161 (62%) Female

Table 6. Sample details for the ASSIST Inventory and Questionnaire

5.3.1 ASSIST Inventory

ASSIST scores were calculated as detailed in Appendix G. This involved totalling the sub-scores for each category. The strategic approach domain contained five categories and the others four, therefore the totals were normalised by multiplying the total strategic score by 0.8 to make the scores for each approach comparable. This gave an overall score for deep, strategic and surface preferences for each student. The preference with the highest score was given a nominal number as this was the preferred approach (1= deep, 2= strategic, 3=surface). In two cases, students had equal preference this was denoted by a number 4. Once the data were prepared, various statistical tests were performed to explore the data.

Examining the frequencies of students' dominant approaches showed that a deep approach was preferentially favoured by students (46.4%). Table 7 displays the preferences for approaches to learning anatomy.

Approach to Learning Anatomy	Frequency	Percent
Deep (1)	122	46.4%
Strategic (2)	104	39.5%
Surface (3)	35	13.3%
No Preference (4)	2	0.8%
Totals	263	100%

Table 7. Preference of approach to learning anatomy

I decided to test if there were significant differences between the types of learning approach regardless of year or course of study. Paired Samples *t*-tests were suitable to compare the means of the sample and were performed between each approach. As a check, a non-parametric Wilcoxon Signed Ranks test was performed on all approaches and the results confirmed the *t*-tests. There was a clear and statistically significant preference for a deep approach to learning anatomy. When looking at the data in more detail there was a significant difference between students who used a deep over a strategic approach to learning ($p < 0.001$) and students who used a strategic over a surface approach to learning ($p< 0.001$). Students' preference between a deep approach and a surface approach was also significant ($p< 0.001$). Confidence in these results is supported by three factors: a large number of cases, the mean values, and the small standard deviations. Lines of fit were examined and illustrated by histograms confirming the suitability of the *t*-test. The Wilcoxon test provided additional confirmation of the significant differences found. Further details of the *t*-test and Wilcoxon tests can be found in Appendix K.

The final sample of 263 (24.4%) was relatively small, although not too unexpected for this type of exploratory study. It was therefore difficult to be sure that it was fully representative of the population characteristics. However, several factors provided a good degree of confidence that the sample outcomes were reasonably reflective of the population and hence could be attributed to the population. The response rates for each year of study were similar (see Table 8) and were not significantly skewed towards any particular year. The gender ratio of the sample reflected the gender ratio of the population (during the 2005/2006 academic year the gender ratio of students within the School of Medicine was 39% male and 61 % female). The level of statistical significance was particularly high, especially between students classified as predominately deep and strategic where the frequencies were relatively close.

The following sections present further analyses of the approaches to learning data which were carried out.

5.3.1.1 Courses

As previously described, the BM 4 and 5 courses had very different curricula and entrance requirements, with the BM 4 course being a graduate programme. To establish if there were differences in how students were approaching their anatomy learning between the BM 4 and 5 courses, a non-parametric test for two independent samples, the Mann-Whitney Test, was performed for each approach to learning. Only one significant difference (p= 0.011) was found between the courses and the approach to learning students adopted, with no students on the BM 4 course adopting a surface approach to anatomy learning. This is interesting and may reflect the graduate nature of the course.

Relatively little had changed in the previous five years on the BM 5 course and it was therefore possible to compare students' approaches to learning anatomy across the years of study. Table 8 illustrates the number of participants across the BM 5 course.

Year of Study	Number of participants per year of study (and response rate)	Total students in year
1	60 (28%)	213
2	49 (24%)	208
3	50 (22%)	226
4	56 (31%)	178
5	28 (16%)	171
Total	243 (24%)	996

Table 8. Number of participants per year of study on the BM 5 course

With a fairly even spread of participants, a one-way analysis of variance (ANOVA) test was carried out for each learning approach to examine any differences. Details of the ANOVA can be found in Appendix L. For students who adopted a deep approach in each year there were no significant differences between years of study. However in comparing year of study and students who adopted a strategic approach in each year, there were three significant differences between years 1st - 3rd (p=0.038) and 3rd - 4th (p=0.011) and 4th - 5th (p=0.036). There was one significant difference in year and surface approach, between 1st- 4th years (p=0.022).

When considering the strategic approach, the differences have occurred at a time when there was significant (real and perceived) change in emphasis in the curriculum as the students progressed. Thus more third years use a strategic approach to second years and more fourth years are using a strategic approach than third years.

The BM 4 course started in the 2004/05 academic year and therefore there were only two cohorts. Within the BM 4 sample 47% adopted a deep approach and 53% adopted a strategic approach. No BM 4 students adopted a surface approach. The smaller sample meant the ANOVA test was unsuitable for this data and the non-parametric Mann-Whitney test was performed to examine any differences between the two years. This demonstrated no significance difference between the year of study and approach to learning anatomy ($p= 0.098$ for a deep approach and $p= 0.154$ for a strategic approach). Further details of this test can be found in Appendix M.

5.3.1.2 Gender

I was interested to explore whether, as the literature suggested, gender was associated with the adopted approach to learning (Mattick & Bligh 2004). I performed a non-parametric Kruskal Wallis test to explore if two independent groups differed (refer to Appendix N for further details). This revealed one significant difference between gender and the deep approach to learning ($p= 0.041$) showing that more males than females adopted a deep approach. More females than males however adopted a strategic approach.

5.3.1.3 Exam results

A Pearson's correlation (bivariate, two tailed) was performed to explore the relationship between students' first year anatomy spotter results and their ASSIST score for each approach. One significant correlation was found between students who had adopted a strategic approach and their anatomy spotter exam results. Students who had adopted a strategic approach performed better ($p < 0.001$, $r = 0.266$) (refer to Appendix O). I was interested to explore the results further and examined the percentage of students who had failed within each learning approach. From the students who had adopted a surface approach, 8.6 % failed the course. This is compared to the other failing students, with only 2.9% having adopted a strategic and 6.6% having adopted a deep approach. This reflects that the approach to learning anatomy adopted has implications for the student's performance in anatomy assessments. Despite this it is unclear if the assessments are promoting a deep or surface approach to learning anatomy.

5.3.2 Discussion of students' approaches to learning anatomy

In summary, 263 students successfully completed the ASSIST inventory. It was possible through the ASSIST inventory to classify students' approaches to learning anatomy. A deep approach was favoured by 46.4% of students (39.5% strategic, 13.3% surface). No BM 4 students adopted a surface approach. More males adopted a deep approach and more females a strategic approach, supporting previous research (Mattick & Bligh 2004).

In comparing years of study no differences were found for a deep approach but for a strategic approach differences were found between years 1-3, 3-4 and 4-5 with students becoming more strategic as the course progressed, reflecting previous findings (Coles 1985b).These differences between course years are a reflection of real differences in the course structure. The first two years of the course are composed of systems-based teaching primarily at the Boldrewood Campus (refer to section 1.3.2). Students' learning activities were composed of lectures and practicals with limited clinical exposure. In the third year students had a significant change as they rotated around different medical and surgical specialities and were based at Southampton General Hospital. Learning was focused on the clinical context but also involved lectures and small group work. In the later years students continued on rotations, becoming more independent and were located at associated hospitals. The significant differences also reflected students' perceptions. Major assessments (BM Primary, Intermediate and Finals) took place in years 1, 3 and 5. The increase in the number of students adopting a strategic approach appeared to reflect the dominance and influence of assessments as the course progresses.

Students who adopted a strategic approach performed better in first year anatomy assessments. Students who adopted a surface approach were more likely to fail. These findings may reflect that the assessments are influencing the approach to learning anatomy adopted by students. However there is a potential issue as the assessment comparison only refers to first-year anatomy assessment. Students later on in the course may have changed their approach to learning anatomy, given the increase in the context of the subject in the more clinically-orientated years. Further investigation through discussions with students from a range of assessment scores was required to explore the relationship between approach to learning anatomy and assessment outcome and the influence of assessments on the approach to learning anatomy adopted.

Overall: Students predominantly adopt a deep approach to learning anatomy. There is a need to investigate further assessment and approach to learning anatomy. Students who adopted a strategic approach performed better. This may highlight implications for the design and choice of assessment. It was unclear why many students adopted a deep approach to anatomy.

The ASSIST inventory expressed how students were approaching their anatomy learning. It was not clear how students' approaches to learning anatomy interacted with students' perceptions and the learning activities students engaged in. I also wanted to further explore if the most successful approach in terms of the assessment, a strategic approach, was best suited to the application of anatomy knowledge in the clinical context. In order to examine these aspects I needed to relate the ASSIST findings to anatomy and this I initially carried out through the Anatomy questionnaire

5.3.3 Anatomy questionnaire

The initial focus groups and observations had illustrated a need to gain an understanding from more students about their experiences of learning anatomy. The anatomy questionnaire was designed to facilitate this through Likert scale questions (using the same scale as the ASISST Inventory to avoid any confusion). It was also important to be able to relate the ASSIST inventory to the context of learning anatomy. I designed a range of questions divided into the following clusters (refer to Appendix H for a list of the questions). The clusters were chosen based on three aspects. Firstly to reflect similar questions discussed by the focus group but to seek a wider range of views. Secondly, to explore further themes highlighted, e.g. relevance, and thirdly, to begin to explore newer themes such as application of anatomy.

- Cluster 1. The activities students prefer to do to learn anatomy
- Cluster 2. Students' experiences and feelings about working on cadavers
- Cluster 3. The problems students encountered in learning anatomy
- Cluster 4. How students currently use their anatomy knowledge
- Cluster 5. Students' overall perceptions of anatomy
- Cluster 6. A few questions specific to either the early or later years of the course.

5.3.3.1 Overall findings

I created a graph of the responses to each question to give an overview of the response and any possible trends, and prior to any further analysis I report on the overall findings from each cluster with some examples. The graphs were created in SPSS using a clustered bar chart technique so that student responses to the Likert scale questions could be shown alongside the year of study in order to facilitate comparison. The key denotes the Likert response to the given question number and the colour used to illustrate this response (5= Strongly Agree, 4= Agree, 3= Neither Agree nor Disagree, 2= Disagree, 1= Strongly Disagree).

Cluster 1 examined the activities students preferred to learn through.
The responses showed that students highly rated learning activities which involved text books, online material and course books. Graph 1 illustrates this using the example of course books. The use of textbooks and course

materials may reflect the students' perceived need for learning in text form and as a reference. Students would be familiar with online learning and may have responded positively due to its flexibility in terms of time to help their learning. Another question asked students to rate the effectiveness of learning anatomy through more clinically-orientated methods such as imaging. This revealed that students did not feel these to be highly effective, as illustrated in Graph 2.

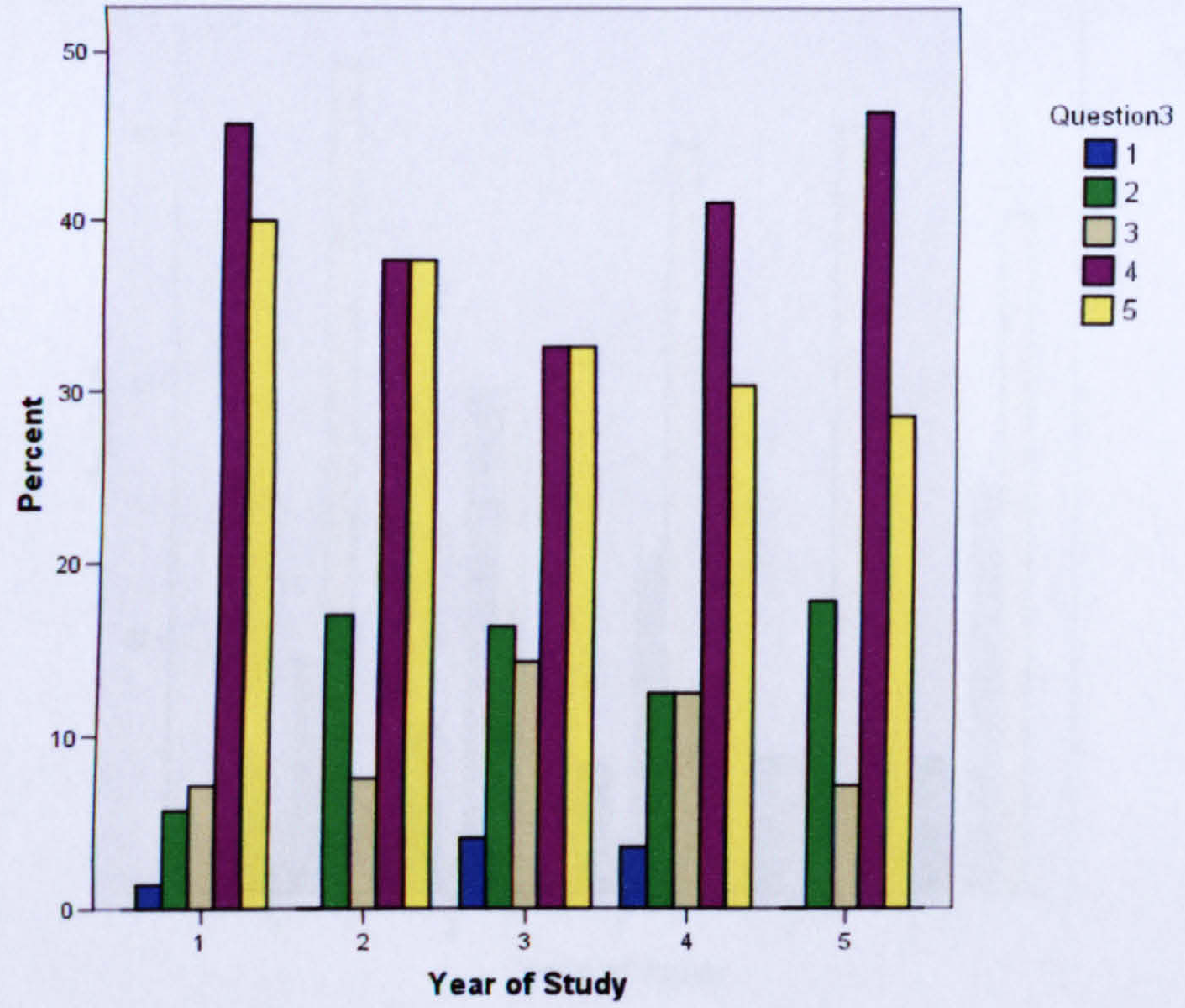
Cluster 2 explored students' perceptions of working on cadavers. Importantly students found working on specimens an effective way of learning anatomy (Graph 3). This may be explained further in that across all years students responded by strongly agreeing to getting their hands in and exploring a specimen and this is may be linked to a touch-mediated perception process that occurs and facilitates understanding (Graph 4).

Cluster 3 explored the problems that students encountered in anatomy. Aspects that students had problems with included:

1. The amount to learn is daunting
2. For some, exploring specimens with their hands
3. Radiology
4. Remembering aspects covered in previous courses/years.

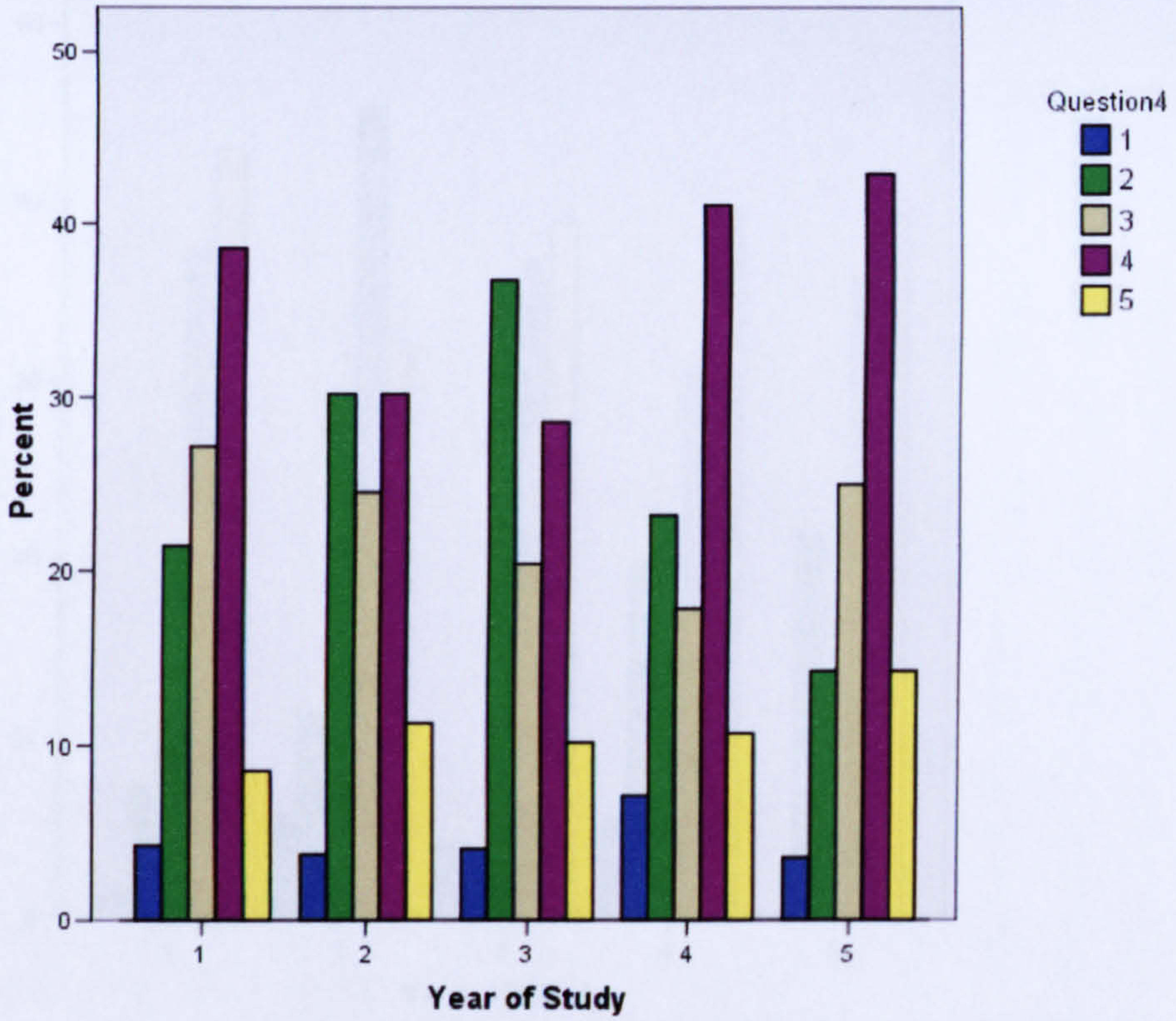
I was not surprised by students responding highly, especially the first years, to finding the amount they have to learn daunting (Graph 5). This confirmed the views of the student focus groups. This perception may be a factor influencing the approach students adopted. I wondered what aspects in particular were driving this. I thought that this might help to explain why students adopted a surface approach in anatomy, and even those who utilised a strategic approach might feel the same and use surface elements. It may mean that some avoid anatomy altogether. I was interested to explore further how students' perceptions of finding the amount of anatomy daunting changed and what factors were important to students who may have initially felt this but who adopted a deep approach to learning.

Question 3: "I find/found material provided by the course books an effective way of learning anatomy e.g. handbooks" - student responses by year of study.



Graph 1. Question 3

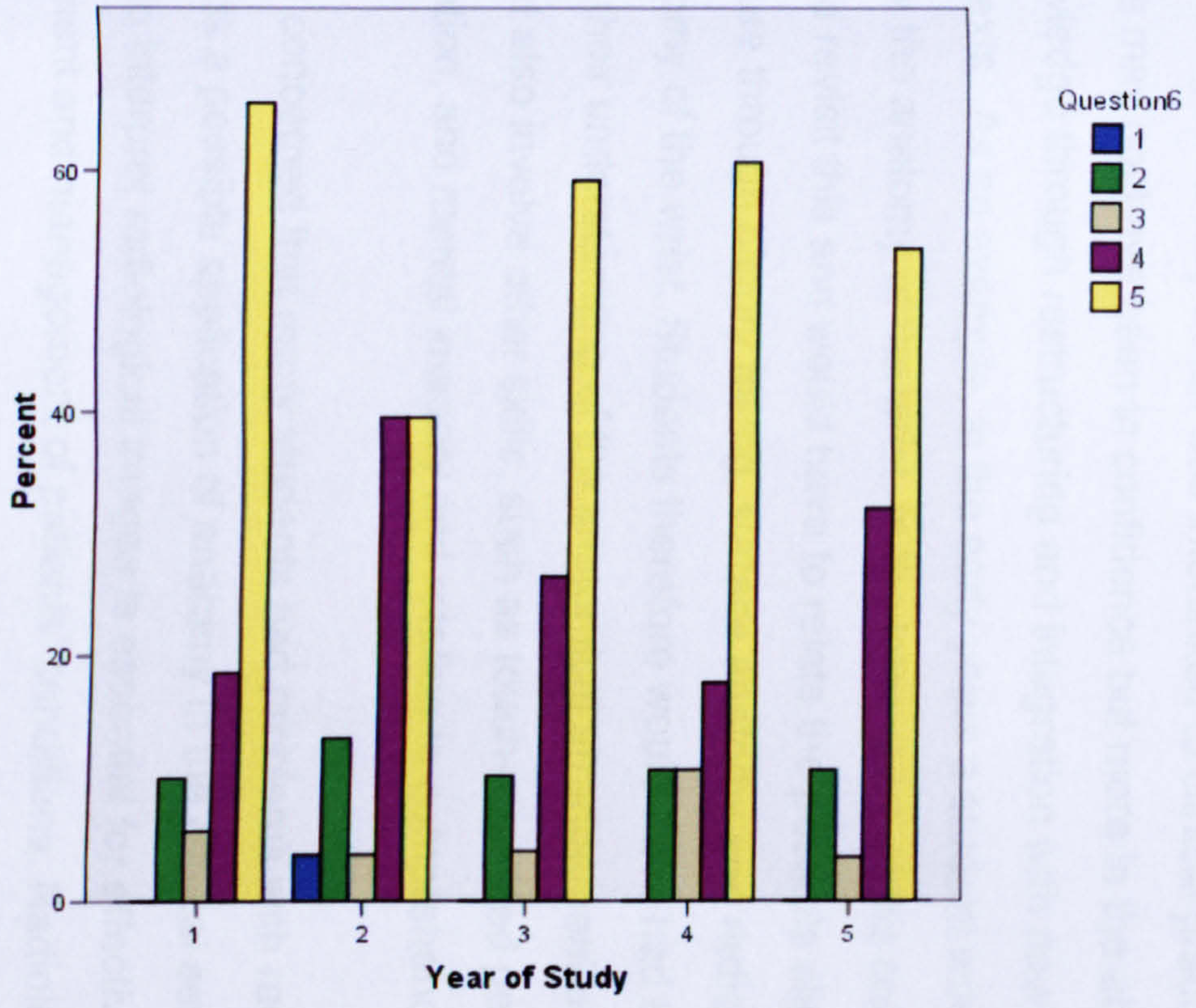
Question 4: "I find/found using imaging material e.g. MRI an effective way of learning anatomy" - student responses by year of study.



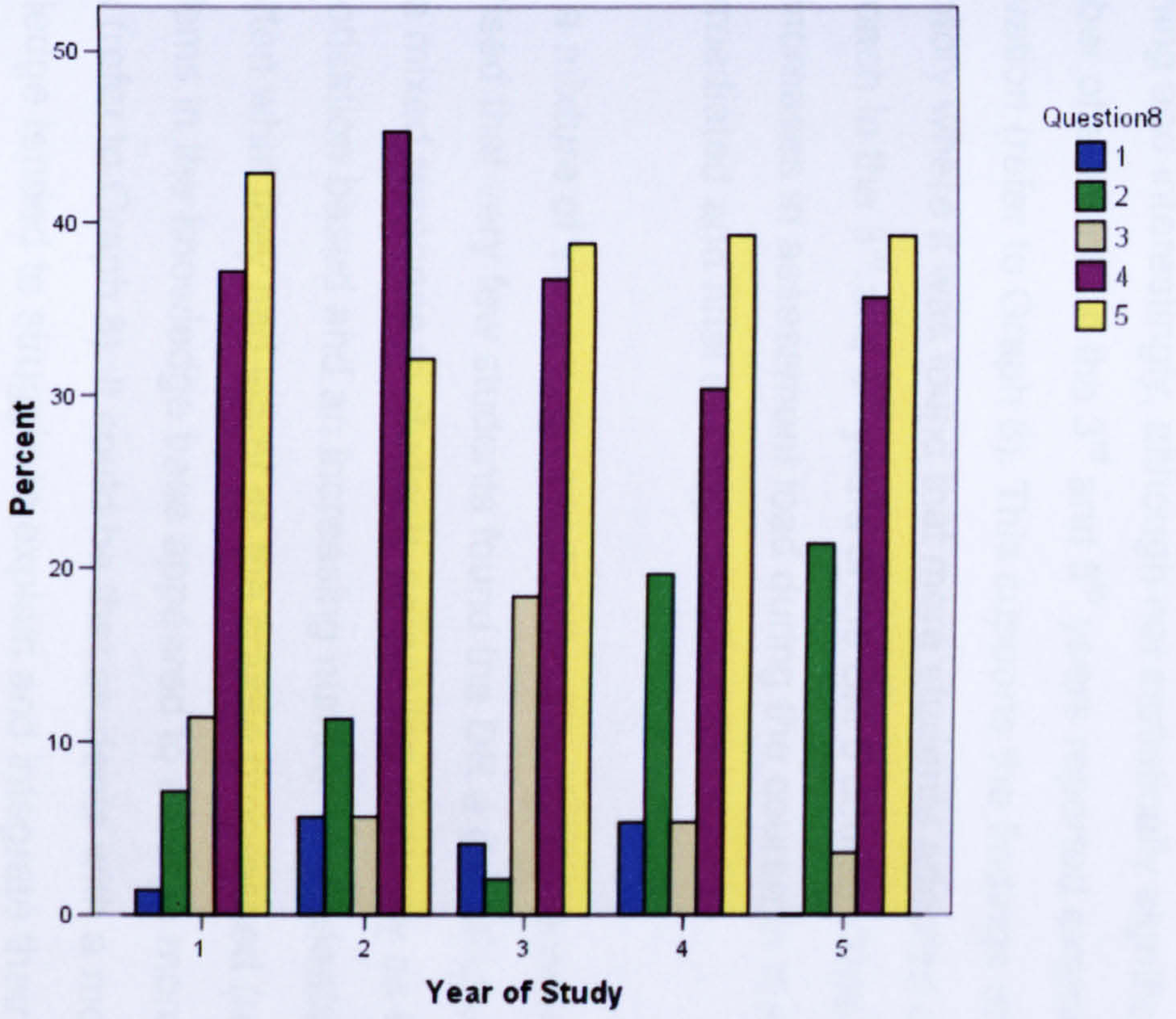
Graph 2. Question 4

Key

- 🟦 1 Strongly Disagree
- 🟩 2 Disagree
- ▨ 3 Neither Agree nor Disagree
- 🟪 4 Agree
- 🟨 5 Strongly Agree


Question 6: " I find/found Dissecting room specimens an effective way of learning anatomy" - response by year of study.

Graph 3. Question 6


Question 8: "The most effective way I learn/t anatomy in the Dissecting Room is/was to get my hands in and feel for structures" - response by year of study

Graph 4. Question 8

Key

- 🟦 1 Strongly Disagree
- 🟩 2 Disagree
- ▨ 3 Neither Agree nor Disagree
- 🟪 4 Agree
- 🟨 5 Strongly Agree

I asked students in the questionnaire about their primary motivation for learning and interestingly, although not statistically significant, a higher number of students in the 3rd and 5th years reported examinations as their motivation (refer to Graph 6). This supports the findings of the ASSIST inventory where it was found that more students adopted a strategic approach in the 3rd and 5th years of the BM 5 course. This perception reflects real increases in assessment load during the course in the 3rd and 5th years (intermediated and final exams).

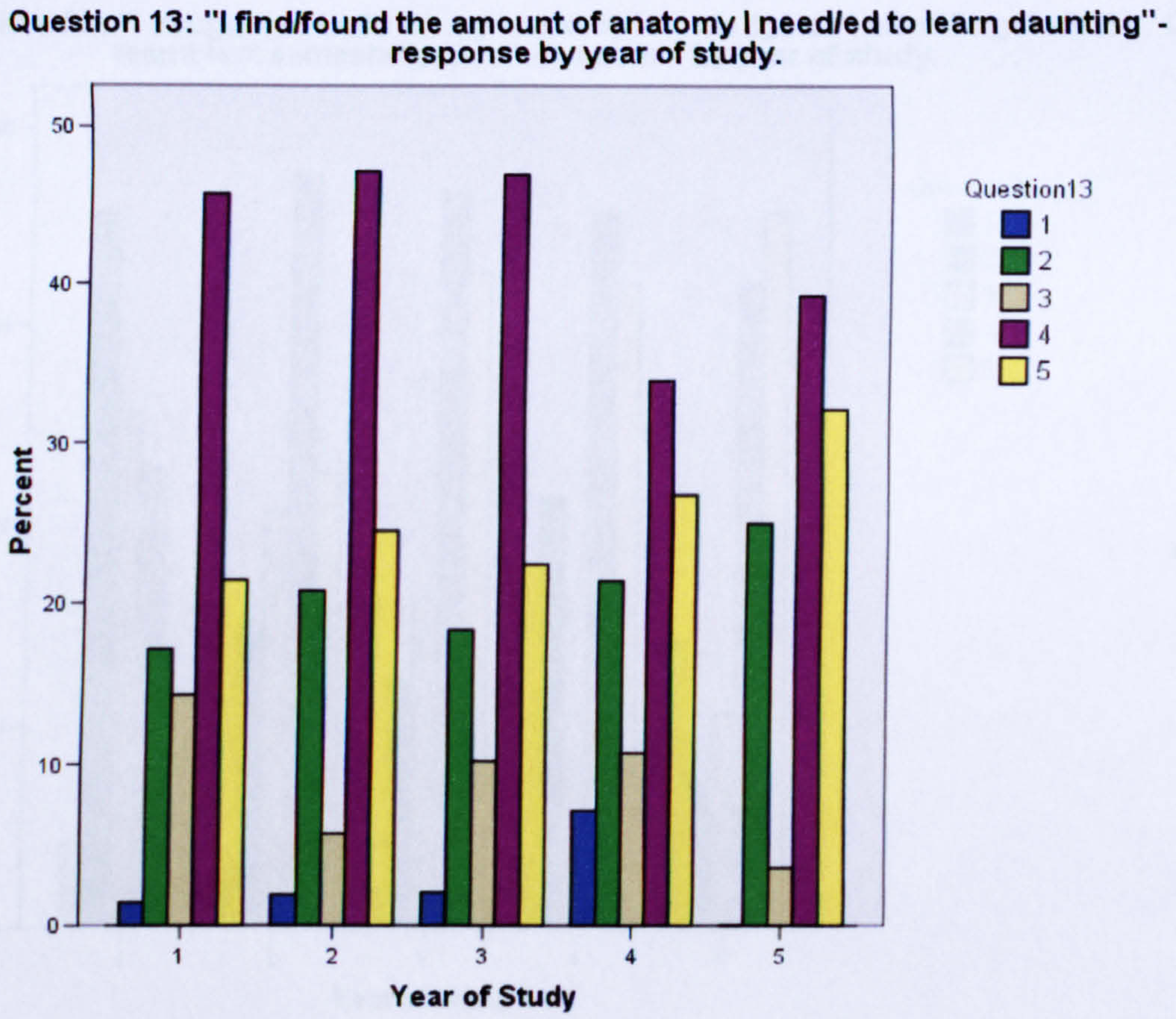
With a mixture of views expressed in the literature (section 2.2.2.1) I was surprised that very few students found the DR a daunting environment. There was a mixed response to students perceiving anatomy as being memorisation based and an increasing number of students said they had forgotten what they had learnt as the course progressed (refer to Graph 7). Problems in the knowledge base appeared to emerge more in the 3rd and 4th years (refer to Graph 8). It could be that students with a more fact-based knowledge tended to struggle to explain and integrate their knowledge with new knowledge. By the 3rd year students would be using their anatomical knowledge in a way which was interlinked to clinical practice and here the issue may not have been in confidence but more in the ability to apply the knowledge through restructuring and integration with new knowledge and contexts. As an example, in the early years a student would be expected to know the anatomy of the wrist. In the later years of the course the student would revisit this and would have to relate the possible clinical signs of fracture through history taking, surface anatomy and radiology to the anatomy of the wrist. Students therefore would have had to integrate and form their understanding of the anatomical arrangement of the wrist. This would also involve other skills, such as touch-mediated perception used in palpation, and mental imagery and rotation to comprehend an X-ray.

I was concerned that many students had problems with radiography as this reflects a possible application of anatomy in the clinical setting, and being able to interpret radiological images is essential for effective diagnosis, treatment and management of patients' conditions. Radiological understanding however is complex and does require the students to have a good spatial understanding of the three-dimensional form.

Cluster 4 began to explore how students were using their anatomy knowledge. In exploring the application of anatomy, students' perception of surface anatomy was the same across all years whilst their perception and use of radiographic anatomy were greater by the later years of the course (refer to Graph 9). This illustrates the application of anatomy and the need to construct meaning in the context of anatomy. It also possibly relates to the need for students to transform their three-dimensional understanding of anatomy into new forms.

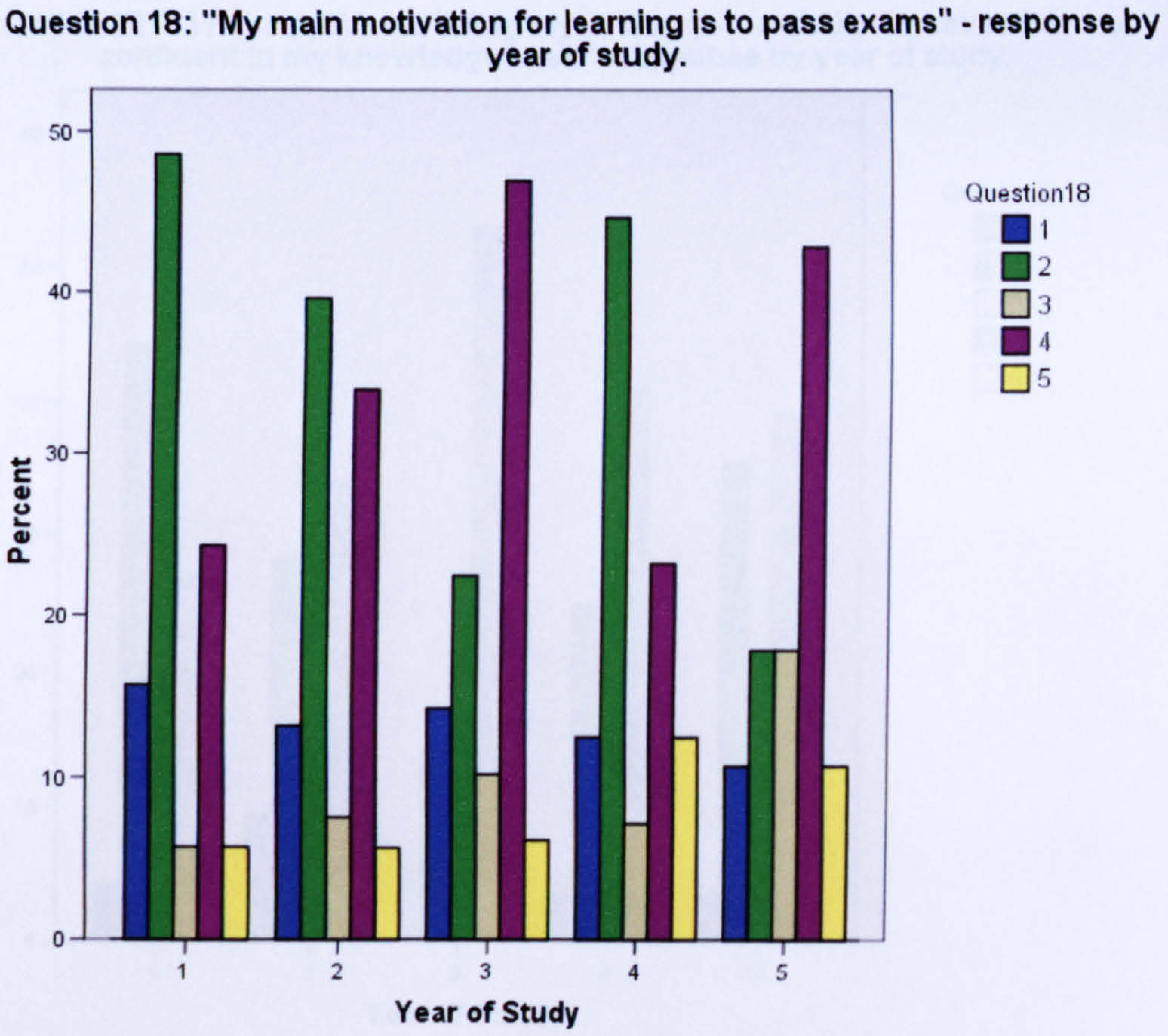
Cluster 5 asked students about their overall perception of anatomy. Importantly, in response to 'I feel that understanding anatomy is a very important part of becoming a doctor' (Graph 10), it is clear that many students agreed with this. This was further extended in a question taken from cluster 5 'I feel that working with cadaveric material is an important part of becoming a doctor' (Graph 11).

Cluster 6 contained a few questions that were specifically designed for either the early or later years of the course. Interestingly and not unexpectedly the last graph (Graph 12) illustrates how in hindsight students' opinions of anatomy's relevance had increased as the course progressed.



Question 13: "I find/found the amount of anatomy I need/ed to learn daunting" - response by year of study.

Graph 5. Question 13



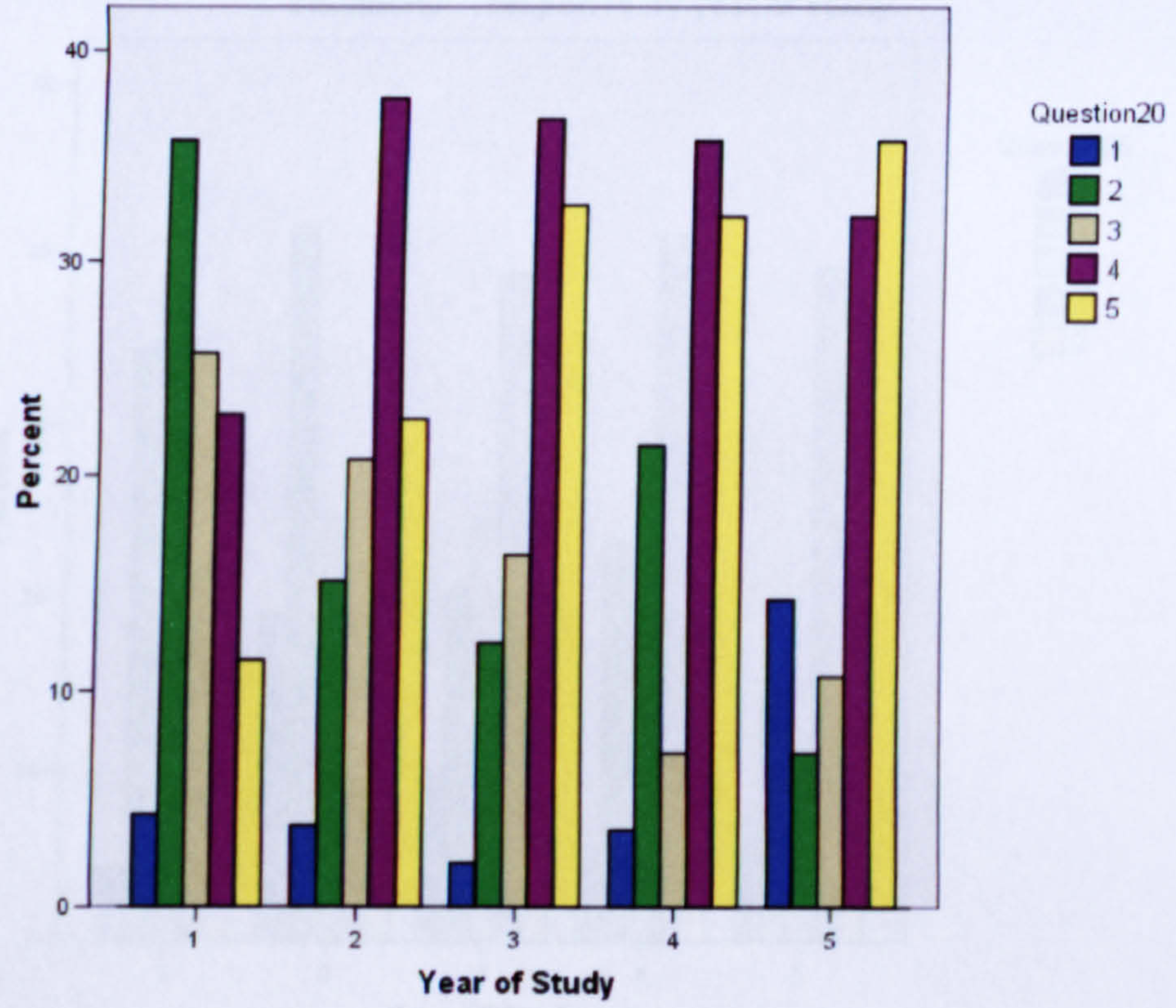
Question 18: "My main motivation for learning is to pass exams" - response by year of study.

Graph 6. Question 18

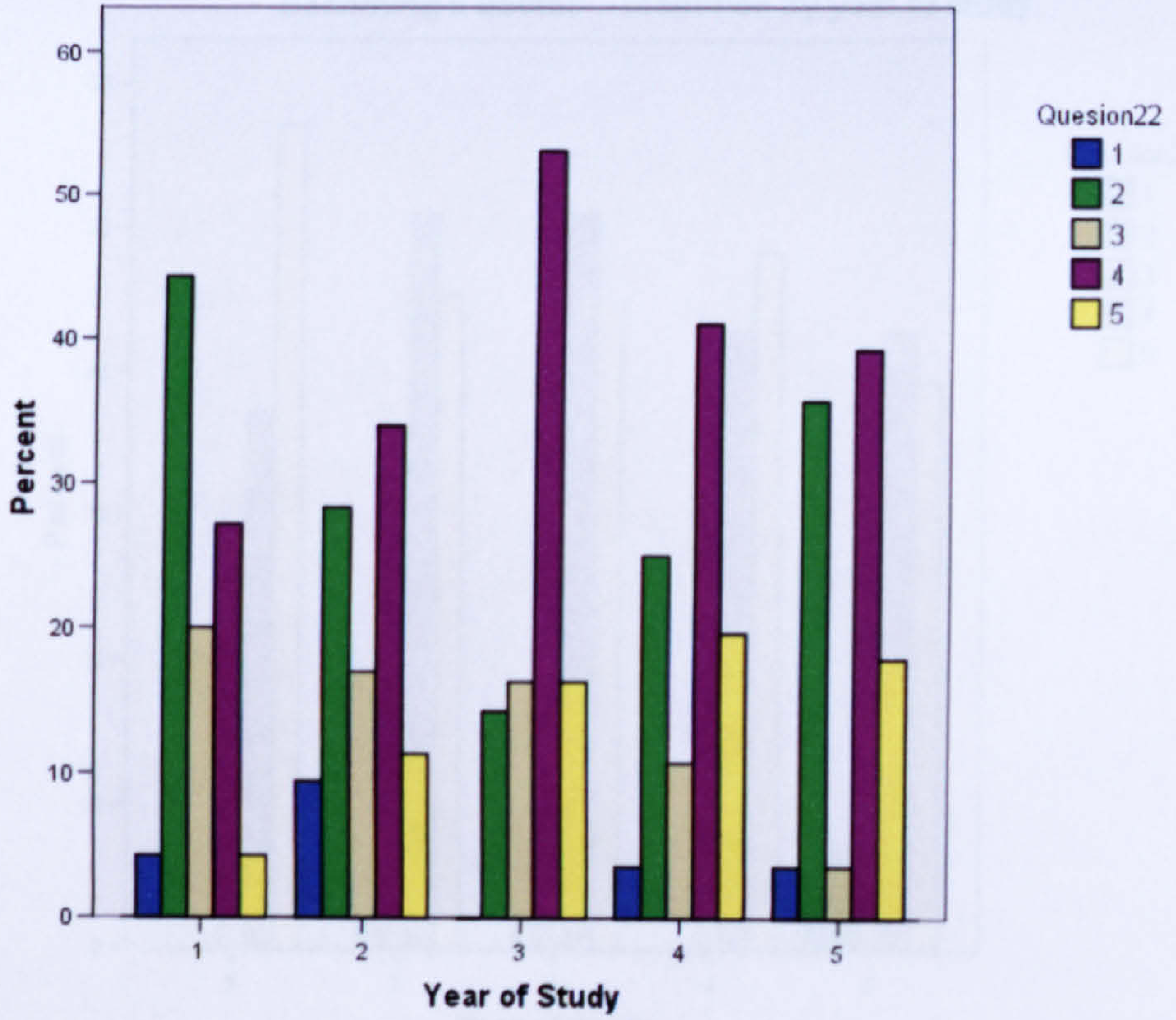
Key

🟦 1 Strongly Disagree
🟩 2 Disagree
▨ 3 Neither Agree nor Disagree
🟪 4 Agree
🟨 5 Strongly Agree

Question 20: "I struggle to build on my anatomy knowledge as I often forget what I learnt last semester/year/s" - response by year of study.



Question 22: "I have problems using my anatomy knowledge because I am not confident in my knowledge base" - response by year of study.



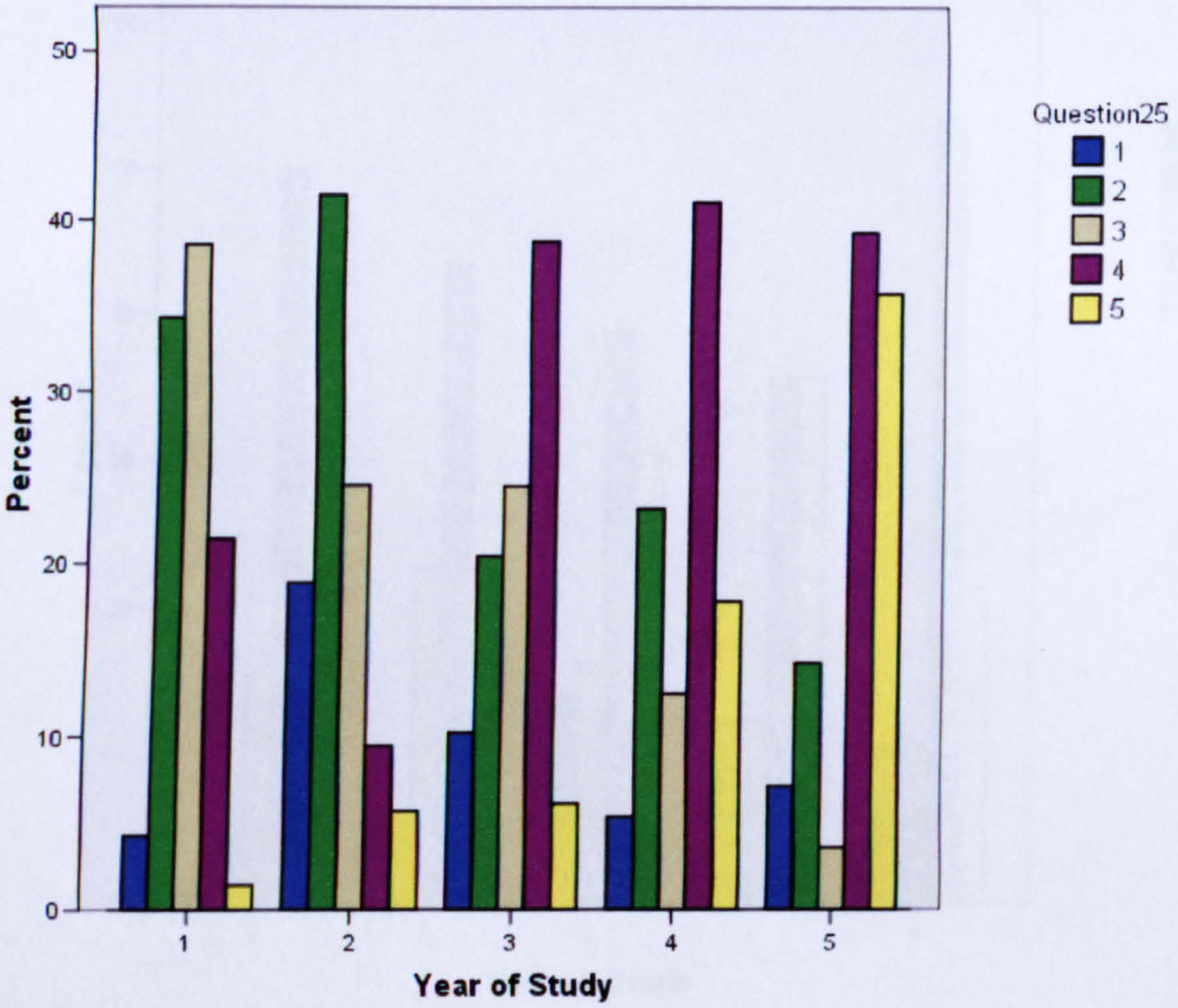
Graph 7. Question 20

Graph 8. Question 22

Key

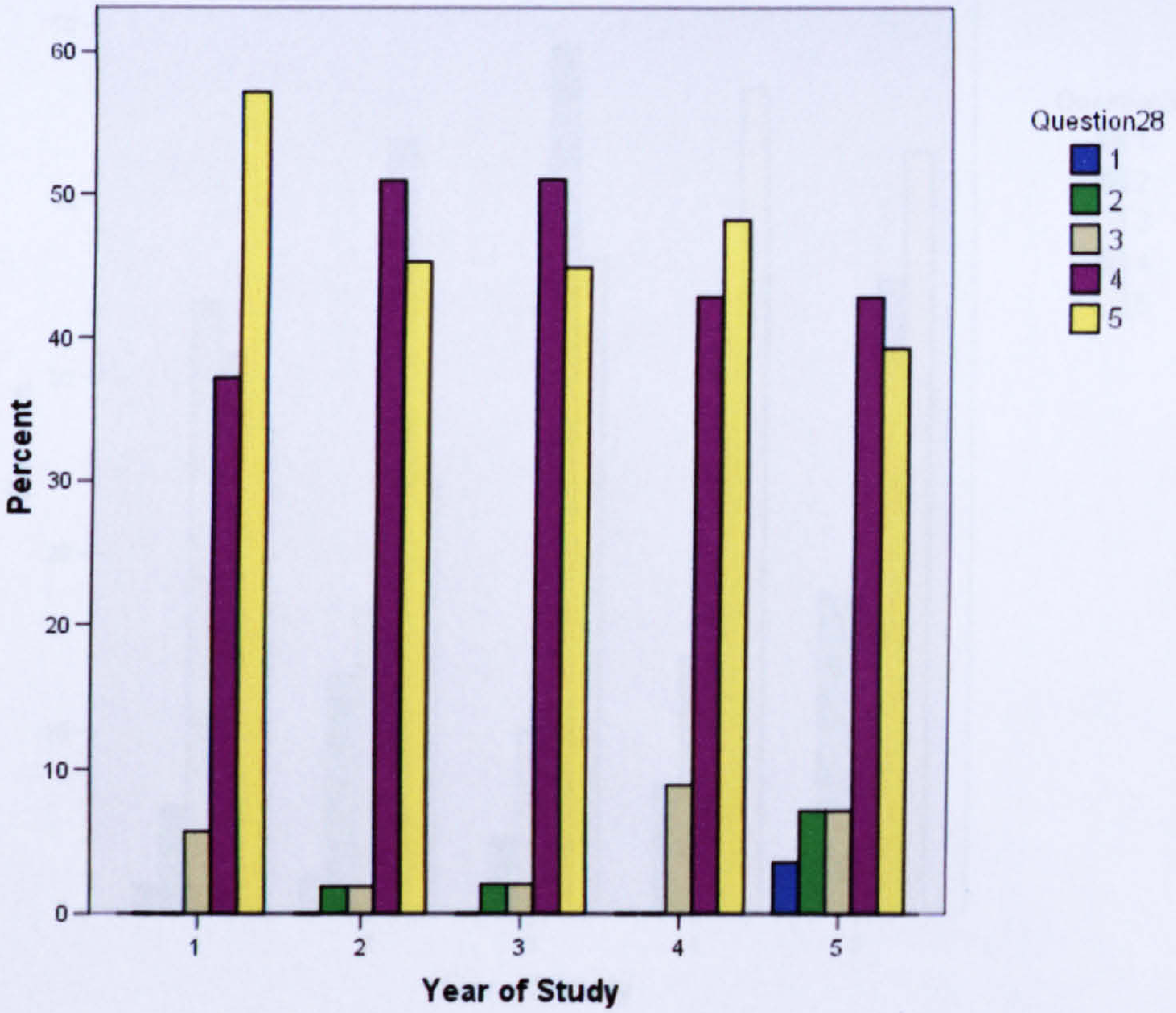
- 🟦 1 Strongly Disagree
- 🟩 2 Disagree
- ▨ 3 Neither Agree nor Disagree
- 🟪 4 Agree
- 🟨 5 Strongly Agree

Question 25: "I find I use my anatomy radiology knowledge frequently in clinical situations" - response by year of study.



Graph 9. Question 25

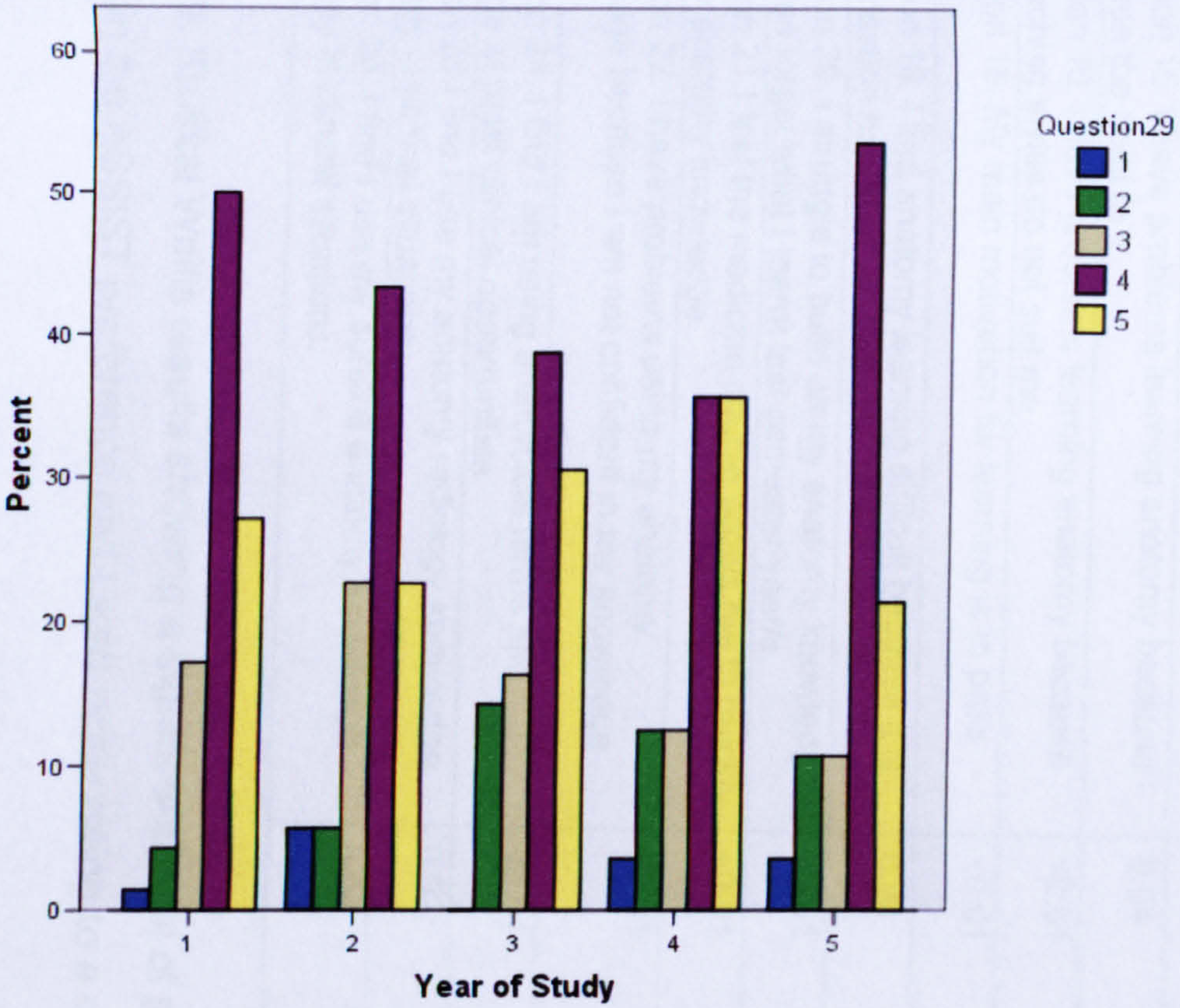
Question 28: "I feel that understanding anatomy is a very important part of becoming a doctor" - response by year of study.



Graph 10. Question 28

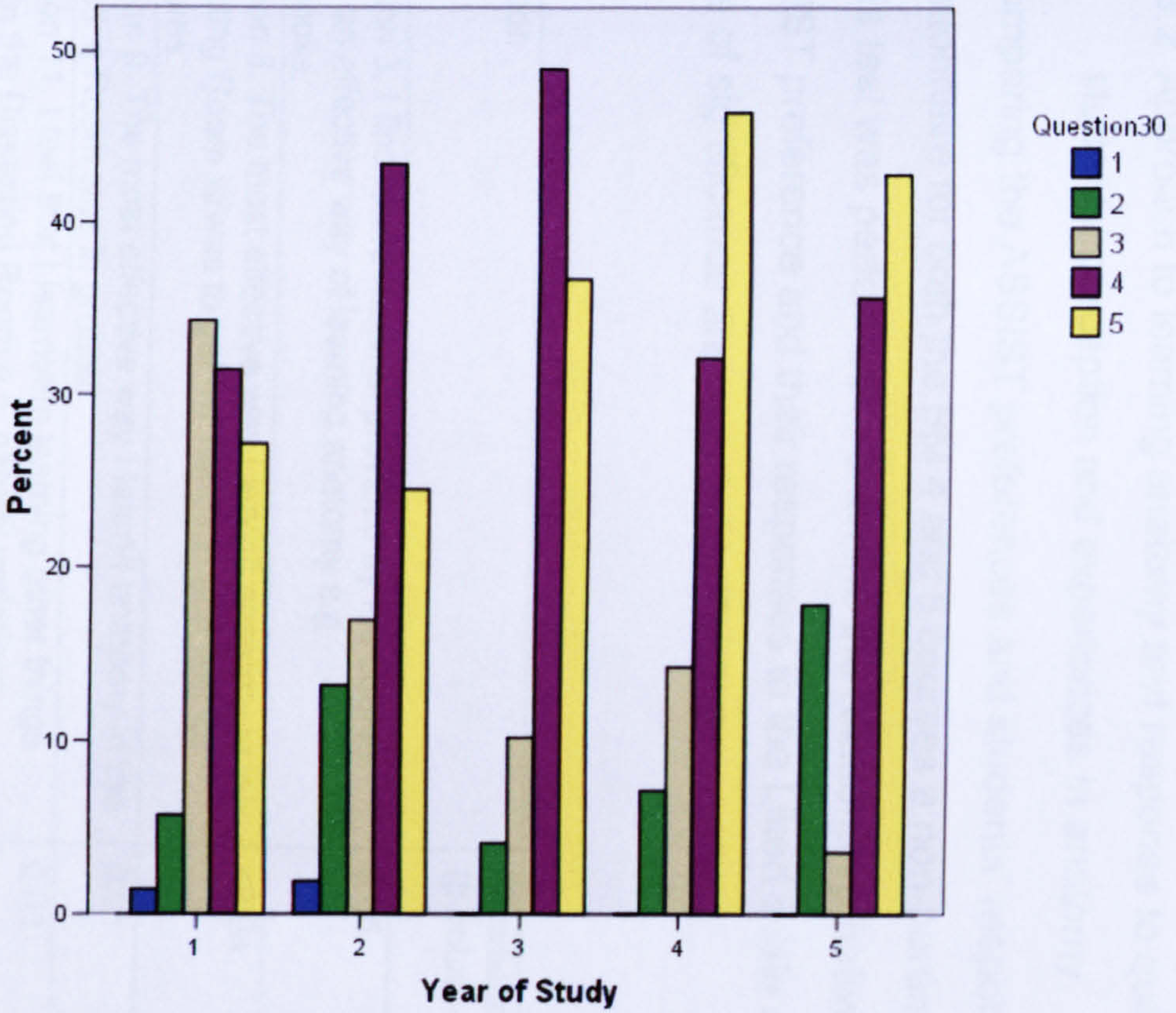
Key

🟦 1	Strongly Disagree
🟩 2	Disagree
▨ 3	Neither Agree nor Disagree
🟪 4	Agree
🟨 5	Strongly Agree



Question 29: "I feel that working with cadaveric material is an important part of becoming a doctor" - response by year of study.

Graph 11. Question 29



Question 30: "My opinions of anatomy's relevance have increased as the course has progressed" - response by year of study.

Graph 12. Question 30

Key

🟦 1 Strongly Disagree
🟩 2 Disagree
▨ 3 Neither Agree nor Disagree
🟪 4 Agree
🟨 5 Strongly Agree

5.3.3.2 Approach to learning anatomy and response to questions regarding students' perception and experiences in anatomy.

In comparing the ASSIST preferences and students' responses to the questionnaire for both the BM 4 and 5 courses a non-parametric Kruskal Wallis test was performed to examine the relationship between a student's ASSIST preference and their responses to the Likert scale questions. Only those of significance are reported in Table 9.

Question	Significance (p value)	Approach to learning anatomy
Question 3. I find/found material provided by the course books an effective way of learning anatomy e.g. handbooks.	0.05	Strategic
Question 8. The most effective way I learn/t anatomy in the Dissecting Room is/was to get my hands in and feel for structures.	<0.01	Deep
Question 9. The most effective way I learn/t anatomy in the Dissecting Room was in groups.	0.01	Strategic
Question 11. I feel that I learnt/am learning other things whilst in the Dissecting Room e.g. natural variations.	0.03	Strategic
Question 13. I find/found the amount of anatomy I need/ed to learn daunting.	<0.01	Surface
Question 15. I have problems learning anatomy because I don't see the point to it.	0.04	Surface
Question 16. I have problems learning anatomy because the teaching styles do not suit me.	<0.01	Surface
Question 18. My main motivation for learning is to pass exams.	<0.01	Surface
Question 19. I find anatomy learning difficult because it is memorisation based.	0.04	Surface
Question 20. I struggle to build on my anatomy knowledge as I often forget what I learnt last semester/year/s.	<0.01	Surface
Question 21.I feel the medicine course allows me to quickly use my anatomy knowledge.	<0.01	Strategic
Question 22. I have problems using my anatomy knowledge because I am not confident in my knowledge base.	<0.01	Surface
Question 24. I find I am using anatomical terms and language at most clinical opportunities.	<0.01	Deep
Question 25.I find I use my anatomy radiology knowledge frequently in clinical situations.	0.02	Deep
Question 26. I find I use my surface anatomy knowledge frequently in clinical situations.	0.04	Strategic

Table 9. Kruskal Wallis results showing a significant level of p=0.05 or below between the ASSIST preference and Likert scale rating to a question

The outcomes of this analysis provided a clear indication of some of the characteristics of each learning approach, e.g. perceptions, attitudes and behaviours. However, these were statistical associations rather than causal relationships, so further investigation was necessary to try to establish what factors were giving rise to each learning approach and whether any could be influenced in the design and teaching of anatomy.

Students who adopted a deep approach to learning anatomy responded more than those using other approaches that getting their hands in and exploring a specimen were important. Such an activity appears to be important in forming links that enable understanding and spatial ability. This touch-mediated perception (described in section 2.3.6) may form an essential part in the true understanding of the human form. Evidence of the holistic nature found in a deep approach came across in anatomy learning with elements of understanding anatomical language and using radiographic knowledge at clinical opportunities. A deep approach establishes an understanding of the setting and aspects not overtly examined, as well as the future application of the knowledge.

Students who adopted a strategic approach rated the course material highly. I was not surprised by this as the course material contains specific information that defines the breadth and depth of the assessment. Students who adopted a strategic approach may not get a complete understanding from this but they know what they need to, reflecting the trade-off between a deep and surface approach. It is also not surprising that they responded positively to working in groups, and sharing and confirming information.

In applying knowledge, students who adopted a strategic approach felt they had to use the knowledge quickly. This may be a strategy for 'use it or lose it' and testing which parts of the knowledge were needed and which were not. It is unclear why students who adopted a strategic approach responded highly to using surface anatomy. It may be as part of good presentation in clinical examinations or a preference for this sub-discipline.

Students who adopted a surface approach to learning anatomy felt that the amount to learn was daunting. They also did not see the point to learning anatomy and this related to their approach and the attitude of 'just remember it'. Students who adopted a surface approach also felt that the teaching methods did not suit them, possibly reflecting a responsibility away from them and onto the teacher. Students who used a surface approach also reported that they learned to pass exams and that learning by memorisation was difficult. This often resulted in them responding that they often forget the details later. Later this finding was supported by their lack of confidence in their knowledge base. These characteristics are very much supported in the literature on learning approaches and can now be related to anatomy learning.

Understanding aspects of the learning approach in relation to anatomy leads onto which of these aspects are more or less successful in respect to assessments. To explore this I compared the questionnaire Likert scale responses to a student's assessment performance.

5.3.3.3 Comparing responses according to examination scores

Spearman's correlations were performed for students on the BM 5 course between the Likert scale responses to a question and that student's examination scores in their first year anatomy spotter assessments. Spearman's correlation was employed as it measures the strength of the relationship between two variables. Spearman's correlation produced several significant p values and weak correlation coefficient values illustrated in Table 10. (refer to Appendix P for further details).

Although the statistical significance is strong, the questions show weak correlation coefficients, suggesting relationships are there but not to a high extent. Students who performed well in anatomy responded highly to the dissecting room environment and the use of the course handbook. Students with good examination scores also rated using their knowledge in the clinical setting and using it as a base to inform other learning (not limiting anatomy learning to anatomy). This is likely to include the strategic and deep approaches to learning.

Students who did not perform well in anatomy examinations reported finding the amount of material in anatomy daunting and memorisation based. This may be a factor which leads students to adopt a surface approach. Students often forgot what they had been taught and showed a lack of confidence in their knowledge base as a result. Previous discussion has shown these to be students who were adopting a surface approach. Such perceptions and experiences may be acting in a causative relationship, hindering students from progressing.

It was not surprising that assessment-motivated students did well in anatomy examinations. However it was unclear if the assessment rewarded or promoted students to adopt a deep or surface approach. It was also unclear what type of learning activities might promote or facilitate an approach.

Question	Coefficient	Significant (p value)
Question 3. I find/found material provided by the course books an effective way of learning anatomy e.g. handbooks.	0.260	<0.001
Question 6. I find/found Dissecting room specimens an effective way of learning anatomy.	0.193	0.005
Question 13. I find/found the amount of anatomy I need/ed to learn daunting.	-0.260	<0.001
Question 19. I find anatomy learning difficult because it is memorisation based.	-0.258	<0.001
Question 20. I struggle to build on my anatomy knowledge as I often forget what I learnt last semester/year/s.	-0.021	0.002
Question 21. I feel the medicine course allows me to quickly use my anatomy knowledge.	0.208	0.002
Question 22. I have problems using my anatomy knowledge because I am not confident in my knowledge base.	-0.243	<0.001
Question 23. I find that my anatomy learning informs other subject learning.	0.206	0.003
Question 33. My chosen career path will mean I will need to learn more anatomy at postgraduate level.	0.250	<0.001
Question 34. In hindsight I see very clearly the importance of anatomy which I did not see in the first couple of years.	0.241	<0.001

Table 10. Relationship between first year anatomy spotter performance and Likert scale responses to questionnaire using a Spearman's correlation test

5.3.3.4 Year of study and response to questions

I felt it was important to explore the journey of learning anatomy as students began to apply their knowledge in the clinical context. To investigate the progressive nature of the course I performed Chi square tests (Pearson's Chi square) to explore associations between the year of study and the Likert responses to questions. I then confirmed the results through a Kruskal Wallis (KW) test and a Jonckheere-Terpstra (JT) test which tests for differences in the medians of the variables and if the order of the groups are meaningful. These tests found significant differences between the year of study and the students' responses to the questions. The relationships which were significant are reported in Table 11. Further details can be found in Appendix Q.

Question	Year of study significantly responding	Pearsons Chi value	JT	KW
1. I find/found reading textbooks an effective way of learning anatomy.	2	0.006	0.001	0.000
5.I find/found mock exams an effective way of learning anatomy.	4	0.001	0.570	0.000
15.I have problems learning anatomy because I don't see the point to it.	5	0.027	0.001	0.009
22. I have problems using my anatomy knowledge because I am not confident in my knowledge base.	3	0.000	0.009	0.000
25. I find I use my anatomy radiology knowledge frequently in clinical situations.	5	0.000	0.000	0.000

Table 11. Significant results comparing the year of study and the Likert responses to the anatomy questions

Table 11 illustrates the possible transition of anatomy learning with students in the second year of the course rating textbooks higher. The increase in the preference for mock exams in the fourth year supports the earlier findings of an increased assessment motivation and strategic approach adopted by students. The table reflects problems encountered by students as they started to enter the more clinically-orientated years of the course. The application of anatomy is represented through radiology by later year students. Only a minority of students responded to the question 15 saying that they agreed with it. However those that did were significantly fifth year students. This may reflect students who were in a rotation where they perceived anatomy to be of little value or who had detrimental experiences of learning anatomy in earlier years.

5.3.3.5 Gender and response to Anatomy questions

Having found a relationship between gender and the approach to learning anatomy adopted (section 5.3.1.2), I performed a Mann Whitney test to explore the relationship between a student's Likert scale response to a question and their gender. Table 12 illustrates the significant responses.

Question	p Value	Male or Female dominant (M or F)
1. I find/found reading textbooks an effective way of learning anatomy.	0.009	F
2. I find/found on-line material an effective way of learning anatomy.	0.009	F
3. I find/found material provided by the course books an effective way of learning anatomy e.g. handbooks.	0.019	F
13. I find/found the amount of anatomy I need/ed to learn daunting.	0.016	F
19. I find anatomy learning difficult because it is memorisation based.	0.036	F
24. I find I am using anatomical terms and language at most clinical opportunities.	0.002	M
36. I feel there is so much to learn and the only way to work is by trying to remember it all.	0.006	M
37. I feel confident about how I am supposed to be learning anatomy.	0.003	M
38. I am enjoying learning anatomy.	0.008	M

Table 12. Comparison of Likert response to a question and an individual's gender

Table 12 demonstrates and supports the findings of the ASSIST inventory regarding gender. Female students were reflecting aspects which related to a strategic approach to learning anatomy and male students to aspects concerned with a deep approach.

5.3.4 Discussion of anatomy questionnaire

The anatomy questionnaire results helped to place the approaches to learning inventory into context. The questionnaire ascertained students' perceptions of anatomy and reflected the importance of anatomy and the use of cadavers in medicine. This is also the view supported by much of the literature, the main exception being the views held by McLachlan (McLachlan 2003; McLachlan 2004; McLachlan & Patten 2006; McLachlan 2002;

McLachlan et al. 2004). First years rated the importance of anatomy the highest of all years, but students' opinions of the relevance of anatomy increased as the course progressed.

In relating the ASSIST inventory to the questionnaire, links were seen between student perceptions, learning activities, influences and the approach to learning that students adopted. This suggests that there may be causal links. In particular, students who adopted a deep approach to learning anatomy reported highly on aspects such as exploration, holistic approach, not being driven by facts, and using the language and radiological knowledge at clinical opportunities. This may illustrate that a deep approach is related to the application of knowledge, such as in radiology. Exploration and application of anatomy also reflects an understanding of the three-dimensional form and a deep approach may facilitate this.

Students adopting a predominantly strategic approach to anatomy learning reported highly on aspects which included the course material, working in groups and confirming information. They liked to use their knowledge quickly ('use it or lose it'). Those students who adopted primarily a surface approach perceived there being too much information, they did not see the point to learning, and felt the teaching methods did not suit them. They learned to pass exams but they often forget their anatomy knowledge and as a possible consequence showed a lack confidence in their knowledge base. Understanding these approaches to learning anatomy has implications for future practice which is discussed later.

In exploring ' What affects and influences the learning of anatomy?' I found that good assessment scores were associated with students who responded highly to the DR environment, the course books and using their knowledge in the clinical setting, illustrating possible causal links. Students who performed less well in anatomy assessments reported finding the amount of information daunting, found it memorisation-based and often forgot it. It is only speculation that detrimental factors such as finding the information daunting are causative in hindering learning.

I was interested in the aspects which promoted learning (e.g. enjoyment, confidence, relevance, and the use of radiographic anatomy) as these increased as the course progressed. In exploring the learning environment and learning activities across years, all students felt that the following were important for their learning of anatomy: learning on human cadavers, learning through text books and course handbooks, learning through mock examination, online material, group learning, anatomical language and learning other things, e.g. natural variation and clinician-based teaching. It was not clear what made these important and further discussion with students would explore this. Despite this, problems with knowledge and confidence also emerged as the course progressed and further exploration is needed to look at the elements that are detrimental to learning anatomy

In examining responses to demographics, an association was found between approach to learning anatomy, response to questions and gender. Females responded more positively to aspects which involved the course material, finding it daunting, liking online material and text books; whereas males responded more to using their knowledge, feel they have to remember it all, are confident in how they are learning and are enjoying it.

How students were applying anatomy appears to be through the use of radiology in particular and further exploration of this is required to understand how anatomy knowledge is reconstructed for clinical practice.

I was beginning to wonder how the approach, activities and other aspects, such as finding it daunting, were related to each other, and if they were possibly causative. The questionnaire did not show if there was an order to the events, i.e. do certain things lead students to adopt a response or are the things described caused by taking that approach? Or if there are any consequences for students who adopt a certain approach in their application of knowledge.

5.4 Conclusions of Students' Perceptions and Approaches to Learning Anatomy

This chapter has shown quantitatively how students approached their learning through the use of the ASSIST inventory. From the sample of students who completed the ASSIST inventory (263 out of 1075 or 24.4%), the majority adopted a deep approach to learning anatomy (46.4%), followed by 39.5% adopting a strategic approach and 13.3% a surface approach. No students on the BM 4 course adopted a surface approach. Gender was correlated with approach, with more males adopting a deep approach and more females a strategic approach.

The approach to learning anatomy a student took is possibly influenced by their perception. For example students who perceived the amount to learn to be daunting adopted a surface approach to learning anatomy. The adopted approach has consequences for students' level of learning, in terms of assessment. Students adopting a strategic approach performed better in assessments. Those who adopted a surface approach were more likely to fail. This raises possible implications for the curriculum, especially in terms of assessment. The possible influences of the curriculum and assessment were highlighted by a greater number of students adopting a strategic approach to learning anatomy as the course progressed.

I was interested to explore student perceptions of anatomy further to comprehend how these affected the approach to learning adopted. I had begun to understand some of the activities that may be related to each approach in the context of anatomy but I felt that the activities used in the process of learning should be explored in more detail as this might be of practical relevance in promoting a desired approach. Students had reported on some of the positive and negative influences that affected anatomy learning but the reasons behind the influences were unclear. I was keen to explore in more depth the impact these influences had on the students' experience of learning anatomy. The questionnaire had conveyed that radiology was part of how students applied their knowledge and I was interested to explore this in more detail. Figure 20 illustrates the key themes identified from the ASSIST inventory and student questionnaire.

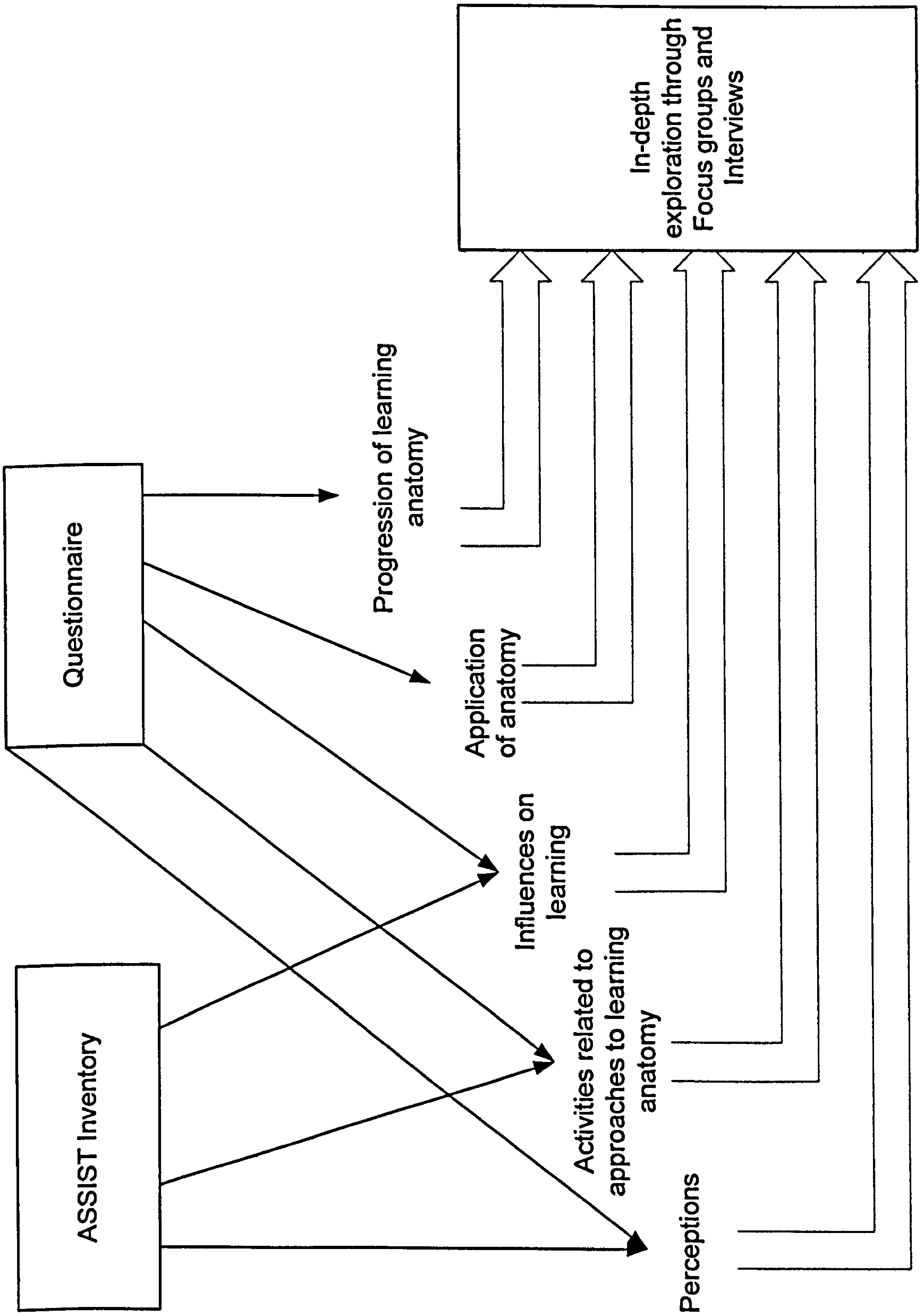


Figure 20. Key themes from the ASSIST Inventory and student questionnaire

5.4.1 Working model of anatomy learning

Initially I was aware that levels of engagement and confirmation of knowledge were going to be important aspects of learning anatomy. However, I found through the ASSIST inventory that learning anatomy could be approached in three ways. These learning approaches (deep, strategic and surface) each represent levels of intention and engagement. Within each approach certain activities and problems appeared to be common. Students all perceived anatomy and the use of human cadavers to be important for their future career as doctors, yet many students also perceived anatomy to be daunting. It is possible that there were causal links between students' perceptions and the approach they took and activities they utilised.

The examination success of the strategic approach might make it the desired approach for students coping with a demanding curriculum where assessment performance was critical for progression. However, it was becoming evident that the application and the progression of anatomy into the clinical setting were not associated with a strategic approach but a deep approach. In particular, the deep approach was associated with exploration and understanding the three-dimensional form in a way that is required for the application of anatomy. I was unclear how confirmation of knowledge fitted into the approaches or if it was still relevant.

I needed to make decisions as to which themes should be explored further and in greater depth in the time available for the research. I was keen to explore the different activities in which students engaged and how they fitted into an approach to learning anatomy. Such understanding might aid the design of activities within a curriculum and the teaching sessions so as to have a promotional influence on a student's learning of anatomy. While I had identified interesting associations between, for example, gender and learning of anatomy, I felt that these were probably of less importance in terms of identifying practical ways of improving anatomy learning and teaching, and therefore I decided not to pursue these themes further.

6 Chapter 6. Students' Perspectives of Learning Anatomy – In-depth Discussions

6.1 Introduction

I chose to use a series of focus groups and interviews to develop and further comprehend the findings from the ASSIST inventory and questionnaire. I was guided by the research questions asked at the beginning of Chapter 5 with particular interest in students' perceptions, activities, influences and application of anatomy. The focus groups were conducted first and aimed to further explore through discussion the students' perceptions and influences on learning anatomy. The themes that emerged from the focus groups and the previously identified areas were constructed into a semi-structured interview. This refined the activities and influences experienced by students within a particular approach to learning anatomy. The interviews also examined the individual's application of anatomy and how this changed as the course progressed.

6.2 Focus Groups

The focus groups in the preliminary study were successful at facilitating discussion and were suitable to use at this point in the study for four reasons. Firstly, to support and confirm the results of the questionnaire; secondly, to further develop areas; and thirdly, to gain feedback about the ASSIST Inventory and questionnaire results. Finally, focus groups also permitted an opportunity for students to discuss any elements or aspects regarding their learning that I may have missed. It was hoped that by using a focus group method I could facilitate debate and disclosure (Wilkinson 2003). I developed key questions (Appendix R) which aimed to produce discussion about how students used resources, e.g. text books, what influenced their learning and why students had problems with aspects such as radiology. Students were sampled by using those that selected the option 'I would like to participate in a focus group to discus anatomy education' in the questionnaire (probability snowball sampling). Students were then divided into groups by their course and year of study. Students were contacted by email and invited to participate in a focus group. Students responded and their email was acknowledged with a confirmation of date and location for the focus groups.

6.2.1 Organisation

Six focus groups were held (refer to Table 13). One focus group was run per year of study. Due to the smaller numbers of students on the BM 4 course, the two years (years 1 and 2) were combined in one group to allow sufficient numbers to aid discussion. For all focus groups a couple of students did not attend. It was agreed by myself and my supervisor that it was appropriate for students who participated to be offered a book token as gratitude for their time and involvement.

Course/ Year	Date	Time	Number of Students attending
BM 5 Year 1 (05 cohort)	22nd May 2006	12:50-13:50	5
BM 5 Year 2	31st May 2006	12:50-13:50	5
BM 5 Year 3	5th June 2006	13:00-14:00	6
BM 5 Year 4	24th May 2006	13:00-14.00	5
BM 5 Year 5	24th May 2006	16:00-17:00	2
BM 4 Year 1 BM 4 Year 2	8th June 2006	10:00-11:00	2

Table 13. Student focus group details

The focus groups conversations were recorded and transcribed verbatim within 24 hours so that my initial thoughts and feelings could also be recorded in note form. I added in bracketing of my own perceptions and experiences (e.g. 'line 4 refers to a wish for didactic teaching'), where applicable.

6.2.2 Results

The focus groups used a guidance sheet that contained a string of generic questions (Appendix R). Questions for the early years of the course additionally explored students' perceptions of the DR environment and their use of anatomy in aspects which were clinically relevant, e.g. surface anatomy and radiology. Students in the later years of the course were also asked to discuss their application of anatomy and specifically about their use of radiology and their confidence in their knowledge base.

The transcripts were analysed by developing initial codes and then line by line coding (Charmaz 2003) which was formed into clusters. I then added my own brackets of my ideas and experience, refer to appendix S for an example of a focus group coded transcript. I used the codes generated to allow for the grounded theory approach to identify categories as they emerged.

Five main themes were identified: process of learning, issues of learning, application of learning, spatial learning and assessment. (I had not set out to explore assessment and spatial learning; these were brought up by students.) In relation to each of these themes I concluded the following:

1. In exploring the process of learning there was conflicting information on how students would prefer the handbooks and practicals to be run. For example, some wanted to be didactically taught and others wanted the opportunity to explore further though dissection. This appears to reflect the various approaches that students had taken. It was however not possible to clearly link the activities to the students' approaches to learning.

2. The aspects that influenced a student's learning of anatomy involved their early perception of anatomy, which frequently involved students feeling that anatomy had too many facts and that they had problems with the language. Although not specific, I suspected that this might be

detrimental to the future learning of anatomy. Students explained similar problems in relation to the following areas of their studies: motivation, confirmation, time and external pressures, for example:

> It's really dry without putting it (anatomy) into context. (Year 1 student)
> I think there's that one opportunity when you can get help, so even though it (anatomy practical) is available the rest of the week you don't know what you are looking at so it's no good standing there. It gets really crowded you can't get near the specimens. (Year 2 student)

It was not possible to establish what areas were related to the curriculum or to an approach to learning.

3. Students had common problems with their application of knowledge and use of anatomy in clinical practice. This needed to be further explored as it might be linked to the other problems and students' approach to learning anatomy.

4. All students showed a level of concern with assessment, and this dominated their learning environment. For example:

> There's learning for exam and there's learning to be a doctor, I think there's a big difference. (Year 4 student)
> I have spent a significant time on anatomy because of the spotter, yes, ok it all benefits your learning in the long term, but I don't always think it's important, it's the same problem with the MCQ questions the questions are not always representative of the learning, umm. (Year 3 student)

It appeared to influence their learning activities although it was not possible to elucidate any links between assessment and approach to learning and activities adopted.

5. As a defining feature of anatomy as a subject students explained how they experienced a variety of spatial problems, including recognition, two/three-dimensional understanding and the ability to visualise and rotate structures.

6.2.3 Discussion of the focus groups

I found the focus groups to be very engaging and effective as students discussed a variety of aspects which confirmed the findings of the questionnaire. The focus groups elucidated further that students' processes of learning and the activities they engaged in varied. However, the focus groups did not clearly discriminate these in relation to the approach to learning anatomy adopted by students. The focus groups reflected further that perception may be linked to the approach to learning adopted and that influences experienced by students might also be related to the approach to learning taken. Further exploration with individuals would facilitate the identification of any causal links. The focus groups highlighted the need to investigate retrospectively how doctors in practice learned their anatomy, their experiences, problems and application of anatomy in practice.

In reference to the literature (section 2.3.5) this activity also brought to light the problems that students encountered with spatial ability and understanding the human three-dimensional form. At this point I felt that spatial understanding might be linked to the application of anatomy but I was unsure of how and if certain difficulties with spatial understanding were associated with a certain approach to learning anatomy.

A drawback of these focus groups was that they did not allow for categorisation of a student's perceptions, experiences and application in relation to their approach to learning anatomy. The following figure (Figure 21) represents the progressive focusing themes that emerged from the focus groups.

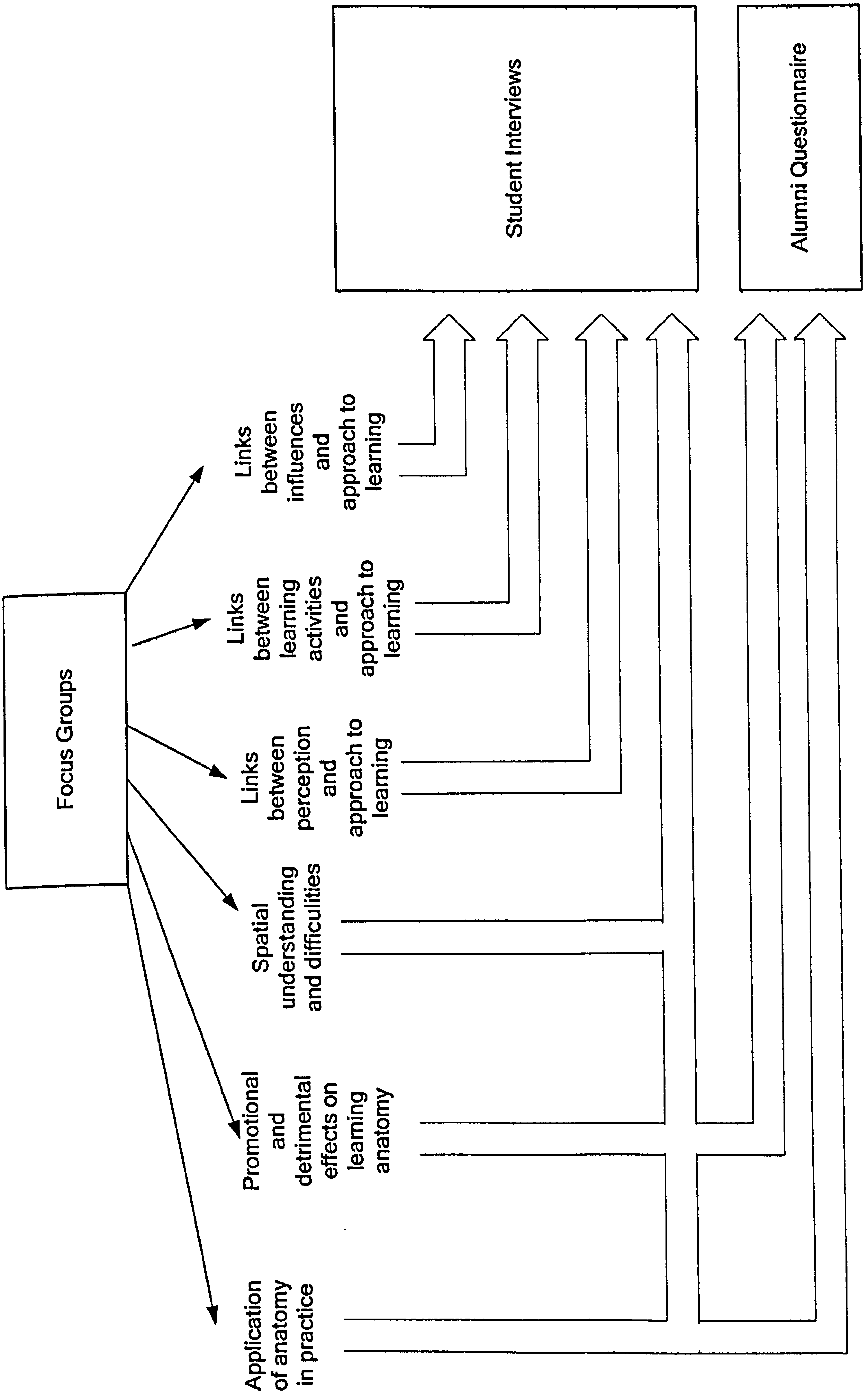


Figure 21. Progressive focusing themes that emerged from the student focus group

6.3 Student Interviews

The focus groups had enabled a discussion of anatomy learning, the influences on learning and issues related to the application of anatomy. The results of the focus groups strengthened the possibility that perceptions, approach, activities, influences and application may all be linked or causative to the approach to learning anatomy adopted. For this reason I felt it was important to use an interview method to allow a one-to-one encounter with participants' experiences of learning anatomy in greater depth. The aim of the interviews was to examine through a student's known approach to learning anatomy and assessment success their perceptions, activities and application of anatomy. I also wished to explore two themes in more depth: student spatial understanding and the progressive nature of learning anatomy over the course of study, building on trends reflected in the student questionnaire.

I felt that the semi-structured stakeholder interviews had been an appropriate method for exploring in depth a participant's experiences and that this would be a suitable method within the overall framework to further refine how students were learning and applying anatomy. The interview was based on a series of open-ended questions (refer to Appendix T) divided under two headings of perceptions and experiences. Often many issues flowed into one another and students often added their own areas of discussion to which I listened and acknowledged. To further explore students' spatial ability, students were asked to draw a diagram of the brachial plexus as they remembered it. These diagrams would then be compared and rated according to Biggs' SOLO Taxonomy (Biggs 2003) as described in section 2.3.

6.3.1 Organisation

Students were selected from the online questionnaire data set through a purposive sampling strategy. I wanted to select students that would allow for a variety of experiences so I initially used assessment results as a criterion. Students who had achieved over 85%, between 65-68% and less than 50%

(i.e. failed) in their year one spotter mark were included in the sample. I also ensured that the selection encompassed a variety of approaches to learning anatomy and a range of students from different years of study. This sampling style reflects that the sample was not, and not designed to be, representative of the population. Table 14 illustrates the characteristics of the sample selected. I felt it was appropriate to determine the sample size based on representation of the characteristics required. Therefore the potential sample size was determined by the number of students within the selected assessments results criteria (n= 57). Students were invited by email to attend a one-to-one discussion for approximately 45 minutes. Some students decided not to participate and some did not turn up to the interview. Eighteen interviews were carried out in total, although one interview recording failed and that interview was omitted from the study. The interviews took place in the first semester of the following academic year and as such no first year students were involved. Fifth year students were on placements and were also unavailable to participate.

Variables	Year of Study 2	Year of Study 3	Year of Study 4	Total within each variable
Deep Approach	3	2	0	5
Strategic Approach	2	2	3	7
Surface Approach	2	1	2	5
<50% examination score	2	0	0	2
65-68% examination score	3	1	3	7
>85% examination score	2	4	2	8
Male	1	2	1	4
Female	6	3	4	13
Total number of interviews	7	5	5	17

Table 14. Characteristics of the interview sample

The interviews took place in October and November 2006. I explained to participants that the purpose of meeting was to refine and confirm aspects from the questionnaire and focus groups and to listen to, and understand their individual experiences. I reiterated information provided in the Participant Information Sheet and assured participants that information would be treated as confidential. The interview ended when saturation was reached. Saturation was considered when participants had discussed all of the elements on the guide sheet, either though the natural conversation or through asking questions. Many students discussed elements which had been discussed by other students or in other activities so the students were listened to. In examples where students brought up a new themes they were asked to discuss these further. Participants were always asked if they had any other comments to make in general or specific to any area at the end of the interview. If there was nothing the interview was brought to a close. No students discussed any major element not discussed by any other student or in any other research activity so it was considered that theme saturation had occurred. At the end of the interview I thanked the participant and offered them a book voucher. The interviews were transcribed verbatim within the month. After each interview I made notes about my initial thoughts and feelings. These were later added to the end of the transcript.

6.3.2 Results

The seventeen transcripts were imported into NVivo ^{TM} (Version 7) which I used alongside the paper transcripts. The interviews were analysed according to learning approach category, enabling me to seek common trends within a given approach. The interviews were initially subject to free node coding for both content and meaning. I added to the paper transcripts brackets (my own input or thoughts), reference points and possible questions at the end of each page. At the end of the interview a short summary was displayed on the paper transcripts. Delimiting (Barnard, McCosker & Gerber 1999) enabled me to suspend any preconceived ideas and report in a clear manner the students' experiences. To achieve delimiting I used bracketing and formulated diagrammatic representations of the interview. The diagrams displayed nodes and illustrated nodes that were interlinked. Refer to Appendix U for an example of a coded paper interview transcript and the associated diagrammatic representation.

I generated coding summaries in NVivo which illustrated the frequency of free nodes. However, I found the number too many and not particularly helpful. Using NVivo and the delimiting diagrams, the free nodes were formed into the following clusters.

- Curriculum influences
- Dealing with Cadavers
- Deep Approach
- External Attitudes
- Future Career
- 'Good Student'
- Learning Pathway
- Negative Factors
- Personal Feeling
- Perception of Dissection
- Perception of Southampton
- Positive factors
- Previous Experience
- Prosection
- Re-learning
- Relevance
- Short Term Memory
- Strategic Approach
- Surface Approach
- Use of Anatomy in Practice
- Visual
- Year 3 Transition

My supervisor then examined the interview transcripts, the initial coding and the clusters before any further analysis occurred. My supervisor concurred with the main themes. Further analysis occurred in the form of revisiting the transcripts and the coding to ensure the main themes were represented and to begin to deduce meaning. Any additional coding or refinement made at this stage was added to the transcripts. Thematizing then occurred and the following outcome spaces (Figure 22) were decided upon, each of which is addressed in turn.

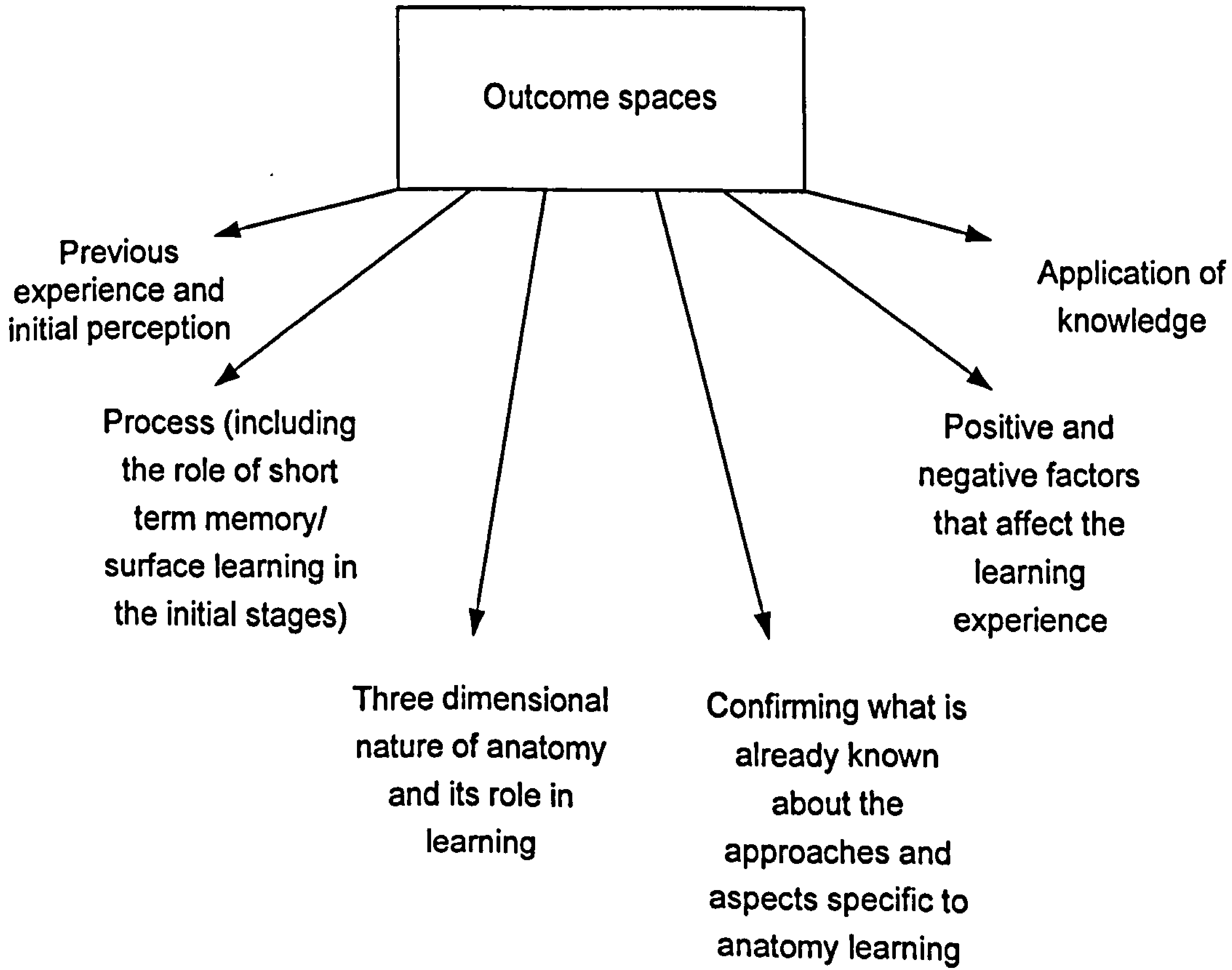


Figure 22. Outcome spaces

- Previous experience and initial perception

Each interview provided a detailed description of the participant's journey of learning anatomy. Previous experience was frequently linked to a student's school or sports experience, e.g. a sheep's heart dissection. Several students that entered medical school as 'school leavers' discussed how medical school was different, illustrating a gap between the two education establishments, for example:

> Everybody wants to be taught it, rather than learn it themselves because we haven't done learning it for ourselves before. (Year 3 student, deep approach)

A student's initial ideas about what learning anatomy would entail tended to be from a relative or friend:

> Well, informally my dad used to teach me stuff. (Year 3 student, strategic approach)

Students' previous experience influenced their perception of the dissecting room. Some students focused on the element of death, explaining that many students had not seen a dead body before, whereas those students who had could draw on their experience. Several students discussed ideas regarding rite of passage and the issues of dealing with human specimens:

> Almost defines you as a medical student to students of other subjects you know. It's like a rite of passage – it's not but it's an introduction to the human body in a way. (Year 3 student, strategic approach)

These views support the literature reported in section 2.2.2.1. Possibly as a result of previous experiences almost all students perceived anatomy as being memorisation based:

> When I first opened the anatomy book and there were so many names I was overwhelmed. I thought it was more memory work than understanding but once you have got the hang of it... (Year 4 student, strategic approach)

Many students were shocked about the amount of anatomy:

> Terrified me, never thought I could learn it to be honest. (Year 3 student, strategic approach)

This coupled with the possible gap from previous education, and a possible anxiety of using human cadavers may act in a detrimental manner on the quality of students' learning. Such perceptions may cause the student to be withdrawn, demotivated and may promote a surface approach to learning. Several students either discussed or, when asked, reported how they felt about the prosection course and about not dissecting. Many students reported that they would have been interested in dissecting, just to experience it. However they were concerned about the time it would involve and what they would get out if they cut though anatomical structures. This is illustrated in the following quotes:

> I guess I expected to do some dissection. (Year 2 student, strategic approach)
> There's so much fat around everything if I was left to my own devices I would never find anything. (Year 4 student, strategic approach)
> He was disgusted I came into this non-dissection course. His views are different now! It's been an excellent experience but umm actually having to learn anatomy like that would not have been a good way. (Year 3 student, strategic approach -This last quote is from a student who did an SSU which involved dissection and is talking about the view of their parent who was a doctor.)

It is possible that a student's expectation to dissect may alter their perceptions of anatomy and their approach to learning.

- Process of learning anatomy (including the role of short-term memory and surface learning in the initial stages)

At the early stages of a student's learning process there was evidence from the activities they adopted of students' previous experiences and perceptions. Students during this time appeared to work at a much more superficial level using short-term memory to get to grips with new material. A quote taken from a student who adopted a deep approach but is discussing the early stages of learning anatomy reflects this:

> I would go round with my friends we would have the book and basically I would highlight the name of everything that was mentioned. (Year 3 student, deep approach)

This initial process may be important in the approach to learning a student later adopts.

- Phases of learning anatomy

After this initial exposure the learning process can be divided by its context into three stages. The initial stage took place before the practical session and involved an amount of work (possibly a lecture) that was based around listening, reading and drawing in preparation for the practical session, as highlighted by these students:

> I made sure I did the reading before. (Year 2 student, strategic approach)
> You do several hours of preparation before you go in. (Year 2 student, strategic approach)

The level of preparation reflected the degree of engagement. Common activities included underlining, highlighting, colouring in diagrams, annotating them, drawing diagrams and cross referencing between books. The quote below reflects an example of this preparation:

> I would have probably have noted the areas I wasn't too sure about and looked it up in the text book and written notes down the side as to how to find certain things when I got in, so from the diagram what related to what and like that I go into the DR. (Year 3 students, deep approach)

The second stage was represented by the learning activities that occurred in the DR and it was here students came into contact with human cadavers. A key element in the DR was the need to see and experience contact with anatomical specimens, as reflected by theses quotes:

> Show you what you need to see. (Year 3 student, strategic approach)
> I tended just to look the first time I'd go in there and the second or third time onwards I actually touch the specimens myself and try to go without the book. (Year 2 student, strategic approach)

The last quote reflected the need to both see and then touch specimens.

Many students reported how they worked in a group with fellow students and the following quote illustrates how the group members had different roles:

> Because I work with a couple of other students all the time and what we do is work in three, one has the text book, one has the diagrams and the other will be poring over the specimen and we work by consensus and it was really only poring over the specimens and going back looking at the diagrams that we had head nor tail of it and looking at the text we got there. I have to make sense of it, there no point in telling me which um you know roots and which nerves if I can't see why if it goes that way. Because I do think the human body is going to be designed a certain way you are not going to get the fibres from C5 ending up down there, and it finally made sense and got that 'ahh'. It was only after looking at specimens and books that looking at the diagrams and text and this process going round in circles all the time. (Year 2 student, deep approach)

An element that stood out from the strategic and deep approaches was that students (five students out of fifteen) discussed the need to divide the DR time up even further and in many cases this involved two or three visits. The reason behind this may be as explained by this student:

> I felt like I need to digest it and for it to go through and then I would go back for another half hour and I think half hour slots was all I could manage. (Year 4 student, strategic approach)

This division of the DR time was also reflected in a previous quote where the student used the first session to just look at the specimens.

The third and final phase of learning reflected the confirmation and consolidation of material and included revision. This was highlighted by several students and is illustrated in the following quote:

> Once you have found it you feel confident you could find it again. (Year 4 student, strategic approach)

Various sources of confirmation were discovered. These included asking friends and asking a tutor. Many sought peer teaching as a way to find confirmation:

> If I can answer questions from other students in the DR then that confirms to me that I know all I need to know. (Year 3 student, strategic approach)

Other activities students were engaged in after the DR session included online material, further drawing, colouring, underlining and making notes. An issue for curriculum design was highlighted by one student:

> As soon as you have done that you're onto the next. (Year 2 student, strategic approach)

This comment reflects that the fast pace nature of the course might impede consolidation and confirmation, and supports another study where students learning anatomy on a slow-paced course performed better (Elizondo-omana et al. 2006).

Importantly, not all students exhibited using all three stages. Students who adopted a surface approach in particular engaged in only one stage. Table 15 illustrates the approach to learning adopted and the stages the students engaged in.

Stages of learning anatomy students engaged in	Deep approach	Strategic approach	Surface approach
All 3 Stages	4	1	0
2 Stages	1	6	3
1 Stage	0	0	2
Total number of students	5	7	5*

Table 15. Number of students within each approach and the phases of learning they engaged in

*Note: All students in the surface approach category referred to sometimes attending a practical session

- Three-dimensional nature of anatomy and its role in learning

All students referred to some aspect of the three-dimensional nature of learning anatomy. What emerged was a series of five stages that students engaged in. Stage one was the understanding gained by reading text, and this appeared to be satisfactory for a few students. Stage two involved seeking understanding by looking at a diagram or drawing a diagram. Stage three involved looking at structures through an atlas. Stage four encompassed students looking at specimens. Stage five was associated with students exploring a specimen using touch-mediated perception. There appeared to be sequential jumps between these stages which students found that they had difficulty with. The sequential jumps involve a transformation of understanding at each stage. The transformation worked through the following stages: text, two-dimensional diagrammatic form and picture form to three-dimensional visual and spatial perception to finally reach a complete three-dimensional understanding, as described by Rochford (1985).

The amount of engagement in each stage also varied. Some students sought to memorise the text and/or diagram and/or specimen, limited by their own memory. Other students used drawings to enhance their understanding as illustrated in the following quotes:

> I remember it better if I draw it myself. (Year 4 student, strategic approach)
> Some people can write it down that this nerve goes here and here and is supplied, but it's easier for me if I draw it out. (Year 2 student, surface approach)

Other students, particularly those who adopted a deep approach, reported using diagrams to integrate information. Recognition also appeared to be important as this quotes illustrates:

> Well the diagrams in the handbooks are normally pretty good and if you can find a specimen which matches up the size you can normally recognise it. (Year 2 student, deep approach).

Nevertheless, the ability to recognise and compare does present some (particularly for those less engaged) with difficulties as illustrated by these students:

> Sometimes when I am reading I have been to the book to see where everything is but then when you come to the anatomy room and it doesn't look like it straight away and that can be quite tricky. (Year 4 student, strategic approach)
> I have a major problem transferring what I have seen on one specimen to another specimen. (Year 2 student, surface approach)

Several students explained how they could visualise either a diagram or a specimen, as represented in the following quotes:

> I prefer to visualise things. (Year 4 student, strategic approach)
> I can see it as a specimen now. (Year 3 student, strategic approach)

> It's important that anything you want to explain you should be able to visualise it in your mind, that's most important. (Year 3 student, strategic approach)

Visualising was discussed by anatomists in the stakeholder interviews (section 4.4.2.1) and represents a way in which anatomical understanding may be stored and utilised.

To analyse the student's two-dimensional diagrams of the brachial plexus, myself and another anatomists rated each diagram using the SOLO taxonomy levels (Pre-structural, Uni-structural, Multi-structural, Relational and Extended abstract) in relation to the objectives of the core curriculum (Dyball et al. 2003). Table 16 illustrates the number of students who reached the various SOLO levels and their approach to learning. (Note: one student who adopted a surface approach declined to do a diagram). The SOLO ratings reflected the discussions in the interviews in that students used diagrams with various levels of engagement. These findings support others that a deep approach is associated with higher SOLO levels (Trigwell & Prosser 1991). The findings that the majority of students obtained the Uni-structural level are reflective of another study into SOLO ratings in anatomy education (Pandey 2005). It is unclear why no students who adopted a surface approach scored level 1; it may reflect that they adopted an active surface approach. Table 17 illustrates that the SOLO levels are not dependant or reflective of students' year of study, although it might have been expected that SOLO level would increase as the course progressed. However, this might be experienced in a larger sample. Please refer to the appendix V for a scan of one of the student's drawings.

SOLO Level	Surface Approach	Strategic Approach	Deep Approach
1. Pre-structural	0	2	2
2. Uni-structural	4	2	2
3. Multi-structural	0	2	0
4. Relational	0	1	1
5. Extended Abstract	0	0	0

Table 16. Student SOLO levels and approaches to learning anatomy.

Year of Study	SOLO Level 1, Pre-structural	SOLO Level 2, Uni-structural	SOLO Level 3, Multi-structural	SOLO Level 4, Relational	SOLO Level 5, Extended Abstract
2	1	4	1	1	0
3	2	1	1	0	0
4	1	3	0	1	0

Table 17. SOLO ratings and year of study

- Confirming what is already known about the approaches to learning and aspects specific to anatomy learning.

The interviews revealed characteristics which strongly reflect the literature on approaches to learning. This supports the ASSIST inventory findings. There were a few key aspects which reflected anatomy as a discipline and these are now explored under each approach.

Five students adopted a surface approach to learning anatomy from the interview group. These students perceived learning as knowledge based. This resulted in the experience of learning anatomy involving rote learning and a considerable amount of repetition to seek confirmation of the knowledge, as illustrated by a student:

> I just kept going over and over things. (Year 2 student, surface approach)

This classically represents the focus of the surface learner. The literature discussed two subdivisions of active and passive surface learning (Fransson 1977) and these are represented in this study. Students who adopted an active approach reported enjoying the subject but spending considerable time and effort on it as discussed by this student:

> There were particular points in anatomy I would actually draw it out and stick in on my wall in halls, I had the hip, the pelvis and..., that's how I learn; I suppose I quite like fact learning. (Year 4 student, surface approach)

Of the three students who adopted an active surface approach, one performed very well (>85%) and two well (65-68%) in anatomy spotter examinations in their first year. However there emerged a downside to students' apparent examination success in that it was limited; students referred to struggling with concepts and the notion of having to learn by repetition made the experience very narrow:

> I wasn't really going into the detail; I wasn't able to connect things up. (Year 2 student, surface approach)

Later in the course students reported that they had to re-learn a significant amount of anatomy.

The two students who adopted a passive surface approach both made comments which reflected disengagement:

> I still ended up failing them because I had not done the work. (Year 2 student, surface approach)
> I think it was because I didn't put the time in... I only had time to do things superficially and I didn't like that in anatomy because to me it wasn't logical-there was no rhyme or reason to it you just had to sit there and learn it. (Year 4 student, surface approach)

This disengagement resulted in poor assessment marks (<50%) which may have disengaged students further. Some issues raised by students who adopted a surface approach are related to anatomy as a discipline. They included the vast amount of terminology to be learned and anatomy being a three-dimensional subject. Such factors appeared to be detrimental in their understanding of the human form.

Seven students adopted a strategic approach to learning anatomy. Four students performed very well (>85%) and three students performed well (65-68%) in anatomy spotter examinations in their first year. Students who adopted a strategic approach were influenced by the context and their motivation was to pass examinations (Newble & Clarke 1986). The spotter examinations in particular and the process of the mock spotter were deemed to be very important as this fourth year student explained:

> I saw anatomy and histology as a way to pick up easy points. (Year 4 student, strategic approach)

Students ascertained which type of answers would give more marks as illustrated by this student's comment:

> I think it's important to get to that level to understand function to get those extra marks in the spotter. (Year 2 student, strategic approach)

The strategic approach appeared to contain several factors which the students calculated. For example, this involved students working out if they had seen the anatomical structure before, the assessment weighting and the likelihood of questions in a certain area occurring.

A key element reported by students who adopted a strategic approach was the need to test and seek confirmation of their learning. Students were not only aware of what they needed to learn but also how they felt they could learn it most efficiently. This enabled students to take either a more surface or deep approach when deemed necessary. Confirmation of knowledge appeared in students' learning pathways at various points. Good examination scores possibly acted to reinforce the students' learning approach.

Five students from the interview group adopted a deep approach. The fundamental aspect of the deep approach is the learner's drive to understand (Newble & Entwistle 1986), as reflected by this student:

> I do aim to understand as much as possible. (Year 2 student, deep approach)

The division of the operation learner and the comprehension learner (Newble & Entwistle 1986) was represented by students in the interviews. It appeared that the comprehension learner is possibly better suited to understanding anatomy in a medical curriculum as this approach involved the student making many interconnections. The interconnections were explained in the interviews as 'everything coming together'

In describing their process of learning anatomy students referred to learning in all three stages, in most cases going beyond the level of knowledge required for assessment. In the DR students were active in finding structures, discussing things and asking for help if they needed it. Group work in the form of peer teaching and testing was something students rated.

Confirmation of understanding enabled students to form links between anatomy, other subjects and to clinical practice. On finishing an area of study students reported being happy.

In considering students' spotter assessment success, two students who adopted a deep approach performed very well (>85%), two well (65-68%) and one poorly (<50%). The difference in examination scores for students who adopted a deep approach compared to a strategic approach may reflect that the anatomy spotter examination did not promote or reward a deep approach to learning.

Specific to anatomy as a discipline within medical education, students who adopted a deep approach sought to explore their knowledge in a clinical context, e.g. imaging, as this student describes:

> I certainly find it really useful to look at CT scan and slices... it teaches you to try and rotate the body in your mind and look at it from different perspectives. (Year 3 student, strategic approach)

The application of anatomy knowledge requires understanding to enable students to utilise mental imagery and form. Students frequently used such context to confirm not just their knowledge but also their understanding and application of it. This reflects that a deep approach facilitates understanding and application of the three-dimensional nature of the human form. The quote below summarises the characteristics of a deep approach to learning anatomy:

> I could see it [anatomy] was going to be important and everything we learn will hang on it and for me the anatomy from foundation term really focused me. Understanding the nervous system and I think with pharmacology mixed in nothing else would make sense and I think I did get to grips with it and I was glad. I am not saying it's stayed in there but the way I learn it is really read deep on it and spend a lot of time on that rather than memorise a million different things. I make sure I get it, I will read different text books, I will look at the lecture notes, I will look at the anatomy book and I'll try and sort of say I understand you know where these, where's the nucleus where do the fibres go what type of fibres is it, what is it carrying. I have to know why and then I can add on pharmacology what neurotransmitter or whatever, I build things on top. I make sure I get a more overall and comprehensive view that pulls in a bit of everything and I get everything and I will flip back and forward so even if I am doing anatomy or pharmacology I will go and get a physiology text book and look it up so it makes sense. (Year 2 student, deep approach)

- Positive and negative factors that affect the learning experience

Every student discussed aspects which helped or hindered their learning. Those who adopted a surface approach reported many more negative factors than positive, with the opposite for the deep approach. This supports the earlier findings from the ASSIST Inventory and Questionnaire as discussed in section 5.3.4.

Referred to in the literature as learning pathologies (section 2.3.3), the student interviews supported suggestions that workload, time, motivation and assessment have a detrimental effect on learning. Students who feel overburdened are more likely to adopt a surface approach (Entwistle & Tait 1990). This is highlighted in the following quotes:

> I just thought oh my god how I am I ever going to learn this and just kind of flipped a switch and I can't I am not going to look at it or learn it"(Year 2 student, surface approach)
> It would go, I didn't go to the last one so what's the point in going and that would carry on and with locomotor you had to know, there were so many things, you had to know all the blood vessels, and nerves, the bones and where they attaches, what they did. (Year 2 student, surface approach)

Time pressure was frequently discussed by students and comments such as "I never have time" featured in all approaches. Students who adopted a strategic approach were specifically aware of time and commented on activities that they felt wasted time. Assessment is known to affect motivation to learning and the approach to learning adopted (Biggs 2003). In particular, assessments which focus on factual recall may push students towards a surface approach (Thomas 1986). The interview discussions supported the literature and ASSIST inventory results, that if anatomy assessment was perceived to require factual information then a surface or strategic approach was likely to be adopted. This is reflected in the following quotes:

> I think you have to do assessments to prove that you know stuff. (Year 2 student, surface approach)
> I saw anatomy as a way to pick up easy points... because I am going to retain a lot. (Year 4 student, strategic approach)

A lack of clarity and understanding of how students were supposed to be learning were considered a hindrance by some students:

> I did not know how to learn it. (Year 4 student, strategic approach)

These students mostly adopted a surface approach which may suggest that they reverted to an approach they had used in education prior to university or did so in the absence of any promotional factors.

Positive factors included how students perceived the use of the material (relevance), their own like and enjoyment of the subject, and assessment. Students who perceived anatomy to be relevant had a greater level of engagement in the process and activities, predominantly adopting a deep approach. Enjoyment of the subject was an element that was associated with students who adopted a deep approach. This supports the findings found in the ASSIST Inventory and Questionnaire. Positive factors were related to students showing an interest in anatomy as part of their career as the following quote illustrates:

> I like anatomy, so I will like surgery, it's a very basic view but it's sort of what I like. (Year 2 student, strategic approach)

Aspects which influenced student approaches to learning anatomy which have not been reported in the literature and appear to be specific to anatomy include the experience of the DR and the engagement with human cadavers. Influences regarding the DR were derived from either the students themselves but also external influences and perceptions from family, friends and other students. The dissecting room environment caused most students to be apprehensive about it. Some remembered vividly their experiences, as this student recalls:

> I felt physically ill going into the DR....I can clearly remember the tables laid out with the white cloths. (Year 4 student, strategic approach)

For two students it was later connections to normal activities that disturbed them:

> It's very wrong, everyone gets hungry and it's not right. (Year 4 student, strategic approach)
> I would be looking at a piece of leg thinking I fancy a tuna sandwich. (Year 4 student, strategic approach)

As discussed earlier in this section, the learning of anatomy can be divided into three stages. It was expressed by students that if they did not engage in the first stage of preparation, it hindered their learning. A few students opened up to reveal that the apparently more able students were able to ask questions, and did, making it difficult for those who had not prepared to ask simple questions. This meant that the apparently less able students did not have the confidence to ask questions and were possibly pushed aside by the more able students, as reflected by the student below:

> People who had kind of prepared and kind of pretty much knew what they are talking about are able to ask questions and deepened their knowledge. Whereas if people haven't prepared or gone that deep into the anatomy book or anything, I didn't tend to try and ask questions as I thought they would be so simple and they were in the book and I would just end up being stupid. (Year 2 student, surface approach)

The factors that affect anatomy learning may be causative and a couple of isolated factors may act in cycle to reinforce elements which hinder or promote understanding. The delimiting diagrams used to summarise the interviews often illustrated these possible causal links (refer to Appendix U).

- Application of knowledge

Five students were in year 4 of the course and five students were in their third year. These students reflected on an aspect referred to as the 'third year shift'. They viewed the first and second years as a 'learn it', with only some students seeing the relevance of the material. However, their motivation and the use of their knowledge changed in the third year causing them all to exhibit a greater use of aspects associated with a deep approach. Students reported that it was here the information 'came together' as reflected by this student:

> Definitely in the third year everything came together and I found it a lot more interesting. (Year 4 student, strategic approach)

If students had to re-learn information, they were doing so in context and for some this made them re-learn anatomy in a different way, but others reverted back to the anatomy handbooks and the methods they had previously used. This is reflected in the quote below:

> With things like histology it will forever be pink blobs to me. But it certainly did make more sense because I was on a liver firm at the end of the third year and we went to their histo-pathology and they have like discussions about people who have liver disease. They had like slides and I was like oh god it's still pink blobs I don't get it and then I went to it, it was a four week thing and the fourth week finally things are coming together, like it stopped looking like pink blobs and I could see what they were trying to say a little bit and when you see the clinical relevance it makes it a lot easier. (Year 4 student strategic approach to learning anatomy)

For some students a negative experience of learning anatomy previously resulted in the student feeling put off, as this student explained:

> Several times annoyed me as I didn't know my anatomy so well, the nerves are related to the symptoms, but I had such a block on it I found it so hard to overcome. (Year 4 student, surface approach)

The use of a surface approach in the early years of learning anatomy may hinder students when they have to apply the knowledge later on, as this student commented:

> I have noticed that a lot of the students who maybe didn't do quite as well, they have struggled with putting some of the clinical practice in the picture. Just testing reflexes that sort of things and having in my mind where it's working and putting the whole picture together and even looking at X-rays. I noticed students who spent a lot of time in the DR room tend to be pretty good at looking at X-rays. (Year 3 student, strategic approach)

6.3.3 Issues with the interviews

I found some of the participants were more forthcoming in nature and some were more reflective than others. Initially, I found it difficult to use non-leading questions that resulted in further explanation rather than the student agreeing. In the analysis stages any leading questions were identified in the transcripts and corresponding nodes were confirmed from other parts of the interview to ensure the adopted themes were based on a general view.

During the sequences of interviews my own research skills developed and I was able to use promoting questions more skilfully to help progress a difficult area of the interview. The coding reporting I carried out in NVivo was not as effective as I had expected and I could draw very little from the reports of nodal coding.

6.3.4 Discussion of student interviews

The focus groups illustrated the need to confirm the findings from the earlier work with individuals adopting particular approaches to learning and from a mixture of assessment successes. It was hoped that this opportunity would explore the issues of the learning process, influences and application to clinical practice in further depth. In particular I sought to identify links between influences and learning activities to a given approach. This would make it possible to suggest implications which were directly related to learning anatomy. The method of one-to-one semi-structured interviews suited this well.

The analysis of the student interviews revealed the following outcome spaces.

- Previous experience and initial perception

As already suggested from the initial focus groups and the stakeholder interviews, there is a possible gap between students' previous learning experiences and expectations within higher education. All students initially perceived anatomy learning to be memorisation based.

- Process (including the role of short-term memory/surface learning in the initial stages)

In early stages all students used a certain amount of surface approach and short-term memory as they got to grips with the subject. The learning process involved three phases: preparation, during the DR and after the DR session.

The amount of student engagement was reflected in their overall approach. This clarifies the results of the other activities and has resulted in an understanding of the level of engagement in the various activities and the process that at first seemed so varied.

- Three-dimensional nature of anatomy and its role in learning anatomy

There are sequential aspects involved in learning anatomy and understanding its three-dimensional form. The amount of engagement and difficulties that students encountered were again related to their approach to learning anatomy. At the optimum of understanding the three-dimensional form, students could visualise the specimen and work their way around it. Students who adopted a surface approach did not reach high SOLO taxonomy levels and experienced more difficulties in understanding and applying anatomy.

- Confirming what is already known about the approaches and aspects specific to anatomy learning

Many aspects related to each approach were confirmed and supported other literature. Specific to anatomy was the amount of new terminology which might encourage a surface approach. Comprehension learning (refer to section 2.3.1.2) appeared to be best suited as a deep approach because this facilitated the integration and relevance of the knowledge and understanding.

- Positive and negative factors that affect the learning experience

Known influences were found in anatomy, such as work load and assessment. The main positive factors were relevance, enjoyment and confirmation/confidence. Negative factors included the volume of information and time. In particular the experience of the DR was specific to anatomy and might be positive or negative. Perception appeared to clearly influence the approach to learning adopted and the level of engagement; for example, if students perceived the learning to be too much and memorisation based they adopted a surface approach. The findings corroborated those of the preliminary study, ASSIST Inventory and Questionnaire.

- Application of knowledge

Understanding the relevance of the material under study promoted a deep approach. Students reflected a shift in attitude due to the increasing clinical contexts that often occurred during the third year. For some students the recognition of the relevance in hindsight initiated them to re-learn or re-visit an area. A student's later ability to apply their knowledge was linked to how they had initially approached anatomy. Students who had adopted a surface or strategic approach experienced problems in forgetting anatomy, or not being able to understand the information to apply it.

Overall: Anatomy learning appears to be influenced by the student's perception, not just of the learning environment but how they will use the information. This affects the approach they take and the level to which they engage in the process and the learning activities within it. The in-depth discussions strengthen the likelihood that the relationships between perceptions, approach and subsequent issues are causative. These interviews revealed why the deep approach should be the goal for students learning anatomy. The deep approach facilitates the understanding of the three-dimensional form and the bringing of knowledge into practice. Students who had not adopted a deep approach to learning anatomy experienced problems later on in the course when the clinical context required understanding and application of anatomical knowledge.

Importantly, I have an understanding of the influences and activities which promote a deep approach. The ideal to facilitate anatomy learning would be to create an environment where these elements are promoted and elements which hinder learning are reduced where possible. Clinicians need to practise safely, and producing an effective environment for learning anatomy would help accomplish this.

6.4 Conclusions of Student Perspectives of Learning Anatomy

The student focus groups and the interviews allowed me to confirm, refine and progressively develop the conclusions from the ASSIST inventory and questionnaire. At the beginning of Chapter 5 the following questions were asked:

Sub questions 1. Anatomy learning

- What are medical students' perceptions of anatomy?
- How are medical students approaching anatomy learning?
- What is involved in the learning process?
- What affects and influences the learning of anatomy?
- How are medical students applying their anatomy knowledge?

Chapter 5 established quantitative answers to the questions. In this chapter the qualitative in-depth exploration provided by the focus groups and interviews now enables each question to be holistically addressed.

- What are medical students' perceptions of anatomy?

All research activities reported that the use of human cadavers was perceived to be essential for learning anatomy knowledge and for developing students' attitude and professionalism. The use of human cadavers was seen to facilitate learning of the three-dimensional form, through exploration/ touch-mediated perception. Students perceived understanding the three-dimensional form to be associated with the application of anatomy, e.g. radiology. It is not surprising that students' perception of the relevance of anatomy increased as they moved through the course. This may explain why students early on might adopt a surface approach if they do not see the relevance. Many students perceived anatomy as being memorisation-based and to contain a large number of facts. This appears to be mainly an initial perception, as key features, such as clinical relevance, appeared to influence the majority of students to take a deep approach. Assessment is an important part of the curriculum for students and many commented on working towards how they were going to be assessed.

Students were concerned about how they would be viewed by the rest of the profession if they had not dissected. This reflects the 'rite of passage' view shown by some students to using human cadavers and in particular dissection. Students perceived learning anatomy through human cadavers as a factor that distinguished them from other students and the general public. This factor may be important in the transition from lay person to professional.

- How are medical students approaching anatomy learning?

Students' perceptions of anatomy influence the approach to learning they adopt. Each approach to learning anatomy has certain characteristics which are supported by the literature. Other characteristics, attitudes, activities and behaviours are associated with anatomy as a discipline. A surface approach is classified by a student's perception and intention to memorise information. In anatomy many students perceived anatomy to be memorisation-based and containing too many facts. The surface approach offers students a limited and narrow learning experience with detrimental consequences for assessment and future learning of anatomy. A strategic approach is driven by a student's assessment motivation and in anatomy this involves spotter assessment. Students will use a mixture of superficial and deep learning according to what they perceive the assessment demands. Students who adopt this approach do the best in assessments but may have problems in applying their knowledge. Students who adopt a deep approach aim to understand anatomy and develop activities which promote their understanding of the three-dimensional form. Students begin to reform their knowledge so that they can apply it to a clinical context.

- What is involved in the learning process?

The learning process of anatomy may be divided into three stages by its practical nature: preparation, practical and confirmation. The level to which students engaged in these three stages is reflective of their approach to learning anatomy. The activities students engage in and their level of engagement are again reflected in their approach. Students who adopt a deep approach to learning anatomy engage fully in all three stages and engage in activities which reflect development of touch-mediated perception and understanding of the three-dimensional form. In a deep approach students seek to apply knowledge in a clinical context and confirmation tests understanding. A student who adopts a surface approach will not engage in all stages and will focus on activities which help them to memorise information and confirm it.

Involved in the process of learning anatomy is the student's ability to understand the three-dimensional form. There are five levels to this understanding which when complete enables students to:

> Perceive, retain and recognise or reproduce three-dimensional objects in their correct proportions when they are rotated in space, translated, juxtapositioned, projected, sectioned, re-assembled, inverted, re-orientated or verbally described. (Rochford 1985)

Not all students reach level five. Students who adopted a surface approach had more problems in understanding the three-dimensional form, reaching only the early levels. Understanding the three-dimensional form (level five) was associated with a deep approach and appears important in reconstructing the knowledge to apply it, for example in radiology. Comprehending the learning process will enable recommendations to be made based on practical applications to improve the teaching and learning of anatomy.

- What affects and influences the learning of anatomy?

Initially, previous experiences and initial perceptions influence students early on in the curriculum, with the majority of students perceiving anatomy to be memorisation-based. Many students adopt superficial learning in the beginning to acquaint themselves with the new terminology. From here other influences can be broadly defined into elements which are detrimental (negative) and elements which promote a deep approach and are positive (promotional). These influences affect the approach to learning adopted by students and hence are likely to be causative. Detrimental factors, such as not seeing the relevance and time constraints, are linked to a surface approach. Promotional factors include the clinical context, ability to visualise anatomy, enjoyment and confidence, and were related to students adopting a deep approach. There are practical applications for understanding the influences as it may be possible to promote or reduce them as required within the context of the curriculum and day-to-day teaching activities.

- How are medical students applying their anatomy knowledge?

Students who adopted a deep approach reported activities that directly related to the clinical context, for example, using anatomical language and radiological knowledge. Students who saw the relevance in hindsight either used further study to re-learn information previously forgotten or were able to build new information in the new context. This then enabled them to apply their knowledge directly to the clinical setting.

How students were using their anatomy knowledge was not directly examined or observed. However, from the research activities the essential areas which allowed students to use their knowledge early on was found to be in the form of surface anatomy and radiology. Later on this was linked to basic clinical procedures, e.g. catheterisation. These findings should be compared to how doctors in practice apply their knowledge.

There are consequences for a student's application of knowledge based on the approach to learning they adopted. Students who adopted a deep approach did not report any problems in applying their knowledge. Students who adopted a strategic approach wanted to apply their knowledge quickly and in some cases had to revisit or re-learn information in a new context. Students who adopted a surface approach struggled when applying their knowledge and often had to re-learn it.

Chapters 4, 5, and 6 have explained how students are learning and applying their anatomy. However, emerging from the stakeholder interviews, student questionnaire, focus groups and interviews was the need to explore the learning and progression of anatomy retrospectively from doctors in practice. The activities have enabled an understanding of a student's application of anatomy, but this reflects only on training for clinical practice. Based on the activities so far a number of themes were taken into the final part of the research to seek alumni experiences and perceptions of anatomy in clinical practice (refer to Figure 23).

6.4.1 Working model of learning anatomy

There are causative interactions between student perceptions of anatomy, the approaches to learning anatomy they adopt (deep, strategic and surface), the influences students experience, the assessment outcome and students' ability to apply anatomy knowledge in the clinical context. The adoption of a deep approach to learning anatomy appears to be the desired approach. The deep approach facilitates students' understanding of the three-dimensional form and their application of anatomy in the clinical setting.

Anatomy is learned through the engagement in all or part of three stages. It is concerning that initially students perceive anatomy to be memorisation-based. Despite this many overcome this by being influenced by the relevance of the material. Relevance is important in all stages of learning anatomy and influences the approach that students adopt. It is therefore possible that relevance helps students move beyond their initial perception and could be promoted to encourage students to adopt a deep approach to learning anatomy.

There are consequences to adopting a certain approach, not only in terms of assessment success but for the application of anatomy in later years of the course when information is integrated and reformed. Students who adopt a surface or strategic approach to learning anatomy early on are more likely to have difficulty in applying their knowledge. Therefore it is possible that the removal of factors which may drive students towards a surface or strategic approach would be best for ensuring effective learning of anatomy.

In understanding the three-dimensional form students engage in a series of levels which allows understanding to be built up. The final level is the transforming of this understanding into the clinical context, e.g. radiology. A deep approach best accomplishes this.

My initial thoughts from the preliminary student focus groups which highlighted the students need for confirmation have now been unravelled and I can see that this is part of the learning process but that it varies according to the approach adopted and the amount of engagement. This creates an opportunity to ensure that any activities designed for students to confirm their learning can be done so in a way that promotes confirmation of understanding and application.

For the next stage of the research I decided to move away from the student perspective to focus on doctors in practice or 'alumni'. I aimed to seek confirmation of results so far and explore retrospectively the experiences of doctors' anatomy learning, if this affected their clinical practice and how anatomy knowledge was transformed for clinical application.

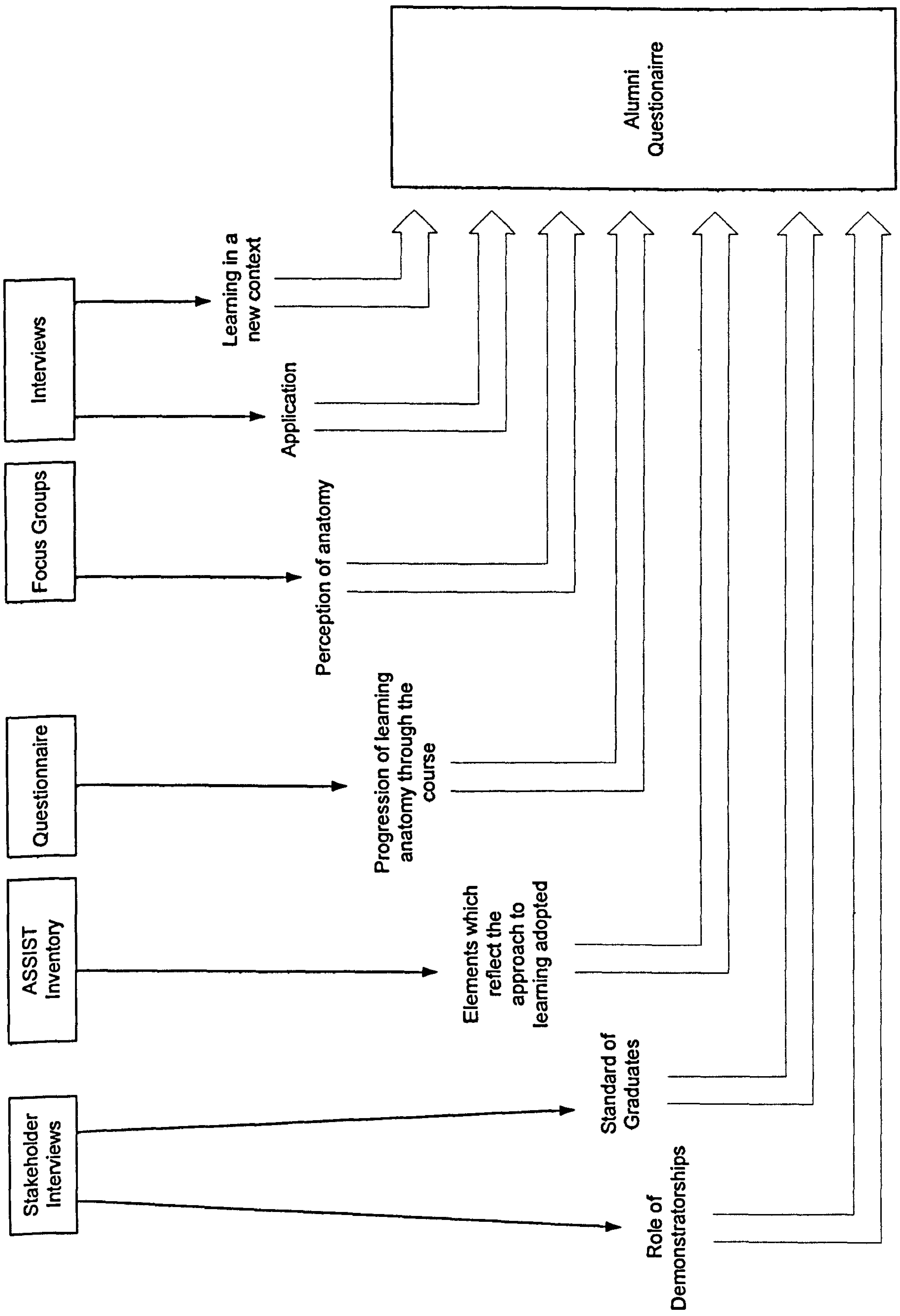


Figure 23. Key themes identified for further exploration from alumni's perspective

7 Chapter 7. Alumni Experiences of Learning and Applying Anatomy

7.1 Introduction

Having gained an understanding of the students' experiences of learning anatomy I was interested to examine a number of themes: graduates' perceptions, possible adopted learning approaches, progression of the learning process, and the application of anatomy and learning in a new context. These themes emerged from the ASSIST inventory, student questionnaire, student focus groups and student interviews. The stakeholders highlighted the themes of the role of demonstratorships, standards of graduates and student engagement. There was little evidence in the literature to support these themes so they were built into the study to explore them further. These alumni make up a diverse population; nonetheless they have all experienced anatomy education at Southampton. The discussion of the curriculum history (section 1.2.4) indicates that alumni undergraduate anatomy teaching would have involved the same teaching methods with only minor alterations in the curriculum, therefore making alumni and students comparable for the purpose of this study.

To confirm the results of the study so far and to explore the themes identified above within the progressive focusing framework, a questionnaire method was selected. A questionnaire was suitable as it allowed the experiences of a broad range of alumni to be investigated in a quantitative and qualitative form. An on-line questionnaire was also selected as a convenient method to reach a wide range of potential participants, the majority of whom would be doctors in practice. Refer to section 3.5.5 for the rationale of the questionnaire method adopted in this study. This chapter addresses the second research question: How does anatomy education prepare doctors in practice?

Informed by the literature and study so far, the following sub questions were developed.

Sub questions 2: Relevance in practice and reflections on anatomy education.

- In hindsight, what are alumni's experiences of anatomy education?
- What factors influenced alumni's learning?
- Did alumni's experiences influence their career and how?
- How do alumni use their anatomy knowledge?
- How did alumni re-learn and transform their knowledge?
- Having experienced medical education, what, if anything, would alumni change about their anatomical education?

7.2 Organisation

A questionnaire was designed into four clusters. Each cluster contained a series of question which required a Likert scale response as well as questions which required open-ended responses (Appendix I). The clusters were influenced by the literature, stakeholders' and students' perspectives. The clusters were selected to confirm earlier results or to develop the selected themes. The rationale for each cluster is briefly described.

Cluster 1: 'Perceptions and experiences of anatomy' was selected to confirm the findings of the students' perspectives and to allow for any further elements to be raised from different perspectives.

Cluster 2: 'Feelings of anatomy at the time of graduation'. The stakeholders had highlighted the possible variation in standards and I was interested to explore perceptions of anatomy at the transition from student to clinician. This section also began to investigate the application of anatomy.

Cluster 3: 'Anatomy in your current job role' was chosen to contain questions that would explore the application of anatomy, re-learning of anatomy and transforming knowledge into practice.

Cluster 4: 'Overall reflections' explored overall perceptions of anatomy, reflecting on those expressed from the students' perspectives. This section contained a greater number of open-ended questions that investigated how alumni's experiences as a student in anatomy influenced their future career, alumni's experiences of demonstratorships, alumni's perceptions of medical students today and what they would have changed about their experience.

The questionnaire was constructed in Question Mark Perception^{TM} and was subjected to several stages of testing. A similar online format was used to that of the student questionnaire. To allow alumni access, the questionnaire was located in the public domain and thus was open to various search engines. Therefore I gave potential participants instructions to use their name and a password ('anatomy') to log in to the questionnaire. This would enable identification of multiple entries and identify any attempts to complete the questionnaire from unsolicited internet users. The questionnaire was accessible to participants during March and April 2007.

To allow for comparisons between the results obtained from the student perspective and the alumni, only alumni from Southampton were invited to participate. Alumni were sampled through data provided by the University of Southampton Alumni Office. The Alumni Office held a limited number of email addresses but a wider range of postal addresses. Postal addresses in Hampshire and Dorset with no email available were contacted with a written version of the invitation to take part in the study. Response rates from postal surveys tend to be small and it was decided that alumni could also be contacted through the postgraduate Wessex Deanery. The Dean agreed to help in this study by allowing the sending of an email invitation to students registered within the Deanery. This included graduates from anywhere in the UK, although predominately from Southampton, so the email stipulated the need for response from only Southampton alumni. Responses were then checked against the school database. Table 18 illustrates the sampling strategy of the alumni group.

Method of contacting alumni	Potential sample size	Number of sample contacted
Alumni Office	1622 postal addresses	305 postal addresses (Hampshire and Dorset)
	575, email addresses	492, email addresses *
Wessex Deanery	172	172
	Total: 2197	Total: 792

Table 18. Sample strategy details

* 83 emails were returned as undeliverable. It was unclear if the alumni contacted by the Wessex Deanery had already been contacted by the alumni office. Based on contacting graduates through the alumni office the response rate was 18%.

7.3 Alumni Results

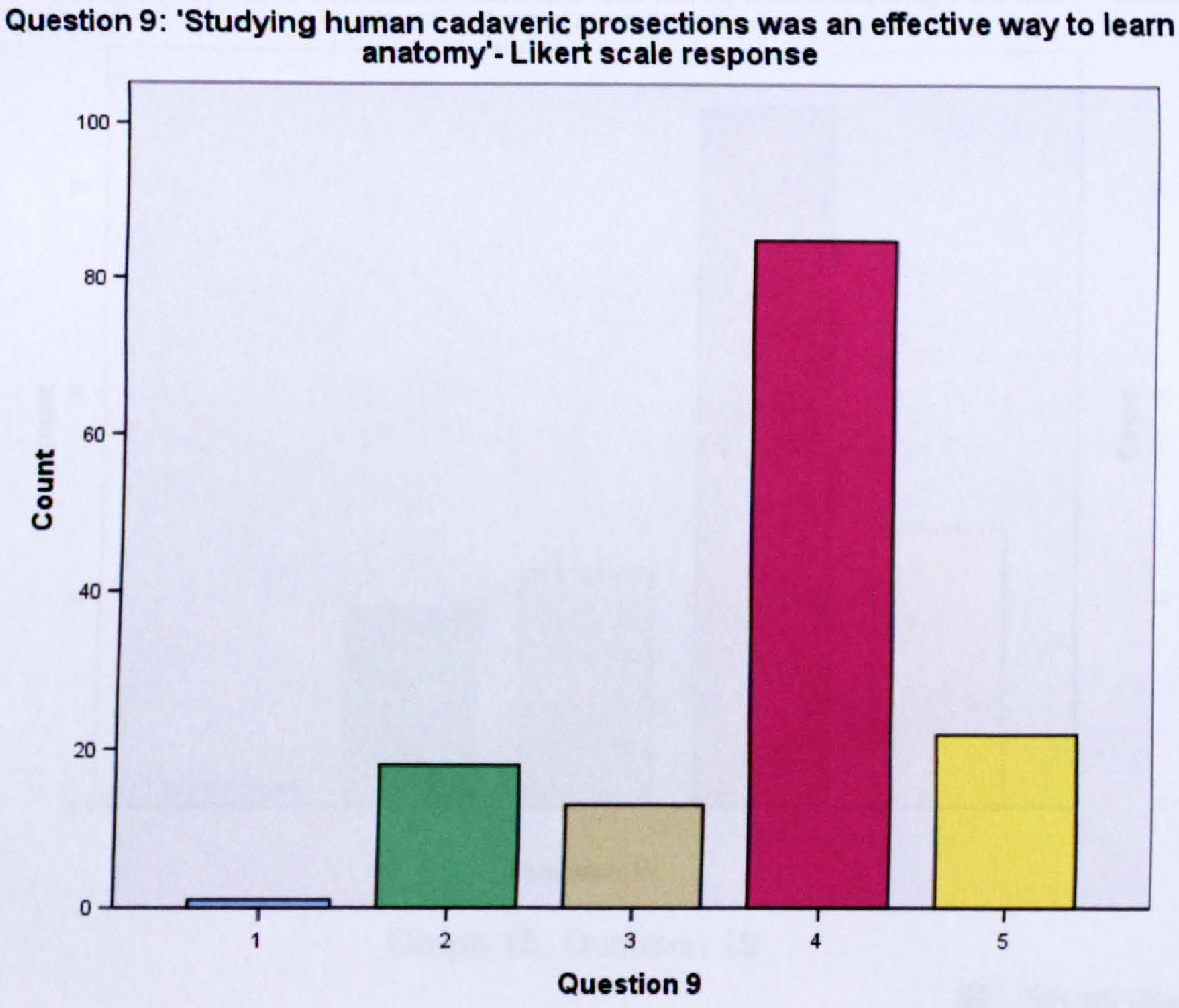
The data were extracted from the server and imported into Statistical Package for Social Sciences ™ (SPSS). The answers to the open-ended questions were imported into Microsoft Word files. Any entry which contained incomplete Likert scale answers was deleted. This left a final sample of 140 alumni (6.4% of all alumni from Southampton Medical School). The sample contained 69 (49%) males and 71 females (51%).

I created a graph of the responses to each question to give an overview of the responses and possible trends. Trends were then further examined through statistical analysis. The graphs were created in SPSS using a bar chart technique to illustrate alumni's Likert scale responses. The key denotes the Likert scale responses to the given question number and the colour used to illustrate the responses (1=Strongly Disagree, 2= Disagree, 3= Neither Agree nor Disagree, 4= Agree, 5= Strongly Agree).

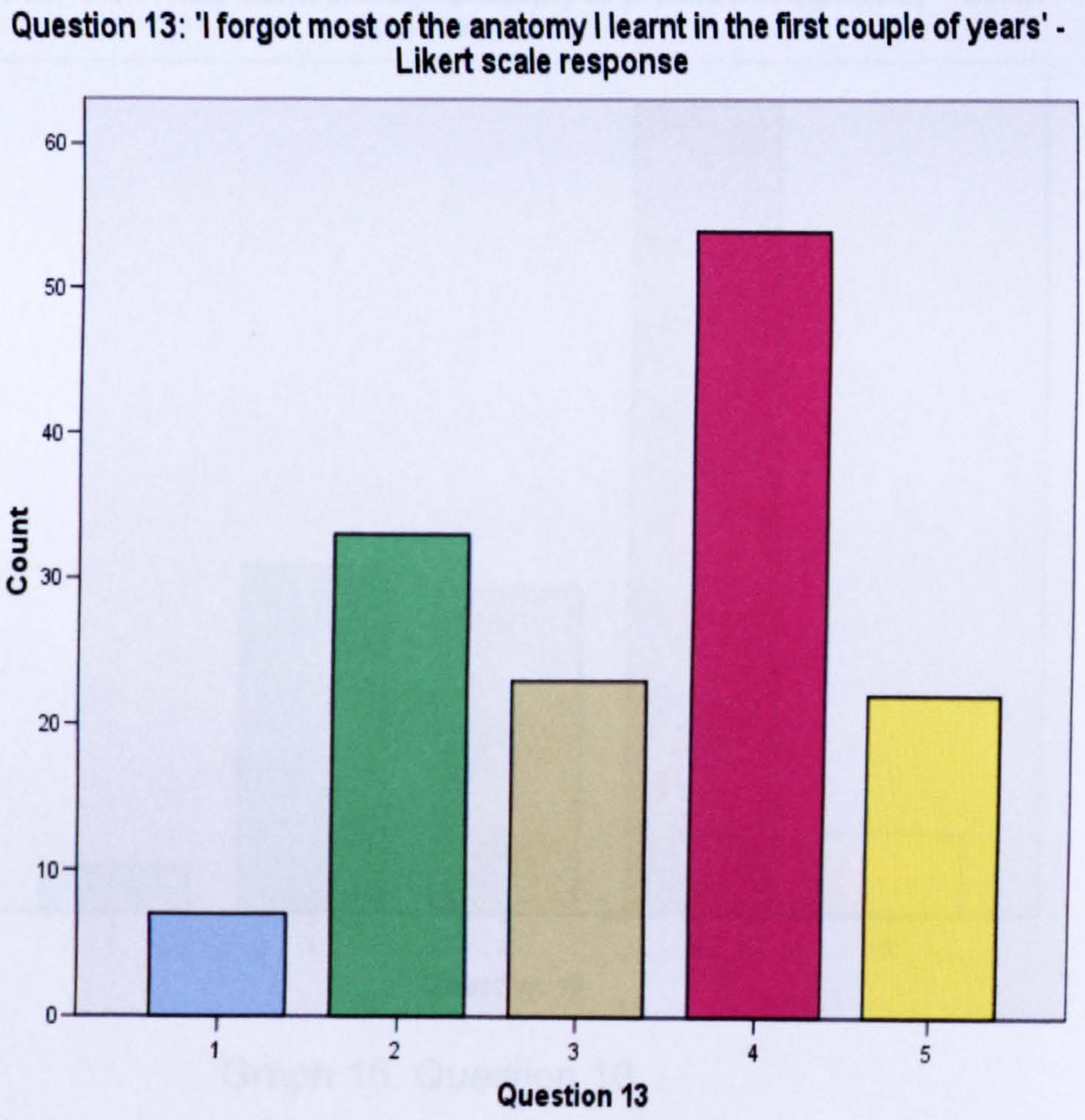
7.3.1 Overall responses

Cluster 1 examined alumni's perceptions and experiences of anatomy and conveyed similar experiences and preferences to those found in the activities reflecting the students' experiences. In exploring alumni's perceptions many reflected that assessment acted as a major influence and motivator for learning anatomy, reflecting the findings of the students' perspectives. Alumni felt they were not given advice on how to learn anatomy. Alumni agree that using human cadaveric prosections was an effective way of learning anatomy (Graph 13) and that this understanding was facilitated through exploring the specimen. Despite this, over 54% of alumni reported forgetting a lot of the anatomy they had learned in the first and second years (Graph 14). This is likely to reflect the adoption of a strategic or surface approach. It is not uncommon to forget information taught in 'early years', however the percentage of alumni who reported this reflects that approach to learning adopted may be a contributing factor.

Cluster 2 established alumni's feelings at the time of graduation. As a possible consequence of feeling that they had forgotten their anatomy (Graph 14) alumni were concerned that there was still a great deal of anatomy to learn (Graph 15). This finding reflects students early perceptions of anatomy and confirms that such perceptions remains post qualification. Alumni's perceptions of their knowledge base being sufficient for clinical practice revealed that the majority (77%) felt their knowledge was safe for practice (at the time of graduation) (Graph 16). Other studies have reported that 33% of graduates felt that their knowledge was inadequate (Blyth & Insull 2006). It is possible that some alumni had difficulty in applying the knowledge and this is reflected by half of the alumni reporting that they found it difficult to relate the anatomy they had been taught to practice (Graph 17). This finding possibly reflects on the approach to learning adopted but also highlights the importance of the learning being relevant and in a clinical context. Alumni (79%) reported that if they did forget something it came back easily with a small amount of study (Graph 18), highlighting that if the foundations are there then the knowledge can be restructured and used.



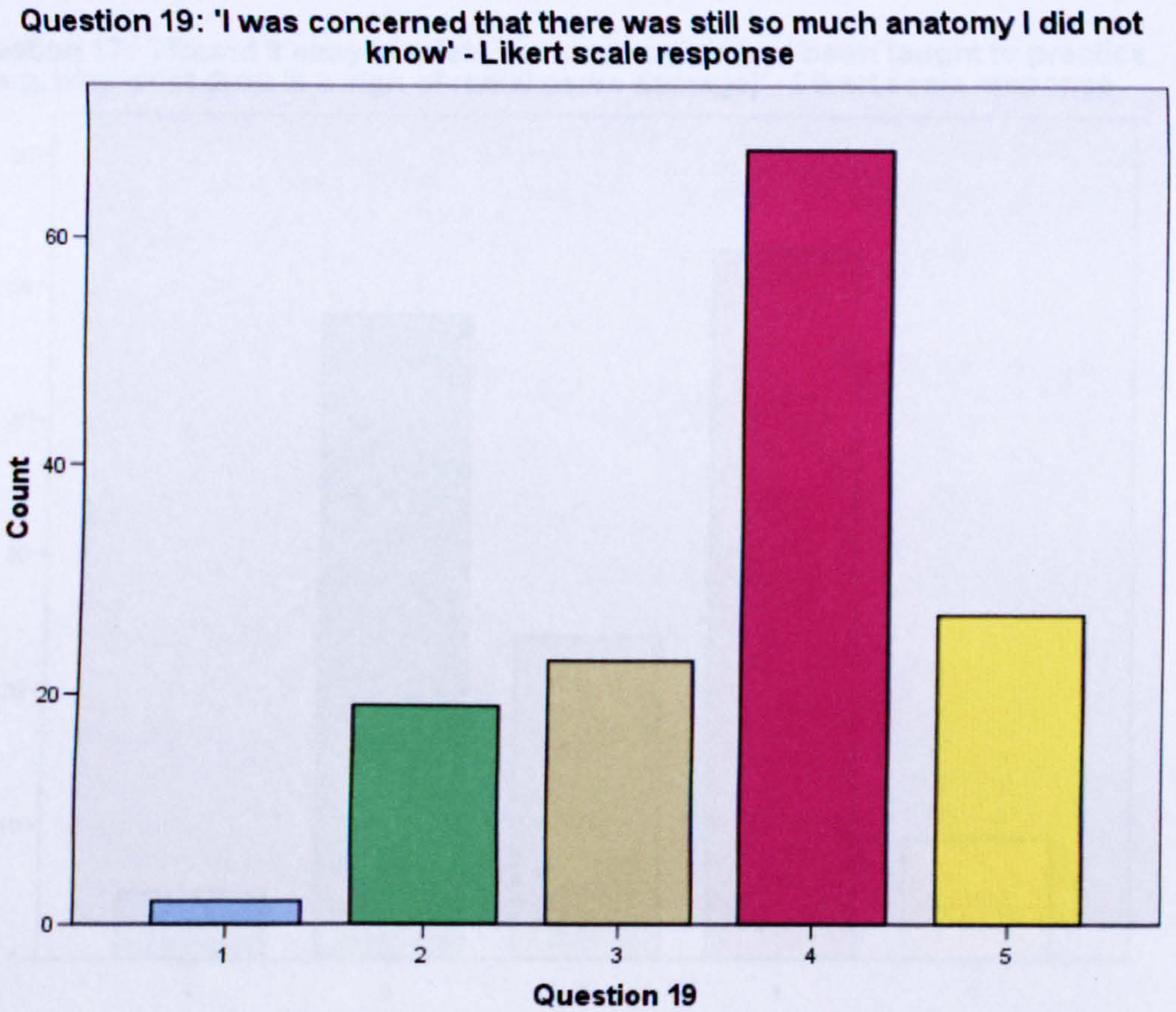
Graph 13. Question 9



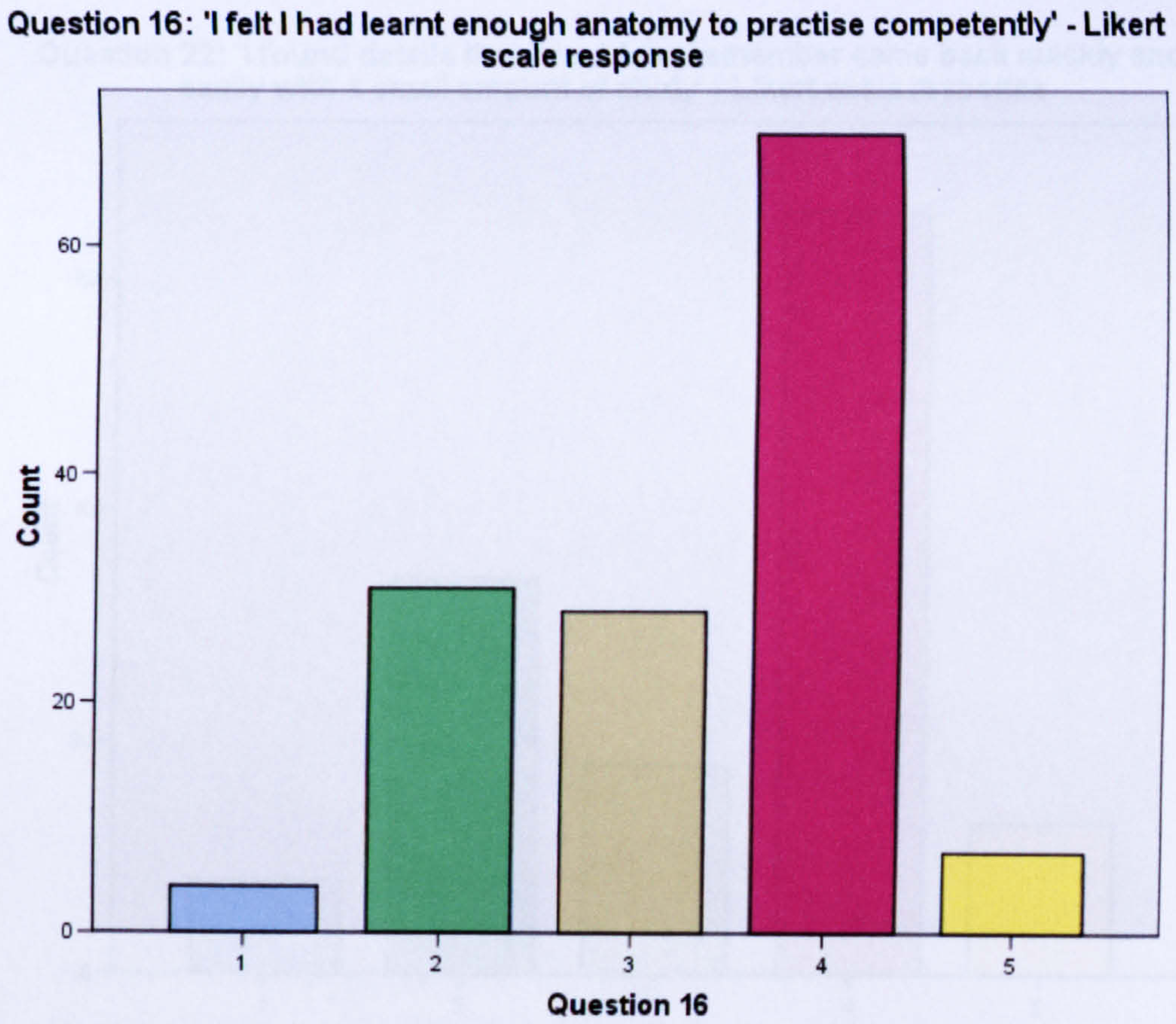
Graph 14. Question 13

Key

- 🟦 1 Strongly Disagree
- 🟩 2 Disagree
- ▨ 3 Neither Agree nor Disagree
- 🟪 4 Agree
- 🟨 5 Strongly Agree

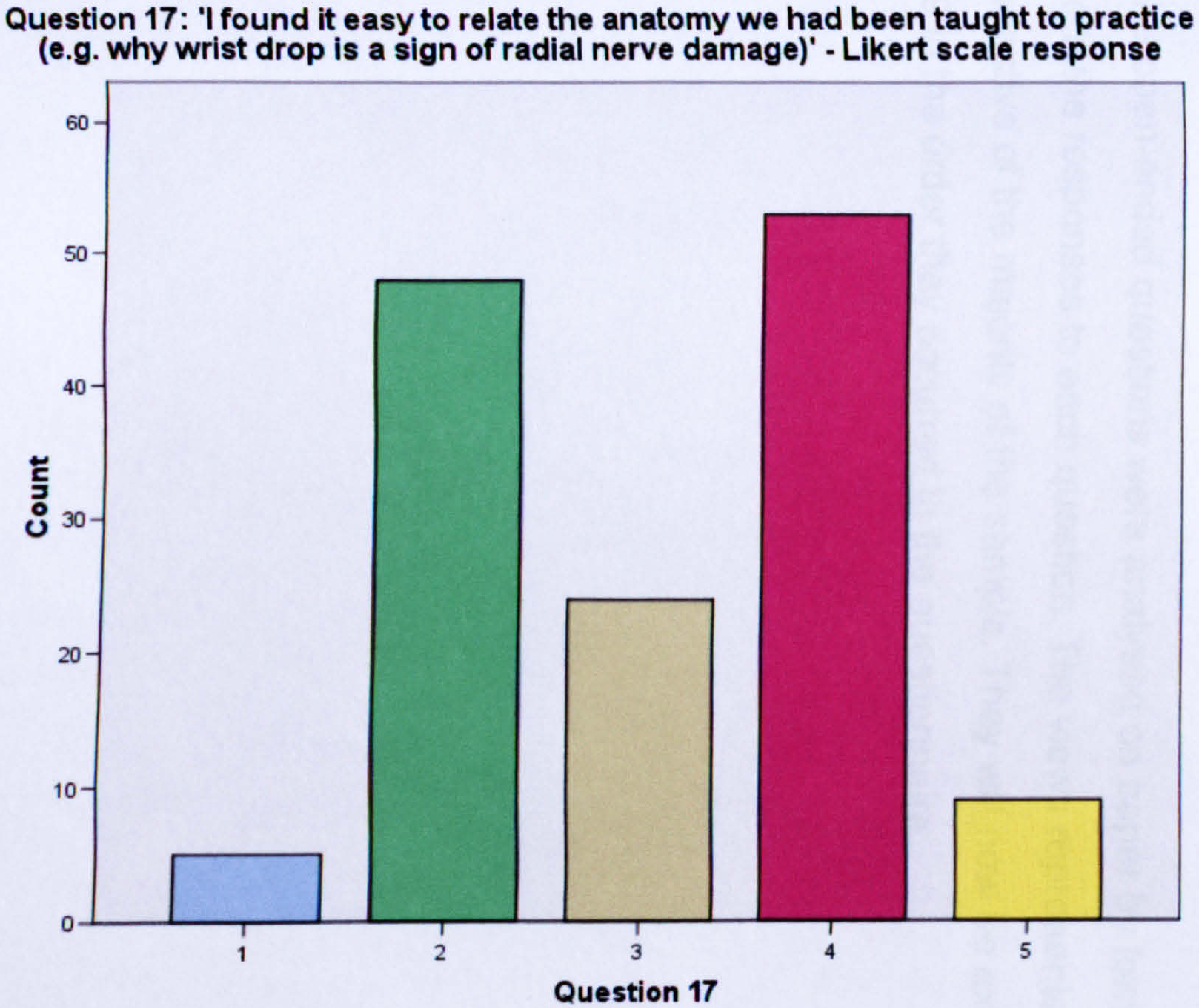

Question 19: 'I was concerned that there was still so much anatomy I did not know' - Likert scale response

Graph 15. Question 19

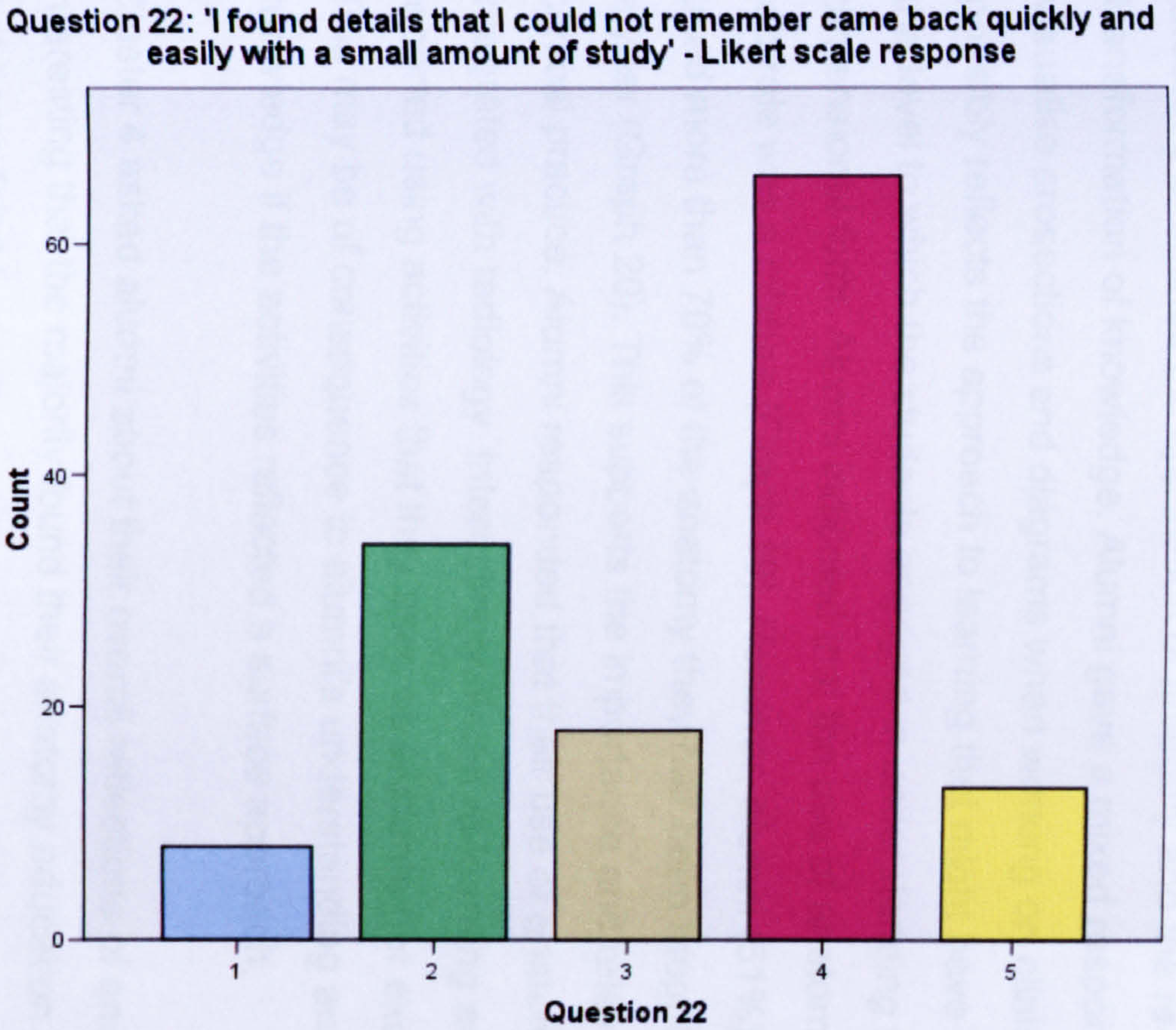

Question 16: 'I felt I had learnt enough anatomy to practise competently' - Likert scale response

Graph 16. Question 16

Key
- 🟦 1 Strongly Disagree
- 🟩 2 Disagree
- ▨ 3 Neither Agree nor Disagree
- 🟪 4 Agree
- 🟨 5 Strongly Agree



Graph 17. Question 17



Graph 18. Question 22

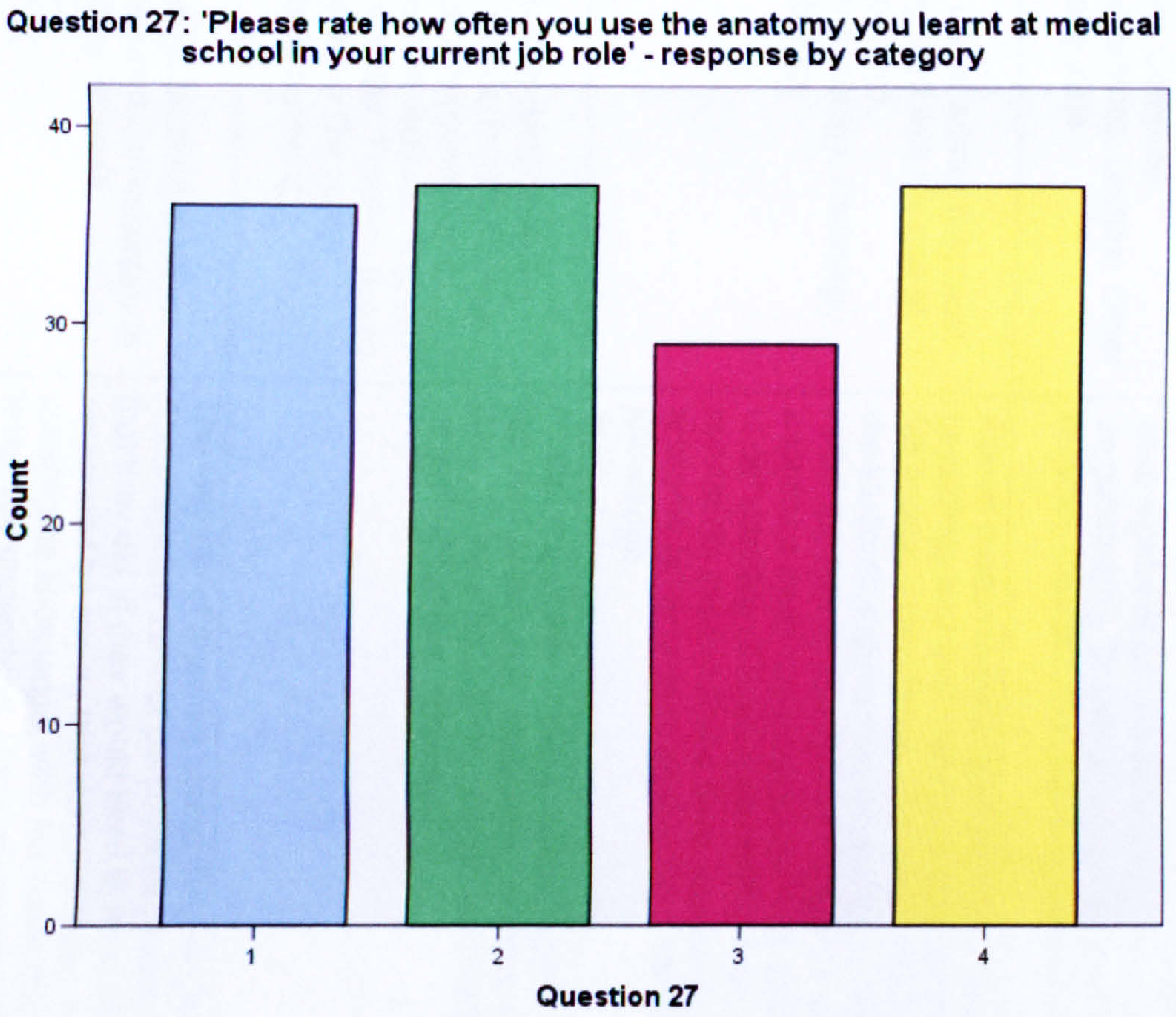
Key

🟦 1 Strongly Disagree
🟩 2 Disagree
🟫 3 Neither Agree nor Disagree
🟪 4 Agree
🟨 5 Strongly Agree

Cluster 3 examined the application of anatomy and the re-learning and transformation of knowledge. Alumni gave a mixed response to their ability to visualise prosections and diagrams when working on clinical areas. This possibly reflects the approach to learning that might have been adopted or the level to which the students engaged in understanding the three-dimensional form. Alumni indicated that the use of anatomy in their current job role was a mixture (Graph 19). However, alumni (51%) reported that they used more than 70% of the anatomy they had been taught over the course of a year (Graph 20). This supports the importance and relevance of anatomy in clinical practice. Alumni responded that their use of anatomy was most integrated with radiology. Interestingly, when re-learning anatomy alumni reported using activities that they used as students (for example, text books). This may be of consequence to alumni's understanding and application of knowledge if the activities reflected a surface approach.

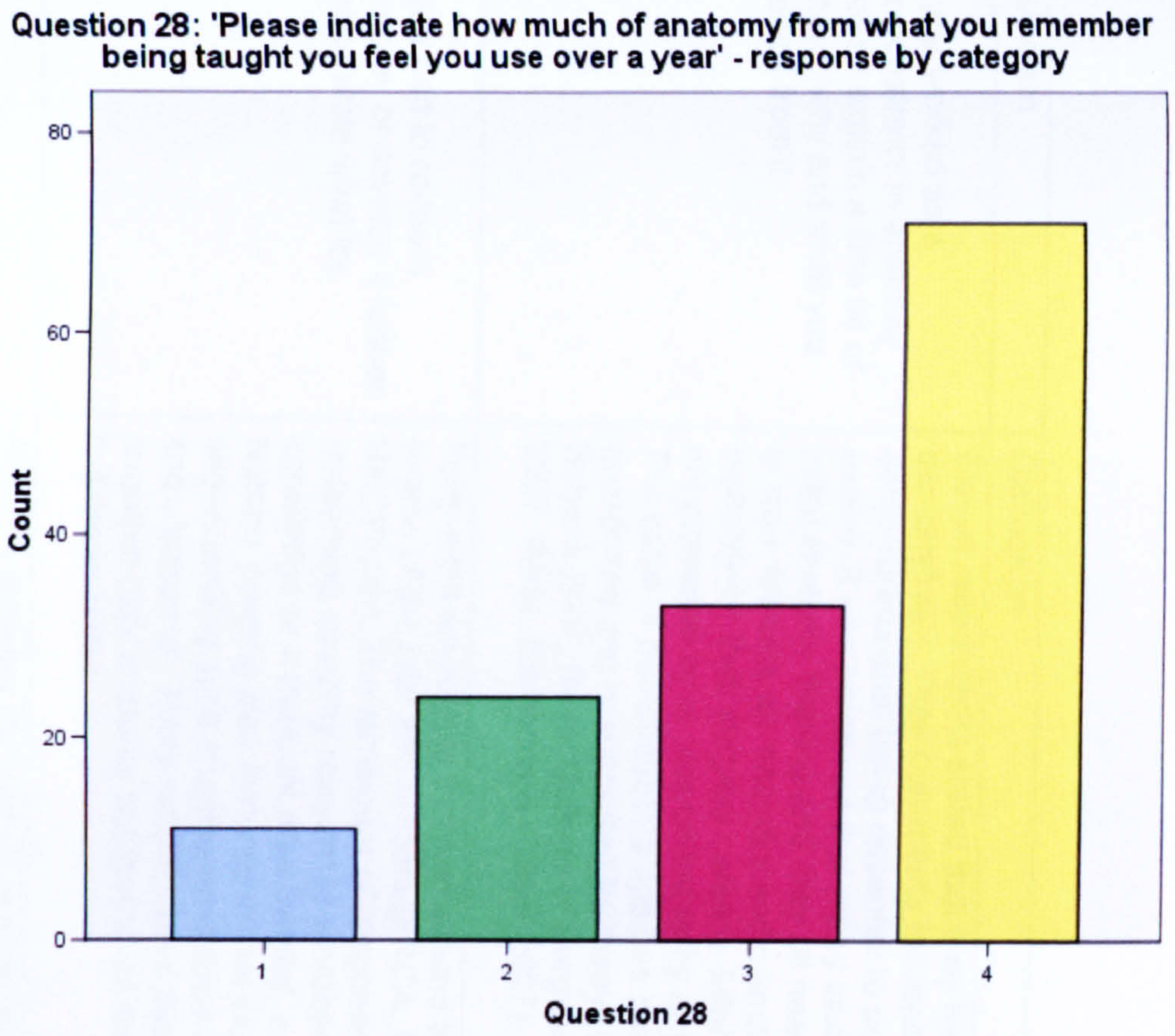
Cluster 4 asked alumni about their overall reflections of anatomy and it was interesting that the majority found their anatomy education invaluable and that some felt it had influenced their career.

The open-ended questions were analysed on paper by forming categories from the responses to each question. The views represented are therefore reflective of the majority of the sample. They will now be examined in Table 19 in the order they occurred in the questionnaire.


Question 27: 'Please rate how often you use the anatomy you learnt at medical school in your current job role' - response by category

Graph 19. Question 27

Key:
1= All the time
2= Most days
3= Most weeks
4= Not very often


Question 28: 'Please indicate how much of anatomy from what you remember being taught you feel you use over a year' - response by category

Graph 20. Question 28

Key:
1= Less than 30%
2= 30-50%
3= 50-70%
4= More than 70%

Question	Discussion
If you worked as a demonstrator in anatomy please explain a little bit of where, why and what you gained from it.	Eleven respondents stated that they had worked as a demonstrator. Their comments focused on the role of a demonstrator post being essential to pass surgical exams. It was perceived that many students forgot their initial anatomy training and they all needed to re-learn it to work towards an 'encyclopaedic knowledge' of anatomy for their surgical careers. Interestingly it was not promoted by or responded to by any other discipline. The value of demonstratorships has been recently questioned and is supported by many (Lockwood & Roberts 2007; Royal College of Surgeons of England 2007; White, Edmonds & Fraser 2007).
If you had to re-learn anatomy or develop it further please state what for.	Forty-eight responses focused around the postgraduate exams of the past and present (FRCA, MRCS, MRCPsych). The remainder of responses (44) reported re-learning anatomy relevant to a procedure, case, new knowledge or a frequent area treated, e.g. central line. Notably imaging also featured in that alumni reported understanding such imaging modalities as X-rays, CT and ultrasound. Many simply stated that they had forgotten their anatomy but that when they had revised it, it made sense.
How did you re-learn your anatomy? Text Books, Dissecting room, Computer programmes, Lecture, Other please state	Alumni's answers focused on textbooks or handbooks they used as a student, reflecting the small amount of learning resource technology that was available to many alumni when they were students. Postgraduate courses were a point of perceived learning, as was demonstrating. Drawings were also mentioned which reflected their previous learning experiences.
My use of anatomy is most integrated with my use of: Physiology, Pharmacology, Pathology, Radiology.	Alumni predominately listed radiology first, and then physiology and then pathology illustrating how alumni felt anatomy knowledge was integrated in practice. From the students experiences applying knowledge though radiology was associated with students who had adopted a deep approach to learning anatomy and an understanding of three-dimensional form. The alumni comments support that a deep approach to learning anatomy is the ideal to enable the application of knowledge.
I found anatomy learning was most effective through: Practical's prosection or dissection, lectures, tutorials, self directed, Problem Based Learning or Computer Assisted Learning	Alumni responses to this question were a mixture; many reported prosection, textbooks, tutorials, diagrams and CAL. Quite a few alumni responded that they would have liked to have dissected.
I would have liked to have worked as a demonstrator in anatomy because	The majority of answers stated they would not! Approximately 20% of participants responded saying that they did. If they would liked to have or did, alumni responded by saying that demonstrating would consolidate knowledge, with the belief that if you can teach you understand. Many alumni perceived demonstrator roles as an opportunity to catch up and

Question	Discussion
	further their anatomy knowledge. Many reported that this activity was essential for a surgical career.
What changes would you like to see in anatomy education?	Alumni's comments focused on the wanting of a more functional, interactive and linked approaches to aspects such as radiology and surface anatomy. Some responded by requesting further anatomy 'refresher' courses and dissection. Several comments were made about wanting to try computer programmes, especially virtual reality ones.
If you were not happy with your experience of anatomy please say why	Some alumni (14%) reported not seeing anatomy early on in their training as being clinically relevant and hence this affected their motivation to learn. Approximately 10% of comments reflected alumni's personal experiences of finding the dissecting room environment distasteful, while others felt that not dissecting had hindered their learning. Comments also reflected that learning anatomy was time consuming. A lack of direction as to what alumni were supposed to be doing also featured (13%) with some alumni reporting that felt unable to ask for help. Several responses (13%) were positive saying that they found it effective
If you have contact with students or junior staff, how effective do you perceive anatomy education today to be?	The majority of comments reflected a negative response. Alumni felt that students did not know as much as their predecessors. The stakeholder interviews reflected the same experience of the students. However several alumni did point out that it was student dependant and that many students quickly forget the information they had learnt.
Please add any other comments	There were a couple of references to Southampton having a reputation for students not knowing any anatomy. To explore this further, Southampton when it opened was different from the traditional medical schools and part of this was a reduction in anatomy (which was later recommended to all medical schools by the GMC) which may have initially caused the reputation. Later, Southampton decided to stop all medical students dissecting and moved towards prosection, again a break in tradition. Further on it removed its demonstrator posts. However, there remains a lack of evidence to say Southampton (or any medical school) graduates are deficient in anatomy. Some alumni would have liked to have had the opportunity to dissect. This reflects an element of feeling they are missing out on what is perceived to be done elsewhere, possibly as part of medical tradition. Since 2003 students can dissect in a Student Selected Unit (SSU).

Table 19. Responses and discussion of free comments

The free comments revealed that alumni experiences of learning anatomy were similar to that of the undergraduate students who took part in this study.

Alumni's experiences involved both promotional and detrimental factors which affected their learning and possibly influenced their future career. Similar to the students' experiences, alumni found a positive change in motivation as the clinical context required re-learning and/or revisiting previous knowledge. This highlights that relevance is a key part of enabling students, undergraduate or postgraduate, to become engaged in the subject. This facilitates new knowledge to then be built in context, either formally through postgraduate training or though self-directed learning.

Alumni would have liked to have had more exposure throughout the course, and as a postgraduate, to anatomy in the form of short refreshers. This happened to an extent but could be improved and reflects the continuing nature of anatomy learning. Alumni suggested that to improve anatomy learning the relevance and context of the material should be studied. This could be achieved by increasing the amount of surface anatomy and radiology. The recommendations made by alumni support the possible recommendations from the student results, especially as the ways in which alumni would like to see anatomy improved reflect the influences and the activities which are associated with a deep approach to learning anatomy.

The questionnaire was subjected to a series of statistical tests to seek possible related clusters or associations by correlating each question to the other questions. Demographics such as the year of graduation and current job were examined in relation to the Likert responses to each question.

7.3.2 Inter-question analysis

To examine if there was a relationship between how an individual responded to one question compared to another, I performed a non-parametric test to examine the relationship between two variables (Spearman's correlation coefficient). Spearman's correlation tests were performed for all questions. Further details of the correlation tests are presented Appendix W.

Significant associations (r>0.5, $p < 0.05$) reflect that enjoyment (Question 1, looking retrospectively) was linked to promotional learning activities (possibly those that are part of a deep approach). For example, studying human cadaveric specimens (Question 9) was correlated to that information was conveyed into understanding when exploring specimens with their hands (Question 32). Alumni, who responded by agreeing that they enjoyed anatomy also were able to visualise images (Question 14). These findings support the promotion factors described by students. The correlations highlighted that alumni who responded to remembering doing well in anatomy examinations were associated with alumni who also responded finding it easy to relate anatomy to practice (Question 17) and felt their anatomy education was invaluable to them (Question 29).

The correlation analysis revealed that the responses of alumni who reported forgetting most of the anatomy they had learned (Question 13) were negatively associated with their response to feeling that anatomy was invaluable to them (Question 29). Whilst not significant, medium associations were highlighted between possible negative factors in alumni's experience and being concerned there was still a lot of anatomy to know. They could not relate the anatomy to practice and struggled to form a three-dimensional map of the body and visualise prosections. Details alumni forgot over time did not come easily for them and they responded to not looking forward to learning more anatomy. Possibly, therefore, they reported using a lower amount of their anatomy in their professional practice (Q28 and 29).

I was interested to explore if alumni's year of graduation was linked to their Likert scale responses. To investigate this I adopted a non-parametric Mann Whitney test to explore the differences between two samples. To conduct this test I collapsed the year of graduation into two categories according to when changes in the curriculum occurred. Before 1988 anatomy was taught in regions in year 1 (category 1, 1975-1992 graduation). After 1988 anatomy was taught in systems to year 1 and 2 students (category 2, 1993-2006 graduation). Three significant differences were found (refer to Appendix X for further details of this test).

- Question 6 (The structures and concepts which we were examined on clearly reflected the anatomy that I used as a House Officer) was responded to highly by group 1 or early graduates (*p*=0.026)

- Question 7 (I saw clearly how anatomy would be part of clinical practice from the beginning) was responded to again more highly by group 1 or early graduates (*p*=0.012)

- Question 20 (I felt confident that I could ask for help with my anatomy knowledge if I needed to) was responded by group 2 or later alumni (*p*=0.032), reflecting they felt more able to ask for help.

The early graduates would have had more time devoted to anatomy and this perhaps explains these responses.

I was interested to see in which areas of medicine the alumni who responded were currently working in and if there was any association between their current job and how they responded to the Likert scale questions. Two members of the medical curriculum board were asked to categorise the alumni's responses into five job categories. Details of the categories are represented in Table 20.

Category of Job	Number of respondents
Anaesthetic	17 (12%)
General Practitioner	28 (20%)
Surgical	25 (18%)
Medical	58 (41%)
Other (including Yr 1 and 2 foundation posts, academic and career break/sick leave)	12 (9%)

Table 20. Categories of alumni's current job roles

To investigate the association between alumni's job role and their response to the Likert scale questions I performed a non-parametric Kruskal Wallis test to examine independent groups. The significant associations are represented in Table 21, and further details of the Kruskal Wallis test can be found in

Appendix Y. The results show that alumni who were working in surgical specialties agreed with the question statements more than any other discipline. This confirms that surgeons' use of anatomy was greater than for other specialities. The questions that alumni who worked in surgery responded to reflect the promotional elements described earlier.

Alumni who responded significantly to forgetting their anatomy were associated with the category of 'other'. In examining the job roles in the 'other' category 60% of alumni were working in areas not related to practice and 40% were in their foundation year of practice. In speculating a possible explanation for this finding, alumni working in areas not related to clinical practice may have been influenced by negative experiences in anatomy.

Question	*P* Value	Significant to category
1, I personally enjoyed my time studying anatomy	0.007	Surgical
9, Studying human cadaveric prosections was an effective way to learn anatomy	0.011	Surgical
10, The dissecting room experience helped me deal with the issues of death	0.021	Surgical
13, I forgot most of the anatomy I learnt in the first couple of years	0.027	Others
15, From what I recall I did very well in anatomy examinations	0.019	Surgical
21, I was looking forward to learning more anatomy in my future career	0.008	Surgical
24, I find it easy to work though a clinical case and pick out the anatomy components	0.010	Surgical
27, Please rate how often you use the anatomy you learnt at medical school in your current job role	0.000	Surgical
29, My anatomy education was invaluable to me	0.031	Surgical
30, My knowledge and interest in anatomy influenced my chosen career path	0.000	Surgical
32, I found information was conveyed into understanding when exploring specimens with my hands	0.022	Surgical

Table 21. Significant associations between alumni's job role and their response to Likert scale questions

The student questionnaire revealed associations between a student's approach to learning anatomy and their gender, with males more likely to adopt a deep approach and females a strategic approach. I was interested to see if this association was reflected in alumni responses to the Likert scale questions. I conducted a non-parametric Mann Whitney test to examine the differences between two independent samples. Only two questions were significantly associated with any gender differences and support the findings of the student questionnaire.

> Question 2 (I preferred learning anatomy by having the structures demonstrated to me) was responded to significantly higher by females (*p*=0.016)
>
> Question 14 (I have a three dimensional map of the human body in my mind which I can visualise) was responded to significantly higher by males (*p*=0.002).

7.4 Conclusions of Alumni's Experiences of Learning and Applying Anatomy

The alumni questionnaire aimed to confirm the results from the student perspective and to develop an understanding of the application of anatomy knowledge. This should enable undergraduate anatomy education to be developed to aid students' transition to practitioner. At the beginning of the chapter the following questions were asked:

Sub questions 2. Relevance in practice and reflections on anatomy education.

- In hindsight, what are alumni's experiences of anatomy education?
- What factors influenced alumni's learning?
- Did alumni's experiences influence their career and how?
- How do alumni use their anatomy knowledge?
- How did alumni re-learn and transform their knowledge?
- Having experienced medical education, what, if anything, would alumni change about their anatomical education?

With support from the literature, the alumni questionnaire enabled each question to be addressed.

- In hindsight, what are alumni's experiences of anatomy education?

Alumni reported that using human cadaveric prosections was an effective way of learning anatomy. However, alumni also felt that they were not given advice on how to learn anatomy. Possibly as a consequence some alumni reported that they experienced problems with the clinical context and were concerned that they still had a lot of anatomy to learn. The change to a system-based course revealed those who experienced the early curriculum reported seeing the relevance of anatomy clearly. It is possible that a crowded curriculum impedes clinical relevance and this has implications for the design and signposting of curricula. Alumni's perceptions and experiences echo those found in the student population, e.g. that human cadavers are an effective way of learning anatomy and that anatomy involves learning a large amount of information.

- What factors influenced alumni's learning?

Anatomy learning was felt by alumni to be influenced primarily by the assessment. Further positive and negative factors, similar to those experienced by students, were reported. Promotional factors included enjoyment which was linked to active learning activities such as exploration and a higher ability to visualise the body. This was similar to the experience of undergraduates who adopted a deep approach. Alumni who reported enjoying anatomy also reported using a lot of anatomy in their jobs (predominantly surgeons).

- Did alumni's experiences influence their career and how?

The learning experiences of alumni influenced their career depending on the degree of promotional and negative influences alumni experienced as students. Alumni responses reflected the three approaches to learning.

Alumni who responded illustrating characteristics associated with a surface approach and negative influences did not feel their anatomy was invaluable to them. They experienced problems with understanding the three-dimensional form and the application of anatomy, and did not look forward to learning more anatomy. Alumni who responded highlighting characteristics of a deep approach and promotional factors found it easier to relate anatomy to clinical practice. Alumni in surgical job roles showed a significant association with such characteristics. These findings reflect on the importance of creating a learning platform and environment which facilitates learning anatomy in context.

- How do alumni use their anatomy knowledge?

In investigating how frequently alumni used the anatomy they had learnt at medical school an even distribution was found, suggesting that the answers reflected their job roles and the variation in the amount of applied anatomical knowledge. Nevertheless, alumni reported that over a year the majority used over 70% of the anatomy they remembered being taught. Alumni felt that their anatomy knowledge was most integrated with radiology.

- How did alumni re-learn and transform their knowledge?

Alumni reported that they predominantly learnt or re-learnt anatomy for postgraduate exams or to revise, or when reviewing a certain area of anatomy in relation to a procedure or a disease. Alumni's learning activities focused on textbooks or handbooks. For those in surgical careers, postgraduate anatomy included demonstrator posts which offered alumni an opportunity to develop their anatomy knowledge through teaching. Such posts were perceived as essential for surgical careers. Alumni responses reflected elements of situated learning (Maudsley & Strivens 2000) and conceptual, procedural and perceptual learning (Boshuizen et al. 1995).

- Having experienced medical education, what, if anything, would alumni change about their anatomical education?

The responses made by alumni focused on three aspects. Firstly, increasing the relevance and interlinking to elements such as radiology. Secondly, alumni would have liked more guidance on how to learn. Thirdly, alumni felt they would have benefited from refresher courses and the opportunity to dissect.

The alumni questionnaire supported the findings from the student perspectives and has explored to a greater depth the application of anatomy. In particular, the findings supported that students' experiences of anatomy do influence and affect their clinical practice. The theme of demonstrator posts and standards of graduates raised by the stakeholder group were explored further. However, they did not raise any significant issues or findings. As this was the final stage of the research, no themes were taken forward. Elements considered for further study are discussed in Chapter 8.

7.4.1 Working model of learning anatomy

The alumni study supported the findings from the student perspectives in that the ideal approach for learning and applying anatomy is the deep approach. Alumni who responded to elements which indicated that a deep approach might have been adopted reported similar learning promotion factors to students and encountered fewer problems in applying anatomy. Relevance is very important in promoting a deep approach and may influence an individual's approach to learning. In suggesting changes to anatomy teaching, alumni requested an increase in relevance and interlinking of disciplines. This supported the student study findings that clinical context promoted the use of a deep approach which in turn aided students' application of knowledge.

The consequences of adopting certain approaches found from the student perspective are continued post qualification. Characteristics associated with surface or strategic approaches were found to be detrimental to the application of knowledge. Negative experiences in anatomy may act to influence the career a graduate pursues. Characteristics associated with a deep approach enabled alumni to effectively apply their knowledge and more were involved in surgical careers.

Reflecting the findings of the students' perceptions, the alumni study found that learning anatomy through touch-mediated perception from human cadavers aided alumni's understanding of the three-dimensional form. This in turn enabled alumni to integrate anatomy with radiology.

Anatomy learning takes place along a continuum that includes both undergraduate and postgraduate anatomy. The application of anatomy, which begins at undergraduate level, is influenced by the context and situation in which knowledge is applied, i.e. situated learning. This involves the transformation of conceptual knowledge (most effectively acquired by a deep approach) through procedural and perceptual learning. This allows the knowledge structure to develop and become restructured (encapsulated) (Schmidt & Rikers 2007). This is in turn allows the knowledge to be applied through the development of 'illness scripts' (Boshuizen & Schmidt 1992).

8 Chapter 8. Conclusions, Recommendations and Future Work

8.1 Introduction

My interest in this research came from my own experiences of learning, and later, teaching anatomy. I wanted to comprehend how students were learning anatomy and how anatomy knowledge is transformed into application in the clinical context. Anatomy understanding enables diagnosis, management, treatment and communication within the medical profession. The principles, values and clinical care on which Good Medical Practice (General Medical Council 2006) are founded involve attitudes, knowledge and skills acquired from anatomy education.

As demonstrated by the literature review, relatively little is known about learning anatomy from the student perspective and even less about how anatomy knowledge is transformed in practice. However, literature has been quick to accuse or defend anatomy teaching, but this appears to be based on practically no evidence. This illuminative study sought to find evidence and to begin to understand the elements and processes involved in learning and applying anatomy so that recommendations could be made to work towards improving the training of future doctors.

Progressive focussing was used to explore the phenomena of learning anatomy. This was an appropriate strategy in this case study because there was little previous research. This methodology enabled the research to be guided by the findings of various activities. The approach proved successful and the early findings were worked into developing themes, and issues were identified and subsequently focused on. These were further investigated and refined. This enabled me to form a working hypothesis that, as further work was carried out, was continually refined and developed (grounded theory). To keep the focus of the work from proliferating too much, key issues were selected for refinement. Issues that were of little relevance or importance were not further explored. This was done on the basis of the issues of significance to the various groups and from the important issues arising from the literature.

The structure of this thesis has aimed to reflect the unfolding nature of the research that progressive focusing has enabled and has drawn on principles from grounded theory to construct a model of learning anatomy. The thesis began by setting the scene and explained the history of anatomy education and its development to the time of writing, in general and at Southampton.

The next stage of study involved reviewing what was already known on the subject and is reported in the literature chapter. The literature added specific examples and these served to support the rationale behind this study: the lack of understanding of students' learning of anatomy and how individuals turn this theory into practice. The literature indicated that anatomy learning has some unique aspects to it and presents with a vast amount of material to be learnt. It is generally acknowledged what the end results of medical education should be. However, there is great disparity of views as to how the end result should be achieved.

The 'how' students learn anatomy has received very little attention and thus understanding this process is essential for developing future clinicians. Two main research questions were devised to guide the research activities:

1. How do students learn anatomy?

2. How does anatomy education prepare doctors in practice?

Based on the literature a preliminary study was designed to gain a broad understanding of the issues within anatomy education. The understanding gained from the preliminary study was vital in conceptualising the issues described in the literature. The themes that emerged from the preliminary work and the literature suggested two perspectives for further investigation:

- Student perceptions and experience, investigating themes of engagement, process, relevance and influences.

- Alumni perceptions and experiences, investigating standards of graduates.

Sub-questions were developed based on these two perspectives (student and alumni) that would guide the progressive focusing. The findings of the individual research activities were formed into themes and into a working model of learning anatomy.

8.2 Key Findings

Exploration, refinement and critical analysis of the themes produced eleven key findings. The emerging themes are represented overall in Figure 24. These were chosen as they appeared to be the most important from a variety of perspectives, drawing on what has been reported in literature, what stakeholders and students deemed as important, and what findings could best be used for the recommendations of training future doctors. Figure 24 highlights the triangulation that occurred in this study, promoting the validity of the conclusions. The evidence base for the findings is illustrated in Table 22. Using the working model of learning anatomy developed throughout the study and the key findings, a model of anatomy learning will be discussed later. It is important to note that the findings are highly interlinked.

1. Clinical relevance was perceived as an important aspect in approaching learning and understanding anatomy.
2. Anatomy is important in medical education and the use of human cadavers is imperative, enabling touch-mediated learning of the three-dimensional form that can be transferred to the clinical context. The use of human cadavers promotes a deep approach to learning anatomy.
3. Anatomy learning begins upon entry to medical school but is influenced by previous experience and initial perspectives. Anatomy learning occurs throughout medical education and in practice, but is more formally recognised in the early years of the curriculum, i.e. through specific formal assessment.

4. The three stages of the learning process and the activities and level to which students engage in them were reflective of their perceptions and their approaches to learning.
5. There are many influences that affect anatomy learning. Detrimental influences were correlated with students who adopted a surface approach, and promoting influences with students who adopted a deep approach. Assessment appeared to have the most significant influence on students' approaches to learning anatomy.
6. Students who perceived anatomy to be memorisation-based and then experienced detrimental influences adopted a surface approach. This made students more likely to perform poorly in assessments and to exhibit problems in applying the knowledge in the clinical context.
7. A deep learning approach was adopted by the majority of students and enabled the application of information to be integrated holistically into the clinical context. This approach enhanced the understanding of the three-dimensional form and makes it the preferred approach for achieving the desired goals of anatomy education.
8. A strategic approach resulted in high anatomy assessment scores. However, in later years students who adopted a strategic approach exhibited problems in the recall and application of the knowledge.
9. Application of knowledge occurred through situational learning and knowledge encapsulation (i.e. conceptual knowledge is formed, refined and restructured). Also, the application of anatomy was affected by students' initial and previous learning experiences.
10. A large amount of anatomy knowledge was used in clinical practice and it appeared to be most interlinked with radiology.
11. Experience early in undergraduate anatomy influenced the subjects that students engaged in during later years, and ultimately the career speciality they chose. Individuals who reflected on positive experiences, especially seeing the relevance, were more likely to go into careers which involved considerable anatomy and vice versa.

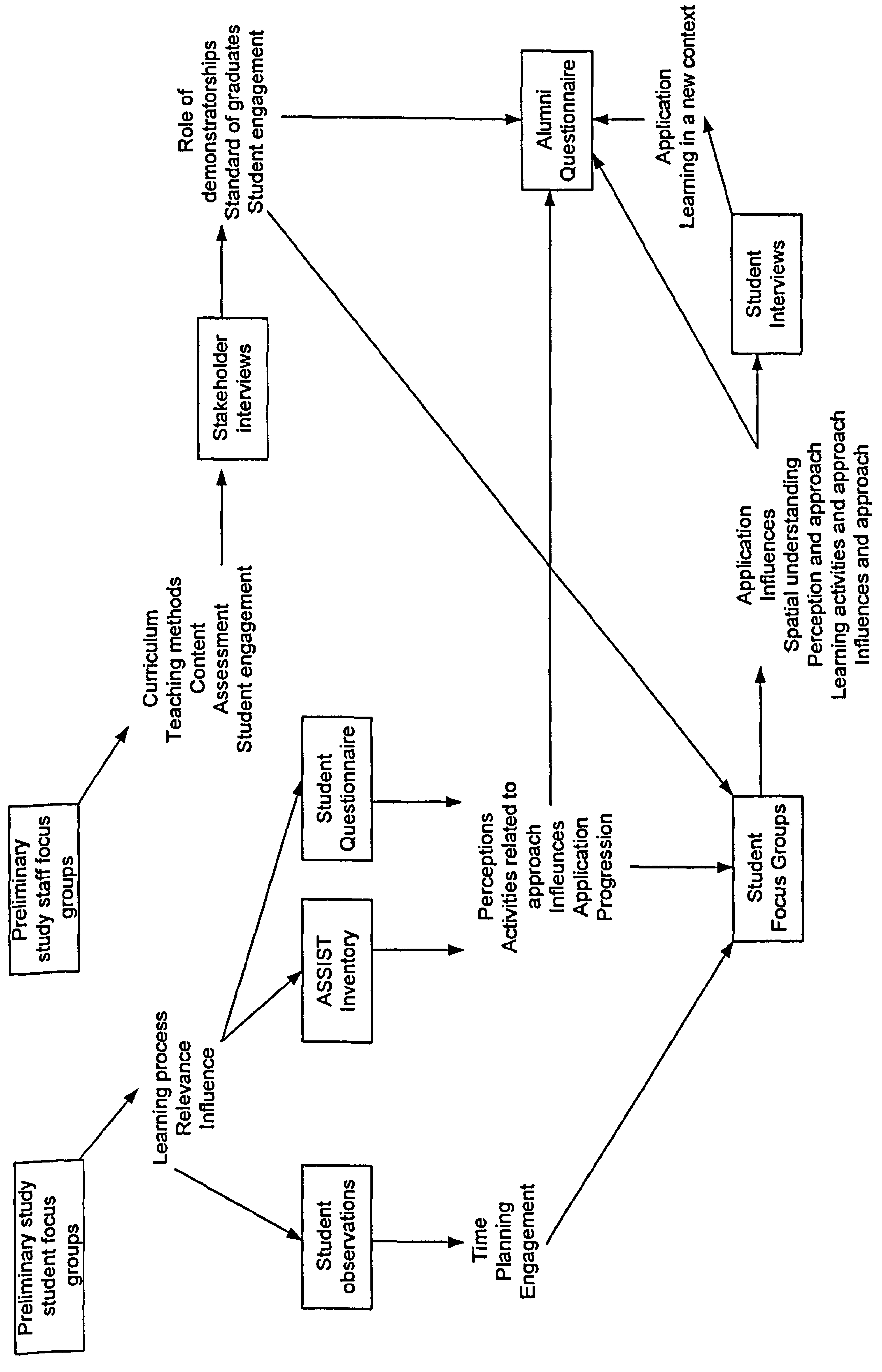


Figure 24. Diagrammatic representation of how the themes emerged

Findings	Evidence	Rating *
1. Clinical Relevance was perceived as an important aspect in approaching learning and understanding anatomy.	All activities: it was particularly prominent in students looking back with hindsight and from alumni questionnaire.	9
2. Anatomy is important in medical education and the use of human cadavers is imperative, enabling touch-mediated learning of the three-dimensional form that can be transferred to the clinical context. The use of human cadavers promotes a deep approach to learning anatomy.	All activities.	9
3. Anatomy learning begins upon entry to medical school but is influenced by previous experience and initial perspectives. Anatomy learning occurs throughout medical education and in practice, but is more formally recognised in the early years of the curriculum, i.e. through specific formal assessment.	Preliminary study student focus groups, ASSIST inventory, student questionnaire, student focus groups, student interviews, stakeholder interviews, alumni questionnaire.	7
4. The three stages of the learning process and the learning activities and level to which students engage in them were reflective of their perceptions and their approaches to learning.	Preliminary study student focus groups, observations, ASSIST inventory, student questionnaire, student focus groups, student interviews, alumni questionnaire.	7
5. There are many influences that affect anatomy learning. Detrimental influences were correlated with students who adopted a surface approach, and promoting influences to those who adopted a deep approach. Assessment appeared to have the most significant influence on students' approaches to learning anatomy.	Preliminary study student focus groups, observations, ASSIST inventory, student questionnaire, student focus groups, student interviews, alumni questionnaire.	7
6. Students who perceived anatomy to be memorisation-based and then experienced detrimental influences adopted a surface approach. This made them more likely to perform poorly in assessments and to exhibit problems in applying the knowledge in the clinical context.	Preliminary study student focus groups, ASSIST inventory, student questionnaire, student focus groups, student interviews, alumni questionnaire.	6
7. A deep learning approach was adopted by the majority of students and enabled the application of information to be integrated holistically into the clinical context. This approach enhanced the understanding of the three-dimensional form and makes it the preferred approach for achieving the desired goals of anatomy education.	ASSIST inventory, student questionnaire, student focus groups, student interviews, alumni questionnaire.	5
8. A strategic approach resulted in high anatomy assessment scores. However, in later years students who adopted a strategic approach exhibited problems in the recall and application of the knowledge.	ASSIST inventory, student questionnaire, student focus groups, student interviews, alumni questionnaire.	5
9. Application of knowledge occurred through situational learning and knowledge encapsulation (i.e. conceptual knowledge is formed, refined and restructured). Also, the application of anatomy was affected by students' initial and previous learning experiences.	Student questionnaire, student interviews, alumni questionnaire.	3
10. A large amount of anatomy knowledge was used in clinical practice and it appeared to be most interlinked with radiology.	Student interviews, alumni questionnaire.	2

Findings	Evidence	Rating *
11. Experience early in undergraduate anatomy influenced the subjects that students engaged in during later years, and ultimately the career speciality they chose. Those who reflected on positive experiences, especially seeing the relevance, were more likely to go into careers which involved considerable anatomy and vice	Student interviews, alumni questionnaire.	2

*Rating: 9 max (the number of sources of evidence)

Table 22. Evidence base for each key finding

The findings in particular provide new information that links the use of human cadavers to promoting a deep approach to learning (refer to Table 9). The identification of the stages of learning, the level of engagement in learning activities and the approach to learning adopted reflect the importance and influence of the anatomy learning setting. The findings identify new information regarding the promotional and detrimental influences on the learning of anatomy and their links between the approach adopted and assessment outcome (refer to Table 10). The findings highlight the effect these experiences have on medical practice.

Findings that reflect and strengthen current theory related to medical education are: the importance of the clinical context in teaching, the developing nature of the subject of anatomy in undergraduate and postgraduate education, and that knowledge is reconstructed through situated learning. The findings support educational theory on approaches to learning and the links between perception, approach to learning adopted and learning outcome. However, of particular importance to medical education is the finding that students who adopted a strategic approach may have performed best in assessments but experienced difficulties in applying their knowledge (refer to sections 5.3.1.3, 6.3.2 and 7.3.2). The findings are now further explored in a model for learning and applying anatomy.

8.3 A Model for Learning and Applying Anatomy

At the end of training students are required to perform the duties of a doctor registered with the General Medical Council (General Medical Council 2003). How students and, later, graduates build and transform anatomical knowledge in the context of professional practice is not really understood. The relatively small amount of research into anatomy education to date and the need to ensure that anatomy learning is effective and prepares students for future practice pointed to the need to understand anatomy learning in medical education.

This exploratory study set out to answer the specific questions of how students learn anatomy and how anatomy education prepares doctors for practice. These have been addressed in the previous chapters. What is now needed is discussion of the research problem in general: how do medical students learn and take their knowledge of anatomy into practice that enables them to be effective clinicians by performing their required duties?

A working model of learning anatomy has been developed through grounded theory at the various progressive stages of the research. This forms the basis for the model of learning and applying anatomy that is now discussed in three parts:

1. Approaches to learning anatomy
2. Process of learning anatomy
3. Application of anatomy in professional medical practice.

8.3.1 Approaches to learning anatomy

An approach to anatomy learning is a way of dealing with or going about the task of learning anatomy. There are three approaches to learning anatomy: deep, strategic and surface (refer to section 2.3.1). The differences in conceptual understanding between the three approaches to learning are affected by the individual's previous experience and perception. These will be first discussed followed by the approach to learning anatomy that a student adopts.

Previous experience adds meaning to a new or naked concept and therefore affects how this is dealt with or approached (Entwistle & Meyer 1992; Ramsden & Entwistle 1981). This study supports findings in the literature and revealed elements which were specific to anatomy education. It is therefore important to first realise what students' experiences and perceptions were. As educators we cannot change or alter a person's previous experience, indeed the richness of the student cohort is formed from it. Whilst not trying to segregate individual students, understanding their previous experience helps to explain why students approach a task in a certain way. This is especially important in decreasing the mismatch of understanding between staff and students.

Students who struggled with anatomy reported using learning techniques that they had used before - and why not? It worked very well to get them the grades to get into medical school. However, in the case of school leavers there appears to be a gap (from all perspectives) in the education system with 11-18 year old education focusing more on directed learning and higher education focusing more on self-directed study. A consequence of this gap is that students are not prepared with skills in how to learn in their new setting. Students are adaptable and so through careful planning of the introduction semester and positive messages from the curriculum, it should be possible to make this a smooth and effective transition, and equip students for effective learning of anatomy.

Students' previous experiences in anatomy varied immensely and areas of previous experience are illustrated in Figure 25. Some students had not taken A-Level Biology (or equivalent) and had no idea of anatomy. Others had studied elements of anatomy in various qualifications or personal interest, e.g. sport. A few students had performed basic dissections of a rat or a sheep's heart at school. Some students had clinical experiences where anatomy in practice had been observed, e.g. operating theatres or nursing homes. It may be worth considering changing the entry requirements to include A-level Biology (or equivalent). This would require further investigation in the form of a comparison study.

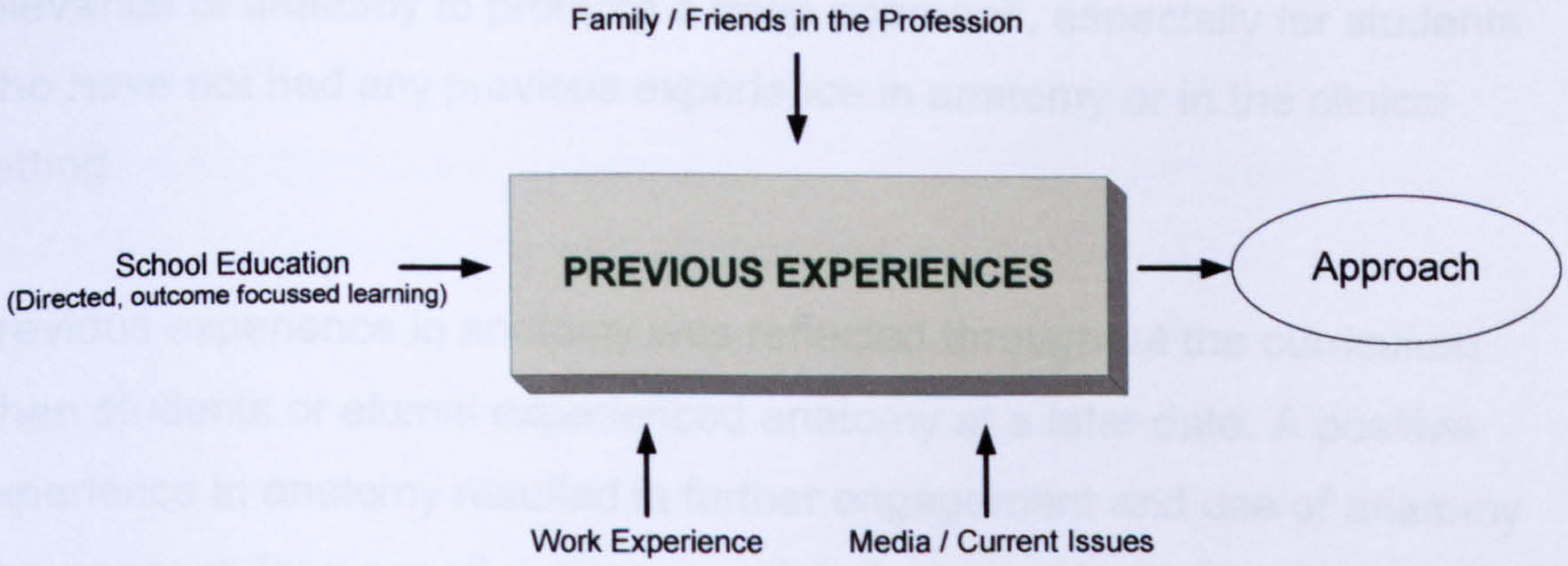


Figure 25. Component parts of previous experiences that influence the approach to learning anatomy

An interesting element, supported by other medical systems (for example, as in the United States), is that students who had previous higher education experience appear to be more articulate and able to deal with the medical learning experience. This point is reflected in this study with no students on the BM 4 graduate course found to be taking a surface approach (refer to section 5.3.1.1). This reflects that perhaps the gap between school and a medical degree is too large and that a possible solution would be to make medicine a postgraduate qualification.

Students' previous experience and perceptions of the learning task are intrinsically linked (Trigwell & Prosser 1991). Whilst students' perceptions may have been influenced by their previous experience, it is only subjective as to their nature and possible effects. Students' perceptions of anatomy illustrated that some elements of the initial perceptions form in a student's first day, week or semester, and appear to be important for informing their approach to learning anatomy. The majority of students initially perceived anatomy to be memory based (refer to section 5.3.3.2). Nevertheless, only some continued to think this and adopted a surface approach to their anatomy learning. If students do not see learning as the reproduction of information, they perceive it to require transformation (Entwistle & Entwistle 1991).

The differences in students' perceptions of context may be something that the foundation/introduction programme could address in highlighting the relevance of anatomy to promote a deep approach, especially for students who have not had any previous experience in anatomy or in the clinical setting.

Previous experience in anatomy was reflected throughout the curriculum when students or alumni experienced anatomy at a later date. A positive experience in anatomy resulted in further engagement and use of anatomy (the opposite for a negative experience) (refer to section 7.3.2). Unless a change in context, attitude or motivation occurred then the ability to learn anatomy at a later point was influenced by students' initial experiences early on in the curriculum. This reflects the importance of the initial experience and early perception of anatomy.

Previous experience and perception are not the only factors influencing how students approached anatomy learning. Once settled into the course, students are exposed to a range of positive factors which act to enhance, motivate and enable a deep approach to learning, and also negative factors which hinder learning and promote a surface approach. These factors affect the initial approach adopted and continually influence the approach throughout training and in practice. The influences on the approach to learning adopted are summarised in Figure 26 and are further discussed below.

8.3.1.1 Inhibitors of learning

Detrimental factors were classified as they had a negative effect on student learning, these being associated with a surface approach. Students' perceptions of there being too much to learn were an initial factor that hindered students' learning. This supports earlier findings by Entwistle & Tait (1990) and Ramsden & Entwistle (1981). The perception of there being too much to learn was frequently coupled in this study with students also not being able to see the point to learning (refer to section 5.3.3.2). It is not surprising that being overwhelmed and unclear about why they needed to understand anatomy, students sought to memorise it for examination.

For some students the impact of the DR, either from apprehension or from unpleasant thoughts and experiences (e.g. "being hungry"), resulted in students avoiding the DR environment (refer to section 6.3.2). These students missed out on the process of engagement through touch-mediated perception which facilitates three-dimensional understanding of the human form. The students then reported problems based on learning the three-dimensional form. For some students their negative experience of the DR was carried with them and subsequently hindered anatomy learning at a later date. As suggested in the literature (Tschernig, Schlaud & Pabst 2000), it would be beneficial to develop how students are prepared for learning in the DR environment. It is also important that where students experience stress caused by the DR environment, help is made available.

Assessment is a potent factor for influencing students' learning behaviours (Biggs 2003; Laurillard 1979; Laurillard 2002). High motivation to perform in assessments inhibits a deep approach. The literature explains how excessive use of factual-driven assessments, such as multiple-choice tests, can push some students towards a surface approach (Thomas 1986). Such assessments have also been criticised for their use in anatomy as being too 'narrow' (Cahill, Leonard & Weiglein 2002). It is the responsibility of curriculum designers to ensure that the design of assessments promotes a deep approach. If assessments promote a surface approach they reward an approach that hinders the future application of knowledge in clinical practice.

8.3.1.2 Promoting a deep approach

Positive factors were categorised as those that inspired, instigated and enhanced learning. Unlike the detrimental factors, the positive factors were associated with students who adopted a deep approach (see Figure 26). The more students perceive learning as relevant, the more likely they are to adopt a deep approach (Entwistle & Tait 1990). In anatomy, relevance and clinical context are important in promoting a deep approach and enabling other elements, such as forming links between disciplines. Students responded well and engaged when they understood the need and application of the learning (refer to section 6.3.2). In particular this was predominant as the curriculum progressed and resulted in some students altering their perceptions and approach to learning anatomy (refer to section 6.3.4). Students who adopted a deep approach reported enjoying anatomy. Enjoyment is a positive factor and enhanced motivation to do more and understand more. Assessments, if placed in context, may promote a deep approach. For example, essays have been shown to examine elements which reflect a deep approach (Thomas 1986).

The impact of human cadavers also influenced students in a positive light in that they appreciated and wanted to make the most of the privilege the donors had given to them and the chance to learn in a real practical manner. This has been already reflected in the literature (Evans & Fitzgibbon 1992; McGarvey et al. 2001; O'Carroll R.E et al. 2002). Students viewed the experience of working with human cadavers as an essential part of their transition to becoming a doctor (refer to sections 5.3.3.1 and 6.3.2). Some researchers have referred to this transition as gaining humanistic values, covering aspects such as professionalism, respect and detachment concern (Francis & Lewis 2001; Pawlina & Lachman 2004).

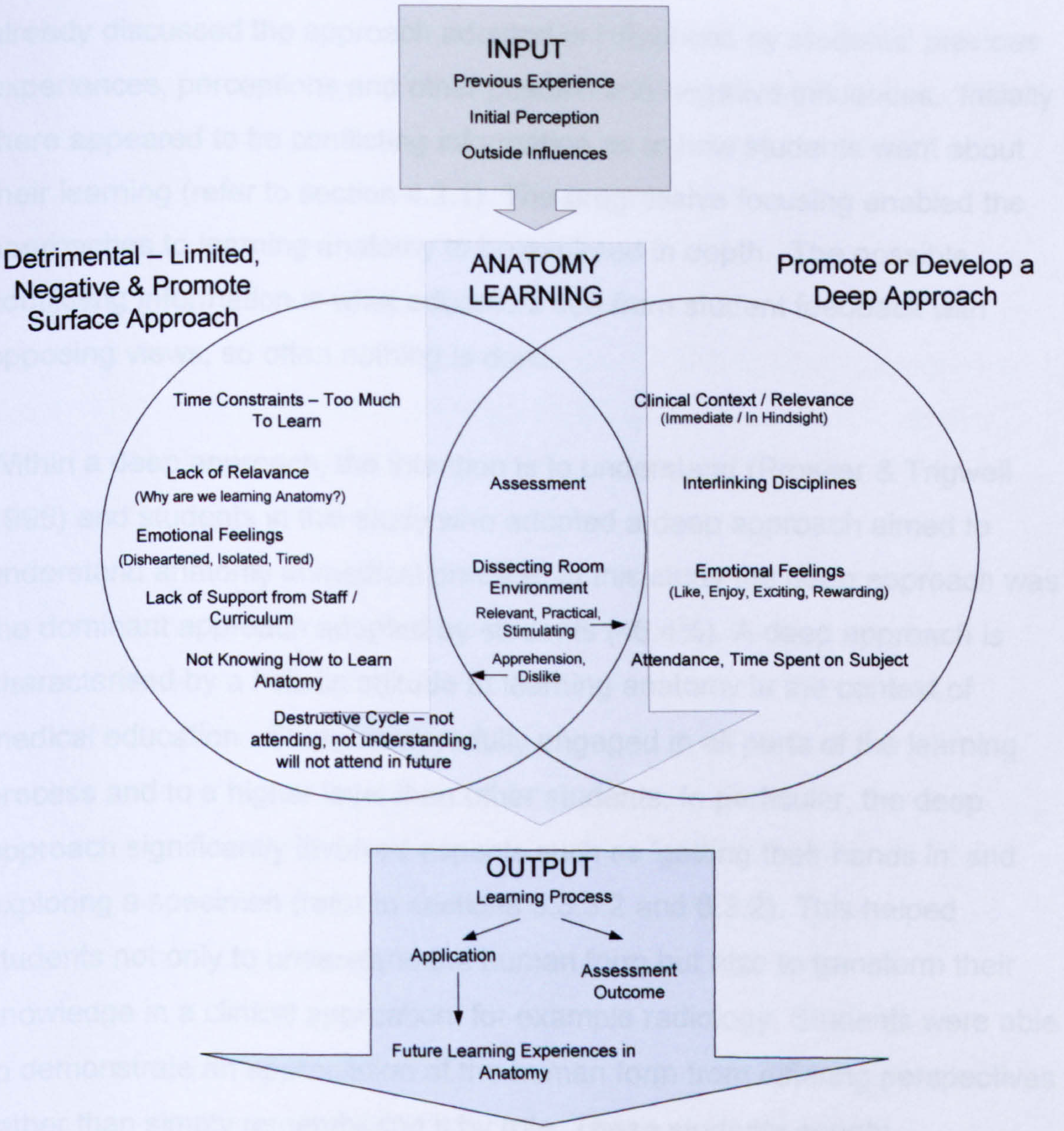


Figure 26. The influences that affect anatomy learning

8.3.1.3 The three approaches to learning anatomy

As earlier described (section 2.3.1), an approach to learning is how the student goes about their learning. "The approach students adopt appears to be an important factor in determining both the quantity and quality of their learning" (Newble & Entwistle 1986). The model proposed for learning anatomy encompasses the three approaches to learning. Overall anatomy was seen as important by all students and alumni. Students and alumni also perceived that learning on specimens was important and that anatomy informed other subjects (refer to section 5.3.3.1 and 7.3.1). It is the move from this perception to the engagement in the learning task that differs. As already discussed the approach adopted is influenced by students' previous experiences, perceptions and other positive and negative influences. Initially there appeared to be conflicting information as to how students went about their learning (refer to section 4.2.1). The progressive focusing enabled the approaches to learning anatomy to be explored in depth. The possible conflicting information is what educators see from student feedback with opposing views, so often nothing is done.

Within a deep approach, the intention is to understand (Prosser & Trigwell 1999) and students in this study who adopted a deep approach aimed to understand anatomy in medical practice. In this study the deep approach was the dominant approach adopted by students (46.4%). A deep approach is characterised by a holistic attitude to learning anatomy in the context of medical education. Students were fully engaged in all parts of the learning process and to a higher level than other students. In particular, the deep approach significantly involved aspects such as 'getting their hands in' and exploring a specimen (refer to sections 5.3.3.2 and 6.3.2). This helped students not only to understand the human form but also to transform their knowledge in a clinical application, for example radiology. Students were able to demonstrate an appreciation of the human form from differing perspectives rather than simply remembering it by rote. These students sought confirmation of their understanding rather than just their knowledge, and appeared confident as reflected by their enjoyment of the subject (refer to section 6.3.2). Many promoting factors discussed earlier were associated with this approach.

The deep approach is the ideal approach and enables understanding and application of knowledge that provides best patient care. Some students will take a deep approach based on their previous experience. However, many need guidance and this is the role of the platform for learning. The curriculum can influence aspects which are known to be associated with a deep approach, or it may promote active engagement which subsequently fosters a deep approach. This may be accomplished, for example, by ensuring the learning is placed in context and by reducing the detrimental influences. The role of assessment is also important in rewarding a deep approach (Newble et al. 1988). Students who adopted a deep approach did not perform best in assessments (section 5.3.1.3), suggesting that assessments may not have promoted and rewarded a deep approach.

The desire to achieve is the distinctive factor in the strategic approach. From this study, 39.5% of participants adopted a strategic approach. The strategic approach was used more and more by students as their course progressed (section 5.3.1). It is not surprising that students who adopted this approach performed the best in their anatomy assessments. Students based their learning on activities and resources which reflected the assessment and allowed them to prepare for it. Their level of engagement varied and was very much influenced by their perception of 'do I need to know it?' Engagement was typically in two or three parts of the learning process (preparation, practical, after confirmation) (refer to section 6.3.2). Influences on students' learning were a mixture of promotional and detrimental factors. The increase in the strategic approach as the course progressed may be of concern especially if learning involved rote memorisation. However, it seemed as much to do with adopting an appropriate coping strategy for success.

The nature of this approach means students were often successful, especially in early parts of the course, but this success may be limited and too narrow for later years. This is especially the case if students used more surface strategies. The possible implications for the design of assessments may be that surface elements should not be promoted and aspects which reflect a deep approach are.

The intention of a surface approach is to meet the assessment requirements by rote memorisation. In the case of this study the minority adopted a surface approach (13.3%, 0.8% students had no preference). This may not seem all that significant or very important, but these students will be treating patients too. From the beginning, students who adopted a surface approach were more likely to fail. This supports the findings of other studies (Mayya, Rao & Ramnarayan 2004; Shankar et al. 2006). Age and prior experience of learning appear to be related to students not adopting a surface approach, such as on the BM 4 course where no students adopted a surface approach.

Students who adopted a surface approach specifically reported finding anatomy daunting, memorisation based, did not see the point, felt teaching did not suit them and struggled to build on the knowledge later, often forgetting it (section 5.3.3.2). Students who perceived the context of anatomy to be not relevant and fact driven adopted a surface approach. Students that showed an active surface approach illustrated engagement in some of the learning process; those who were passive showed little or no engagement at all. A key feature of the surface approach was the need to memorise the material - "just memorise things just for the sake of it". This was not just found in this study but has been a known factor in anatomy for some time:

> A sickening feeling is produced by learning a page of Gray's by heart: then the student sees how many hundreds of pages there are. (Lockhart 1927)

What is important is how students move beyond this and into a deep approach.

As mentioned in section 2.3.1.1, mnemonics are commonplace in anatomy. However, they may unintentionally act to reinforce the use of a surface approach and rote memorisation. This aspect is highlighted by Miller, in that anatomy has two problems: one, that students perceive it to be memorisation based and, two, that the learning process is as important as the learning itself (Miller et al. 2002). This study supports that students perceive anatomy to be memorisation based.

Depending on the amount of engagement and the assessment, it may be possible for the student who adopted a surface approach to perform well. However, regardless of performance a surface approach offers limited and isolated understanding which results in students having difficulty recalling the information in later years (sections 5.3.3.2 and 6.3.2), and they may experience problems with applying and integrating the information. This study illustrated that it was possible for some students to take an active surface approach to anatomy and perform well in the spotter examination. This reflects the need for assessments to reward a deep approach rather than a surface one. It is important that the learning activities provide students with feedback and reflect the ideal deep approach.

8.3.2 Process of learning anatomy

The process of learning anatomy may be viewed as a learning journey and includes both undergraduate and postgraduate anatomy. At the start of the undergraduate course, students' learning of anatomy involved a certain amount of short-term memory and rote memorisation as they learned new terms and began to conceptualise anatomy. Students start off with the same information and experience the same teaching, but as time goes on they use their own judgement and make decisions about how they go about their learning, influenced by the many factors described. The end result can be very different in terms of the quality of learning.

For undergraduate students the process of learning anatomy in the early years of the curriculum may be divided into three stages: preparation, practical and confirmation. Figure 27 illustrates the stages in relation to the adopted approach to learning.

The 'preparation' (first) stage represents deep and strategic approaches in which preparation and planning for the DR experience is carried out. Students who adopted a surface approach did not engage effectively in this stage (section 6.3.2). Stage one involved activities such as reading, drawing, highlighting text or CAL. The amount of engagement is reflective in the activities carried out. If students are engaged in this phase it enabled the DR to become a more effective learning resource.

How students went about learning tasks in stage two ('practical') was reflective of the degree of engagement and approach taken (refer to section 6.3.2). Students who adopted a deep approach used the DR to explore structures through the various resources offered: prosection, plastination, museum pots, models, surface anatomy and radiology.

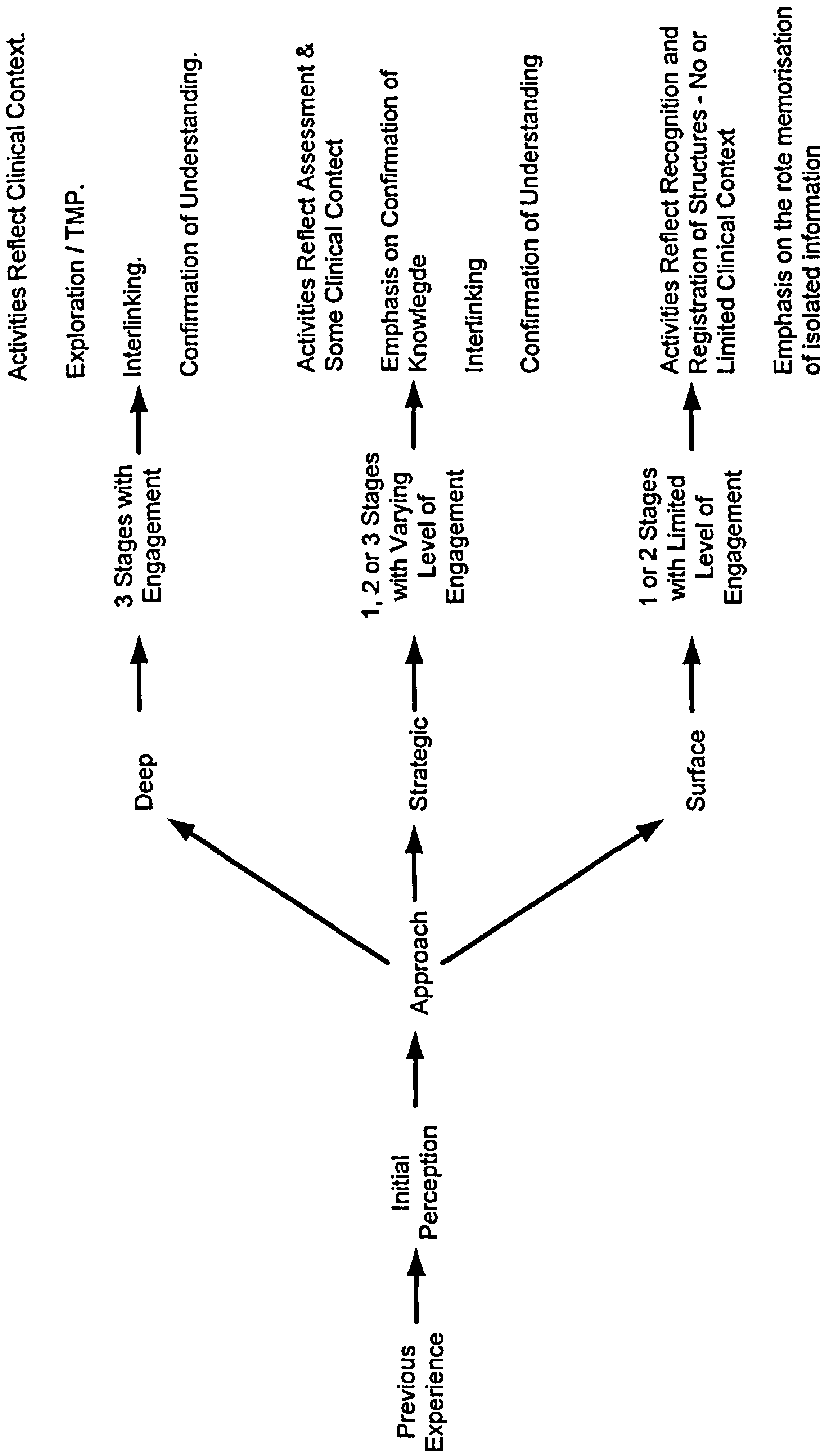


Figure 27. Undergraduate early years' process of learning anatomy in relation to the approach to learning adopted

Students were able to integrate information with other disciplines and based activities around how they might apply the knowledge, for example, what structures might be affected by a tumour of the organ and how it might appear in terms of clinical presentation on radiographs or through surface palpation. Students who adopted a deep approach sought confirmation of their understanding; whereas students who adopted a strategic approach sought confirmation of what they perceived they needed to know for the assessment. For example, a student using a deep approach might test their understanding of how a tumour might grow, what structures it might impinge on and how this might look clinically. Some students who adopted a surface approach did not enter the DR environment at all and hence did not engage in stage two. This may be due to a lack of interest or the result of detrimental factors.

The 'confirmation' stage (three) was used by students who adopted a deep, strategic and some active surface approaches. This phase involved consolidation and often revisiting the environment to build and develop knowledge and confidence (refer to section 6.3.2). For students who adopted a deep approach this phase often involved looking beyond the level of knowledge required. Students who adopted a strategic approach often used this phase to 'test' themselves and seek confirmation of their knowledge.

For students in later years of the course and in postgraduate anatomy the learning process was much less defined. It still encompassed the individual's previous experience of learning anatomy and the three approaches to learning. However, the stages of learning were not clearly defined. This reflects the limited amount of structured anatomy teaching. Students and alumni made recommendations for an increase in curricular-scheduled anatomy and access to human cadavers through the later stages of their undergraduate training and when in practice (refer to section 7.3.1).

8.3.2.1 Component parts of anatomy learning

Involved in the process of learning anatomy are two components: three-dimensional understanding and the use of human cadavers. They are interlinked with each other and are associated with the approaches to learning anatomy and hence the outcome of learning.

- Three-dimensional understanding

Involved in both undergraduate and postgraduate anatomy and in all stages of learning anatomy is the three-dimensional nature of anatomy, which is defined as:

> The ability to perceive, retain and recognise or reproduce three-dimensional objects in their correct proportions when they are rotated in space, translated, juxtapositioned, projected, sectioned and re-assembled, inverted, re-orientated or vernally described. (Rochford 1985)

The capability of being able to close your eyes and imagine your way around a body from all perspectives is something that comes with training, but it is a skill that all anatomists (from the staff focus groups and stakeholder interviews) and some alumni said they possessed. The level of anatomists (experts) is beyond what medical students upon graduation require, but a simpler comprehension of the three-dimensional understanding of the body is essential for competent medical practice.

Developing an understanding of the human form may be helpfully conceptualised as occurring in five stages. In order to complete the five stages (section 6.3.2), students also have to be engaged in stage two of the learning process and use touch-mediated perception on human cadavers to understand the human form. Students who adopted a deep approach were most able to complete all stages.

The literature refers to the mechanics of two-dimensional and three-dimensional interpretations. However, research has not formed links to the level of engagement or the evidence of the relationship that understanding of the human three-dimensional form has to the application of the knowledge and hence clinical practice. It is currently understood that complex visual images, e.g. the whole picture of the human form, are more difficult to reconstruct. Complex visual images were also associated with a high error rate when the image was required to be rotated (Marks 2000). If such an error was made in clinical practice the result could be harmful to a patient.

It would therefore be productive in planning learning activities to introduce simple images first and build up the picture. This suggestion is supported by Miller who proposed that simple imagery early in training would aid the underlying basic patterns of the body (Miller 2000). Reproducing through rote memory is insufficient to provide the ability to rotate, translate, juxtaposition, etc., the image. This study supports this as students who adopted a deep approach appeared to grasp these basic patterns; they appeared to have less trouble building on them with more complex ones and could apply the patterns of the body. Understanding the multi-dimensional form is essential for the application of knowledge.

Anatomy was most linked in its use to radiology (section 7.3.1). Radiological images, (X-ray, CT, MRI and ultrasound) are complex and require the abilities of rotation, translation and so forth, described above. It is therefore essential that students have a three-dimensional understanding of the human form. An increase in exposure to radiology in teaching would not only increase the students' practise of this ability but also would help foster a deep approach and highlight the clinical relevance.

Assessment has a role in providing a platform that can examine a student's understanding of the three-dimensional form and, if appropriate, test student ability to apply this understanding. An assessment which asks students to identify or re-draw a two dimensional diagram does not necessarily test a student's understanding of the human form and may not promote a deep approach to learning anatomy.

- Human cadavers

Working on human cadavers has formed a major part of the literature in the debate on prosection and dissection. This study supports the view that human cadavers are very important in learning anatomy but has sought to understand the process of learning so that learning activities and teaching methods can be best utilised. The support for learning on human cadavers stems from all perspectives (stakeholders, staff, students and alumni). Human cadavers are an important tool which enable engagement and active exploration of the human form (in the case of dissection it can facilitate manual dexterity, which may be of use in some careers). The exploration of human cadavers enables touch-mediated perception, increasing the understanding of the multi-dimensional form. As supported in the literature (Evans & Fitzgibbon 1992), this research also found that the use of human cadavers is important in the transition to the professional role.

This study did not set out to compare whether the use of prosection or dissection might be better, but sought to understand the learning process. Exploring human cadavers is an important aspect which is part of a deep approach to learning anatomy (section 5.3.3.2) and enables the learning to be transformed into the clinical context. From the student and alumni perspectives, a minority felt they were missing out by not dissecting and were concerned about how the profession would view them (refer to section 7.3.1). Students at Southampton have the opportunity to complete a Special Study Unit (SSU) that involves dissection. There may be benefits to extending this opportunity to dissect as part of the later years of the course or as part of postgraduate courses.

The role of a demonstrator and the experience gained from such posts reflect that they are of value to those pursing a surgical career (section 7.3.1). They offer the opportunity to re-learn and restructure knowledge and confirm understanding through teaching. This study therefore supports others (Lockwood & Roberts 2007; Royal College of Surgeons of England 2007) in promoting such posts.

Human cadavers support the teaching of the language of medicine, anatomy variation, pathology and life skills as described in section 2.2.2, although the human cadaver will not by its presence alone create understanding of the human form. It is essential that the curriculum involves human cadavers and that learning activities are designed to promote a deep approach to learning anatomy. Therefore it is the context and engagement in the practical stage of learning anatomy which allows human cadavers to facilitate the understanding of human form.

8.3.3 Application of anatomy in medicine

As students (including alumni looking retrospectively) started to gain knowledge and understanding, intertwined in their level of engagement was their perception of the usefulness of the knowledge and the relevance to future practice (refer to sections 5.3.3.1 and 7.3.1). This affected aspects such as motivation. Students who adopted a deep approach reflected on seeing the relevance and being guided by its use, seeking to understand not just a specific area of anatomy but also how it might be presented, diagnosed and treated in the clinical setting. This often involved integration of information from disciplines and reflects a holistic view of learning.

Students had to use their knowledge and skills to begin to formulate a decision based on a clinical case presentation and the applicable case management. As the course progressed, fewer students 'didn't see the point' (section 5.3.31) and more felt that the course allowed them to use their knowledge. Understanding how knowledge is turned into working practice is now examined in more detail.

Application of knowledge during undergraduate training varied and was highly related to the individual's approach to learning. Students who adopted a surface approach did not mention application and often struggled in later years where application of knowledge was essential. Students who felt that the course quickly allowed them to use their knowledge adopted a strategic approach (section 5.3.3.2) and this may reflect the 'use it or lose it' attitude. Students who adopted a deep approach were always seeking understanding and could easily place knowledge into the clinical context. These students engaged in activities which reflected the application, such as radiology. Such learning activities served them well in later years as they made easier transitions to the clinical environment.

Alumni frequently used a considerable amount (at least 70%, refer to Graph 20) of the anatomy they learned at medical school. The amount of anatomy used day-to-day varied according to the speciality and reflected the role of postgraduate anatomy education. Knowledge involves propositional, functional, procedural and conditional knowledge (Biggs 2003). In anatomy propositional knowledge is 'knowing that', e.g. the median nerve. Functional knowledge refers to the 'how', e.g. the median nerve innervates Flexor Carpi Radialis. Procedural knowledge is applied in the clinical context and reflects the 'why', e.g. lack of flexion and abduction of the hand at the wrist joint may indicate nerve entrapment. Conditional knowledge involves the clinical context 'what next' and the clinician deciding how to deal with a patient. Anatomy also encompasses manual, personal, professional and other skills. Application of anatomy knowledge at both undergraduate and postgraduate level occurred through the process of knowledge restructuring and encapsulation.

8.3.3.1 Knowledge restructuring

The transition from student to practitioner is defined by final examinations and membership of the GMC. Anatomy learning, however, from basic knowledge through the process of knowledge restructuring and encapsulation, is not so readily defined by boundaries. It is a process that occurs over the journey of anatomy learning and may begin to an extent in students who adopt a deep approach in their first year of medical school. In discussing knowledge restructuring I will therefore refer to what may apply to students and alumni as 'individuals'.

Practical experience of applying knowledge in medicine has been referred to as situated learning (Maudsley & Strivens 2000), and is important in knowledge restructuring (Boshuizen et al. 1995). To enable knowledge restructuring in anatomy the knowledge has to be presented in a clinical context. This requires the individual not only to restructure their knowledge but also to break down any compartmentalisation that has occurred as a result of previous learning.

Restructuring of knowledge was particularly seen in third year students in this study (refer to section 6.3.2). It was influenced by the clinical relevance and an increase in the clinical context. For some individuals this resulted in a positive change in motivation. Many students reported that it was in the third year that disciplines, e.g. anatomy and physiology, came together.
The design of the curriculum needs to recognise that students have to engage in knowledge restructuring at some point. While this is done through exposure to clinical contexts, there may be a need to make this process more systematic. This research has shown that knowledge restructuring may be problematic for students who adopt a strategic or surface approach. It might therefore be advantageous to create environments where knowledge restructuring occurs early in the curriculum and in a more progressive nature, so that support is available for students who find this transition difficult.

The integration of knowledge to form a workable model of professional knowledge and practice has to merge the theoretical and practical aspects of knowledge and skills. This explains why dissection and demonstrator posts are advantageous in a surgical career.

8.3.3.2 Knowledge encapsulation

Situated learning allowed students to restructure their anatomy knowledge in relation to the clinical context. Over time and with repeated exposure in the clinical setting the individual's knowledge is further refined and extended (Schmidt & Rikers 2007). This process of further refinement is referred to as knowledge encapsulation (Boshuizen et al. 1995). Knowledge encapsulation occurs as the individual can succinctly apply short lines of reasoning to common and rare clinical cases. Anatomy knowledge becomes embedded in the clinical reasoning.

Research has proposed illness scripts (refer to section 2.4.2) based on human conditions (Schmidt & Boshuizen 1993). Illness scripts are created from previous clinical experience. Anatomy learning in medical education should reflect the clinical context from the beginning of undergraduate training so that the individual has continuous previous clinical experience to relate to. The amount of anatomy used by alumni in different job roles reflects the content required in common illness scripts within a given discipline. Alumni working in the surgical discipline reported using a greater amount of anatomy (section 7.3.2), reflecting not only a greater amount of anatomy in illness scripts but also the specialist area of surgery where anatomy knowledge is applied in a practical, three-dimensional nature. These alumni would also have had significant postgraduate anatomy teaching.

Alumni expressed that they would revisit anatomy education in relation to a specific case or treatment, reflecting that knowledge encapsulation in anatomy is not an end point reached at one point in time. Doctors' anatomy knowledge is constantly undergoing development, restructuring and encapsulation. However, the degree to which knowledge restructuring occurs is affected by their perceptions, approaches and experiences in anatomy education.

With increasing litigation linked to anatomy deficits, it is important that graduates are competent. This is enabled through continued anatomy learning and restructuring in the clinical context. The process of learning and applying anatomy presented in the model is summarised in Figure 28. The model represents the journey of anatomy learning into clinical practice.

At the centre of the model is the individual's previous experience and perception of anatomy. These influence which approach to learning is adopted. Various influences (positive and negative) over time either confirm the initial approach adopted or effect a change in the individual's approach. Each approach to learning anatomy is associated with certain characteristics and level of engagement in the process of learning (three stages). There are consequences to the approach to learning adopted. Individuals who adopt a surface or strategic approach have a limited ability to apply anatomy knowledge in practice. Individuals may experience promotional factors when learning in context (situated learning) and they may alter to a deep approach.

Only the deep approach to learning anatomy enables, through touch-mediated perception, an understanding of the three-dimensional form and a smooth transition to applying anatomy knowledge in the clinical context. Knowledge is effectively restructured and encapsulated in the deep approach, enabling effective clinical practice.

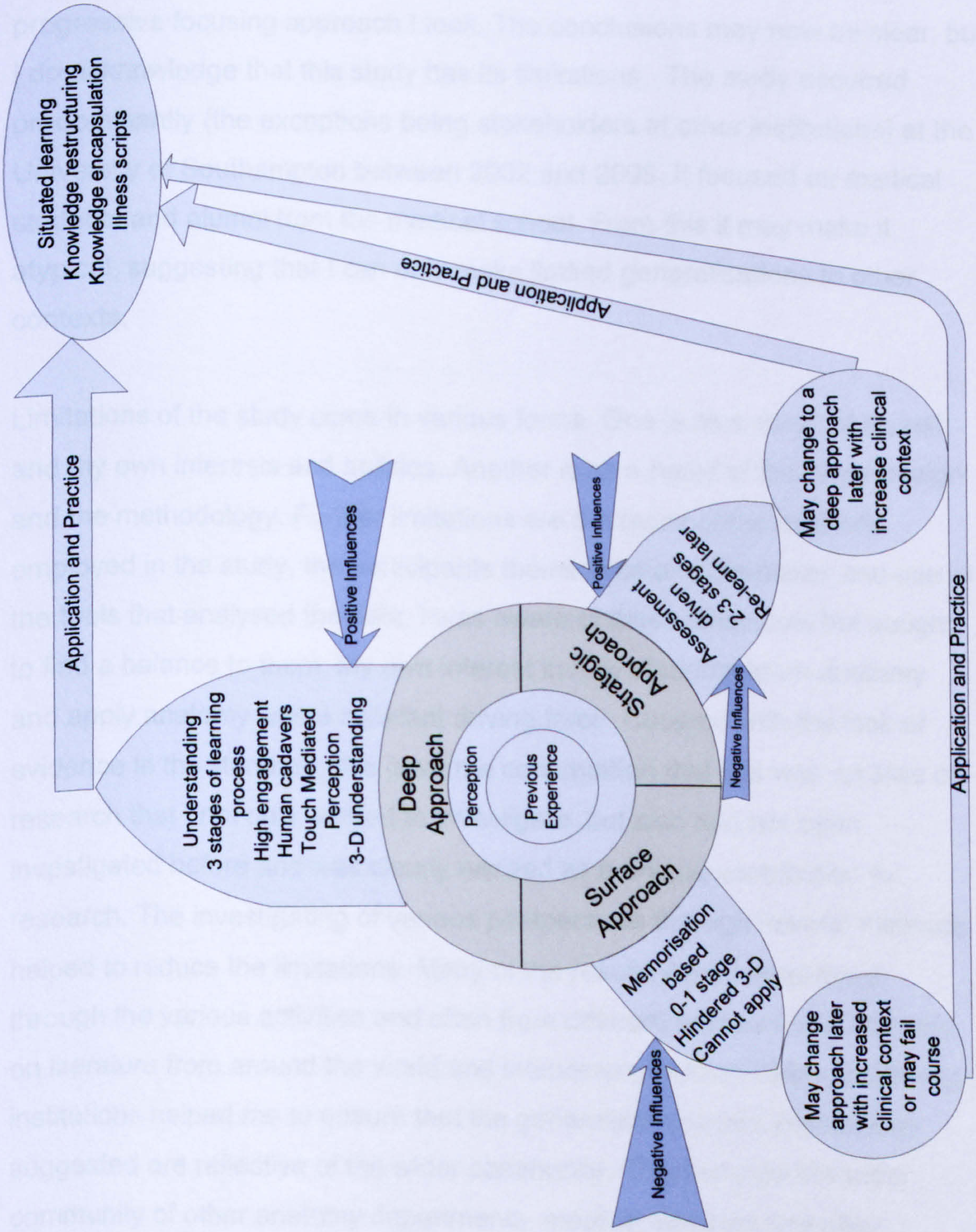


Figure 28. Model of learning and applying anatomy

8.4 Study Limitations

At the beginning of the study I was clearer as to what I was not investigating than to what I was! This was part of the journey and the nature of the progressive focusing approach I took. The conclusions may now be clear, but I do acknowledge that this study has its limitations. The study occurred predominantly (the exceptions being stakeholders at other institutions) at the University of Southampton between 2002 and 2008. It focused on medical students and alumni from the medical school. From this it may make it atypical, suggesting that I can only make limited generalisations to other contexts.

Limitations of the study come in various forms. One is as a result of myself and my own interests and abilities. Another is as a result of the study design and the methodology. Further limitations are the result of the methods employed in the study, the participants themselves and the power and use of the tools that analysed the data. I was aware of these limitations but sought to find a balance to them. My own interest in how students learn anatomy and apply anatomy was a constant driving force. Coupled with the lack of evidence in the literature, this gave me confirmation that this was an area of research that I not only wanted to investigate, but also had not been investigated before and was clearly needed as a unique contribution to research. The investigating of various perspectives through several methods helped to reduce the limitations. Many of the results were triangulated through the various activities and often from different perspectives. Drawing on literature from around the world and interviewing stakeholders at differing institutions helped me to ensure that the generalisations and implications suggested are reflective of the wider community. This includes the wider community of other anatomy departments, medical curricula and other students who learn anatomy.

A case study by its very nature focuses in depth on the particulars of a case (Stake 1995). In this study a range of methods was employed to help focus on key processes and issues through the mechanism of triangulation. In relation to internal validity it is possible that the response rate for the ASSIST inventory and questionnaire for students might be considered on the low side to ensure adequate representation of the population (around 24%). However, the various statistical analyses were rigorously employed to identify those findings which yielded results of high levels of statistical significance. Furthermore, the key findings were supported by multiple sources of corroborating evidence through the process of triangulation to provide a high degree of confidence in the interpretations being made. It should be noted that these interpretations did not go as far as providing a causative model to account for student learning of anatomy but rather a provisional working model which could form the basis for further detailed research (see below).

In relation to the generalisation of the findings to other contexts, this study by its nature was exploratory and some aspects could be further triangulated through carrying out similar research in differing institutions and under different environments, or following students through a course and into practice using a longitudinal study design. The limited literature on anatomy learning and the views of stakeholders provided a degree of confidence that the issues and findings occurring in this case study were also likely to be found in other contexts. Again, this is an area for further research. What seems important in relation to this study is that a substantial base of new evidence has been produced to enable various lines of productive research to be undertaken which are applicable to a wider range of contexts.

I would be wrong to assume that everything in this study was perfect and that I would not change a thing. There are two elements I would look towards changing or developing as part of subsequent research. The first is to trace the student experience from when it began; tracking their experiences and the influences they are exposed to throughout undergraduate study and into the profession. Such a system would allow further confirmation of the research findings but also take it further to explore the causative nature of elements within the learning process. The second is to examine the wider implications for students learning anatomy based on this study but for a different profession, e.g. physiotherapy. Evidence from other students studying anatomy would be important as many departments teach these students in the same way as they teach medical students, which might not be best for that profession.

I would change small aspects that did not affect the study overall. This is part of my development as a researcher and would make future research more effective. For example, as I became more experienced at interviews my ability to use more non-leading expressive questions developed.

I know myself that I carried out this study to the best of my ability. I carried out the research with integrity in an ethical manner and organised fashion. Limitations and problems were not ignored but openly and holistically addressed. I sought guidance from my supervisor and others when required. I can see in hindsight that I would change some aspects and there are some things that for subsequent research I would tackle differently. I am, however, confident of the data I have gathered, the conclusions I have drawn and the recommendations I will now suggest.

8.5 Recommendations

The illuminative approach used in this study was designed to be used to inform future decisions (Parlett & Hamilton 1977a). This study has explored how students are learning anatomy, its effectiveness and application in medical practice. Based on the model of learning anatomy, I suggest five recommendations to improve anatomy education, which in turn will best enable doctors to carry out the principles of professional practice (General Medical Council 2006). The recommendations should be applicable to a wide audience, including university faculty strategic planning, curriculum designers and teachers. Each recommendation is addressed in turn.

The aims of the recommendations are to enable, reward and promote a deep approach to learning anatomy from the beginning of the undergraduate course and into professional practice.

The recommendations are:

1. Increase the clinical context and the application of anatomy taught in the early years of the medical curriculum and enable anatomy teaching to continue in later years of the course.
2. To enable undergraduate and postgraduate students to study anatomy through human cadavers.
3. Assessment should be appropriate for anatomy education and promote a deep approach.
4. Reduce factors which are detrimental to a deep approach to learning, and which promote a strategic or surface approach to anatomy learning.
5. Expand opportunities in postgraduate study and professional practice to enable clinicians to revisit anatomy education in order to facilitate knowledge restructuring.

8.5.1 Main recommendations

- Increase the clinical context and the application of anatomy taught in the early years of the medical curriculum and enable anatomy teaching to continue in later years of the course.

The curriculum design should ensure that all activities within it are related to the relevance and application of clinical practice and that this is clear from the student perspective. This may be in the form of problem-based learning, case-based learning or weekly themes.

In particular, the foundation semester is important as it is where the initial transformation from previous experience and perception meets the real initial experiences of anatomy in the medical context. As shown, these initial experiences can affect later study. It is even more important that at a point, perhaps where context has been reduced for basic sciences, the students can relate the information and begin to move past seeing anatomy as memorisation-based and begin to work on transforming their knowledge. The curriculum must create opportunities for students to place the knowledge in context and begin to integrate information and apply it. The most obvious for anatomy is its use in radiology, surface anatomy and treatment. This may be at the point of learning in the DR or in clinic. This must not be isolated, so that it engages students in the learning activities. Opportunity must be present to enable students to consolidate knowledge and begin to integrate it and de-compartmentalise the disciplines as the knowledge translates to practice. Teaching which promotes integration, e.g. case-based work or symposia, should facilitate this.

- To enable undergraduate and postgraduate students to study anatomy through human cadavers.

Enabling an anatomy facility to have human cadavers requires a large amount of investment. Debates over the expense of such a resource happen at many institutions. This study provides evidence that working with human cadavers enables students and clinicians to understand the three-dimensional nature of the human form through touch-mediated perception, which is vital for the effective restructuring and translation of knowledge in a form that makes for effective clinical practice.

This study supports others in that the use of human cadavers also facilitates many aspects of the transition that students go through to become practitioners, for example fostering professional attitudes. Prosection and dissection offer slightly different experiences and both should be utilised. Prosection should be used at both undergraduate and postgraduate level. Dissection is better suited to later undergraduate and postgraduate study.

Human cadavers are unlike many other teaching resources in that they have to be donated. A continual supply of donations is required. The Human Tissue Act (HTA) and the universities need to continue to facilitate donation, possibly through advertising.

- Assessment should be appropriate for anatomy education and promote a deep approach.

It is imperative that the assessments promote and reward a deep approach. A surface or strategic approach may inhibit future deep learning and application of learning. Therefore the assessment structure should reflect the learning activities and promote a deep approach. This study highlighted that the current assessment in early and later years at Southampton may reward a surface or strategic approach.

Further research is required to determine which assessments are suitable for anatomy and which would best promote a deep approach. Human cadavers should form part of the platform for anatomy assessment. In particular, research needs to be conducted on what the traditional 'anatomy spotter' tests and promotes. Only then can recommendations be made on its use. Anatomy assessment in the early years of the curriculum may involve key anatomical, surface and radiological landmarks and concepts. For example, a favourite spot in the heart is the fossa ovale. Asking students to identify it only tests the student's knowledge to recall it as a landmark. Asking what feature (pinned or illustrated) may cause cardiac problems after birth places the learning in context.

Anatomy assessment should reflect the application of anatomy relevant to the level of training, for example radiology. There is currently a tendency for the early years' assessment to be based on basic science knowledge and the later years on clinical cases. The use of clinical-based problems in early years' assessments would promote a deep approach to learning and would highlight the relevance of the material and facilitate integration of knowledge.

Liaison between postgraduate and undergraduate anatomy assessment boards could work towards producing a clearer and more effective progressive structure of anatomy assessments.

- Reduce factors which are detrimental to a deep approach to learning, and which promote a strategic or surface approach to anatomy learning.

Reducing the detrimental factors will help students to avoid adopting a surface approach. These include the following:

- To prepare and support students at the beginning of the course when they first come into the DR environment.
- Provide students with advice on how to learn anatomy, for example work through three stages of the process.
- Develop activities which require student engagement.
- Use mnemonics with caution.
- Teachers can ensure the content of their material is applicable and should refer to the ASGBI core curriculum.

- Expand opportunities in postgraduate study and professional practice to enable clinicians to revisit anatomy education in order to facilitate knowledge restructuring.

This study recommends that through medical schools, deaneries and the anatomy departments opportunity is increased for postgraduate anatomy learning. For graduates to effectively apply anatomy knowledge, restructure understanding and form illness scripts, graduates should revisit anatomy at various points in their career and for certain purposes, e.g. college membership. There must be appropriate resources to facilitate this. This may involve continued access to lecture notes, online learning or in some cases this requires opportunities for graduates either to explore or to dissect human cadavers. This may be in the form of refresher or open access days or it may be in the form of more structured demonstratorships. As documented, the presence of clinicians in the anatomy department also helps to increase the relevance to undergraduates, helping promote a deep approach to learning.

8.5.2 Advice

Based on the key findings (section 8.2), it is helpful to discuss how in everyday teaching and learning these findings might be used to improve the anatomy learning experience. I have provided here some suggestions aimed at teachers of anatomy regarding teaching and on how they could advise students.

Teachers of anatomy should place, where relevant, the learning into context. This might be in the form of the curriculum, for example if it is case-based, or into activities students might have come across in the clinical setting, or it may be in the future, for example when listening to a patients chest or placing a chest drain in. The anatomy taught should reflect the possible clinical contexts within the guidelines of the core curriculum, (for example, using a radiological image alongside specimens to place the learning in context, ensuring that the level of anatomical detail reflects the core curriculum).

Learning activities should promote engagement and the use of touch-mediated perception using human cadavers. Students can be guided through a variety of activities which should involve exploration of prosections, opportunity to dissect, surface anatomy, radiological anatomy and computer based learning to bring together an understanding of the three dimensional form. Tools such as peer teaching and group work can help students to understand a topic within anatomy and can foster many other skills and attitudes.

Assessment is a major influence on student learning and whilst the teaching should be aligned to the assessment, teaching sessions should aim not to encourage learning just for the assessment or any type of rote learning. In particular, where students receive formative feedback, the feedback is not just providing feedback about factual knowledge but also provides feedback about the application of knowledge. In setting assessments teachers can ensure that, where appropriate anatomy examination is testing more than propositional knowledge ('knowing that') and is related to the clinical context and application of the understanding.

Many teachers of anatomy are often the point of call for students struggling with anatomy learning. Teachers of anatomy are ideally placed to provide information not just on anatomical knowledge but also on how to learn anatomy. Based on the key findings and on personal experience through discussion with either a group or an individual, it is possible to examine students previous experience and perceptions of anatomy. Frequently this might reveal that a student has some difficulty with the teaching environment and/or that they perceive anatomy to be memorisation based. Students may benefit from discussion or specific support if the issues relate to the environment and the use of human cadavers. Some students may be disheartened, either because of poor assessment results or they have been caught up in a spiral of negative factors. If this is the case it may be useful to discuss why the student was interested in medicine and where they feel anatomy fits into clinical practice.

I often ask students to describe what learning activities they carry out for anatomy and it may be useful to provide students with some examples of how to go about learning anatomy, for example preparation before a practical session, or practical advice if students are struggling with motivation, for example finding a video on the web that relates to a clinical element of that region of anatomy e.g. hernia repair. Students may like to try more visual or practical ways of working in their own time, e.g. using plasticine to build models of anatomical areas or drawing diagrams of structures to bring to the practical session. Students may not be aware that there are other ways of learning so a discussion about approaches to learning may help students to appreciate why they are going about things the way they are. Advice on how to learn anatomy should not be confined to the introduction session but should follow students along their journey of anatomy education.

8.5.3 Recommendations that require further research and consideration.

This study has raised aspects which I cannot directly make recommendations on as they require further investigation. They are briefly discussed here as they may form part of the other recommendations. While this study can only provide limited evidence and further research is required, it suggests that two additional factors may improve anatomy education based on the selection process. The first is based on the previous experience of students. Students who do not offer A-level Biology or equivalent may be at a disadvantage to other students who have had some experience of anatomy previously. This may result in these students being more likely to adopt a surface approach. A possible recommendation would be to change the entry requirements to include A-level Biology or equivalent. The second is that none of the graduate entry students who participated in this study adopted a surface approach. This reflects that, as in other countries, medicine may be better suited to graduate entry only.

8.6 Future Studies

I feel this study has formed an understanding of how students learn anatomy and apply it. The study raised several possible areas of further research, for example, other professions where students learn anatomy. I have identified two areas in particular that I wish to pursue: assessment and restructuring of knowledge. Further research in these areas would help to continue to develop anatomy education in the medical context.

During this study a sideline collaboration study developed to explore spatial abilities of experts and novices in anatomy (described in Appendix Z). I aim to continue this study as it explores the mechanics of three-dimensional understanding. This will further contribute to the understanding of anatomy learning.

8.6.1 Assessment

Assessment in anatomy has received very little research interest but, as discussed, assessment is a major influence on the approach to learning that a student adopts. Ideally, assessment should reflect a deep approach.

Current assessments in anatomy may be effective at testing the objectives of the course, however they may produce a backwash where students learn what they think they will be tested on (Biggs 2003), which may result in inappropriate surface learning. In particular the 'anatomy spotter' appears to promote a surface approach. I would conduct case study research in two phases to examine assessments in anatomy. Stage 1 would involve identifying what types of anatomy knowledge the various assessments test. This would encompass the educational theory behind the type of assessment and rating the examination questions to determine the type of knowledge assessed. Stage two would seek to explore from the student perspective their perceptions of each assessment type, their approach to learning anatomy and their assessment scores. Relationships between perceptions of assessment, details of assessment, learning approach and outcome could then be compared.

8.6.2 Restructuring of anatomy knowledge

It would be possible to involve the student participants in this study further to explore in a longitudinal way the journey of learning anatomy, in particular if their approach to learning anatomy changes over the course and why. This could involve asking the same students to re-take the ASSIST inventory at a later date. I would explore in further detail through qualitative methods how anatomy knowledge is restructured and transformed in the clinical context.

8.7 Final Word

The end of this story has been reached. I have found it a stimulating, challenging and enjoyable experience. I have developed my own understanding of anatomy, educational theory / practice, research methodology and of course about myself, to name just a few! I am certain that it will not be the end of my research journey into anatomy education. I started off (some six years previously) wanting to find out how students learned and applied their anatomy. I feel that this original research has made a significant and advanced contribution to our understanding in an area which has surprisingly received little research attention given the importance of anatomy in medical education. To take you back to the beginning, we now have a much better understanding of learning anatomy at university, its effectiveness, the issues and the implications for the future education of doctors.

v. Appendices

A. Code of Practice for the Dissecting Room
B. Participant Information Sheet and Consent form
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Z. Side Line Spatial Abilities Study

Appendix A

Code of Practice for CLAS Laboratories
(Dissecting Room & Histology Laboratory)

The **Dissecting Room (DR)** and the **Histology Laboratory** facilities operate under license from the Human Tissue Authority under the Human Tissue Act 2004. Adherence to the regulations is monitored and failure to comply with the regulations has serious consequences. Health and Safety policy must be observed at all times in the above laboratory spaces.
(https://www.soton.ac.uk/safety/policies/Educationpolicy.pdf)

For these reasons, users of the facility are required to adhere to the following **Code of Practice**:

Users of these facilities **must not:**

- Remove anything from the facilities
- Take photographs within the facilities (this includes camera and mobile phones)
- Bring mobile phones with you into the facilities
- Smoke, eat or drink in the facilities (this includes chewing gum)
- Behave in a disrespectful manner
- Bring any unauthorised person into the facility
- Move specimens from tables
- Wear high heel shoes (height >2 inches), stilettos, open toe shoes, or flip flops as these may cause slipping on wet floors, and expose skin to fluid spills.
- Wear contact lenses; instead use your spectacles. (Gases and vapours may be absorbed by contact lenses and cause irritation of the eye)

Good laboratory practice requires that users **must**:

- Wear a lab coat in the **DR** at all times which should not be used outside the facility
- Make themselves aware of the location of the **fire exits** and **first aid box**
- Avoid lone working
- Report any injuries sustained in the DR to the DR staff
- Handle specimens carefully and report any damage to DR staff
- Wrap specimens in wet cloth and cover with a plastic sheet when they are not in use to prevent drying out.
- Use gloves when handling wet specimens
- Wash hands before leaving
- Dispose of rubbish in the bins provided
- Store belongings in the designated areas (but do not leave valuables unattended)
- Wear closed toe shoes with slip resistant soles
- Tie back long hair
- Exercise caution when using wheeled chairs on vinyl floor (Histology laboratory)

Participant Information Sheet and consent form

Each participant group had their own participant information sheet reflecting their role and the research activities they would be invited to take part in. The example below was used for the stakeholder interviews.

Information sheet for research participants
COREC Ref No: 05/Q1702/96
Version 2.0 (Created 20/09/2005)
Claire Smith University of Southampton 2005

This is an invitation for you to take part in a PhD research study. Please read and sign the consent form. In doing so you are saying that you understand the aims of the project and your role within it. You are invited to ask any questions.

You may withdraw consent and discontinue to participate in the project at any time without prejudice.

The purpose of the study
The aim of this research is to gain a greater understanding of teaching and learning gross anatomy, with particular emphasis on undergraduate medical students in the UK.

Your role in the study
You were chosen to take part in the study because of your role as a university member of staff with an input into the curriculum, or as a member of an organisation with an input into anatomy.

Do I have to take part in the study?
It is up to you to decide whether or not to take part. If you do decide to take part you will be given this information sheet to keep and be asked to sign a consent form. If you decide to take part you are still free to withdraw at any time and without giving a reason.

What will happen to me if I take part?
You will be interviewed for up to hour on your experiences and thoughts about the anatomy education and the medical curriculum. The interview will be recorded digitally so that it can later be transcribed and anonymised. Quotes may be used if you give permission.

What are the possible risks of taking part?
This study does not expose you to any potential risks or discomforts. If you have any concerns please contact the researcher

What are the benefits of taking part?
Hopefully our discussion will give you chance to explore the issues of anatomy teaching and learning and enable you to reflect on your own work and development in light of the discussion from day to day activities to the wider picture of training doctors of tomorrow.

What happens if new information becomes available?
You will be contacted and either informed in person of this information or directed to the relevant source .e.g. web site

What happens when the research study stops?
There are no implications to you; if the research has raised areas which you wish to further investigate a separate study may be set up.

What if something goes wrong?
If this occurs you should seek the advise of the supervisor whose details are provided for you. If necessary you should contact the University Insurance department.

Will my taking part in this study be confidential?
All participants will be treated anonymously in that they will not be identified by name or from the information they provide. All information received will be treated as confidential and will only be disclosed in an appropriate research dissemination manor.

What will happen to the results of the research study?
The results of this study will form part of the researches PhD thesis. Participants will be informed of any publications relating to the research.

Who is organising and funding the research?

Organisers

The study is being supervised by the School of Education, University of Southampton. Funding has been provided by the University of Southampton.

Who has reviewed the study?

The study has been reviewed by the South West Hampshire and the Isle of Wight Ethics Committee.

Contact for further information.

Mrs Claire Smith (Researcher)
Centre for Learning Anatomical Sciences
School Of Medicine
University of Southampton
Biomedical Sciences Building
Bassett Crescent East
Southampton
SO16 7PX
Email: C.F.Smith@soton.ac.uk

Dr H. Mathias (Supervisor)
Building 2 Room 4075
Centre for Learning and Teaching
University of Southampton
University Road
Highfield
SO17 1BJ
Email: H.S.Mathias@soton.ac.uk

Thank you for taking part in this study.

Appendix B

Study Number: Group 1
Participant Identification Number for this trial:

CONSENT FORM

Title of Project: Understanding attitudes and trends in teaching and learning gross anatomy in the 21st Century-What does this mean for doctors of tomorrow?

Name of Researcher: Mrs C.F.Smith

Please initial box

1. I confirm that I have read and understand the information sheet dated .... (version ....) for the above study and have had the opportunity to ask questions.
2. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason, without my medical care or legal rights being affected.
3. I agree to take part in the above study.

______________________ Name of Participant	_______________ Signature	Date
______________________ Researcher	_______________ Signature	Date

i. I agree to my participation being recorded and kept securely in alignment with the Data Protection Act.

Signature________________

ii. I agree to the researcher using anonymised quotes.

Signature________________

Appendix C

COREC Approval Letter

SOUTHAMPTON & SOUTH WEST HAMPSHIRE
RESEARCH ETHICS COMMITTEES (B)
1ST Floor, Regents Park Surgery
Park Street, Shirley
Southampton
Hampshire
SO16 4RJ

Tel: 023 8036 2466
023 8036 3462
Fax: 023 8036 4110

Email: GM.E.hio-au.SWHRECB@nhs.net

SKS

07 December 2005

Mrs Claire F Smith
Teaching Fellow
University of Southampton
Centre for Learning Anatomical Sciences
Biomedical Sciences Building
Bassett Crescent East
SO16 7PX

Dear Mrs Smith

Full title of study: **Understanding attitudes and trends in teaching and learning gross anatomy in the 21st Century- What does this mean for doctors of tomorrow?**

REC reference number: **05/Q1704/147**

The Research Ethics Committee reviewed the above application at the meeting held on 23 November 2005.

Ethical opinion

The members of the Committee present gave a favourable ethical opinion of the above research on the basis described in the application form, protocol and supporting documentation.

Ethical review of research sites

The Committee agreed that all sites in this study should be exempt from site-specific assessment (SSA). There is no need to complete Part C of the application form or to inform Local Research Ethics Committees (LRECs) about the research. The favourable opinion for the study applies to all sites involved in the research.

Conditions of approval

The favourable opinion is given provided that you comply with the conditions set out in the attached document. You are advised to study the conditions carefully.

Approved documents

The documents reviewed and approved at the meeting were:

Document	*Version*	*Date*
Application PARTS A/B		14 September 2005
Investigator CV Mrs Claire France Smith - Chief Investigator		21 September 2005
Investigator CV Dr Haydn - Supervisor		28 June 2005
Protocol	2.1	21 September 2005
Covering Letter		19 September

Guide Sheet used for Preliminary Student Focus Group

Student perspective Friday 7th march 11am

- How do you prepare for a dissecting room (DR) session? E.g. read DR book
- How has this changed since the foundation term?
- What do you do once you are in the DR?
- How do you consolidate your anatomy learning after the DR session?
- In which phase of your learning cycle do you feel the most effective learning occurs (phase 1: before the practical, phase 2: during the practical, phase 3: after the practical)
- Do you feel most of your learning occurs inside or outside of the timetabled sessions?
- How do you revise for anatomy written exams?
- How do you revise for anatomy spotter exams?
- What other things do you feel you are learning whilst learning anatomy? E.g. teamwork
- Teaching styles:
- Can you give some strengths and weaknesses of the various styles of anatomy teaching.

Lectures
Tutorials
Practicals
Self directed study

- How do you use the anatomy handbook?
- Can you give some strengths and weaknesses of the handbooks?
- Do you have any recommendations for how the handbook could be improved to aid your learning?

Thank you very much for your time and cooperation

Claire Smith

Appendix E

Observation Recording Sheet

Example of a completed recording sheet (types up)

Participant observation sheet

Date: 17 October
Time: 1.45
Participants being observed: 7

<u>Lead points</u>
General setting, Head and Neck class
Atmosphere, fairly quiet
Grouping of people, 3, 2,2
What are they doing, engaged around DR tables
Relationships, two groups of 2 with one group of 3 moving between other groups

Event sampling:

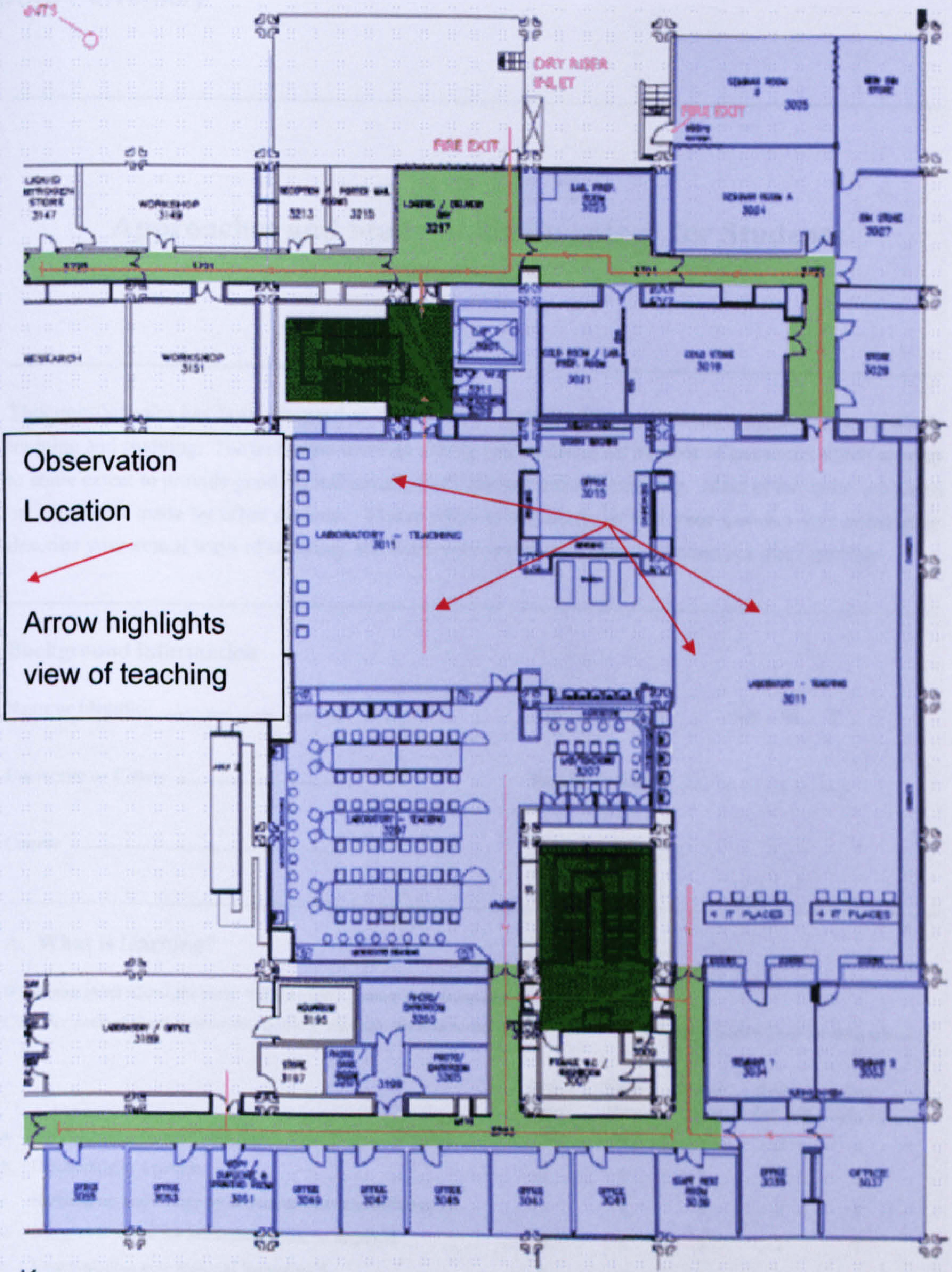
Event	Tally
Student read handbook	//////////
Student looked at specimen	/////
Student explored specimen	////////
Student discussion	////
Student referred to other learning resource	//
Student made notes	/////
Student drew diagram	/
Student asked staff	///

Instantaneous sampling:

Student read handbook	Student looked at specimen	Student explored specimen	Student discussion	Student referred to learning resource	Student made notes	Student asked staff
1	5	5	2	3		4
1	2	3			4	
5	3	4			2	1
2	1	3			4	5
1	3	4	2		6	5
1	2	4	3	5		6
2	1	3	5	4		6

Appendix F

Floor Plan of the Dissecting Room



Key

🟦 Anatomy Department

🟩 Fire Escape Route

ASSIST Inventory

A S S I S T
Approaches and Study Skills Inventory for Students
(Short version)

This questionnaire has been designed to allow you to describe, in a systematic way, how you go about learning and studying. The technique involves asking you a substantial number of questions which overlap to some extent to provide good overall coverage of different ways of studying. Most of the items are based on comments made by other students. Please respond truthfully, so that your answers will accurately describe your **actual** ways of studying, and work your way through the questionnaire quite **quickly**.

Background information

Name or Identifier .... **Age** ...... **years** **Sex** M / F

University or College .... **Faculty or School** ....

Course .... **Year of study** ......

A. What is learning?

When you think about the term 'LEARNING', what does it mean to you?
Consider each of these statements carefully, and rate them in terms of how close they are to your own way of thinking about it.

	Very close	*Quite close*	*Not so close*	*Rather different*	*Very different*
a. Making sure you remember things well.	5	4	3	2	1
b. Developing as a person.	5	4	3	2	1
c. Building up knowledge by acquiring facts and information.	5	4	3	2	1
d Being able to use the information you've acquired.	5	4	3	2	1
e. Understanding new material for yourself.	5	4	3	2	1
f. Seeing things in a different and more meaningful way.	5	4	3	2	1

Please turn over

B. Approaches to studying

The next part of this questionnaire asks you to indicate your relative agreement or disagreement with comments about studying again made by other students. Please work through the comments, giving your **immediate** response. In deciding your answers, think in terms of **this particular lecture course.** It is also very important that you answer **all** the questions: check you have.

5 means agree (√)   4 = agree somewhat (√?)   2 = disagree somewhat (x?)   1 = disagree (x).

Try not to use 3 = unsure (??), unless you really have to, or if it cannot apply to you or your course.

	√	√?	??	x?	x
1. I manage to find conditions for studying which allow me to get on with my work easily.	5	4	3	2	1
2. When working on an assignment, I'm keeping in mind how best to impress the marker.	5	4	3	2	1
3. Often I find myself wondering whether the work I am doing here is really worthwhile.	5	4	3	2	1
4. I usually set out to understand for myself the meaning of what we have to learn.	5	4	3	2	1
5. I organise my study time carefully to make the best use of it.	5	4	3	2	1
6. I find I have to concentrate on just memorising a good deal of what I have to learn.	5	4	3	2	1
7. I go over the work I've done carefully to check the reasoning and that it makes sense.	5	4	3	2	1
8. Often I feel I'm drowning in the sheer amount of material we're having to cope with.	5	4	3	2	1
9. I look at the evidence carefully and try to reach my own conclusion about what I'm studying.	5	4	3	2	1
10. It's important for me to feel that I'm doing as well as I really can on the courses here.	5	4	3	2	1
11. I try to relate ideas I come across to those in other topics or other courses whenever possible.	5	4	3	2	1
12. I tend to read very little beyond what is actually required to pass.	5	4	3	2	1
13. Regularly I find myself thinking about ideas from lectures when I'm doing other things.	5	4	3	2	1
14. I think I'm quite systematic and organised when it comes to revising for exams.	5	4	3	2	1
15. I look carefully at tutors' comments on course work to see how to get higher marks next time.	5	4	3	2	1
16. There's not much of the work here that I find interesting or relevant.	5	4	3	2	1
17. When I read an article or book, I try to find out for myself exactly what the author means.	5	4	3	2	1
18. I'm pretty good at getting down to work whenever I need to.	5	4	3	2	1
19. Much of what I'm studying makes little sense: it's like unrelated bits and pieces.	5	4	3	2	1
20. I think about what I want to get out of this course to keep my studying well focused.	5	4	3	2	1
21. When I'm working on a new topic, I try to see in my own mind how all the ideas fit together.	5	4	3	2	1
22 I often worry about whether I'll ever be able to cope with the work properly.	5	4	3	2	1
23. Often I find myself questioning things I hear in lectures or read in books.	5	4	3	2	1
24. I feel that I'm getting on well, and this helps me put more effort into the work.	5	4	3	2	1
25. I concentrate on learning just those bits of information I have to know to pass.	5	4	3	2	1
26. I find that studying academic topics can be quite exciting at times.	5	4	3	2	1
27. I'm good at following up some of the reading suggested by lecturers or tutors.	5	4	3	2	1
28. I keep in mind who is going to mark an assignment and what they're likely to be looking for.	5	4	3	2	1
29. When I look back, I sometimes wonder why I ever decided to come here.	5	4	3	2	1
30. When I am reading, I stop from time to time to reflect on what I am trying to learn from it.	5	4	3	2	1

		√	√?	??	x?	x
31.	I work steadily through the term or semester, rather than leave it all until the last minute.	5	4	3	2	1
32.	I'm not really sure what's important in lectures so I try to get down all I can.	5	4	3	2	1
33.	Ideas in course books or articles often set me off on long chains of thought of my own.	5	4	3	2	1
34.	Before starting work on an assignment or exam question, I think first how best to tackle it.	5	4	3	2	1
35.	I often seem to panic if I get behind with my work.	5	4	3	2	1
36.	When I read, I examine the details carefully to see how they fit in with what's being said.	5	4	3	2	1
37.	I put a lot of effort into studying because I'm determined to do well.	5	4	3	2	1
38.	I gear my studying closely to just what seems to be required for assignments and exams.	5	4	3	2	1
39.	Some of the ideas I come across on the course I find really gripping.	5	4	3	2	1
40.	I usually plan out my week's work in advance, either on paper or in my head.	5	4	3	2	1
41.	I keep an eye open for what lecturers seem to think is important and concentrate on that.	5	4	3	2	1
42.	I'm not really interested in this course, but I have to take it for other reasons.	5	4	3	2	1
43.	Before tackling a problem or assignment, I first try to work out what lies behind it.	5	4	3	2	1
44.	I generally make good use of my time during the day.	5	4	3	2	1
45.	I often have trouble in making sense of the things I have to remember.	5	4	3	2	1
46.	I like to play around with ideas of my own even if they don't get me very far.	5	4	3	2	1
47.	When I finish a piece of work, I check it through to see if it really meets the requirements.	5	4	3	2	1
48	Often I lie awake worrying about work I think I won't be able to do.	5	4	3	2	1
49	It's important for me to be able to follow the argument, or to see the reason behind things.	5	4	3	2	1
50.	I don't find it at all difficult to motivate myself.	5	4	3	2	1
51.	I like to be told precisely what to do in essays or other assignments.	5	4	3	2	1
52.	I sometimes get 'hooked' on academic topics and feel I would like to keep on studying them.	5	4	3	2	1

C. Preferences for different types of course and teaching

5 means definitely like (√)   4 = like to some extent (√?)   2 = dislike to some extent (x?)   1 = definitely dislike (x).
Try not to use 3 = unsure (??), unless you really have to, or if it cannot apply to you or your course.

		√	√?	??	x?	x
a.	lecturers who tell us exactly what to put down in our notes.	5	4	3	2	1
b.	lecturers who encourage us to think for ourselves and show us how they themselves think	5	4	3	2	1
c.	exams which allow me to show that I've thought about the course material for myself.	5	4	3	2	1
d.	exams or tests which need only the material provided in our lecture notes.	5	4	3	2	1
e.	courses in which it's made very clear just which books we have to read.	5	4	3	2	1
f.	courses where we're encouraged to read around the subject a lot for ourselves.	5	4	3	2	1
g.	books which challenge you and provide explanations which go beyond the lectures.	5	4	3	2	1
h.	books which give you definite facts and information which can easily be learned.	5	4	3	2	1

Finally, how well do you think you have been doing in your assessed work overall, so far?
Please rate yourself objectively, based on the grades you have been obtaining

Very well		*Quite Well*		*About average*		*Not so well*		*Rather badly*
9	8	7	6	5	4	3	2	1

Thank you very much for spending time completing this questionnaire: it is much appreciated.

Scoring Key for the
Approaches and Study Skills Inventory for Students *(ASSIST)*

A. What is learning? – Conceptions of learning

This first section can be omitted. It is still at an early stage of development, but it is based on the conceptions of learning described by Marton & Saljo (1996) and extended by Hattie (1996). The categories can be seen as a hierarchy, although not all the steps or categories are generally agreed. The first four, to a decreasing extent, tend to relate to an instrumental approach and can therefore be combined to indicate a conception of learning as reproducing knowledge, while the remaining four cover a view of learning involving personal understanding and development.

g. Getting on with the things you've got to do.
c. Building up knowledge by acquiring facts and information.
a. Making sure you remember things well.
e Being able to use the information you've acquired.
f. Understanding new material for yourself.
h. Seeing things in a different and more meaningful way.
d. Using all your experiences in life.
b. Developing as a person.
i. Being able to relate to people better.

B. Approaches to studying

Approaches to studying derive from Marton & Saljo's (1976, 1997) ideas on approaches to learning, combined with Entwistle & Ramsden's (1983, see also Ramsden & Entwistle, 1979) descriptions on a strategic approach to studying. The first three sub-scales in each approach are most consistently related to each other, and can be combined with confidence. Subsequent sub-scales are more likely to vary in their relationships across different samples. Relationships thus need to be checked in the particular sample used for the study. Descriptions of the development and use of this particular version of the inventory will be found in Tait & Entwistle (1996), Tait, Entwistle & McCune (1998) and Entwistle, Tait & McCune (1999, in press).

Scoring procedure

Students respond to items on a 1 - 5 scale (5 high). Sub-scale scores are formed by adding together the responses on the items in that sub-scale. Scores on the three main approaches are created by adding together the sub-scale scores which contribute to each approach. Scoring can be carried out by computer, using a program such as SPSS. Each item is set as a variable (e.g. D04 = Deep item 4), and then a sub-scale total is produced by creating a new variable by summing the items. For example, Seeking Meaning (SM) = D04 + D17 +D30 + D43. Then the approaches can be created in the same way Deep Approach (DA) = SM + RI + UE + II.

Deep Approach

Seeking meaning

4. I usually set out to understand for myself the meaning of what we have to learn.

17. When I'm reading an article or book, I try to find out for myself exactly what the author means.

30. When I am reading I stop from time to time to reflect on what I am trying to learn from it.

43. Before tackling a problem or assignment, I first try to work out what lies behind it.

Relating ideas

11. I try to relate ideas I come across to those in other topics or other courses whenever possible.

21. When I'm working on a new topic, I try to see in my own mind how all the ideas fit together.

33 Ideas in course books or articles often set me off on long chains of thought of my own.

46. I like to play around with ideas of my own even if they don't get me very far.

Use of evidence

9 I look at the evidence carefully and try to reach my own conclusion about what I'm studying.

23. Often I find myself questioning things I hear in lectures or read in books.

36. When I read, I examine the details carefully to see how they fit in with what's being said.

49. It's important for me to be able to follow the argument, or to see the reason behind things.

Interest in ideas ***(Related sub-scale)***

13. Regularly I find myself thinking about ideas from lectures when I'm doing other things.

26. I find that studying academic topics can be quite exciting at times.

39. Some of the ideas I come across on the course I find really gripping.

52. I sometimes get 'hooked' on academic topics and feel I would like to keep on studying them.

Strategic approach

Organised studying

1. I manage to find conditions for studying which allow me to get on with my work easily.

14. I think I'm quite systematic and organised when it comes to revising for exams.

27. I'm good at following up some of the reading suggested by lecturers or tutors.

40. I usually plan out my week's work in advance, either on paper or in my head.

Time management

5. I organise my study time carefully to make the best use of it.

18. I'm pretty good at getting down to work whenever I need to.

31. I work steadily through the term or semester, rather than leave it all until the last minute.

44. I generally make good use of my time during the day.

Alertness to assessment demands

2. When working on an assignment, I'm keeping in mind how best to impress the marker.

15. I look carefully at tutors' comments on course work to see how to get higher marks next time.

28. I keep in mind who is going to mark an assignment and what they're likely to be looking for.

41. I keep an eye open for what lecturers seem to think is important and concentrate on that.

Achieving ***(Related sub-scale)***

10. It's important to me to feel that I'm doing as well as I really can on the courses here.
24. I feel that I'm getting on well, and this helps me put more effort into the work.
37. I put a lot of effort into studying because I'm determined to do well.
50. I don't find it at all difficult to motivate myself.

Monitoring effectiveness ***(Related sub-scale)***

7. I go over the work I've done carefully to check the reasoning and that it makes sense.
20 I think about what I want to get out of this course to keep my studying well focused.
34. Before starting work on an assignment or exam question, I think first how best to tackle it.
47. When I have finished a piece of work, I check it through to see if it really meets the requirements.

Surface Apathetic Approach

Lack of purpose

3. Often I find myself wondering whether the work I am doing here is really worthwhile.
16. There's not much of the work here that I find interesting or relevant.
29. When I look back, I sometimes wonder why I ever decided to come here.
42. I'm not really interested in this course, but I have to take it for other reasons.

Unrelated memorising

6. I find I have to concentrate on just memorising a good deal of what I have to learn.
19. Much of what I'm studying makes little sense: it's like unrelated bits and pieces.
32. I'm not really sure what's important in lectures, so I try to get down all I can.
45. I often have trouble in making sense of the things I have to remember.

Syllabus-boundness

12. I tend to read very little beyond what is actually required to pass.
25. I concentrate on learning just those bits of information I have to know to pass.
38. I gear my studying closely to just what seems to be required for assignments and exams.
51. I like to be told precisely what to do in essays or other assignments.

Fear of failure ***(Related sub-scale)***

8. Often I feel I'm drowning in the sheer amount of material we're having to cope with.
22. I often worry about whether I'll ever be able to cope with the work properly.
35. I often seem to panic if I get behind with my work.
48. Often I lie awake worrying about work I think I won't be able to do.

Preferences for different types of course and teaching Scored as the sum of the four items.

Supporting understanding *(related to a deep approach)*

b. - lecturers who encourage us to think for ourselves and show us how they themselves think.
c. - exams which allow me to show that I've thought about the course material for myself.
f. - courses where we're encouraged to read around the subject a lot for ourselves.
g. - books which challenge you and provide explanations which go beyond the lectures.

Transmitting information *(related to a surface approach)*

a. - lecturers who tell us exactly what to put down in our notes.

d. - exams or tests which need only the material provided in our lecture notes.

e. - courses in which it's made very clear just which books we have to read.

h. - books which give you definite facts and information which can easily be learned.

Recent analyses using *ASSIST*

A maximum likelihood factor analysis of 817 first-year university students drawn from ten contrasting departments in six British universities who completed *ASSIST*.

Table 1

Factor pattern matrix for conceptions, approaches, and preferences for teaching

(N = 817, 54.5 % variance)	**Factor**	**I**	**II**	**III**	
(alpha)*		Deep	Strategic	Surface apathetic	
Conceptions of learning					
Learning as reproducing			(.20)	(.13)	
Learning as transforming		.41			
Approaches to Studying					
Deep approach					**(0.84)**
Seeking meaning		.72			(0.57)
Relating ideas		.79			(0.59)
Use of evidence		.77			(0.53)
Interest in ideas		.65			(0.76)
Strategic approach					**(0.80)**
Organised studying			.76		(0.54)
Time management			.87		(0.68)
Monitoring effectiveness		.45	.43		(0.62)
Achievement motivation			.73		(0.76)
Surface apathetic approach					**(0.87)**
Lack of understanding				.77	(0.57)
Lack of purpose				.42	(0.76)
Syllabus boundness				.42	(0.55)
Fear of failure				.73	(0.69)
Preferences for teaching which					
Encourages understanding		.61			(0.62)
Transmits information				.35	(0.69)

Correlations between factors *

	I	**II**	**III**
Factor I **(Deep)**	1.00		
Factor II **(Surface Apathetic)**	- 0.20	1.00	
Factor III **(Strategic)**	0.35	- 0. 22	1.00

Note: Rotated maximum likelihood analysis with delta set at zero.
Loadings less than 0.3 have mostly been omitted. * from a subsequent analysis of data described for Table 3 below

This development from the *ASI* includes additional scales intended to extend the description of studying and reactions to teaching. The definition of the strategic approach has also been broadened to include an aspect of metacognition and self-regulation - monitoring effectiveness. The surface approach puts more emphasis on ineffective studying through the inclusion of a scale indicating a 'lack of purpose', and the scale is now called 'surface apathetic'. The sub-scales included in this analysis were those contributing to the three main factors described above, supported by items describing students' conceptions of learning and their preferences for different kinds of teaching. Three factors produced eigen values above unity and that solution also provided the best balance between interpretability and the percentage of variance explained.

The original version of the *ASI* explicitly included Pask's two styles of learning. In *ASSIST*, however, these have been subsumed within the definition of the deep approach, which is taken to require both ways of thinking - relating ideas (holist) and using evidence (serialist) - or a versatile style in learning. The factor analysis confirms that these two processes link closely with both the intention to seek meaning and interest in ideas (an attitudinal correlate of intrinsic motivation). Linkages between approach and motive are also clear-cut within the strategic approach, where achievement motivation (Atkinson & Feather, 1966) is strongly associated with both organised studying and time management. Similarly, the 'surface apathetic' factor brings together syllabus boundness and lack of understanding with both lack of purpose and fear of failure.

As in previous studies, the deep approach is linked with a conception of learning as 'transforming' (e.g. Meyer, 1999), and also with a preference for teaching which encourages and challenges understanding (Entwistle & Tait, 1990). A parallel finding indicates that students with a reproducing conception, adopting a surface apathetic approach, prefer teaching that transmits information and directs learning towards assessment requirements, although this is less marked in the analysis shown in Table 1. Other research has indicated that students who show a deep strategic approach are also better able to discern and utilise the aspects of a learning environment which will support their way of studying (Meyer, Parsons & Dunne, 1990; Meyer, 1991).

Versions of *ASSIST* have been used in studies with rather different purposes. One recent study was designed to investigate reasons for poor performance in the first year at university. Deep, strategic and surface apathetic approaches were treated as single scales, but the motive components were kept separate. The items describing conceptions were not used, but additional items indicated how well-prepared for university students judged themselves to be, and what had influenced their studying. The inventory was given to 604 first-year students from six departments in a technological university.

The analysis (Table 2) showed separate factors describing strategic and surface apathetic approaches. The strategic approach in Factor I linked the achieving motive with high academic performance and, more weakly, with a lack of interference in studying from social or sporting activities. The surface apathetic approach in Factor II was associated not just with fear of failure, but also with inadequate prior knowledge (particularly in mathematics) and, less strongly, with the effects on studying of doing paid work or of personal relationships. This combination, not surprisingly, was negatively related to academic performance. The final factor showed its highest loadings on interest in academic content and deep approach, but it also showed elements of both strategic (positive) and surface apathetic (negative) approaches, together with a similar pattern for teaching preferences.

Table 2

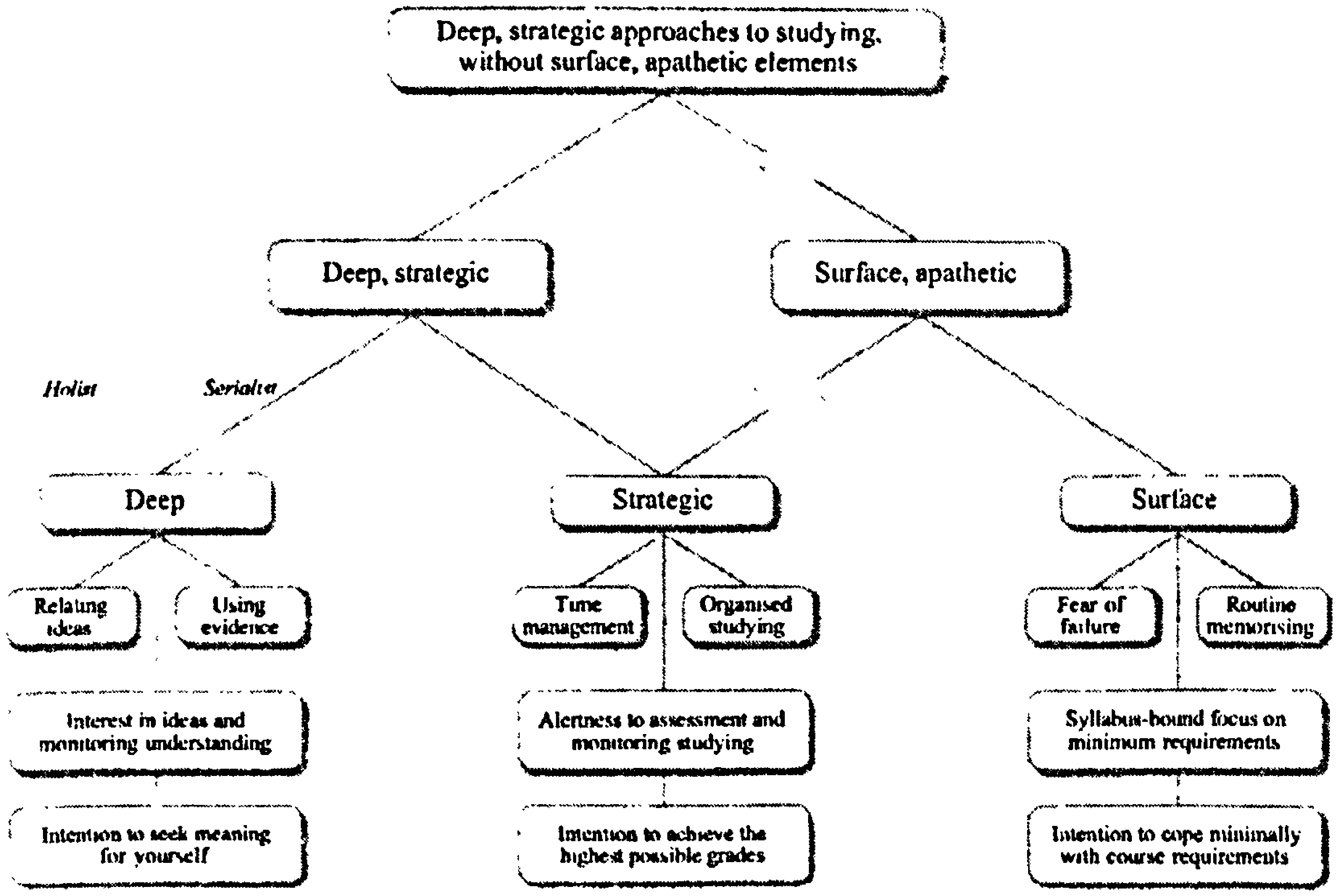
Factor pattern matrix for variables derived from a modified version of *ASSIST*

(N = 604, 46.0% variance) **Factors**	**I** Strategic	**II** Surface apathetic	**III** Deep, non-apathetic
Preparation for higher education			
Choosing courses out of interest			.42
Experience in studying independently		(-.25)	
Having adequate prior knowledge		-.46	
Approaches to studying (excluding motives)			
Deep approach			.70
Strategic approach	.75		(.27)
Surface apathetic approach		.53	-.39
Motives for studying			
Interest in the content			.75
Achieving high grades	.81		
Fear of failure		.78	
Influences on studying			
Social or sporting activities	-.31		
Doing paid work		.31	
Personal relationships		.39	
Difficulties with maths		.38	
Teaching preferences			
Encouraging understanding			.55
Transmitting information			(-.26)
Academic performance			
Average first term marks	.43	-.46	

Rotated maximum likelihood analysis with delta set at zero. Loadings less than 0.3 have mostly been omitted.
The low percentage of variance explained is partly due to the presence of seven single item variables.

The factor analyses shown in Tables 3 and 4 suggest an even broader construct summarising the components of effective studying. It bridges the combination of holist and serialist modes of thinking, and also includes a strategic awareness of the rules of the academic assessment game and of how to use relevant aspects of the learning environment. Figure 1 presents a conceptual mapping of these relationships, building up a hierarchical pattern from the sub-scales of *ASSIST* to a broader, idealised view of the successful student. It also indicates some of the other linkages identified in the factor analyses, suggesting that the approach to studying is affected both by the student's conception of learning and by the type of teaching experienced. The negative relationships shown in the concept map indicate that low scores on the strategic approach are related to the apathetic approach, while low levels of surface approach contribute to being a successful student.

Figure 1
Conceptual mapping of components of effective studying from ASSIST



Dissonance in approaches to studying

The factor structure of *ASSIST* is clear-cut and has been confirmed with other samples and at different levels of performance. These factors, and the aspects of studying they have been designed to tap, then provided a well-established analytic categories for describing general tendencies in studying and their correlates. Factor analysis describes the relationships between variables in ways which show the broad overall pattern clearly, but cannot identify different patterns of relationship which may exist in sub-groups within a population (Meyer, 2000). For this reason, alternative methods of analysis have been used, such as cluster analysis, which groups together individuals who have responded to items in similar ways. By considering how the samples differ on additional variables not included in the cluster analysis, a clearer picture of the nature of the clusters can then be obtained. In a recent analysis (Entwistle, Tait & McCune, 2000) data from *ASSIST* was obtained from 1284 first-year students from three long established and three recently established British universities covering a spread of areas of study. A k-means relocation analysis was carried out. This method allows the fullest possible description of the clusters. As the defining features of clusters vary as increasing numbers of clusters are selected, it is important to check the stability of these features both through the cluster levels and from split-half solutions at the same level (Entwistle & Brennan, 1971; Entwistle & Ramsden, 1983). For these purposes, the six, twelve and eighteen cluster solutions were examined, with the eighteen level giving the clearest differences. The full sample was then split randomly into comparable halves using the appropriate SPSS procedure, and the eighteen cluster solution repeated for samples of 665 and 619 students respectively.

To illustrate the kinds of variation which can be obtained using this technique, Table 3 compares two high achieving groups and two whose self-rating of their academic progress was much lower. Group 1 is the usual pattern of responses found among highly successful students – a deep strategic approach with low scores on surface apathetic. Group 2 differs somewhat (as indicated by the figures in bold) in that these students, more of whom were female and from non-science courses, combined deep, well-organised and well-motivated studying with relatively high levels of anxiety and syllabus boundness. Group 4 shows the opposite characteristics of Group 1 and also have the lowest self-ratings of academic progress. Group 3, with almost equally poor levels of performance, respond in ways which suggest a 'dissonant' pattern of responses, with the surface apathetic approach being associated with indications of a relatively strong deep approach.

Table 3 Pattern of means describing the centroids of clusters with contrasting self-ratings on academic progress within the 18 cluster solution

Cluster means					
Sub-scales	**1**	**2**	**3**	**4**	
(N = in 1284 sample)	(60)	(73)	(43)	(22)	
Deep Approach					
Seeking meaning	17.2	15.7	**13.4**	9.1	
Relating ideas	16.3	15.1	**14.4**	9.2	
Use of evidence	16.6	15.7	**14.5**	9.8	
Interest in ideas	16.9	15.9	**13.0**	6.6	
Surface Apathetic Approach					
Lack of understanding	7.9	9.9	14.2	12.2	
Lack of purpose	5.0	5.8	14.1	15.8	
Syllabus-boundness	8.7	**12.3**	16.5	18.0	
Fear of failure	8.8	**14.1**	17.1	13.4	
Strategic Approach					
Organised studying	16.4	14.4	8.7	7.3	
Time management	17.2	14.9	7.1	6.2	
Monitoring effectiveness	16.8	15.8	**11.5**	7.6	
Achievement motivation	18.0	16.5	9.2	7.9	
Preferences for learning environments					
Deep (Encouraging understanding)	17.4	15.6	13.4	10.2	
Surface (Transmitting information)	16.2	17.5	17.5	18.6	
Descriptive statistics (not used in forming the clusters)					
Self-rating of ac. progress (out of 9)	6.8	6.7	4.0	3.5	
% of cluster who were					*(% in total sample)*
in pre-1990s university	80.0	**71.3**	**48.8**	59.1	(68.7)
in science and engineering	56.6	**48.0**	**62.8**	77.3	(55.8)
male	46.7	**34.2**	**58.1**	68.2	(54.0)

Defining a deep approach

Research using the ASI and interviews looking at approaches to studying allow a fuller picture of the defining features of the deep approach to be presented (Table 4 - from McCune & Entwistle, 2000). The core aspect of a fully developed deep approach is the intention to form a personal understanding of the topic under study, this is then combined with a range of conceptually related learning processes. Unsurprisingly, students taking a deep approach also tend to show active engagement and interest in their studies.

Table 4 Elements of the deep approach

Intention to understand

Active interest and personal engagement

Relating ideas
Gaining an overview
Creating outlines and structures
Questioning and using evidence critically
Seeking the central point
Drawing conclusions
Seeing the purpose of a task or seeing it in its wider context

While this research has confirmed and extended our understanding of patterns of study behaviour in relation to academic achievement, and indicated the general influences of methods of teaching and assessment, it is much less successful at providing full or detailed descriptions of individual students' learning. Approaches to learning and studying provide analytic abstractions which summarise research findings and simplify the complexity of everyday studying. While such concepts have proved useful, observed behaviour and interviews leading to case studies (McCune, 2000; McCune & Entwistle, 2000) suggest the importance of the idiosyncratic details of students' learning and the complex effects of differing learning environments.

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Student Questionnaire

Welcome to this Study into Anatomy Education.
The aim of this research is to gain an understanding of how medical students learn anatomy.
This part of the study involves you answering the following questionnaire.
Please read the Participant Information Sheet
If you would be happy to be contacted and invited to a focus group session please click here
In order to proceed you need to please read and sign the consent form
Perception Software requires a user ID to stop multiple entries.
Please type your student ID number
Please select the applicable information by ticking the relevant response.
Female Male Mature Student Overseas Student

BM5 Course Year 1 2 3 4 5

BM4 Course Year 1 2 3

There are 5 generic clusters of questions and 1 cluster specific to your year of study. All require you to please rate the statement by ticking which box you most agree with.
Read the statement and select which category reflects your feelings and experiences.
5 =Strongly agree 4 = Agree 2 =Disagree 1 = Strongly disagree
Try not to use 3 = Neither agree nor disagree, unless you really have to, or if it cannot apply to you or your course.

This first cluster of questions asks about your learning.

1. I find/found reading textbooks an effective way of learning anatomy.
2. I find/found on-line material an effective way of learning anatomy .
3. I find/found material provided by the course an effective way of learning anatomy e.g. Handbooks.
4. I find/found using imaging material e.g. MRI an effective way of learning anatomy.
5. I find/found mock exams an effective way of learning anatomy.
6. I find/found Dissecting Room specimens an effective way of learning anatomy.
7. I find/found clinician based teaching an effective way of learning anatomy.

Please note any other ways, if any, of learning anatomy that you personally find effective.
Free Comments

This second cluster asks you about learning on cadavers

8. The most effective way I learn/t anatomy in the Dissecting room is/was to get my hands in and feel for structures.
9. The most effective way I learn/t anatomy in the Dissecting room is/was in groups.
10. I feel the Dissecting room is a daunting environment to learn in.
11. I feel that I learned/am learning other things whilst in the Dissecting room e.g. natural variation.
12. I feel that working with Cadavers helped me to positively address the issue of death.

The third cluster of questions asks you about your learning problems

13. I find/found the amount of anatomy I need/ed to learn daunting.
14. I believe that the anatomy resources within the School of Medicine are limited.
15. I have problems learning anatomy because I don't see the point to it.
16. I have problems learning anatomy because the teaching styles do not suit me.
17. I feel course assessments do not reflect the learning that occurs.
18. My main motivation for learning anatomy is to pass exams.
19. I find anatomy learning difficult because it is memorisation based.
20. I struggle to build on my anatomy knowledge as I often forget what I learnt last semester/year/s.

The fourth cluster of questions asks you how you use anatomy at present.

21. I feel the medicine course allows me to quickly use my anatomy knowledge.
22. I have problems using my anatomy knowledge because I am not confident in my knowledge base.
23. I find that my anatomy learning informs other subject learning.
24. I find I am using anatomical terms and language at most clinical opportunities.
25. I find I use my anatomy radiology knowledge frequently in clinical situations.
26. I find I use my surface anatomy knowledge frequently in clinical situations.
27. This fifth and final cluster of questions asks you about your perceptions of anatomy.
28. I feel that I will become part of the medical profession once I can fully communicate in medical (anatomical) language.
29. I feel that understanding anatomy is a very important part of becoming a doctor.
30. I feel that working with cadaveric material is an important part of becoming a doctor.
31. My opinions of anatomy's relevance have increased as the course has progressed.
32. Because of the speciality I am interested in I feel anatomy is not of importance to me

Questions for final year only

33. I am concerned that my knowledge of anatomy is not good enough to practice safely.
34. In hindsight I would have preferred the anatomy teaching to be more spread out over the 5 years.
35. My chosen career path will mean I will need to learn more anatomy at postgraduate level.
36. In hindsight I see very clearly the importance of anatomy which I did not see in the first couple of years.

Questions for first and second years only

37. I feel that there is so much to learn and the only way to work is by trying to remember it all.
38. I feel confident about how I am supposed to be learning anatomy.
39. I am enjoying learning anatomy.

Alumni Questionnaire

Welcome to this Study into Anatomy Education

The aim of this research is to gain an understanding of how medical students and doctors in practice learn/t anatomy.

This part of the study involves you answering the following questionnaire.
Please read the Participant Information Sheet
If you would be happy to be contacted and invited to participate in an interview session and or spatial experiment please click here
Please provide the following information.
Female Male
Year of graduation
Current job

This questionnaire is divided into 4 clusters. Please answer each section as accurately as possible by either selecting the level with which you most agree or by completing the open ended questions with your own words.

Cluster 1: This cluster asks for your perceptions and experiences of anatomy during the Bachelor of Medicine course
1. I personally enjoyed my time studying anatomy
2. I preferred learning anatomy by having the structures demonstrated to me
3. I preferred learning anatomy by exploring it in my own way
4. We were given advice and instruction on the possible ways to learn anatomy
5. My motivation for learning anatomy was primarily driven by the examination structure
6. The structures and concepts which we were examined on clearly reflected the anatomy that I used as a House Officer
7. I saw clearly how anatomy would be part of clinical practice from the beginning
8. I applied my basic sciences knowledge of anatomy whilst learning it in the first 2 years of the course
9. Studying human cadaveric prosections was an effective way to learn anatomy
10. The dissecting room experience helped me deal with the issues of death
11. The dissecting room helped my learning of the language of medicine
12. The curriculum and teaching methods in anatomy suited my style of learning at the time
13. I forgot most of the anatomy I learnt in the first couple of years
14. I have a three dimensional map of the human body in my mind which I can visualise
15. From what I recall I did very well in anatomy examinations

Cluster 2: This cluster asks you about your feelings of anatomy at the time of graduation.

16. I felt I had learnt enough anatomy to practise competently
17. I found it easy to relate the anatomy we had been taught to practice (e.g. why wrist drop is a sign of radial nerve damage)
18. I only began to realise anatomy's' relevance to clinical practice when I graduated.
19. I was concerned that there was still so much anatomy I did not know
20. I felt confident that I could ask for help with my anatomy knowledge if I needed to
21. I was looking forward to learning more anatomy in my future career
22. I found details that I could not remember came back quickly and easily with a small amount of study

If you worked as a demonstrator in anatomy please explain a little bit of where, why and what you gained from it.
OPEN BOX
Cluster 3: This cluster asks you about anatomy in your current job role
If you are involved in teaching or supervising medical students please tick here BOX

23. In practice I do not see or think about anatomy as a separate subject
24. I find it easy to work though a clinical case and pick out the anatomy components
25. When working in a clinical area or whilst reading I can visualise some prosections that we worked on
26. I can visualise some anatomy drawings/diagrams that we used (e.g. the brachial plexus)

27. Please rate how often you use the anatomy you learnt at medical school in your current job role
All the time. Most days. Most weeks. Not very often
28. Please indicate how much of anatomy from what you remember being taught you feel you use over a year
Less than 30% 30-50% 50-70% More than 70%
If you had to re-learn anatomy or develop it further please state what for.
E.g. Forgot it, intricate detail relevant to a specific case, surgical or medical examinations, etc
OPEN BOX
How did you re-learn your anatomy?
Text Books, Dissecting room, Computer programmes, Lecture, Other please state
OPEN BOX
My use of anatomy is most integrated with my use of
Physiology. Pharmacology. Pathology. Radiology.
OPEN BOX
Cluster 4: This cluster asks you about some overall reflections.
29. My anatomy education was invaluable to me
30. My knowledge and interest in anatomy influenced my chosen career path
31. I struggled learning the 3 dimensional aspect of anatomy
32. I found information was conveyed into understanding when exploring specimens with my hands

I found anatomy learning was most effective through.
Practical's prosection or dissection, lectures, tutorials, self directed, Problem Based Learning or Computer Assisted Learning
OPEN BOX
I would have liked to have worked as a demonstrator in anatomy because
OPEN BOX
I find my anatomy knowledge is comparable to colleagues who studied at other medical schools
OPEN BOX
What changes would you like to see in anatomy education?
OPEN BOX
If you were not happy with your experience of anatomy please say why
OPEN BOX
If you have contact with students or junior staff, how effective do you perceive anatomy education today to be?
OPEN BOX
Please add any related comments in the space below.
Thank you
OPEN BOX

Example of Stakeholder Interview Questions

Interview schedule

History:

- Can you please describe how in your experience of teaching and learning anatomy has changed from being a student to today?
- What were your perceptions of anatomy at medical school, have they changed and how?
- How do you think anatomy education within your institution has changed?

Today:

- What would you describe as your current roles within the university?
- What would you describe as your current roles with professional bodies/other universities?
- What do you think students perceptions of anatomy are?
- What would you describe as important issues today for anatomy education, institution specific and in general?
- Do you feel there is a significant difference in graduate standards around the UK? Please explain how you perceive the consequences of this.

Teaching:

- In your experience are there particular teaching methods/styles that you have found especially effective for anatomy learning?
- Are there particular problems or issues that you experience from the student cohort in terms of knowledge and attitude?

Learning:

- How would you characterise the ways in which students learn in general and specifically to anatomy?
- If you have experience with paramedical courses are there any issues which we have discussed that are common to other courses?
- I have found that students learning of anatomy can be placed into a series of categories' depending on their learning pathway or process and that medical students are strategic learners, is this something you have experienced?

Future:

- What do you feel the future holds for anatomy in terms of curriculum, time, knowledge, technology etc?

Appendix K

Details of ASSIST T-Test used to compare the mean scores of each approach to test for significant differences between the preferred approach. (Stratn=Strategic)

1. SPSS output of T-test comparing deep and strategic approaches

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair	deep	58.5779	263	8.82747	.54433
1	stratn	56.2829	263	10.20416	.62922

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	deep & stratn	263	.302	.000

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	deep - stratn	2.29506	11.29704	.69661	.92340	3.66671	3.295	262	.001

2. SPSS output of T-test comparing deep and surface approaches

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair	deep	58.5779	263	8.82747	.54433
1	surface	44.3422	263	9.92437	.61196

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	deep & surface	263	-.395	.000

Paired Samples Test

		Paired Differences					t	df	Sig (2-tailed)
		Mean	Std Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	deep - surface	14.23574	15.67384	.96649	12.33266	16.13882	14.729	262	.000

3. SPSS output of T-test comparing strategic and surface approaches

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	stratn	56.2829	263	10.20416	.62922
	surface	44.3422	263	9.92437	.61196

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	stratn & surface	263	-.281	.000

Paired Samples Test

		Paired Differences					t	df	Sig (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std Deviation	Std. Error Mean	Lower	Upper			
Pair 1	stratn - surface	11.94068	16.11078	.99343	9.98455	13.89681	12.020	262	.000

4. SPSS output of Non-parametric test Wilcoxon Signed Rank for deep and strategic approaches, used to confirm the *t*- test results.

Ranks

		N	Mean Rank	Sum of Ranks
stratn - deep	Negative Ranks	146[a]	141.90	20718.00
	Positive Ranks	116[b]	118.41	13735.00
	Ties	1[c]		
	Total	263		

a. stratn < deep

b. stratn > deep

c. stratn = deep

Test Statistics[b]

	surface - deep
Z	-11.306[a]
Asymp. Sig. (2-tailed)	.000

a. Based on positive ranks.

b. Wilcoxon Signed Ranks Test

5. SPSS output of Non-parametric test Wilcoxon Signed Rank for deep and surface approaches, used to confirm the *t*- test results.

Ranks

		N	Mean Rank	Sum of Ranks
surface - deep	Negative Ranks	213[a]	141.13	30061.00
	Positive Ranks	44[b]	70.27	3092.00
	Ties	6[c]		
	Total	263		

a. surface < deep

b. surface > deep

c. surface = deep

Test Statistics[b]

	surface - deep
Z	-11.306[a]
Asymp. Sig. (2-tailed)	.000

a. Based on positive ranks.

b. Wilcoxon Signed Ranks Test

6. SPSS output of Non-parametric test Wilcoxon Signed Rank for strategic and surface approaches, used to confirm the *t*- test results.

Ranks

		N	Mean Rank	Sum of Ranks
surface - stratn	Negative Ranks	200[a]	147.42	29484.50
	Positive Ranks	63[b]	83.04	5231.50
	Ties	0[c]		
	Total	263		

a. surface < stratn

b. surface > stratn

c. surface = stratn

Test Statistics[b]

	surface - stratn
Z	-9.821[a]
Asymp. Sig. (2-tailed)	.000

a. Based on positive ranks.

b. Wilcoxon Signed Ranks Test

Appendix L

Details of ASSIST ANOVA Test, used to examine the differences in means of the approaches to learning from different years of study.

1. Deep approach across year of study

ANOVA

deep

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	267.676	4	66.919	.857	.490
Within Groups	18580.176	238	78.068		
Total	18847.852	242			

Multiple Comparisons

Dependent Variable: deep
LSD

		Mean Difference			95% Confidence Interval	
(I) yearofstudy	(J) yearofstudy	(I-J)	Std. Error	Sig.	Lower Bound	Upper Bound
1.00	2.00	-1.95782	1.70128	.251	-5.3093	1.3937
	3.00	.18667	1.69189	.912	-3.1463	3.5197
	4.00	1.14167	1.64171	.487	-2.0925	4.3758
	5.00	.44524	2.02220	.826	-3.5384	4.4289
2.00	1.00	1.95782	1.70128	.251	-1.3937	5.3093
	3.00	2.14449	1.77611	.228	-1.3544	5.6434
	4.00	3.09949	1.72838	.074	-.3054	6.5044
	5.00	2.40306	2.09317	.252	-1.7204	6.5266
3.00	1.00	-.18667	1.69189	.912	-3.5197	3.1463
	2.00	-2.14449	1.77611	.228	-5.6434	1.3544
	4.00	.95500	1.71914	.579	-2.4317	4.3417
	5.00	.25857	2.08555	.901	-3.8499	4.3671
4.00	1.00	-1.14167	1.64171	.487	-4.3758	2.0925
	2.00	-3.09949	1.72838	.074	-6.5044	.3054
	3.00	-.95500	1.71914	.579	-4.3417	2.4317
	5.00	-.69643	2.04505	.734	-4.7251	3.3323
5.00	1.00	-.44524	2.02220	.826	-4.4289	3.5384
	2.00	-2.40306	2.09317	.252	-6.5266	1.7204
	3.00	-.25857	2.08555	.901	-4.3671	3.8499
	4.00	.69643	2.04505	.734	-3.3323	4.7251

2. Strategic approach across year of study

ANOVA

stratn

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	995.769	4	248.942	2.425	.049
Within Groups	24434.608	238	102.666		
Total	25430.376	242			

Multiple Comparisons

Dependent Variable: stratn
LSD

(I) yearofstudy	(J) yearofstudy	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
1.00	2.00	.49361	1.95098	.800	-3.3498	4.3370
	3.00	4.04267*	1.94022	.038	.2205	7.8649
	4.00	-.99619	1.88267	.597	-4.7050	2.7126
	5.00	3.94667	2.31900	.090	-.6217	8.5151
2.00	1.00	-.49361	1.95098	.800	-4.3370	3.3498
	3.00	3.54906	2.03680	.083	-.4634	7.5615
	4.00	-1.48980	1.98206	.453	-5.3944	2.4148
	5.00	3.45306	2.40039	.152	-1.2757	8.1818
3.00	1.00	-4.04267*	1.94022	.038	-7.8649	-.2205
	2.00	-3.54906	2.03680	.083	-7.5615	.4634
	4.00	-5.03886*	1.97146	.011	-8.9226	-1.1551
	5.00	-.09600	2.39165	.968	-4.8075	4.6155
4.00	1.00	.99619	1.88267	.597	-2.7126	4.7050
	2.00	1.48980	1.98206	.453	-2.4148	5.3944
	3.00	5.03886*	1.97146	.011	1.1551	8.9226
	5.00	4.94286*	2.34521	.036	.3228	9.5629
5.00	1.00	-3.94667	2.31900	.090	-8.5151	.6217
	2.00	-3.45306	2.40039	.152	-8.1818	1.2757
	3.00	.09600	2.39165	.968	-4.6155	4.8075
	4.00	-4.94286*	2.34521	.036	-9.5629	-.3228

*. The mean difference is significant at the .05 level.

3. Surface approach across year of study

ANOVA

surface

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	592.553	4	148.138	1.584	.179
Within Groups	22255.875	238	93.512		
Total	22848.428	242			

Multiple Comparisons

Dependent Variable: surface
LSD

(I) yearofstudy	(J) yearofstudy	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
1.00	2.00	3.58537	1.86197	.055	-.0827	7.2534
	3.00	2.94333	1.85170	.113	-.7045	6.5911
	4.00	4.14405*	1.79677	.022	.6044	7.6837
	5.00	2.62619	2.21320	.237	-1.7338	6.9862
2.00	1.00	-3.58537	1.86197	.055	-7.2534	.0827
	3.00	-.64204	1.94388	.741	-4.4714	3.1874
	4.00	.55867	1.89163	.768	-3.1678	4.2852
	5.00	-.95918	2.29088	.676	-5.4722	3.5538
3.00	1.00	-2.94333	1.85170	.113	-6.5911	.7045
	2.00	.64204	1.94388	.741	-3.1874	4.4714
	4.00	1.20071	1.88152	.524	-2.5058	4.9073
	5.00	-.31714	2.28253	.890	-4.8137	4.1794
4.00	1.00	-4.14405*	1.79677	.022	-7.6837	-.6044
	2.00	-.55867	1.89163	.768	-4.2852	3.1678
	3.00	-1.20071	1.88152	.524	-4.9073	2.5058
	5.00	-1.51786	2.23821	.498	-5.9271	2.8914
5.00	1.00	-2.62619	2.21320	.237	-6.9862	1.7338
	2.00	.95918	2.29088	.676	-3.5538	5.4722
	3.00	.31714	2.28253	.890	-4.1794	4.8137
	4.00	1.51786	2.23821	.498	-2.8914	5.9271

*. The mean difference is significant at the .05 level.

Details of ASSIST Mann Whitney Test, used due to the sample being too small for an ANOVA test to test for differences in the means of the approaches to learning across the year of study in the BM 4 course.

1. Deep approach in the BM 4 and 5 courses

Ranks

	course	N	Mean Rank	Sum of Ranks
deep	4.00	19	163.79	3112.00
	5.00	243	128.98	31341.00
	Total	262		

Test Statistics[a]

	deep
Mann-Whitney U	1695.000
Wilcoxon W	31341.000
Z	-1.930
Asymp. Sig. (2-tailed)	.054

a. Grouping Variable: course

2. Strategic approach in the BM 4 and 5 courses

Ranks

	course	N	Mean Rank	Sum of Ranks
stratn	4.00	19	151.37	2876.00
	5.00	243	129.95	31577.00
	Total	262		

Test Statistics[a]

	stratn
Mann-Whitney U	1931.000
Wilcoxon W	31577.000
Z	-1.187
Asymp. Sig. (2-tailed)	.235

a. Grouping Variable: course

3. Strategic approach in the BM 4 and 5 courses

Ranks

	course	N	Mean Rank	Sum of Ranks
surface	4.00	19	88.71	1685.50
	5.00	243	134.85	32767.50
	Total	262		

Test Statistics[a]

	surface
Mann-Whitney U	1495.500
Wilcoxon W	1685.500
Z	-2.557
Asymp. Sig. (2-tailed)	.011

a. Grouping Variable: course

Details of ASSIST Kruskal Wallis Test, used to explore whether two different groups vary, i.e. between the means of the preferred approaches to learning for males and females.

1. Deep approach and gender association

Ranks

	gender	N	Mean Rank
deep	1.00	92	133.78
	2.00	151	114.82
	Total	243	

Test Statistics[a,b]

	deep
Chi-Square	4.164
df	1
Asymp. Sig.	.041

a. Kruskal Wallis Test

b. Grouping Variable: gender

2. Strategic approach and gender association

Ranks

	gender	N	Mean Rank
stratn	1.00	92	110.66
	2.00	151	128.91
	Total	243	

Test Statistics[a,b]

	stratn
Chi-Square	3.854
df	1
Asymp. Sig.	.050

a. Kruskal Wallis Test

b. Grouping Variable: gender

3. Surface approach and gender association

Ranks

	gender	N	Mean Rank
surface	1.00	92	112.20
	2.00	151	127.97
	Total	243	

Test Statistics[a,b]

	surface
Chi-Square	2.880
df	1
Asymp. Sig.	.090

a. Kruskal Wallis Test

b. Grouping Variable: gender

Details of ASSIST Pearsons Correlation Test, used to explore the correlation between the approach to learning scores and anatomy assessment scores.

1. Deep approach and correlation to total Year 1 spotter examination mark

Correlations

		deep	totalspotter
deep	Pearson Correlation	1	.080
	Sig. (2-tailed)		.244
	N	243	215
totalspotter	Pearson Correlation	.080	1
	Sig. (2-tailed)	.244	
	N	215	215

2. Strategic approach and correlation to total Year 1 spotter examination mark

Correlations

		stratn	totalspotter
stratn	Pearson Correlation	1	.266**
	Sig. (2-tailed)		.000
	N	243	215
totalspotter	Pearson Correlation	.266**	1
	Sig. (2-tailed)	.000	
	N	215	215

**. Correlation is significant at the 0.01 level (2-tailed).

3. Strategic approach and correlation to total Year 1 spotter examination mark

Correlations

		surface	totalspotter
surface	Pearson Correlation	1	-.036
	Sig. (2-tailed)		.598
	N	243	215
totalspotter	Pearson Correlation	-.036	1
	Sig. (2-tailed)	.598	
	N	215	215

Details of Spearman's Rank Correlation Test, used to explore the strength of the relationship between two variables i.e. a students response to the Likert questionnaire and their examination marks.

Appendix P

Table of results comparing: anatomy questionnaire Likert responses and total year 1 spotter examination mark.

		Q21	Q22	Q23	Q24	Q25	Q26	Q27	Q28	Q29	Q30	Q31	Q32	Q33	Q34	Q35	Q36	Q37	Q38
total	Correlation Coefficient	.208(**)	-.243(**)	.206(**)	0.075	-0.058	0.078	-0.002	0.050	0.063	0.064	0.028	0.017	.250(**)	.241(**)	-0.065	-0.103	-0.087	-0.099
	Sig. (2-tailed)	0.002	0.000	0.003	0.281	0.403	0.258	0.974	0.476	0.445	0.359	0.685	0.808	0.000	0.000	0.354	0.144	0.215	0.160
	N	210	210	210	210	210	210	209	209	209	209	209	209	209	209	203	203	203	203
Q1	Correlation Coefficient	0.025	-.177(**)	0.079	0.094	-.146(*)	0.027	0.130	0.087	0.021	-0.025	-0.115	0.070	.187(**)	.145(*)	-0.010	-0.023	-0.040	-0.058
	Sig. (2-tailed)	0.714	0.010	0.254	0.177	0.034	0.693	0.061	0.211	0.763	0.720	0.097	0.316	0.007	0.036	0.886	0.745	0.567	0.412
	N	210	210	210	210	210	210	209	209	209	209	209	209	209	209	203	203	203	203
Q2	Correlation Coefficient	0.111	-0.103	0.043	0.076	0.003	0.069	0.123	0.015	-0.061	-0.046	-0.022	0.131	-0.025	-0.034	-0.079	-0.115	-.142(*)	-0.125
	Sig. (2-tailed)	0.108	0.136	0.534	0.270	0.960	0.318	0.076	0.828	0.379	0.509	0.747	0.058	0.718	0.623	0.260	0.103	0.043	0.076
	N	210	210	210	210	210	210	209	209	209	209	209	209	209	209	203	203	203	203
Q3	Correlation Coefficient	.295(**)	-.295(**)	.159(*)	.171(*)	0.035	0.130	0.100	0.118	0.082	0.096	-0.025	0.015	.278(**)	.223(**)	-0.079	-0.107	-0.073	-0.074
	Sig. (2-tailed)	0.000	0.000	0.021	0.013	0.616	0.059	0.151	0.089	0.240	0.168	0.722	0.832	0.000	0.001	0.263	0.128	0.299	0.294
	N	210	210	210	210	210	210	209	209	209	209	209	209	209	209	203	203	203	203
Q4	Correlation Coefficient	0.127	-0.116	0.039	0.074	.336(**)	0.116	0.109	0.046	0.007	-0.012	-0.092	-.149(*)	0.014	-0.028	0.008	0.024	0.074	0.079
	Sig. (2-tailed)	0.066	0.094	0.574	0.287	0.000	0.095	0.116	0.509	0.920	0.862	0.185	0.032	0.846	0.682	0.915	0.736	0.297	0.262
	N	210	210	210	210	210	210	209	209	209	209	209	209	209	209	203	203	203	203
Q5	Correlation Coefficient	0.074	-0.018	.150(*)	-0.007	0.000	0.078	0.045	0.110	0.013	0.135	-.173(*)	-0.019	-0.045	-0.027	-0.059	-0.090	-0.065	-0.066
	Sig. (2-tailed)	0.285	0.800	0.030	0.914	0.998	0.262	0.518	0.112	0.854	0.051	0.012	0.782	0.518	0.693	0.403	0.203	0.357	0.351
	N	210	210	210	210	210	210	209	209	209	209	209	209	209	209	203	203	203	203
Q6	Correlation Coefficient	.243(**)	-.200(**)	0.107	.189(**)	.151(*)	.164(*)	0.069	.201(**)	.250(**)	.248(**)	-.229(**)	-0.092	.150(*)	.200(**)	-0.108	-0.136	-0.090	-0.099
	Sig. (2-tailed)	0.000	0.004	0.124	0.006	0.029	0.017	0.323	0.004	0.000	0.000	0.001	0.185	0.031	0.004	0.125	0.054	0.201	0.160
	N	210	210	210	210	210	210	209	209	209	209	209	209	209	209	203	203	203	203
Q7	Correlation Coefficient	0.053	0.024	0.026	0.088	.155(*)	0.089	0.002	-0.044	0.092	.160(*)	-0.110	-0.052	-0.016	-0.028	-0.002	0.010	0.004	0.021
	Sig. (2-tailed)	0.443	0.729	0.705	0.203	0.024	0.198	0.974	0.528	0.186	0.021	0.113	0.456	0.823	0.684	0.972	0.890	0.951	0.762
	N	210	210	210	210	210	210	209	209	209	209	209	209	209	209	203	203	203	203
Q8	Correlation Coefficient	.226(**)	-.142(*)	0.050	.232(**)	.147(*)	.146(*)	0.122	.283(**)	.280(**)	.246(**)	-.170(*)	-0.080	0.084	.145(*)	-0.040	-0.107	-0.063	-0.088
	Sig. (2-tailed)	0.001	0.039	0.475	0.001	0.033	0.034	0.079	0.000	0.000	0.000	0.014	0.250	0.224	0.036	0.576	0.130	0.368	0.213
	N	210	210	210	210	210	210	209	209	209	209	209	209	209	209	203	203	203	203
Q9	Correlation Coefficient	0.042	-0.061	-0.092	0.097	-0.002	0.098	-0.054	0.044	-0.017	0.068	0.023	-0.004	0.065	0.108	-0.119	-0.095	-0.105	-0.103
	Sig. (2-tailed)	0.542	0.380	0.183	0.163	0.972	0.159	0.439	0.524	0.807	0.327	0.745	0.955	0.350	0.119	0.091	0.179	0.137	0.145
	N	210	210	210	210	210	210	209	209	209	209	209	209	209	209	203	203	203	203
Q10	Correlation Coefficient	-.267(**)	.294(**)	-0.028	-.234(**)	-.156(*)	-.183(**)	0.046	-.299(**)	-.221(**)	-.308(**)	.224(**)	.216(**)	-0.072	-0.095	0.053	0.032	0.003	0.000
	Sig. (2-tailed)	0.000	0.000	0.687	0.001	0.024	0.008	0.513	0.000	0.001	0.000	0.001	0.002	0.301	0.169	0.453	0.652	0.965	0.999
	N	210	210	210	210	210	210	209	209	209	209	209	209	209	209	203	203	203	203
Q11	Correlation Coefficient	.344(**)	-.198(**)	.172(*)	.142(*)	.143(*)	.157(*)	0.065	.162(*)	.223(**)	.233(**)	-0.135	-0.089	.182(**)	.205(**)	0.049	0.039	0.095	0.083
	Sig. (2-tailed)	0.000	0.004	0.012	0.040	0.038	0.023	0.349	0.019	0.001	0.001	0.052	0.202	0.008	0.003	0.491	0.577	0.176	0.241
	N	210	210	210	210	210	210	209	209	209	209	209	209	209	209	203	203	203	203
Q12	Correlation Coefficient	.341(**)	-.180(**)	0.134	.139(*)	.167(*)	0.103	.256(**)	0.079	.254(**)	.159(*)	-0.126	0.054	.179(**)	.189(**)	0.061	0.038	0.080	0.060
	Sig. (2-tailed)	0.000	0.009	0.052	0.044	0.016	0.138	0.000	0.255	0.000	0.022	0.069	0.439	0.010	0.006	0.391	0.587	0.256	0.395
	N	210	210	210	210	210	210	209	209	209	209	209	209	209	209	203	203	203	203
Q13	Correlation Coefficient	-.363(**)	.372(**)	-.188(**)	-.208(**)	-.243(**)	-0.131	0.013	-.179(**)	-.178(**)	-.234(**)	.169(*)	.288(**)	-.149(*)	-.152(*)	0.039	0.010	-0.008	-0.011
	Sig. (2-tailed)	0.000	0.000	0.006	0.002	0.000	0.059	0.853	0.009	0.010	0.001	0.014	0.000	0.032	0.028	0.585	0.884	0.912	0.878
	N	210	210	210	210	210	210	209	209	209	209	209	209	209	209	203	203	203	203
Q14	Correlation Coefficient	-.279(**)	.252(**)	-0.065	-0.036	-0.033	-0.098	-0.091	-0.026	-0.044	-0.036	0.043	0.110	-.180(**)	-0.109	.147(*)	0.134	0.109	.148(*)
	Sig. (2-tailed)	0.000	0.000	0.346	0.605	0.630	0.156	0.188	0.712	0.524	0.601	0.536	0.111	0.009	0.115	0.036	0.056	0.120	0.035
	N	210	210	210	210	210	210	209	209	209	209	209	209	209	209	203	203	203	203
Q15	Correlation Coefficient	-.292(**)	.350(**)	-.270(**)	-.242(**)	-0.134	-.219(**)	-0.113	-.390(**)	-.212(**)	-.177(*)	.429(**)	0.106	-.229(**)	-.250(**)	0.138	0.132	0.057	0.125
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.053	0.001	0.103	0.000	0.002	0.010	0.000	0.127	0.001	0.000	0.050	0.060	0.422	0.076
	N	210	210	210	210	210	210	209	209	209	209	209	209	209	209	203	203	203	203
Q16	Correlation Coefficient	-.391(**)	.360(**)	-.159(*)	-.271(**)	-.242(**)	-.259(**)	-0.066	-.247(**)	-.147(*)	-.221(**)	.218(**)	.274(**)	-.183(**)	-.164(*)	0.128	0.094	0.039	0.074
	Sig. (2-tailed)	0.000	0.000	0.021	0.000	0.000	0.000	0.343	0.000	0.033	0.001	0.002	0.000	0.008	0.018	0.069	0.180	0.581	0.294
	N	210	210	210	210	210	210	209	209	209	209	209	209	209	209	203	203	203	203
Q17	Correlation Coefficient	-.155(*)	.272(**)	-0.129	-0.091	-.140(*)	-0.121	-0.109	-.178(**)	-.155(*)	-0.129	.151(*)	0.111	-0.081	-0.122	.161(*)	.139(*)	0.101	0.107
	Sig. (2-tailed)	0.025	0.000	0.063	0.190	0.042	0.081	0.116	0.010	0.025	0.062	0.029	0.109	0.242	0.077	0.022	0.047	0.153	0.128
	N	210	210	210	210	210	210	209	209	209	209	209	209	209	209	203	203	203	203
Q18	Correlation Coefficient	-.235(**)	.286(**)	-.212(**)	-.233(**)	-0.134	-.143(*)	-0.090	-.295(**)	-.184(**)	-.210(**)	.346(**)	.198(**)	-0.120	-.209(**)	0.114	0.107	0.067	0.111
	Sig. (2-tailed)	0.001	0.000	0.002	0.001	0.052	0.039	0.194	0.000	0.008	0.002	0.000	0.004	0.085	0.002	0.107	0.127	0.345	0.116
	N	210	210	210	210	210	210	209	209	209	209	209	209	209	209	203	203	203	203
Q19	Correlation Coefficient	-.285(**)	.363(**)	-.195(**)	-.221(**)	-.159(*)	-.200(**)	-0.108	-.223(**)	-.164(*)	-.139(*)	0.114	.250(**)	-.149(*)	-.159(*)	0.005	-0.047	-0.100	-0.043
	Sig. (2-tailed)	0.000	0.000	0.004	0.001	0.021	0.004	0.121	0.001	0.018	0.045	0.101	0.000	0.031	0.022	0.941	0.508	0.156	0.546
	N	210	210	210	210	210	210	209	209	209	209	209	209	209	209	203	203	203	203
Q20	Correlation Coefficient	-.343(**)	.582(**)	-.180(**)	-.246(**)	-0.126	-.162(*)	-0.008	-.159(*)	-0.097	-0.084	.183(**)	0.122	-.255(**)	-.257(**)	0.050	0.024	-0.039	0.013
	Sig. (2-tailed)	0.000	0.000	0.009	0.000	0.068	0.019	0.911	0.022	0.161	0.226	0.008	0.078	0.000	0.000	0.479	0.732	0.578	0.852
	N	210	210	210	210	210	210	209	209	209	209	209	209	209	209	203	203	203	203
Q21	Correlation Coefficient	1.000	-.329(**)	.304(**)	.297(**)	.223(**)	.264(**)	.222(**)	.271(**)	.251(**)	0.086	-0.114	-0.049	.311(**)	.264(**)	0.037	0.025	0.057	0.043
	Sig. (2-tailed)		0.000	0.000	0.000	0.001	0.000	0.001	0.000	0.000	0.216	0.101	0.479	0.000	0.000	0.598	0.725	0.418	0.547
	N	210	210	210	210	210	210	209	209	209	209	209	209	209	209	203	203	203	203
Q22	Correlation Coefficient	-.329(**)	1.000	-.174(*)	-.244(**)	-0.016	-0.114	0.008	-0.093	-0.103	-0.067	0.115	0.005	-.339(**)	-.310(**)	0.006	-0.025	-0.088	-0.049
	Sig. (2-tailed)	0.000		0.011	0.000	0.816	0.098	0.913	0.180	0.137	0.335	0.098	0.941	0.000	0.000	0.936	0.719	0.211	0.491
	N	210	210	210	210	210	210	209	209	209	209	209	209	209	209	203	203	203	203
Q23	Correlation Coefficient	.304(**)	-.174(*)	1.000	.225(**)	0.135	.191(**)	0.041	.250(**)	.165(*)	.140(*)	-.308(**)	-0.097	0.129	.148(*)	0.034	-0.015	0.032	0.014
	Sig. (2-tailed)	0.000	0.011		0.001	0.051	0.005	0.554	0.000	0.017	0.043	0.000	0.165	0.062	0.032	0.625	0.835	0.652	0.845
	N	210	210	210	210	210	210	209	209	209	209	209	209	209	209	203	203	203	203
Q24	Correlation Coefficient	.297(**)	-.244(**)	.225(**)	1.000	.192(**)	.228(**)	.173(*)	.256(**)	.205(**)	0.082	-.234(**)	-0.102	0.110	0.102	0.075	0.083	0.127	0.108
	Sig. (2-tailed)	0.000	0.000	0.001		0.005	0.001	0.012	0.000	0.003	0.240	0.001	0.142	0.111	0.140	0.287	0.240	0.070	0.125
	N	210	210	210	210	210	210	209	209	209	209	209	209	209	209	203	203	203	203
Q25	Correlation Coefficient	.223(**)	-0.016	0.135	.192(**)	1.000	.337(**)	0.109	0.076	0.090	.187(**)	-0.064	-.295(**)	-0.085	-0.094	0.018	0.078	0.112	0.105
	Sig. (2-tailed)	0.001	0.816	0.051	0.005		0.000	0.115	0.272	0.195	0.007	0.359	0.000	0.221	0.174	0.798	0.271	0.111	0.136
	N	210	210	210	210	210	210	209	209	209	209	209	209	209	209	203	203	203	203
Q26	Correlation Coefficient	.264(**)	-0.114	.191(**)	.228(**)	.337(**)	1.000	0.074	0.127	.156(*)	0.097	-0.135	-0.089	0.106	0.100	0.038	0.012	0.077	0.050
	Sig. (2-tailed)	0.000	0.098	0.005	0.001	0.000		0.289	0.067	0.024	0.163	0.051	0.201	0.125	0.150	0.591	0.861	0.275	0.477
	N	210	210	210	210	210	210	209	209	209	209	209	209	209	209	203	203	203	203
Q27	Correlation Coefficient	.222(**)	0.008	0.041	.173(*)	0.109	0.074	1.000	.229(**)	.209(**)	0.093	-.140(*)	0.067	0.059	0.065	0.087	0.063	0.095	0.068
	Sig. (2-tailed)	0.001	0.913	0.554	0.012	0.115	0.289		0.001	0.002	0.181	0.043	0.338	0.392	0.352	0.219	0.370	0.176	0.338
	N	209	209	209	209	209	209	209	209	209	209	209	209	209	209	203	203	203	203
Q28	Correlation Coefficient	.271(**)	-0.093	.250(**)	.256(**)	0.076	0.127	.229(**)	1.000	.445(**)	.265(**)	-.373(**)	-0.059	0.038	0.087	-0.065	-0.090	-0.057	-0.089
	Sig. (2-tailed)	0.000	0.180	0.000	0.000	0.272	0.067	0.001		0.000	0.000	0.000	0.396	0.585	0.210	0.355	0.204	0.421	0.207
	N	209	209	209	209	209	209	209	209	209	209	209	209	209	209	203	203	203	203
Q29	Correlation Coefficient	.251(**)	-0.103	.165(*)	.205(**)	0.090	.156(*)	.209(**)	.445(**)	1.000	.271(**)	-.283(**)	0.006	0.009	0.077	0.021	-0.011	0.044	0.031
	Sig. (2-tailed)	0.000	0.137	0.017	0.003	0.195	0.024	0.002	0.000		0.000	0.000	0.929	0.898	0.267	0.762	0.877	0.532	0.665
	N	209	209	209	209	209	209	209	209	209	209	209	209	209	209	203	203	203	203
Q30	Correlation Coefficient	0.086	-0.067	.140(*)	0.082	.187(**)	0.097	0.093	.265(**)	.271(**)	1.000	-.266(**)	-0.092	-0.014	0.031	0.010	0.016	0.057	0.071
	Sig. (2-tailed)	0.216	0.335	0.043	0.240	0.007	0.163	0.181	0.000	0.000		0.000	0.185	0.846	0.657	0.892	0.825	0.418	0.315
	N	209	209	209	209	209	209	209	209	209	209	209	209	209	209	203	203	203	203
Q31	Correlation Coefficient	-0.114	0.115	-.308(**)	-.234(**)	-0.064	-0.135	-.140(*)	-.373(**)	-.283(**)	-.266(**)	1.000	0.132	-0.032	-0.053	-0.060	-0.058	-0.107	-0.072
	Sig. (2-tailed)	0.101	0.098	0.000	0.001	0.359	0.051	0.043	0.000	0.000	0.000		0.057	0.641	0.442	0.397	0.414	0.129	0.305
	N	209	209	209	209	209	209	209	209	209	209	209	209	209	209	203	203	203	203
Q32	Correlation Coefficient	-0.049	0.005	-0.097	-0.102	-.295(**)	-0.089	0.067	-0.059	0.006	-0.092	0.132	1.000	.513(**)	.532(**)	.146(*)	0.106	0.093	0.089
	Sig. (2-tailed)	0.479	0.941	0.165	0.142	0.000	0.201	0.338	0.396	0.929	0.185	0.057		0.000	0.000	0.038	0.133	0.188	0.208
	N	209	209	209	209	209	209	209	209	209	209	209	209	209	209	203	203	203	203
Q33	Correlation Coefficient	.311(**)	-.339(**)	0.129	0.110	-0.085	0.106	0.059	0.038	0.009	-0.014	-0.032	.513(**)	1.000	.852(**)	0.120	0.106	.166(*)	0.126
	Sig. (2-tailed)	0.000	0.000	0.062	0.111	0.221	0.125	0.392	0.585	0.898	0.846	0.641	0.000		0.000	0.089	0.132	0.018	0.073
	N	209	209	209	209	209	209	209	209	209	209	209	209	209	209	203	203	203	203
Q34	Correlation Coefficient	.264(**)	-.310(**)	.148(*)	0.102	-0.094	0.100	0.065	0.087	0.077	0.031	-0.053	.532(**)	.852(**)	1.000	.139(*)	0.123	.169(*)	0.122
	Sig. (2-tailed)	0.000	0.000	0.032	0.140	0.174	0.150	0.352	0.210	0.267	0.657	0.442	0.000	0.000		0.048	0.081	0.016	0.083
	N	209	209	209	209	209	209	209	209	209	209	209	209	209	209	203	203	203	203
Q35	Correlation Coefficient	0.037	0.006	0.034	0.075	0.018	0.038	0.087	-0.065	0.021	0.010	-0.060	.146(*)	0.120	.139(*)	1.000	.931(**)	.903(**)	.903(**)
	Sig. (2-tailed)	0.598	0.936	0.625	0.287	0.798	0.591	0.219	0.355	0.762	0.892	0.397	0.038	0.089	0.048		0.000	0.000	0.000
	N	203	203	203	203	203	203	203	203	203	203	203	203	203	203	203	203	203	203
Q36	Correlation Coefficient	0.025	-0.025	-0.015	0.083	0.078	0.012	0.063	-0.090	-0.011	0.016	-0.058	0.106	0.106	0.123	.931(**)	1.000	.948(**)	.937(**)
	Sig. (2-tailed)	0.725	0.719	0.835	0.240	0.271	0.861	0.370	0.204	0.877	0.825	0.414	0.133	0.132	0.081	0.000		0.000	0.000
	N	203	203	203	203	203	203	203	203	203	203	203	203	203	203	203	203	203	203
Q37	Correlation Coefficient	0.057	-0.088	0.032	0.127	0.112	0.077	0.095	-0.057	0.044	0.057	-0.107	0.093	.166(*)	.169(*)	.903(**)	.948(**)	1.000	.948(**)
	Sig. (2-tailed)	0.418	0.211	0.652	0.070	0.111	0.275	0.176	0.421	0.532	0.418	0.129	0.188	0.018	0.016	0.000	0.000		0.000
	N	203	203	203	203	203	203	203	203	203	203	203	203	203	203	203	203	203	203
Q38	Correlation Coefficient	0.043	-0.049	0.014	0.108	0.105	0.050	0.068	-0.089	0.031	0.071	-0.072	0.089	0.126	0.122	.903(**)	.937(**)	.948(**)	1.000
	Sig. (2-tailed)	0.547	0.491	0.845	0.125	0.136	0.477	0.338	0.207	0.665	0.315	0.305	0.208	0.073	0.083	0.000	0.000	0.000	
	N	203	203	203	203	203	203	203	203	203	203	203	203	203	203	203	203	203	203

Appendix P

		total	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20
total	Correlation Coefficient	1.000	.137(*)	.139(*)	.260(**)	-0.037	0.099	.193(**)	-0.038	0.011	0.037	-0.074	.140(*)	0.122	-.260(**)	-0.066	-.180(**)	-.159(*)	-.175(*)	-0.058	-.258(**)	-.210(**)
	Sig. (2-tailed)		0.048	0.044	0.000	0.593	0.154	0.005	0.587	0.870	0.592	0.289	0.042	0.078	0.000	0.345	0.009	0.021	0.011	0.403	0.000	0.002
	N	215	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210
Q1	Correlation Coefficient	.137(*)	1.000	.219(**)	.226(**)	-0.046	0.049	0.097	-0.044	0.069	0.058	0.050	0.089	0.007	-0.101	-0.065	-.160(*)	-0.045	-0.005	-0.114	-.191(**)	-.176(*)
	Sig. (2-tailed)	0.048		0.001	0.001	0.504	0.484	0.162	0.529	0.318	0.404	0.470	0.200	0.922	0.146	0.352	0.021	0.520	0.948	0.100	0.005	0.011
	N	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210
Q2	Correlation Coefficient	.139(*)	.219(**)	1.000	.191(**)	0.069	.155(*)	-0.054	-0.033	-0.054	0.048	0.035	-0.074	0.002	-0.022	-0.006	-0.117	-0.010	-0.078	0.008	-0.020	-0.076
	Sig. (2-tailed)	0.044	0.001		0.005	0.318	0.024	0.434	0.639	0.438	0.486	0.610	0.283	0.980	0.757	0.934	0.090	0.880	0.261	0.905	0.770	0.271
	N	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210
Q3	Correlation Coefficient	.260(**)	.226(**)	.191(**)	1.000	0.023	.151(*)	.291(**)	-0.018	.208(**)	0.076	-.293(**)	.189(**)	.162(*)	-.282(**)	-.332(**)	-.297(**)	-.430(**)	-.340(**)	-.146(*)	-.235(**)	-.304(**)
	Sig. (2-tailed)	0.000	0.001	0.005		0.743	0.028	0.000	0.798	0.002	0.272	0.000	0.006	0.019	0.000	0.000	0.000	0.000	0.000	0.034	0.001	0.000
	N	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210
Q4	Correlation Coefficient	-0.037	-0.046	0.069	0.023	1.000	-0.002	0.135	0.056	.174(*)	0.030	-.144(*)	.141(*)	0.076	-0.113	-0.039	-.160(*)	-.159(*)	-.159(*)	-.234(**)	-.136(*)	-.196(**)
	Sig. (2-tailed)	0.593	0.504	0.318	0.743		0.977	0.051	0.419	0.011	0.664	0.038	0.041	0.275	0.103	0.577	0.020	0.021	0.021	0.001	0.048	0.004
	N	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210
Q5	Correlation Coefficient	0.099	0.049	.155(*)	.151(*)	-0.002	1.000	.246(**)	0.074	0.134	0.088	-0.133	0.115	0.017	0.008	-0.096	-.183(**)	-0.104	-.203(**)	-0.017	-0.008	-0.007
	Sig. (2-tailed)	0.154	0.484	0.024	0.028	0.977		0.000	0.283	0.052	0.203	0.055	0.097	0.801	0.913	0.165	0.008	0.131	0.003	0.803	0.907	0.914
	N	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210
Q6	Correlation Coefficient	.193(**)	0.097	-0.054	.291(**)	0.135	.246(**)	1.000	0.107	.533(**)	0.120	-.436(**)	.297(**)	.261(**)	-.277(**)	-.314(**)	-.380(**)	-.504(**)	-.253(**)	-.276(**)	-.258(**)	-.263(**)
	Sig. (2-tailed)	0.005	0.162	0.434	0.000	0.051	0.000		0.123	0.000	0.082	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	N	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210
Q7	Correlation Coefficient	-0.038	-0.044	-0.033	-0.018	0.056	0.074	0.107	1.000	0.009	-0.009	-0.061	0.032	0.082	-0.109	-0.029	0.021	-0.094	0.065	0.089	0.061	0.012
	Sig. (2-tailed)	0.587	0.529	0.639	0.798	0.419	0.283	0.123		0.900	0.899	0.379	0.648	0.237	0.117	0.678	0.766	0.176	0.347	0.201	0.383	0.863
	N	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210
Q8	Correlation Coefficient	0.011	0.069	-0.054	.208(**)	.174(*)	0.134	.533(**)	0.009	1.000	0.046	-.382(**)	.184(**)	.223(**)	-.238(**)	-0.031	-.275(**)	-.298(**)	-0.093	-.357(**)	-.182(**)	-.247(**)
	Sig. (2-tailed)	0.870	0.318	0.438	0.002	0.011	0.052	0.000	0.900		0.504	0.000	0.008	0.001	0.001	0.651	0.000	0.000	0.177	0.000	0.008	0.000
	N	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210
Q9	Correlation Coefficient	0.037	0.058	0.048	0.076	0.030	0.088	0.120	-0.009	0.046	1.000	-0.030	0.075	-0.030	-0.050	-0.135	-0.068	-.166(*)	-0.108	-0.074	-0.065	-0.066
	Sig. (2-tailed)	0.592	0.404	0.486	0.272	0.664	0.203	0.082	0.899	0.504		0.670	0.282	0.665	0.475	0.052	0.329	0.016	0.118	0.287	0.348	0.338
	N	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210
Q10	Correlation Coefficient	-0.074	0.050	0.035	-.293(**)	-.144(*)	-0.133	-.436(**)	-0.061	-.382(**)	-0.030	1.000	-.242(**)	-.190(**)	.362(**)	0.111	.393(**)	.457(**)	.252(**)	.353(**)	.347(**)	.292(**)
	Sig. (2-tailed)	0.289	0.470	0.610	0.000	0.038	0.055	0.000	0.379	0.000	0.670		0.000	0.006	0.000	0.110	0.000	0.000	0.000	0.000	0.000	0.000
	N	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210
Q11	Correlation Coefficient	.140(*)	0.089	-0.074	.189(**)	.141(*)	0.115	.297(**)	0.032	.184(**)	0.075	-.242(**)	1.000	.269(**)	-.285(**)	-.177(*)	-.266(**)	-.360(**)	-.136(*)	-.254(**)	-.187(**)	-.278(**)
	Sig. (2-tailed)	0.042	0.200	0.283	0.006	0.041	0.097	0.000	0.648	0.008	0.282	0.000		0.000	0.000	0.010	0.000	0.000	0.048	0.000	0.007	0.000
	N	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210
Q12	Correlation Coefficient	0.122	0.007	0.002	.162(*)	0.076	0.017	.261(**)	0.082	.223(**)	-0.030	-.190(**)	.269(**)	1.000	-.229(**)	-.202(**)	-.144(*)	-.239(**)	-.137(*)	-.147(*)	-.175(*)	-0.090
	Sig. (2-tailed)	0.078	0.922	0.980	0.019	0.275	0.801	0.000	0.237	0.001	0.665	0.006	0.000		0.001	0.003	0.037	0.000	0.047	0.034	0.011	0.195
	N	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210
Q13	Correlation Coefficient	-.260(**)	-0.101	-0.022	-.282(**)	-0.113	0.008	-.277(**)	-0.109	-.238(**)	-0.050	.362(**)	-.285(**)	-.229(**)	1.000	.313(**)	.385(**)	.516(**)	.303(**)	.464(**)	.504(**)	.526(**)
	Sig. (2-tailed)	0.000	0.146	0.757	0.000	0.103	0.913	0.000	0.117	0.001	0.475	0.000	0.000	0.001		0.000	0.000	0.000	0.000	0.000	0.000	0.000
	N	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210
Q14	Correlation Coefficient	-0.066	-0.065	-0.006	-.332(**)	-0.039	-0.096	-.314(**)	-0.029	-0.031	-0.135	0.111	-.177(*)	-.202(**)	.313(**)	1.000	.216(**)	.578(**)	.391(**)	.210(**)	.229(**)	.325(**)
	Sig. (2-tailed)	0.345	0.352	0.934	0.000	0.577	0.165	0.000	0.678	0.651	0.052	0.110	0.010	0.003	0.000		0.002	0.000	0.000	0.002	0.001	0.000
	N	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210
Q15	Correlation Coefficient	-.180(**)	-.160(*)	-0.117	-.297(**)	-.160(*)	-.183(**)	-.380(**)	0.021	-.275(**)	-0.068	.393(**)	-.266(**)	-.144(*)	.385(**)	.216(**)	1.000	.423(**)	.259(**)	.576(**)	.407(**)	.402(**)
	Sig. (2-tailed)	0.009	0.021	0.090	0.000	0.020	0.008	0.000	0.766	0.000	0.329	0.000	0.000	0.037	0.000	0.002		0.000	0.000	0.000	0.000	0.000
	N	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210
Q16	Correlation Coefficient	-.159(*)	-0.045	-0.010	-.430(**)	-.159(*)	-0.104	-.504(**)	-0.094	-.298(**)	-.166(*)	.457(**)	-.360(**)	-.239(**)	.516(**)	.578(**)	.423(**)	1.000	.398(**)	.434(**)	.379(**)	.431(**)
	Sig. (2-tailed)	0.021	0.520	0.880	0.000	0.021	0.131	0.000	0.176	0.000	0.016	0.000	0.000	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.000
	N	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210
Q17	Correlation Coefficient	-.175(*)	-0.005	-0.078	-.340(**)	-.159(*)	-.203(**)	-.253(**)	0.065	-0.093	-0.108	.252(**)	-.136(*)	-.137(*)	.303(**)	.391(**)	.259(**)	.398(**)	1.000	.274(**)	.276(**)	.306(**)
	Sig. (2-tailed)	0.011	0.948	0.261	0.000	0.021	0.003	0.000	0.347	0.177	0.118	0.000	0.048	0.047	0.000	0.000	0.000	0.000		0.000	0.000	0.000
	N	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210
Q18	Correlation Coefficient	-0.058	-0.114	0.008	-.146(*)	-.234(**)	-0.017	-.276(**)	0.089	-.357(**)	-0.074	.353(**)	-.254(**)	-.147(*)	.464(**)	.210(**)	.576(**)	.434(**)	.274(**)	1.000	.439(**)	.474(**)
	Sig. (2-tailed)	0.403	0.100	0.905	0.034	0.001	0.803	0.000	0.201	0.000	0.287	0.000	0.000	0.034	0.000	0.002	0.000	0.000	0.000		0.000	0.000
	N	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210
Q19	Correlation Coefficient	-.258(**)	-.191(**)	-0.020	-.235(**)	-.136(*)	-0.008	-.258(**)	0.061	-.182(**)	-0.065	.347(**)	-.187(**)	-.175(*)	.504(**)	.229(**)	.407(**)	.379(**)	.276(**)	.439(**)	1.000	.537(**)
	Sig. (2-tailed)	0.000	0.005	0.770	0.001	0.048	0.907	0.000	0.383	0.008	0.348	0.000	0.007	0.011	0.000	0.001	0.000	0.000	0.000	0.000		0.000
	N	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210
Q20	Correlation Coefficient	-.210(**)	-.176(*)	-0.076	-.304(**)	-.196(**)	-0.007	-.263(**)	0.012	-.247(**)	-0.066	.292(**)	-.278(**)	-0.090	.526(**)	.325(**)	.402(**)	.431(**)	.306(**)	.474(**)	.537(**)	1.000
	Sig. (2-tailed)	0.002	0.011	0.271	0.000	0.004	0.914	0.000	0.863	0.000	0.338	0.000	0.000	0.195	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
	N	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210
Q21	Correlation Coefficient	.208(**)	0.025	0.111	.295(**)	0.127	0.074	.243(**)	0.053	.226(**)	0.042	-.267(**)	.344(**)	.341(**)	-.363(**)	-.279(**)	-.292(**)	-.391(**)	-.155(*)	-.235(**)	-.285(**)	-.343(**)
	Sig. (2-tailed)	0.002	0.714	0.108	0.000	0.066	0.285	0.000	0.443	0.001	0.542	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.025	0.001	0.000	0.000
	N	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210
Q22	Correlation Coefficient	-.243(**)	-.177(*)	-0.103	-.295(**)	-0.116	-0.018	-.200(**)	0.024	-.142(*)	-0.061	.294(**)	-.198(**)	-.180(**)	.372(**)	.252(**)	.350(**)	.360(**)	.272(**)	.286(**)	.363(**)	.582(**)
	Sig. (2-tailed)	0.000	0.010	0.136	0.000	0.094	0.800	0.004	0.729	0.039	0.380	0.000	0.004	0.009	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	N	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210
Q23	Correlation Coefficient	.206(**)	0.079	0.043	.159(*)	0.039	.150(*)	0.107	0.026	0.050	-0.092	-0.028	.172(*)	0.134	-.188(**)	-0.065	-.270(**)	-.159(*)	-0.129	-.212(**)	-.195(**)	-.180(**)
	Sig. (2-tailed)	0.003	0.254	0.534	0.021	0.574	0.030	0.124	0.705	0.475	0.183	0.687	0.012	0.052	0.006	0.346	0.000	0.021	0.063	0.002	0.004	0.009
	N	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210
Q24	Correlation Coefficient	0.075	0.094	0.076	.171(*)	0.074	-0.007	.189(**)	0.088	.232(**)	0.097	-.234(**)	.142(*)	.139(*)	-.208(**)	-0.036	-.242(**)	-.271(**)	-0.091	-.233(**)	-.221(**)	-.246(**)
	Sig. (2-tailed)	0.281	0.177	0.270	0.013	0.287	0.914	0.006	0.203	0.001	0.163	0.001	0.040	0.044	0.002	0.605	0.000	0.000	0.190	0.001	0.001	0.000
	N	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210
Q25	Correlation Coefficient	-0.058	-.146(*)	0.003	0.035	.336(**)	0.000	.151(*)	.155(*)	.147(*)	-0.002	-.156(*)	.143(*)	.167(*)	-.243(**)	-0.033	-0.134	-.242(**)	-.140(*)	-0.134	-.159(*)	-0.126
	Sig. (2-tailed)	0.403	0.034	0.960	0.616	0.000	0.998	0.029	0.024	0.033	0.972	0.024	0.038	0.016	0.000	0.630	0.053	0.000	0.042	0.052	0.021	0.068
	N	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210
Q26	Correlation Coefficient	0.078	0.027	0.069	0.130	0.116	0.078	.164(*)	0.089	.146(*)	0.098	-.183(**)	.157(*)	0.103	-0.131	-0.098	-.219(**)	-.259(**)	-0.121	-.143(*)	-.200(**)	-.162(*)
	Sig. (2-tailed)	0.258	0.693	0.318	0.059	0.095	0.262	0.017	0.198	0.034	0.159	0.008	0.023	0.138	0.059	0.156	0.001	0.000	0.081	0.039	0.004	0.019
	N	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210
Q27	Correlation Coefficient	-0.002	0.130	0.123	0.100	0.109	0.045	0.069	0.002	0.122	-0.054	0.046	0.065	.256(**)	0.013	-0.091	-0.113	-0.066	-0.109	-0.090	-0.108	-0.008
	Sig. (2-tailed)	0.974	0.061	0.076	0.151	0.116	0.518	0.323	0.974	0.079	0.439	0.513	0.349	0.000	0.853	0.188	0.103	0.343	0.116	0.194	0.121	0.911
	N	209	209	209	209	209	209	209	209	209	209	209	209	209	209	209	209	209	209	209	209	209
Q28	Correlation Coefficient	0.050	0.087	0.015	0.118	0.046	0.110	.201(**)	-0.044	.283(**)	0.044	-.299(**)	.162(*)	0.079	-.179(**)	-0.026	-.390(**)	-.247(**)	-.178(**)	-.295(**)	-.223(**)	-.159(*)
	Sig. (2-tailed)	0.476	0.211	0.828	0.089	0.509	0.112	0.004	0.528	0.000	0.524	0.000	0.019	0.255	0.009	0.712	0.000	0.000	0.010	0.000	0.001	0.022
	N	209	209	209	209	209	209	209	209	209	209	209	209	209	209	209	209	209	209	209	209	209
Q29	Correlation Coefficient	0.053	0.021	-0.061	0.082	0.007	0.013	.250(**)	0.092	.280(**)	-0.017	-.221(**)	.223(**)	.254(**)	-.178(**)	-0.044	-.212(**)	-.147(*)	-.155(*)	-.184(**)	-.164(*)	-0.097
	Sig. (2-tailed)	0.445	0.763	0.379	0.240	0.920	0.854	0.000	0.186	0.000	0.807	0.001	0.001	0.000	0.010	0.524	0.002	0.033	0.025	0.008	0.018	0.161
	N	209	209	209	209	209	209	209	209	209	209	209	209	209	209	209	209	209	209	209	209	209
Q30	Correlation Coefficient	0.064	-0.025	-0.046	0.096	-0.012	0.135	.248(**)	.160(*)	.246(**)	0.068	-.308(**)	.233(**)	.159(*)	-.234(**)	-0.036	-.177(*)	-.221(**)	-0.129	-.210(**)	-.139(*)	-0.084
	Sig. (2-tailed)	0.359	0.720	0.509	0.168	0.862	0.051	0.000	0.021	0.000	0.327	0.000	0.001	0.022	0.001	0.601	0.010	0.001	0.062	0.002	0.045	0.226
	N	209	209	209	209	209	209	209	209	209	209	209	209	209	209	209	209	209	209	209	209	209
Q31	Correlation Coefficient	0.028	-0.115	-0.022	-0.025	-0.092	-.173(*)	-.229(**)	-0.110	-.170(*)	0.023	.224(**)	-0.135	-0.126	.169(*)	0.043	.429(**)	.218(**)	.151(*)	.346(**)	0.114	.183(**)
	Sig. (2-tailed)	0.685	0.097	0.747	0.722	0.185	0.012	0.001	0.113	0.014	0.745	0.001	0.052	0.069	0.014	0.536	0.000	0.002	0.029	0.000	0.101	0.008
	N	209	209	209	209	209	209	209	209	209	209	209	209	209	209	209	209	209	209	209	209	209
Q32	Correlation Coefficient	0.017	0.070	0.131	0.015	-.149(*)	-0.019	-0.092	-0.052	-0.080	-0.004	.216(**)	-0.089	0.054	.288(**)	0.110	0.106	.274(**)	0.111	.198(**)	.250(**)	0.122
	Sig. (2-tailed)	0.808	0.316	0.058	0.832	0.032	0.782	0.185	0.456	0.250	0.955	0.002	0.202	0.439	0.000	0.111	0.127	0.000	0.109	0.004	0.000	0.078
	N	209	209	209	209	209	209	209	209	209	209	209	209	209	209	209	209	209	209	209	209	209
Q33	Correlation Coefficient	.250(**)	.187(**)	-0.025	.278(**)	0.014	-0.045	.150(*)	-0.016	0.084	0.065	-0.072	.182(**)	.179(**)	-.149(*)	-.180(**)	-.229(**)	-.183(**)	-0.081	-0.120	-.149(*)	-.255(**)
	Sig. (2-tailed)	0.000	0.007	0.718	0.000	0.846	0.518	0.031	0.823	0.224	0.350	0.301	0.008	0.010	0.032	0.009	0.001	0.008	0.242	0.085	0.031	0.000
	N	209	209	209	209	209	209	209	209	209	209	209	209	209	209	209	209	209	209	209	209	209
Q34	Correlation Coefficient	.241(**)	.145(*)	-0.034	.223(**)	-0.028	-0.027	.200(**)	-0.028	.145(*)	0.108	-0.095	.205(**)	.189(**)	-.152(*)	-0.109	-.250(**)	-.164(*)	-0.122	-.209(**)	-.159(*)	-.257(**)
	Sig. (2-tailed)	0.000	0.036	0.623	0.001	0.682	0.693	0.004	0.684	0.036	0.119	0.169	0.003	0.006	0.028	0.115	0.000	0.018	0.077	0.002	0.022	0.000
	N	209	209	209	209	209	209	209	209	209	209	209	209	209	209	209	209	209	209	209	209	209
Q35	Correlation Coefficient	-0.065	-0.010	-0.079	-0.079	0.008	-0.059	-0.108	-0.002	-0.040	-0.119	0.053	0.049	0.061	0.039	.147(*)	0.138	0.128	.161(*)	0.114	0.005	0.050
	Sig. (2-tailed)	0.354	0.886	0.260	0.263	0.915	0.403	0.125	0.972	0.578	0.091	0.453	0.491	0.391	0.585	0.036	0.050	0.069	0.022	0.107	0.941	0.479
	N	203	203	203	203	203	203	203	203	203	203	203	203	203	203	203	203	203	203	203	203	203
Q36	Correlation Coefficient	-0.103	-0.023	-0.115	-0.107	0.024	-0.090	-0.136	0.010	-0.107	-0.095	0.032	0.039	0.038	0.010	0.134	0.132	0.094	.139(*)	0.107	-0.047	0.024
	Sig. (2-tailed)	0.144	0.745	0.103	0.128	0.736	0.203	0.054	0.890	0.130	0.179	0.652	0.577	0.587	0.884	0.056	0.060	0.180	0.047	0.127	0.508	0.732
	N	203	203	203	203	203	203	203	203	203	203	203	203	203	203	203	203	203	203	203	203	203
Q37	Correlation Coefficient	-0.087	-0.040	-.142(*)	-0.073	0.074	-0.065	-0.090	0.004	-0.063	-0.105	0.003	0.095	0.080	-0.008	0.109	0.057	0.039	0.101	0.067	-0.100	-0.039
	Sig. (2-tailed)	0.215	0.567	0.043	0.299	0.297	0.357	0.201	0.951	0.368	0.137	0.965	0.176	0.256	0.912	0.120	0.422	0.581	0.153	0.345	0.156	0.578
	N	203	203	203	203	203	203	203	203	203	203	203	203	203	203	203	203	203	203	203	203	203
Q38	Correlation Coefficient	-0.099	-0.058	-0.125	-0.074	0.079	-0.066	-0.099	0.021	-0.088	-0.103	0.000	0.083	0.060	-0.011	.148(*)	0.125	0.074	0.107	0.111	-0.043	0.013
	Sig. (2-tailed)	0.160	0.412	0.076	0.294	0.262	0.351	0.160	0.762	0.213	0.145	0.999	0.241	0.395	0.878	0.035	0.076	0.294	0.128	0.116	0.546	0.852
	N	203	203	203	203	203	203	203	203	203	203	203	203	203	203	203	203	203	203	203	203	203

Appendix Q

Details of Pearsons Correlations tests, used to explore the correlation between year of study and the response to the Likert questionnaire.

	anatomy1	anatomy2	anatomy3	anatomy4	anatomy5	anatomy6
Chi-Square	20.872	6.049	4.841	3.734	15.659	8.531
df	4	4	4	4	4	4
Asymp. Sig.	0.000	0.196	0.304	0.443	0.004	0.074

	anatomy7	anatomy8	anatomy9	anatomy10	anatomy11	anatomy12
Chi-Square	5.350	1.999	4.625	2.997	0.385	3.912
df	4	4	4	4	4	4
Asymp. Sig.	0.253	0.736	0.328	0.558	0.984	0.418

	anatomy13	anatomy14	anatomy15	anatomy16	anatomy17	anatomy18
Chi-Square	0.934	6.345	13.501	2.577	9.742	8.561
df	4	4	4	4	4	4
Asymp. Sig.	0.920	0.175	0.009	0.631	0.045	0.073

	anatomy19	anatomy20	anatomy21	anatomy22	anatomy23	anatomy24
Chi-Square	2.191	19.569	9.836	21.366	5.053	7.003
df	4	4	4	4	4	4
Asymp. Sig.	0.701	0.001	0.043	0.000	0.282	0.136

	anatomy25	anatomy26	anatomy27	anatomy28	anatomy29	anatomy30
Chi-Square	37.135	1.883	6.336	4.979	2.341	11.709
df	4	4	4	4	4	4
Asymp. Sig.	0.000	0.757	0.175	0.289	0.673	0.020

	anatomy31
Chi-Square	4.683
df	4
Asymp. Sig.	0.321

Jonckheere-Terpstra and Kruskal Wallis Tests *Appendix Q*

	anatomy1	anatomy2	anatomy3	anatomy4	anatomy5	anatomy6
No. Levels yearofstudy	5	5	5	5	5	5
N	257	257	257	257	257	257
Observed J-T Statistic	10,962.500	11,798.000	11,784.500	13,357.000	13,319.000	12,823.500
Mean J-T Statistic	12,978.000	12,978.000	12,978.000	12,978.000	12,978.000	12,978.000
Std. Deviation	621.941	642.207	633.006	644.796	599.538	601.216
Std. J-T Statistic	-3.241	-1.837	-1.885	0.588	0.569	-0.257
Asymp. Sig. (2-tailed)	0.001	0.066	0.059	0.557	0.570	0.797

	anatomy7	anatomy8	anatomy9	anatomy10	anatomy11	anatomy12
No. Levels yearofstudy	5	5	5	5	5	5
N	257	256	256	256	256	256
Observed J-T Statistic	13,986.000	12,314.500	12,649.500	12,851.000	13,214.000	12,818.000
Mean J-T Statistic	12,978.000	12,876.500	12,876.500	12,876.500	12,876.500	12,876.500
Std. Deviation	621.814	629.227	626.530	633.100	612.904	647.114
Std. J-T Statistic	1.621	-0.893	-0.362	-0.040	0.551	-0.090
Asymp. Sig. (2-tailed)	0.105	0.372	0.717	0.968	0.582	0.928

	anatomy13	anatomy14	anatomy15	anatomy16	anatomy17	anatomy18
No. Levels yearofstudy	5	5	5	5	5	5
N	255	255	255	255	255	255
Observed J-T Statistic	12,849.000	14,025.500	14,779.500	12,199.000	13,355.000	14,194.000
Mean J-T Statistic	12,776.500	12,776.500	12,776.500	12,776.500	12,776.500	12,776.500
Std. Deviation	628.099	632.551	591.623	631.699	630.772	632.487
Std. J-T Statistic	0.115	1.975	3.386	-0.914	0.917	2.241
Asymp. Sig. (2-tailed)	0.908	0.048	0.001	0.361	0.359	0.025

	anatomy19	anatomy20	anatomy21	anatomy22	anatomy23	anatomy24
No. Levels yearofstudy	5	5	5	5	5	5
N	255	255	255	255	255	255
Observed J-T Statistic	13,668.000	15,215.000	11,142.000	15,100.500	12,083.500	12,396.500
Mean J-T Statistic	12,776.500	12,776.500	12,776.500	12,776.500	12,776.500	12,776.500
Std. Deviation	636.062	642.046	626.186	633.737	569.846	604.548
Std. J-T Statistic	1.402	3.798	-2.610	3.667	-1.216	-0.629
Asymp. Sig. (2-tailed)	0.161	0.000	0.009	0.000	0.224	0.530

	anatomy25	anatomy26	anatomy27	anatomy28	anatomy29	anatomy30
No. Levels yearofstudy	5	5	5	5	5	5
N	255	255	254	254	254	254
Observed J-T Statistic	15,934.500	13,378.000	11,902.000	11,591.000	12,618.000	14,565.500
Mean J-T Statistic	12,776.500	12,776.500	12,684.000	12,684.000	12,684.000	12,684.000
Std. Deviation	642.945	630.374	633.766	587.526	621.505	624.816
Std. J-T Statistic	4.912	0.954	-1.234	-1.860	-0.106	3.011
Asymp. Sig. (2-tailed)	0.000	0.340	0.217	0.063	0.915	0.003

	anatomy31	anatomy32
No. Levels yearofstudy	5	5
N	254	254
Observed J-T Statistic	13,189.500	8,432.500
Mean J-T Statistic	12,684.000	12,684.000
Std. Deviation	606.946	643.122
Std. J-T Statistic	0.833	-6.611
Asymp. Sig. (2-tailed)	0.405	0.000

These tests were used to confirm the Pearson's findings as they test for the medians of the variables and if the order of the groups are meaningful.

Focus Group Guide Sheet

Generic Outline Briefing for Focus Groups

Welcome: Thank you for taking the time to attend. Please make your-self comfortable and help your-self to tea and coffee. The participants will be made aware of fire exits.
Introduction: The researcher will explain a little of the background to this study and will explain why the participants have been invited. The researcher will explain the Participant Information Sheet and Consent Forms.
Please now take time to read through the Participant Information Sheet and the Consent form. If you are happy and have no questions please sign the consent forms and pass one copy back to me, the other is for your own reference. The researcher will offer the chance for participants to ask questions and she will answer them to the best of her ability.
The researcher will check the consent forms and only if all participants have agreed to being recorded will the Dictaphone be set up and the participants will be informed once it is turned on.
The researcher will then begin the primary part of the focus group.
Depending on the flow the researcher may halt the focus group and re-direct them into a secondary topic area or the discussion may naturally flow into it.
Generic questions for BM 4 and 5 All Years

- Can you please describe when and how you use anatomy text books and online material?
- Many students in the survey felt that anatomy is memory based, how do you cope with this? if you not agree with this, please say so.
- How do you confirm your learning so that you are sure of yourself?
- How much of your anatomy knowledge do you fell you are using in clinical situations?
- The online survey revealed that some find the anatomy resources limiting, can you please explain any more if you feel this or if you have a idea about what others think

Questions for year 1 and 2

- Some of you may find the DR a daunting place to learn can you describe how this encounter with death affects your learning.
- What parts of the Dissecting room experience do you feel make/aid your learning?
- In the questionnaire many said they don't find imaging and surface anatomy an effective way of learning, can you please describe your difficulty with this?

Questions for 3/4/5

- Students in the early years appear to have problems with imaging anatomy and surface anatomy, can you please describe your experience with these 2 modes of anatomy
- Some students felt they were not confident in their anatomy knowledge to practise safely, if this is or isn't you, how does this affect practise? What are these students doing about it?
- If you have taken an SSU in anatomy please explain how this aided your understanding of anatomy.

5 year only

- Could you please summarise in a drawing your learning process/experiences of anatomy?

Once either the time is up or the researcher feels that saturation has been reached the researcher will offer participants the chance to ask questions.
Participants will be thanked for their time and involvement.

Example of Focus Group coded transcript

C.S did you all have a process you went though?

learning changed

Student 7: yeh mine has certainly changed as I have come into the second year I have found a much easier way to learn without stress, although that's a personal thing I was chatting to a few other guys in our year before I came, and there's a fair few people which do it that way and watch DVDs (after a stressful experience in DR found way of avoiding the DR) (justification)

altered
alternative resources

see it.

Student 2: I have to see it look at it and see where it is in relation to everything else. (opposition to student 7)

experience it

groupwork
confirmation
enjoy

Student 5: the other good thing about the DR is that you go in fairly large groups, six of us and somehow that really worked and someone always knew where something was. Test each other and there did always seem to be someone to ask as well. I found it really good I miss it. (very positive experience)

group
peer teaching
confirmation
enjoyment

confirmation
Textbook

Student 7: I still maintain when I was in the DR in the first year it would have been useful to have a bit more clarification that that is what your looking at and even with the specimens when you look at the section in the book, like head and neck 5 or even some of the labels you didn't know what you were looking at the right head or what you should have been looking for. (start/surface approach). (responsibility of the department)

reflective
spec/dia recognition

C.S did you find it very memorisation based?

Student 7: umm it was a mixture really of both for me (strategic approach)

online
understanding clinical
application

Student 8: I've used a lot of the online resources like netters anatomy like clinical scenarios you can run back through the blood vessels and work things out as to which areas are hit by ischemia, and learning it that way in a more an elongated process and it seems to stick in (deep approach)

resources
reasoning
clinical
deep app.

(mixture of approaches - different activities - different engagement)
(what caused student 7 to experience such difficulties with the DR?)

Interview Guide Sheet

Interviews with Students

Perceptions

- Can you please explain a little about your ideas/experiences of anatomy before your university experience
- Do you agree with the statement 'learning for assessment and learning to become a doctor are the same thing'
- How do/have other staff or students influence/d your perception of anatomy
- Has any external sources influenced your anatomy learning e.g. Von Hagen
- Do you avoid certain areas in anatomy? What is it about this area you do not like?

Experiences

- How did/do you seek confirmation of what you are learning in anatomy?
- Has increased confidence changed the way you learn?
- Have you had many ah I get it moments? Please explain one.
- What role does short term memory have in your anatomy learning?
- How do you bridge the gap between recognition of features in a diagram and a specimen?
- What is the largest hindering factor in your learning of anatomy? Motivation, amount of detail, lab closure times
- What has been the most successful factor in your learning of anatomy?

Examples

- Please tell me how you went about learning the brachial plexus
- Could you quickly draw a diagram of the brachial plexus

Appendix U

Example transcript

Interview extract: Deep approach.

-Read
Student: ok before I came in I probably um I would have read the chapter the class chapter
Preparation | thing I the book and I would have probably have noted the areas I wasn't too sure about and - looked up
active – looked it up in the text book and written notes down the side as to how to find certain things – Locating
when I got in so from the diagram what related to what and like that I go into the DR and so I – Relate diagram to specimen
am guessing there is a shoulder and arm and I'd probably have a look at it so then get the
diagram out and try and work out which each of the branches were from the diagram and then
Confirmation – I'd get rid of the diagram and probably sort of test myself then probably someone else would – group interaction
come up and be like and tell me what's what and I would and I think that's quite a good way of
testing that you know it by telling someone else and um then I would and while I was doing – Peer Teaching
that I would probably trying to think about its nerve root this and this and then this nerve does Example of
this kind of like or supplies this area yes and then I would go away and then I would probably Deep Approach
2nd visit come back later on in the week for a little bit and either remember off it for completely forgot it
and go through it all again and maybe try and ill probably remember it and then depending on
who I was with tell me what each one was and sort of.
C.s so quite a second stage, quite a conformation stage

Student: you can go in must, if you go in just with the class but then when you go away and
(After process) when you come back to revise it you are a little bit like ahh but if you add that into after your
class and you go in again then you have probably ironed out any creases they may have adding depth to understanding
Active – been the first time round written them down somewhere, and then when you are revising you
can think I don't know you have your picture in the atlas or I did watch some of the acklands
DVD in the second year and um er I kind of made a mental note of what it looks like in my
visualising mind and then what kind of thing it would do and how I could remember which branch was
which so that I would be and what the did and what the nerve root was as I knew you would
exam driver get asked about it

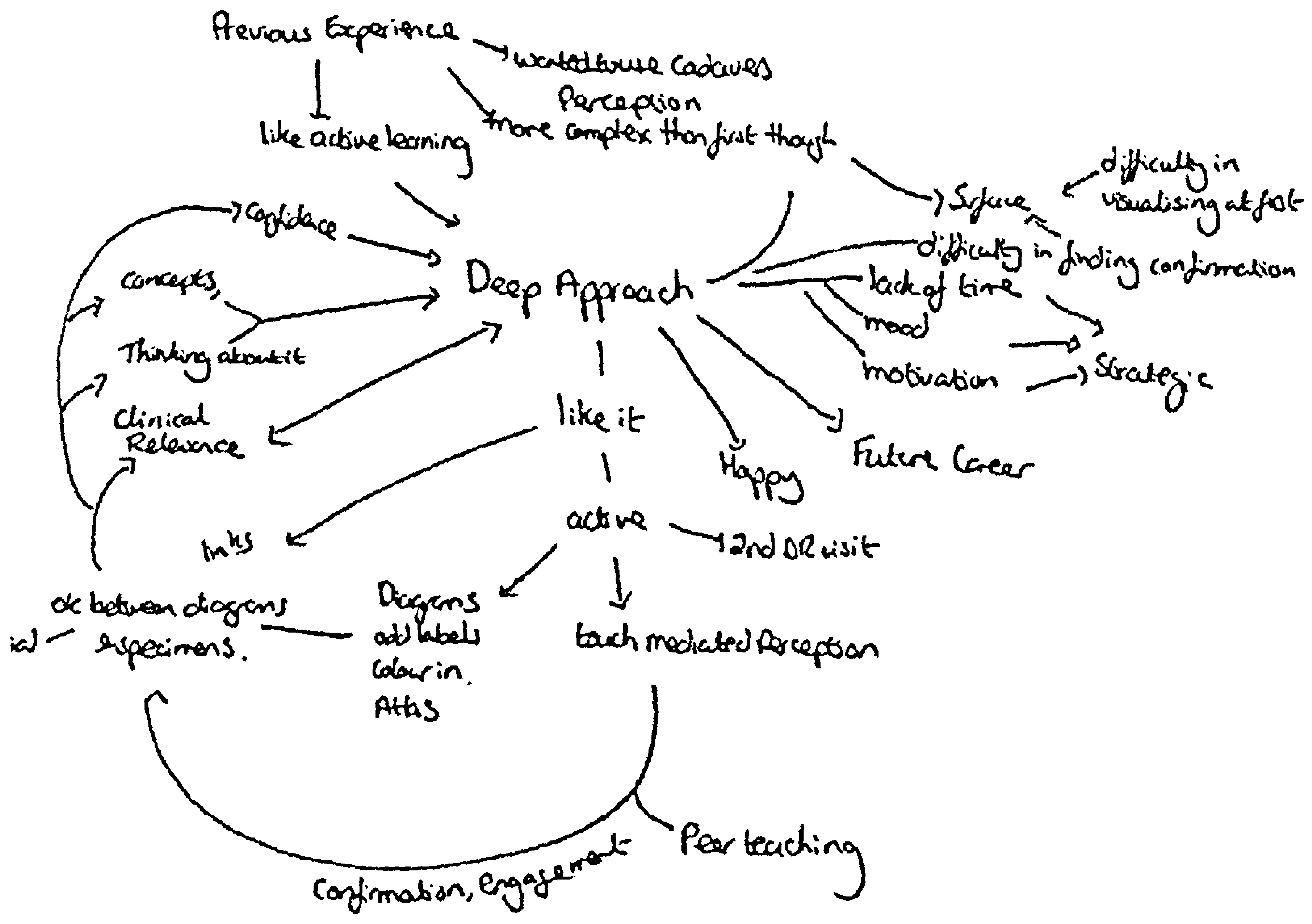
C.s did you leave the DR the first time not sure, but then second time really left going yeh I have done that I can tick it off

Student: I think I'd feel sure the first time, not always sometimes I would think with maybe it
was um I think it was nerves that were the hardest actually and maybe arteries and veins um
then I think I went through it and you just don't get enough time to learn it or you get tired and – Time constraint
you realise you are just not taking it in and you need to have a break and come back, or just – Tired
go away it really depends on what you are feeling that day I think and the first time usually I
confident would feel fairly confident and know that I have to make it concrete in my mind so if I am just - awareness of
going it once I cant say that I will be able to remember it forever or even till like six years later .. how learning

(Separate components to the process) (Feeling of confidence) Page 5
(why nerves & arteries hardest?) (Concrete in mind - ? sediment) (5 page of 12).

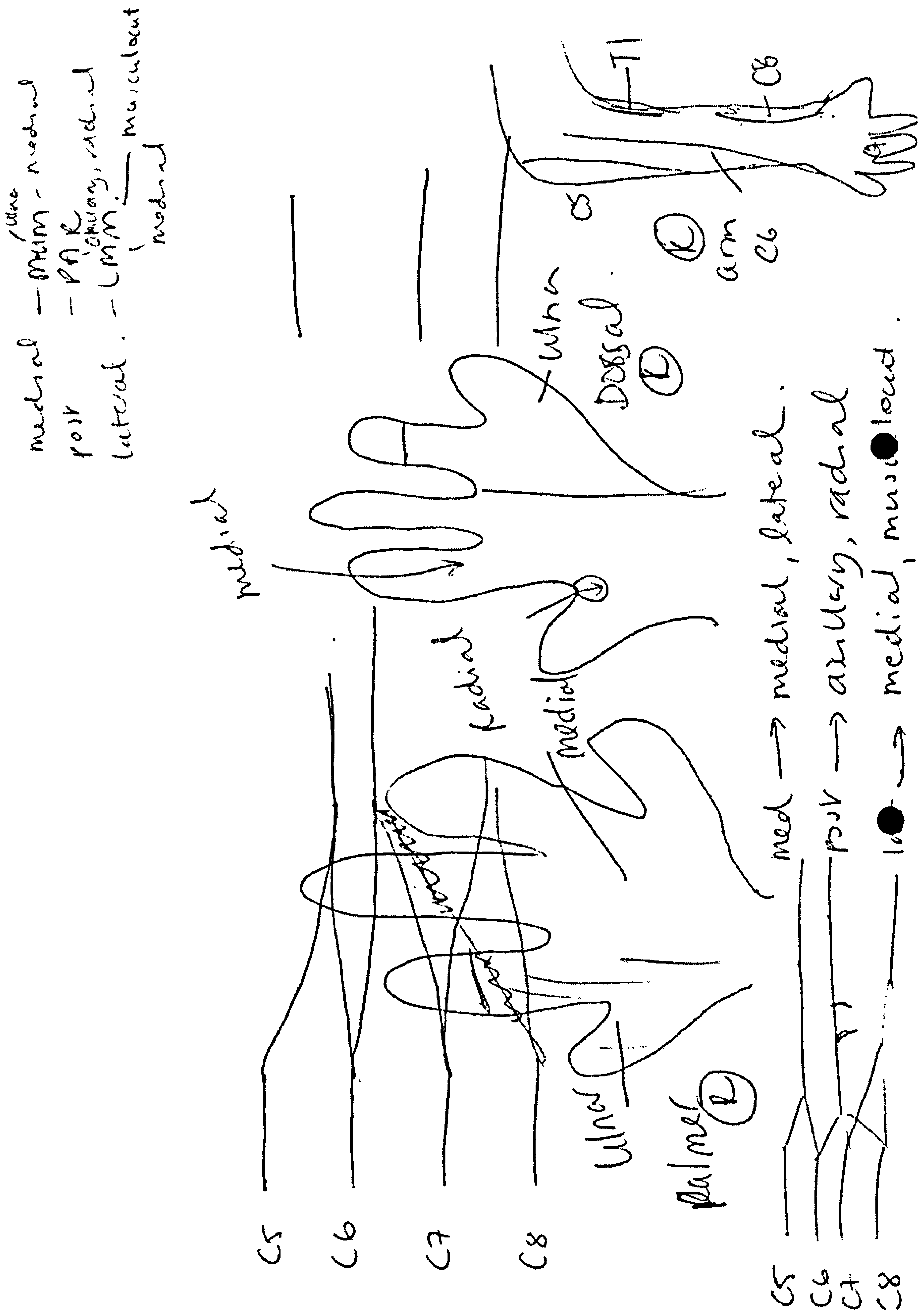
Appendix U

Accompanying delimiting diagram



Appendix V

Scan of student drawing



Details of Spearman's correlations used in the Alumni Study to examine the relationship between how an individual responded to one question compared to another.

Appendix W

		q19	q20	q21	q22	q23	q24	q25	q26	q27	q28	q29	q30	q31	q32
q1	Correlation Coeff.	-.349(**)	.441(**)	.450(**)	.452(**)	-0.023	.346(**)	.460(**)	.336(**)	.411(**)	-.443(**)	.701(**)	.331(**)	-.394(**)	.590(**)
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.789	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	N	140	140	140	140	140	140	140	140	140	140	140	140	140	140
q2	Correlation Coeff.	-0.103	0.017	0.029	0.011	-0.151	-0.069	0.038	-0.089	-0.059	0.004	0.027	-0.044	0.019	-0.121
	Sig. (2-tailed)	0.225	0.838	0.733	0.897	0.074	0.416	0.652	0.297	0.490	0.959	0.750	0.604	0.820	0.155
	N	140	140	140	140	140	140	140	140	140	140	140	140	140	140
q3	Correlation Coeff.	-0.048	0.152	.210(*)	.214(*)	-0.029	0.163	0.132	.212(*)	0.136	-0.127	.279(**)	.191(*)	-.249(**)	.394(**)
	Sig. (2-tailed)	0.571	0.073	0.013	0.011	0.731	0.054	0.121	0.012	0.110	0.136	0.001	0.024	0.003	0.000
	N	140	140	140	140	140	140	140	140	140	140	140	140	140	140
q4	Correlation Coeff.	-.199(*)	.372(**)	.195(*)	.353(**)	-0.095	0.091	.324(**)	.265(**)	.179(*)	-0.144	.363(**)	0.087	-.170(*)	.229(**)
	Sig. (2-tailed)	0.018	0.000	0.021	0.000	0.263	0.286	0.000	0.002	0.035	0.089	0.000	0.309	0.045	0.006
	N	140	140	140	140	140	140	140	140	140	140	140	140	140	140
q5	Correlation Coeff.	0.092	-.267(**)	-.303(**)	-0.153	0.000	-0.074	-0.113	-0.111	-0.162	.202(*)	-.333(**)	-.170(*)	.227(**)	-.256(**)
	Sig. (2-tailed)	0.277	0.001	0.000	0.071	0.996	0.383	0.184	0.190	0.056	0.017	0.000	0.044	0.007	0.002
	N	140	140	140	140	140	140	140	140	140	140	140	140	140	140
q6	Correlation Coeff.	-0.138	.175(*)	0.128	.300(**)	-0.097	0.038	.274(**)	.182(*)	0.118	-.216(*)	.405(**)	0.110	-0.150	.201(*)
	Sig. (2-tailed)	0.103	0.039	0.139	0.000	0.257	0.654	0.001	0.031	0.166	0.010	0.000	0.196	0.077	0.017
	N	140	140	140	140	140	140	140	140	140	140	140	140	140	140
q7	Correlation Coeff.	-.262(**)	.275(**)	.233(**)	.431(**)	-0.057	0.049	.271(**)	.289(**)	.209(*)	-0.144	.495(**)	0.130	-0.145	.246(**)
	Sig. (2-tailed)	0.002	0.001	0.006	0.000	0.503	0.562	0.001	0.001	0.013	0.089	0.000	0.125	0.087	0.003
	N	140	140	140	140	140	140	140	140	140	140	140	140	140	140
q8	Correlation Coeff.	-.187(*)	.311(**)	0.077	.284(**)	-0.009	0.128	0.102	.168(*)	0.105	-0.127	.335(**)	0.089	-0.117	0.153
	Sig. (2-tailed)	0.027	0.000	0.363	0.001	0.917	0.132	0.229	0.048	0.217	0.136	0.000	0.295	0.168	0.070
	N	140	140	140	140	140	140	140	140	140	140	140	140	140	140
q9	Correlation Coeff.	-.253(**)	.252(**)	.339(**)	.370(**)	-0.100	.219(**)	.360(**)	.333(**)	.401(**)	-.270(**)	.524(**)	.219(**)	-.332(**)	.514(**)
	Sig. (2-tailed)	0.003	0.003	0.000	0.000	0.239	0.009	0.000	0.000	0.000	0.001	0.000	0.009	0.000	0.000
	N	140	140	140	140	140	140	140	140	140	140	140	140	140	140
q10	Correlation Coeff.	0.051	0.018	.170(*)	.301(**)	-0.149	0.129	.235(**)	.277(**)	.230(**)	-.301(**)	.332(**)	.219(**)	-0.124	.316(**)
	Sig. (2-tailed)	0.550	0.837	0.045	0.000	0.078	0.130	0.005	0.001	0.006	0.000	0.000	0.009	0.144	0.000
	N	140	140	140	140	140	140	140	140	140	140	140	140	140	140
q11	Correlation Coeff.	-0.010	0.111	.272(**)	.322(**)	0.071	.207(*)	.366(**)	.359(**)	.323(**)	-.217(*)	.353(**)	.215(*)	-.195(*)	.298(**)
	Sig. (2-tailed)	0.906	0.193	0.001	0.000	0.407	0.014	0.000	0.000	0.000	0.010	0.000	0.011	0.021	0.000
	N	140	140	140	140	140	140	140	140	140	140	140	140	140	140
q12	Correlation Coeff.	-.334(**)	.414(**)	.241(**)	.490(**)	-0.076	0.148	.456(**)	.213(*)	.184(*)	-.267(**)	.608(**)	0.154	-.252(**)	.474(**)
	Sig. (2-tailed)	0.000	0.000	0.004	0.000	0.371	0.080	0.000	0.012	0.029	0.001	0.000	0.070	0.003	0.000
	N	140	140	140	140	140	140	140	140	140	140	140	140	140	140
q13	Correlation Coeff.	.272(**)	-.225(**)	-.310(**)	-.381(**)	0.074	-.246(**)	-.377(**)	-.329(**)	-.256(**)	.310(**)	-.555(**)	-.183(*)	.262(**)	-.262(**)
	Sig. (2-tailed)	0.001	0.008	0.000	0.000	0.387	0.003	0.000	0.000	0.002	0.000	0.000	0.030	0.002	0.002
	N	140	140	140	140	140	140	140	140	140	140	140	140	140	140
q14	Correlation Coeff.	-0.102	.183(*)	.325(**)	.348(**)	0.093	.511(**)	.332(**)	.245(**)	.337(**)	-.253(**)	.384(**)	0.153	-.443(**)	.237(**)
	Sig. (2-tailed)	0.231	0.030	0.000	0.000	0.277	0.000	0.000	0.004	0.000	0.003	0.000	0.071	0.000	0.005
	N	140	140	140	140	140	140	140	140	140	140	140	140	140	140
q15	Correlation Coeff.	-.292(**)	.456(**)	.360(**)	.417(**)	0.025	.276(**)	.366(**)	.342(**)	.277(**)	-.322(**)	.597(**)	.229(**)	-.390(**)	.457(**)
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.769	0.001	0.000	0.000	0.001	0.000	0.000	0.006	0.000	0.000
	N	140	140	140	140	140	140	140	140	140	140	140	140	140	140
q16	Correlation Coeff.	-.394(**)	.355(**)	0.116	.409(**)	0.019	.193(*)	.174(*)	.176(*)	0.066	-0.136	.460(**)	-0.018	-.349(**)	.259(**)
	Sig. (2-tailed)	0.000	0.000	0.172	0.000	0.823	0.022	0.039	0.037	0.441	0.108	0.000	0.834	0.000	0.002
	N	140	140	140	140	140	140	140	140	140	140	140	140	140	140
q17	Correlation Coeff.	-.353(**)	.317(**)	0.163	.424(**)	0.045	.264(**)	.303(**)	.296(**)	.237(**)	-.178(*)	.583(**)	0.023	-.368(**)	.322(**)
	Sig. (2-tailed)	0.000	0.000	0.054	0.000	0.598	0.002	0.000	0.000	0.005	0.036	0.000	0.783	0.000	0.000
	N	140	140	140	140	140	140	140	140	140	140	140	140	140	140
q18	Correlation Coeff.	.253(**)	-.251(**)	-0.159	-0.118	-0.061	0.070	-0.031	-0.026	0.077	0.085	-.237(**)	-.175(*)	0.148	-.220(**)
	Sig. (2-tailed)	0.003	0.003	0.061	0.164	0.477	0.410	0.718	0.761	0.365	0.320	0.005	0.039	0.081	0.009
	N	140	140	140	140	140	140	140	140	140	140	140	140	140	140
q19	Correlation Coeff.	1.000	-.288(**)	0.110	-.259(**)	0.001	-0.161	-.221(**)	-0.144	-0.006	0.032	-.286(**)	-0.031	.200(*)	-0.151
	Sig. (2-tailed)		0.001	0.198	0.002	0.990	0.058	0.009	0.090	0.942	0.707	0.001	0.720	0.018	0.074
	N	140	140	140	140	140	140	140	140	140	140	140	140	140	140
q20	Correlation Coeff.	-.288(**)	1.000	.288(**)	.409(**)	0.051	0.154	.278(**)	.218(**)	.268(**)	-.225(**)	.487(**)	0.116	-.277(**)	.305(**)
	Sig. (2-tailed)	0.001		0.001	0.000	0.547	0.070	0.001	0.010	0.001	0.008	0.000	0.173	0.001	0.000
	N	140	140	140	140	140	140	140	140	140	140	140	140	140	140
q21	Correlation Coeff.	0.110	.288(**)	1.000	.301(**)	0.133	.312(**)	.377(**)	.274(**)	.368(**)	-.291(**)	.444(**)	.434(**)	-.472(**)	.322(**)
	Sig. (2-tailed)	0.198	0.001		0.000	0.117	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000
	N	140	140	140	140	140	140	140	140	140	140	140	140	140	140
q22	Correlation Coeff.	-.259(**)	.409(**)	.301(**)	1.000	-0.078	.371(**)	.398(**)	.307(**)	.251(**)	-.213(*)	.525(**)	.167(*)	-.360(**)	.361(**)
	Sig. (2-tailed)	0.002	0.000	0.000		0.361	0.000	0.000	0.000	0.003	0.012	0.000	0.048	0.000	0.000
	N	140	140	140	140	140	140	140	140	140	140	140	140	140	140
q23	Correlation Coeff.	0.001	0.051	0.133	-0.078	1.000	.237(**)	0.029	0.006	-0.043	-0.016	0.022	-0.014	-0.036	-0.069
	Sig. (2-tailed)	0.990	0.547	0.117	0.361		0.005	0.729	0.940	0.616	0.850	0.799	0.873	0.675	0.419
	N	140	140	140	140	140	140	140	140	140	140	140	140	140	140
q24	Correlation Coeff.	-0.161	0.154	.312(**)	.371(**)	.237(**)	1.000	.324(**)	.288(**)	.419(**)	-.232(**)	.376(**)	0.131	-.349(**)	.248(**)
	Sig. (2-tailed)	0.058	0.070	0.000	0.000	0.005		0.000	0.001	0.000	0.006	0.000	0.122	0.000	0.003
	N	140	140	140	140	140	140	140	140	140	140	140	140	140	140
q25	Correlation Coeff.	-.221(**)	.278(**)	.377(**)	.398(**)	0.029	.324(**)	1.000	.517(**)	.322(**)	-.332(**)	.577(**)	.217(*)	-.358(**)	.400(**)
	Sig. (2-tailed)	0.009	0.001	0.000	0.000	0.729	0.000		0.000	0.000	0.000	0.000	0.010	0.000	0.000
	N	140	140	140	140	140	140	140	140	140	140	140	140	140	140
q26	Correlation Coeff.	-0.144	.218(**)	.274(**)	.307(**)	0.006	.288(**)	.517(**)	1.000	.373(**)	-.227(**)	.429(**)	.274(**)	-.302(**)	.372(**)
	Sig. (2-tailed)	0.090	0.010	0.001	0.000	0.940	0.001	0.000		0.000	0.007	0.000	0.001	0.000	0.000
	N	140	140	140	140	140	140	140	140	140	140	140	140	140	140
q27	Correlation Coeff.	-0.006	.268(**)	.368(**)	.251(**)	-0.043	.419(**)	.322(**)	.373(**)	1.000	-.614(**)	.486(**)	.275(**)	-.292(**)	.320(**)
	Sig. (2-tailed)	0.942	0.001	0.000	0.003	0.616	0.000	0.000	0.000		0.000	0.000	0.001	0.000	0.000
	N	140	140	140	140	140	140	140	140	140	140	140	140	140	140
q28	Correlation Coeff.	0.032	-.225(**)	-.291(**)	-.213(*)	-0.016	-.232(**)	-.332(**)	-.227(**)	-.614(**)	1.000	-.505(**)	-.270(**)	.333(**)	-.296(**)
	Sig. (2-tailed)	0.707	0.008	0.000	0.012	0.850	0.006	0.000	0.007	0.000		0.000	0.001	0.000	0.000
	N	140	140	140	140	140	140	140	140	140	140	140	140	140	140
q29	Correlation Coeff.	-.286(**)	.487(**)	.444(**)	.525(**)	0.022	.376(**)	.577(**)	.429(**)	.486(**)	-.505(**)	1.000	.228(**)	-.441(**)	.487(**)
	Sig. (2-tailed)	0.001	0.000	0.000	0.000	0.799	0.000	0.000	0.000	0.000	0.000		0.007	0.000	0.000
	N	140	140	140	140	140	140	140	140	140	140	140	140	140	140
q30	Correlation Coeff.	-0.031	0.116	.434(**)	.167(*)	-0.014	0.131	.217(*)	.274(**)	.275(**)	-.270(**)	.228(**)	1.000	-.197(*)	.279(**)
	Sig. (2-tailed)	0.720	0.173	0.000	0.048	0.873	0.122	0.010	0.001	0.001	0.001	0.007		0.020	0.001
	N	140	140	140	140	140	140	140	140	140	140	140	140	140	140
q31	Correlation Coeff.	.200(*)	-.277(**)	-.472(**)	-.360(**)	-0.036	-.349(**)	-.358(**)	-.302(**)	-.292(**)	.333(**)	-.441(**)	-.197(*)	1.000	-.328(**)
	Sig. (2-tailed)	0.018	0.001	0.000	0.000	0.675	0.000	0.000	0.000	0.000	0.000	0.000	0.020		0.000
	N	140	140	140	140	140	140	140	140	140	140	140	140	140	140
q32	Correlation Coeff.	-0.151	.305(**)	.322(**)	.361(**)	-0.069	.248(**)	.400(**)	.372(**)	.320(**)	-.296(**)	.487(**)	.279(**)	-.328(**)	1.000
	Sig. (2-tailed)	0.074	0.000	0.000	0.000	0.419	0.003	0.000	0.000	0.000	0.000	0.000	0.001	0.000	
	N	140	140	140	140	140	140	140	140	140	140	140	140	140	140

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Details of Spearman's correlations used in Alumni Study

		q1	q2	q3	q4	q5	q6	q7	q8	q9	q10	q11	q12	q13	q14	q15	q16	q17	q18
q1	Correlation Coeff.	1.000	0.003	.386(**)	.291(**)	-.332(**)	.279(**)	.396(**)	.256(**)	.605(**)	.311(**)	.307(**)	.623(**)	-.423(**)	.410(**)	.635(**)	.332(**)	.490(**)	-.224(**)
	Sig. (2-tailed)		0.968	0.000	0.000	0.000	0.001	0.000	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.008
	N	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140
q2	Correlation Coeff.	0.003	1.000	-.287(**)	0.041	0.063	0.116	0.067	0.072	0.056	0.026	0.022	0.071	-0.006	-0.062	0.013	0.010	-0.027	0.030
	Sig. (2-tailed)	0.968		0.001	0.629	0.460	0.171	0.432	0.401	0.507	0.759	0.792	0.403	0.945	0.469	0.880	0.904	0.750	0.726
	N	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140
q3	Correlation Coeff.	.386(**)	-.287(**)	1.000	0.165	-.211(*)	0.125	0.135	0.031	.291(**)	.196(*)	0.080	0.118	-.182(*)	.235(**)	.218(**)	0.158	.194(*)	-0.071
	Sig. (2-tailed)	0.000	0.001		0.052	0.012	0.143	0.111	0.713	0.000	0.020	0.347	0.167	0.032	0.005	0.010	0.062	0.022	0.405
	N	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140
q4	Correlation Coeff.	.291(**)	0.041	0.165	1.000	-0.074	.376(**)	.371(**)	.406(**)	.381(**)	.327(**)	.206(*)	.345(**)	-.227(**)	.198(*)	.310(**)	.189(*)	.257(**)	-0.114
	Sig. (2-tailed)	0.000	0.629	0.052		0.388	0.000	0.000	0.000	0.000	0.000	0.015	0.000	0.007	0.019	0.000	0.026	0.002	0.179
	N	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140
q5	Correlation Coeff.	-.332(**)	0.063	-.211(*)	-0.074	1.000	-0.025	-0.141	-0.059	-0.161	-0.039	0.049	-.175(*)	.258(**)	-.175(*)	-.308(**)	-0.130	-.184(*)	.223(**)
	Sig. (2-tailed)	0.000	0.460	0.012	0.388		0.770	0.097	0.488	0.057	0.645	0.566	0.038	0.002	0.039	0.000	0.124	0.030	0.008
	N	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140
q6	Correlation Coeff.	.279(**)	0.116	0.125	.376(**)	-0.025	1.000	.492(**)	.334(**)	.199(*)	.332(**)	.285(**)	.413(**)	-.301(**)	.246(**)	.216(*)	.224(**)	.305(**)	-.180(*)
	Sig. (2-tailed)	0.001	0.171	0.143	0.000	0.770		0.000	0.000	0.019	0.000	0.001	0.000	0.000	0.003	0.010	0.008	0.000	0.033
	N	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140
q7	Correlation Coeff.	.396(**)	0.067	0.135	.371(**)	-0.141	.492(**)	1.000	.377(**)	.330(**)	.195(*)	.267(**)	.442(**)	-.343(**)	.297(**)	.344(**)	.313(**)	.463(**)	-.381(**)
	Sig. (2-tailed)	0.000	0.432	0.111	0.000	0.097	0.000		0.000	0.000	0.021	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	N	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140
q8	Correlation Coeff.	.256(**)	0.072	0.031	.406(**)	-0.059	.334(**)	.377(**)	1.000	.212(*)	.253(**)	.240(**)	.365(**)	-.200(*)	.185(*)	.350(**)	.332(**)	.385(**)	-.275(**)
	Sig. (2-tailed)	0.002	0.401	0.713	0.000	0.488	0.000	0.000		0.012	0.003	0.004	0.000	0.018	0.029	0.000	0.000	0.000	0.001
	N	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140
q9	Correlation Coeff.	.605(**)	0.056	.291(**)	.381(**)	-0.161	.199(*)	.330(**)	.212(*)	1.000	.377(**)	.371(**)	.472(**)	-.363(**)	.307(**)	.466(**)	.322(**)	.397(**)	-0.101
	Sig. (2-tailed)	0.000	0.507	0.000	0.000	0.057	0.019	0.000	0.012		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.237
	N	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140
q10	Correlation Coeff.	.311(**)	0.026	.196(*)	.327(**)	-0.039	.332(**)	.195(*)	.253(**)	.377(**)	1.000	.486(**)	.341(**)	-.219(**)	.245(**)	.241(**)	0.157	.204(*)	0.039
	Sig. (2-tailed)	0.000	0.759	0.020	0.000	0.645	0.000	0.021	0.003	0.000		0.000	0.000	0.009	0.004	0.004	0.064	0.016	0.645
	N	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140
q11	Correlation Coeff.	.307(**)	0.022	0.080	.206(*)	0.049	.285(**)	.267(**)	.240(**)	.371(**)	.486(**)	1.000	.412(**)	-.190(*)	.167(*)	.257(**)	0.140	.354(**)	0.014
	Sig. (2-tailed)	0.000	0.792	0.347	0.015	0.566	0.001	0.001	0.004	0.000	0.000		0.000	0.024	0.048	0.002	0.098	0.000	0.870
	N	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140
q12	Correlation Coeff.	.623(**)	0.071	0.118	.345(**)	-.175(*)	.413(**)	.442(**)	.365(**)	.472(**)	.341(**)	.412(**)	1.000	-.352(**)	.292(**)	.514(**)	.425(**)	.499(**)	-.289(**)
	Sig. (2-tailed)	0.000	0.403	0.167	0.000	0.038	0.000	0.000	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.000	0.000	0.001
	N	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140
q13	Correlation Coeff.	-.423(**)	-0.006	-.182(*)	-.227(**)	.258(**)	-.301(**)	-.343(**)	-.200(*)	-.363(**)	-.219(**)	-.190(*)	-.352(**)	1.000	-.277(**)	-.354(**)	-.287(**)	-.431(**)	.239(**)
	Sig. (2-tailed)	0.000	0.945	0.032	0.007	0.002	0.000	0.000	0.018	0.000	0.009	0.024	0.000		0.001	0.000	0.001	0.000	0.005
	N	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140
q14	Correlation Coeff.	.410(**)	-0.062	.235(**)	.198(*)	-.175(*)	.246(**)	.297(**)	.185(*)	.307(**)	.245(**)	.167(*)	.292(**)	-.277(**)	1.000	.329(**)	0.166	.286(**)	0.062
	Sig. (2-tailed)	0.000	0.469	0.005	0.019	0.039	0.003	0.000	0.029	0.000	0.004	0.048	0.000	0.001		0.000	0.050	0.001	0.467
	N	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140
q15	Correlation Coeff.	.635(**)	0.013	.218(**)	.310(**)	-.308(**)	.216(*)	.344(**)	.350(**)	.466(**)	.241(**)	.257(**)	.514(**)	-.354(**)	.329(**)	1.000	.445(**)	.523(**)	-.187(*)
	Sig. (2-tailed)	0.000	0.880	0.010	0.000	0.000	0.010	0.000	0.000	0.000	0.004	0.002	0.000	0.000	0.000		0.000	0.000	0.027
	N	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140
q16	Correlation Coeff.	.332(**)	0.010	0.158	.189(*)	-0.130	.224(**)	.313(**)	.332(**)	.322(**)	0.157	0.140	.425(**)	-.287(**)	0.166	.445(**)	1.000	.552(**)	-.378(**)
	Sig. (2-tailed)	0.000	0.904	0.062	0.026	0.124	0.008	0.000	0.000	0.000	0.064	0.098	0.000	0.001	0.050	0.000		0.000	0.000
	N	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140
q17	Correlation Coeff.	.490(**)	-0.027	.194(*)	.257(**)	-.184(*)	.305(**)	.463(**)	.385(**)	.397(**)	.204(*)	.354(**)	.499(**)	-.431(**)	.286(**)	.523(**)	.552(**)	1.000	-.222(**)
	Sig. (2-tailed)	0.000	0.750	0.022	0.002	0.030	0.000	0.000	0.000	0.000	0.016	0.000	0.000	0.000	0.001	0.000	0.000		0.008
	N	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140
q18	Correlation Coeff.	-.224(**)	0.030	-0.071	-0.114	.223(**)	-.180(*)	-.381(**)	-.275(**)	-0.101	0.039	0.014	-.289(**)	.239(**)	0.062	-.187(*)	-.378(**)	-.222(**)	1.000
	Sig. (2-tailed)	0.008	0.726	0.405	0.179	0.008	0.033	0.000	0.001	0.237	0.645	0.870	0.001	0.005	0.467	0.027	0.000	0.008	
	N	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140
q19	Correlation Coeff.	-.349(**)	-0.103	-0.048	-.199(*)	0.092	-0.138	-.262(**)	-.187(*)	-.253(**)	0.051	-0.010	-.334(**)	.272(**)	-0.102	-.292(**)	-.394(**)	-.353(**)	.253(**)
	Sig. (2-tailed)	0.000	0.225	0.571	0.018	0.277	0.103	0.002	0.027	0.003	0.550	0.906	0.000	0.001	0.231	0.000	0.000	0.000	0.003
	N	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140
q20	Correlation Coeff.	.441(**)	0.017	0.152	.372(**)	-.267(**)	.175(*)	.275(**)	.311(**)	.252(**)	0.018	0.111	.414(**)	-.225(**)	.183(*)	.456(**)	.355(**)	.317(**)	-.251(**)
	Sig. (2-tailed)	0.000	0.838	0.073	0.000	0.001	0.039	0.001	0.000	0.003	0.837	0.193	0.000	0.008	0.030	0.000	0.000	0.000	0.003
	N	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140
q21	Correlation Coeff.	.450(**)	0.029	.210(*)	.195(*)	-.303(**)	0.126	.233(**)	0.077	.339(**)	.170(*)	.272(**)	.241(**)	-.310(**)	.325(**)	.360(**)	0.116	0.163	-0.159
	Sig. (2-tailed)	0.000	0.733	0.013	0.021	0.000	0.139	0.006	0.363	0.000	0.045	0.001	0.004	0.000	0.000	0.000	0.172	0.054	0.061
	N	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140
q22	Correlation Coeff.	.452(**)	0.011	.214(*)	.353(**)	-0.153	.300(**)	.431(**)	.284(**)	.370(**)	.301(**)	.322(**)	.490(**)	-.381(**)	.348(**)	.417(**)	.409(**)	.424(**)	-0.118
	Sig. (2-tailed)	0.000	0.897	0.011	0.000	0.071	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.164
	N	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140
q23	Correlation Coeff.	-0.023	-0.151	-0.029	-0.095	0.000	-0.097	-0.057	-0.009	-0.100	-0.149	0.071	-0.076	0.074	0.093	0.025	0.019	0.045	-0.061
	Sig. (2-tailed)	0.789	0.074	0.731	0.263	0.996	0.257	0.503	0.917	0.239	0.078	0.407	0.371	0.387	0.277	0.769	0.823	0.598	0.477
	N	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140
q24	Correlation Coeff.	.346(**)	-0.069	0.163	0.091	-0.074	0.038	0.049	0.128	.219(**)	0.129	.207(*)	0.148	-.246(**)	.511(**)	.276(**)	.193(*)	.264(**)	0.070
	Sig. (2-tailed)	0.000	0.416	0.054	0.286	0.383	0.654	0.562	0.132	0.009	0.130	0.014	0.080	0.003	0.000	0.001	0.022	0.002	0.410
	N	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140
q25	Correlation Coeff.	.460(**)	0.038	0.132	.324(**)	-0.113	.274(**)	.271(**)	0.102	.360(**)	.235(**)	.366(**)	.456(**)	-.377(**)	.332(**)	.366(**)	.174(*)	.303(**)	-0.031
	Sig. (2-tailed)	0.000	0.652	0.121	0.000	0.184	0.001	0.001	0.229	0.000	0.005	0.000	0.000	0.000	0.000	0.000	0.039	0.000	0.718
	N	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140
q26	Correlation Coeff.	.336(**)	-0.089	.212(*)	.265(**)	-0.111	.182(*)	.289(**)	.168(*)	.333(**)	.277(**)	.359(**)	.213(*)	-.329(**)	.245(**)	.342(**)	.176(*)	.296(**)	-0.026
	Sig. (2-tailed)	0.000	0.297	0.012	0.002	0.190	0.031	0.001	0.048	0.000	0.001	0.000	0.012	0.000	0.004	0.000	0.037	0.000	0.761
	N	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140
q27	Correlation Coeff.	.411(**)	-0.059	0.136	.179(*)	-0.162	0.118	.209(*)	0.105	.401(**)	.230(**)	.323(**)	.184(*)	-.256(**)	.337(**)	.277(**)	0.066	.237(**)	0.077
	Sig. (2-tailed)	0.000	0.490	0.110	0.035	0.056	0.166	0.013	0.217	0.000	0.006	0.000	0.029	0.002	0.000	0.001	0.441	0.005	0.365
	N	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140
q28	Correlation Coeff.	-.443(**)	0.004	-0.127	-0.144	.202(*)	-.216(*)	-0.144	-0.127	-.270(**)	-.301(**)	-.217(*)	-.267(**)	.310(**)	-.253(**)	-.322(**)	-0.136	-.178(*)	0.085
	Sig. (2-tailed)	0.000	0.959	0.136	0.089	0.017	0.010	0.089	0.136	0.001	0.000	0.010	0.001	0.000	0.003	0.000	0.108	0.036	0.320
	N	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140
q29	Correlation Coeff.	.701(**)	0.027	.279(**)	.363(**)	-.333(**)	.405(**)	.495(**)	.335(**)	.524(**)	.332(**)	.353(**)	.608(**)	-.555(**)	.384(**)	.597(**)	.460(**)	.583(**)	-.237(**)
	Sig. (2-tailed)	0.000	0.750	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.005
	N	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140
q30	Correlation Coeff.	.331(**)	-0.044	.191(*)	0.087	-.170(*)	0.110	0.130	0.089	.219(**)	.219(**)	.215(*)	0.154	-.183(*)	0.153	.229(**)	-0.018	0.023	-.175(*)
	Sig. (2-tailed)	0.000	0.604	0.024	0.309	0.044	0.196	0.125	0.295	0.009	0.009	0.011	0.070	0.030	0.071	0.006	0.834	0.783	0.039
	N	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140
q31	Correlation Coeff.	-.394(**)	0.019	-.249(**)	-.170(*)	.227(**)	-0.150	-0.145	-0.117	-.332(**)	-0.124	-.195(*)	-.252(**)	.262(**)	-.443(**)	-.390(**)	-.349(**)	-.368(**)	0.148
	Sig. (2-tailed)	0.000	0.820	0.003	0.045	0.007	0.077	0.087	0.168	0.000	0.144	0.021	0.003	0.002	0.000	0.000	0.000	0.000	0.081
	N	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140
q32	Correlation Coeff.	.590(**)	-0.121	.394(**)	.229(**)	-.256(**)	.201(*)	.246(**)	0.153	.514(**)	.316(**)	.298(**)	.474(**)	-.262(**)	.237(**)	.457(**)	.259(**)	.322(**)	-.220(**)
	Sig. (2-tailed)	0.000	0.155	0.000	0.006	0.002	0.017	0.003	0.070	0.000	0.000	0.000	0.000	0.002	0.005	0.000	0.002	0.000	0.009
	N	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Details of Mann Whitney test used in the Alumni Study to explore the relationship between the year of graduation and the individual's response to questions.

	Gradcat	N	Mean Rank	Sum of Ranks		Gradcat	N	Mean Rank	Sum of Ranks
q1	1.00	60	65.91	3,954.50	q17	1.00	60	76.61	4,596.50
	2.00	79	73.11	5,775.50		2.00	79	64.98	5,133.50
	Total	139				Total	139		
q2	1.00	60	70.12	4,207.00	q18	1.00	60	71.36	4,281.50
	2.00	79	69.91	5,523.00		2.00	79	68.97	5,448.50
	Total	139				Total	139		
q3	1.00	60	67.66	4,059.50	q19	1.00	60	71.15	4,269.00
	2.00	79	71.78	5,670.50		2.00	79	69.13	5,461.00
	Total	139				Total	139		
q4	1.00	60	72.73	4,363.50	q20	1.00	60	61.92	3,715.00
	2.00	79	67.93	5,366.50		2.00	79	76.14	6,015.00
	Total	139				Total	139		
q5	1.00	60	73.64	4,418.50	q21	1.00	60	64.68	3,880.50
	2.00	79	67.23	5,311.50		2.00	79	74.04	5,849.50
	Total	139				Total	139		
q6	1.00	60	78.28	4,696.50	q22	1.00	60	74.38	4,462.50
	2.00	79	63.72	5,033.50		2.00	79	66.68	5,267.50
	Total	139				Total	139		
q7	1.00	60	79.36	4,761.50	q23	1.00	60	72.58	4,354.50
	2.00	79	62.89	4,968.50		2.00	79	68.04	5,375.50
	Total	139				Total	139		
q8	1.00	60	70.66	4,239.50	q24	1.00	60	70.44	4,226.50
	2.00	79	69.50	5,490.50		2.00	79	69.66	5,503.50
	Total	139				Total	139		
q9	1.00	60	67.52	4,051.00	q25	1.00	60	74.62	4,477.00
	2.00	79	71.89	5,679.00		2.00	79	66.49	5,253.00
	Total	139				Total	139		
q10	1.00	60	71.59	4,295.50	q26	1.00	60	72.61	4,356.50
	2.00	79	68.79	5,434.50		2.00	79	68.02	5,373.50
	Total	139				Total	139		
q11	1.00	60	68.39	4,103.50	q27	1.00	60	64.25	3,855.00
	2.00	79	71.22	5,626.50		2.00	79	74.37	5,875.00
	Total	139				Total	139		
q12	1.00	60	69.47	4,168.00	q28	1.00	60	76.71	4,602.50
	2.00	79	70.41	5,562.00		2.00	79	64.91	5,127.50
	Total	139				Total	139		
q13	1.00	60	66.77	4,006.00	q29	1.00	60	72.83	4,369.50
	2.00	79	72.46	5,724.00		2.00	79	67.85	5,360.50
	Total	139				Total	139		
q14	1.00	60	77.15	4,629.00	q30	1.00	60	68.66	4,119.50
	2.00	79	64.57	5,101.00		2.00	79	71.02	5,610.50
	Total	139				Total	139		
q15	1.00	60	70.88	4,252.50	q31	1.00	60	72.51	4,350.50
	2.00	79	69.34	5,477.50		2.00	79	68.09	5,379.50
	Total	139				Total	139		
q16	1.00	60	68.49	4,109.50	q32	1.00	60	65.04	3,902.50
	2.00	79	71.15	5,620.50		2.00	79	73.77	5,827.50
	Total	139				Total	139		

Appendix Y

Details of Kruskal Wallis Test used in the Alumni Study to compare the relationship between an individuals responses to the questions and their current job role.

	q1	q2	q3	q4	q5	q6
Mann-Whitney U	2,124.500	2,363.000	2,229.500	2,206.500	2,151.500	1,873.500
Wilcoxon W	3,954.500	5,523.000	4,059.500	5,366.500	5,311.500	5,033.500
Z	-1.081	-0.032	-0.620	-0.721	-0.992	-2.230
Asymp. Sig.	0.280	0.974	0.535	0.471	0.321	0.026

	q7	q8	q9	q10	q11	q12
Mann-Whitney U	1,808.500	2,330.500	2,221.000	2,274.500	2,273.500	2,338.000
Wilcoxon W	4,968.500	5,490.500	4,051.000	5,434.500	4,103.500	4,168.000
Z	-2.524	-0.176	-0.725	-0.418	-0.443	-0.143
Asymp. Sig.	0.012	0.860	0.469	0.676	0.658	0.887

	q13	q14	q15	q16	q17	q18
Mann-Whitney U	2,176.000	1,941.000	2,317.500	2,279.500	1,973.500	2,288.500
Wilcoxon W	4,006.000	5,101.000	5,477.500	4,109.500	5,133.500	5,448.500
Z	-0.860	-1.898	-0.232	-0.416	-1.779	-0.362
Asymp. Sig.	0.390	0.058	0.816	0.677	0.075	0.717

	q19	q20	q21	q22	q23	q24
Mann-Whitney U	2,301.000	1,885.000	2,050.500	2,107.500	2,215.500	2,343.500
Wilcoxon W	5,461.000	3,715.000	3,880.500	5,267.500	5,375.500	5,503.500
Z	-0.315	-2.144	-1.412	-1.193	-0.703	-0.120
Asymp. Sig.	0.753	0.032	0.158	0.233	0.482	0.904

	q25	q26	q27	q28	q29	q30
Mann-Whitney U	2,093.000	2,213.500	2,025.000	1,967.500	2,200.500	2,289.500
Wilcoxon W	5,253.000	5,373.500	3,855.000	5,127.500	5,360.500	4,119.500
Z	-1.229	-0.698	-1.515	-1.858	-0.748	-0.355
Asymp. Sig.	0.219	0.485	0.130	0.063	0.454	0.723

	q31	q32
Mann-Whitney U	2,219.500	2,072.500
Wilcoxon W	5,379.500	3,902.500
Z	-0.664	-1.347
Asymp. Sig.	0.507	0.178

Side Line Spatial Abilities Study

Side line study

During the main study a theme that was brought up throughout every stage of the study without conclusion was the idea of spatial abilities. During the later parts of the study it became apparent that further work could explore this, with the initial aim of including this in the study.

Links were made with Spatial Abilities Experts within the University after reading papers by Professor Dror. A collaboration project was set up to test the spatial abilities of 'experts' and 'novices' in anatomy. It was hoped that the work would serve 2 functions, one to be included in the study and the second to serve as pilot work to a larger collaborative study into spatial abilities and touch medicated perception at a later date.

The study is briefly summarised below.

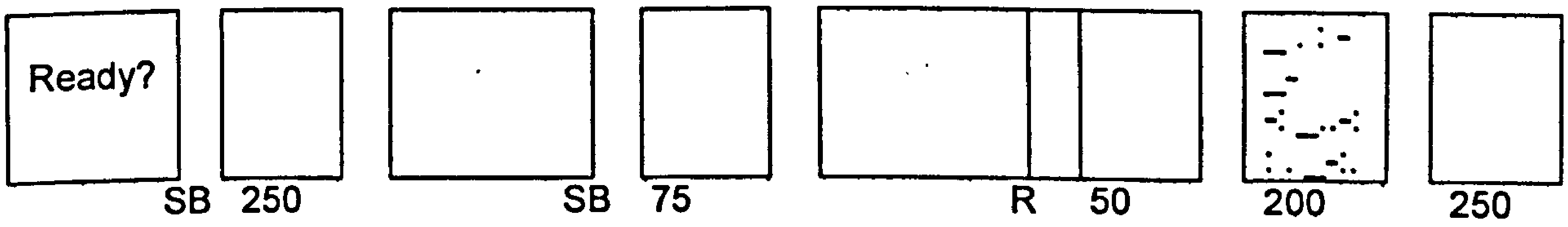
Rationale
Spatial ability has been referred to by students and staff in comments such as; 'they either get it or they don't', 'I can't even find my car in a car park!' Spatial ability in anatomy requires further investigation and an experiment has been designed to test if there are spatial abilities differences between experts and novices in anatomy.

Method

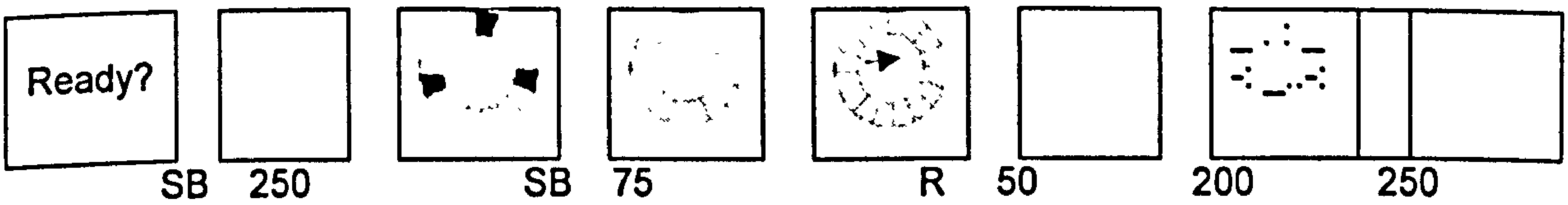
Participants
20 participants were recruited for this study; half were regarded as experts in the field of anatomy (Experts) and half as novices (Novices). The Experts and Novices differed in the number of years' experience they had with anatomy, with Experts having approximately 5 years more experience than Novices. The Experts and Novices each consisted of 5 males and 5 females. All participants had normal or corrected–to-normal vision and 18 were right-handed.

Tasks
Participants completed 4 computerised spatial tasks: a mental rotation task, a scanning task, a categorical spatial relation task and a metric spatial relation task. The tasks were administered and counterbalanced in an order unique to each participant. Practice sessions were administered before each of the tasks. Participants first had a practice session to familiarise themselves with which keys to press. Participants then had a practice with stimuli not used in the actual task to familiarise themselves with the procedure. For all the practice trials, participants received feedback if they were incorrect. Participants were asked to read the on screen instructions before beginning the trail one and then they were presented with the actual task.

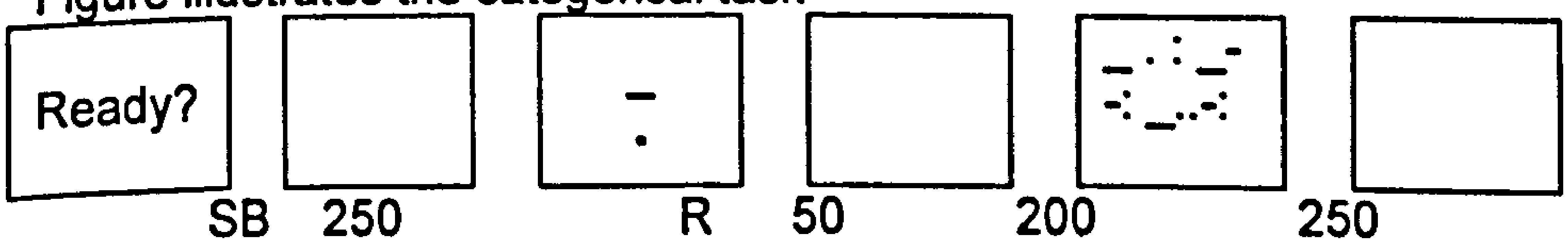
Rotation Task
Participants were presented with two sequential black and white line meaningful drawings (e.g. a cat, boat). The first drawing was always presented upright whereas the second drawing was either identical or differed slightly from the first presentation (e.g. an additional line was present or absent, or a shape was changed) and was presented at 0, 35, 70, or 105 degrees. The participants were asked to judge whether the two drawings were the same, regardless of orientation. This task consisted of 48 trials, the trials were presented in a fixed pseudo-random order; no more than three consecutive 'yes' or 'no' trials, no more than three consecutive trials with the second stimuli in the same orientation and no more than three consecutive trials with the same objects. All participants received the same order of presentation. If they thought the two presentations were the same, regardless of orientation, they pressed the 'yes' key with their dominant hand. As soon as a response was made, the screen went blank for 50 ms, after which a mask screen, comprised of many bars and dots, was displayed for 200 ms. The screen then went blank for 250 ms before the next trial started. The figure below illustrates this task.



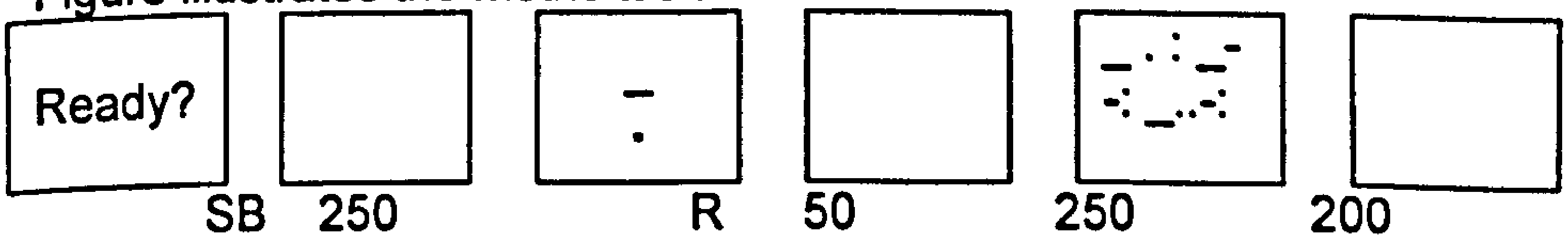
Scanning Task
Participants were presented with a circle consisting of 16 segments. Three of these segments were black and the others remained white. All the segments then turned white and an arrow appeared in the centre of the circle. Participants had to judge whether the segment to which the arrow was pointing was previously black. This task consisted of 48 trials in which on half of the trials the arrow pointed to a segment which was previously black and the other half pointed to a segment which was previously white. The trials were presented in a fixed pseudo-random order; no more than three consecutive 'yes' or 'no' trials, no more than three consecutive trials with the arrow pointing to the same segment and no more than three consecutive trials with the arrow pointing from the same distance. All participants received the same order of presentation.
Figure illustrates the scanning task



Categorical Task
Participants were presented with a dot located above or below a bar, and were to judge whether the dot was above the bar. The dot could appear at 1 of 4 distances away from the bar. The bar could appear in 1 of 3 locations; centrally and slightly above and below central. Bar-dot stimuli were presented in a fixed pseudo-random order; there were no more than three consecutive 'above' or 'below' trials and no more than three consecutive trials with the dot being a certain distance away from the bar. All participants received the stimuli in the same order.
Figure illustrates the categorical task



Metric Task
Participants were presented with a dot located above or below a bar at different distances. For this task, participants were asked to estimate the distance between the dot and the bar. Exactly the same stimuli were used as described in the categorical task. All that differed was the type of spatial judgement to be made and the order in which they were shown (same for each participant but different from the categorical task). Participants made their response by typing in their estimate (in cm) using the number pad on the keyboard with their dominant hand.
Figure illustrates the metric task



Spatial Results

All the data was exported into Excel and formulated into columns to allow for statistical analysis. Distribution testing was carried out for each experiment.
Results for the Rotation Task
Reaction times were examined by ANOVA and this illustrated if there was any difference in the mean reaction times for the 4 rotation angles, between the 2 groups: experts and novices

or if there was any interaction of these 2 main effects. There was an effect for rotation (P<0.001) in a linear trend showing that as the rotation increased so did the response time. However there was no effect for expertise, reflecting that both experts and novices need the same amount of time. Error rates were also examined using ANOVA and found a similar trend in that as the rotation increased the error rate increased but again there was no effect for expertise (p= 0.85). Further in depth analysis showed that at 0 angle the experts performed less errors that the novices (P<0.5).

Results for the Scanning Task

Similar analysis was run for this task revealing that in looking at reaction times increased as did the complexity of the task. However experts performed slower than novices. No interaction was found between the experts and the novices. In examining the error rates an effect was again found reflecting that error increases with complexity. Again there was no overall effect.

Results for the Categorical test

The reaction times were examined and revealed that there was no effect on difficulty so that as the difficulty increased the reaction times did not. As the error rates were not normally distributed non parametric testing was used and again illustrated there was no effect.

Results of the metric task

Reaction times were examined using ANOVA and this showed an effect for the increase in distance (p<.001). There was only 1 significant different found between the experts and novices in distances 1 and 4. (p<.01). The other distances are almost significant, reflecting the need to extend this study. There was an increase in error rate with distance but no main effect or the error rate between experts and novices.

The problems with this first part of the study was partly in the recruitment numbers of experts as the study and the equipment would have to be moved to other institutions at considerable cost and time to find further experts. Further novices and controls could be recruited but this would have given an unmatched sample which is important as gender and dominant handedness need to be equal across the participant groups. The closeness of the data found illustrates that continuation of this project to finish this phase and to develop a further phase would be worthwhile in understanding more how spatial abilities influence the learning of anatomy and if this is linked to the approach students take. The second part of the study is to look in detail about how touch mediated perception affects learning in experts and novices in anatomy.

vi. Glossary

Cadaver: Formal name used to describe a dead human body that is used for medical education and research.

Didactic: Information given in a direct, instructive and factual manner.

Dissection: The act of disassembling the human form for investigation of its internal structure.

Grounded Theory: A theory which emerges from the data.

Learning milieu: The social-psychological environment.

Learning pathologies: Aspects which hinder learning

Ontological reasoning: Nature of existence and the assumptions that underpin it.

Pedagogical: Profession, science or theory of teaching

Phenomenography: The study of the differing ways in which people experience, perceive, understand, conceptualise various phenomena in and aspects of the world around us.

Prosection: Professionally dissected to reveal anatomical structures
Spiral approach:

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