An investigation into the value of supplementing dissection of the human body with alternatives: perceptions of students and staff at the University of Cape Town

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Dissertation submitted in fulfilment of the requirements for the degree:

Master of Science in Clinical Anatomy

in the Division of Clinical Anatomy and Biological Anthropology

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Faculty of Health Sciences

University of Cape Town

South Africa

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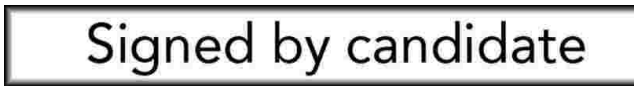
2016

Declaration of Original Work

I, Shakira Ramgoolam, hereby declare that the dissertation is my original work. All other sources of work used as reference material have been properly acknowledged and referenced in accordance with departmental standards. I have not used work previously produced by another, nor will I allow another to replicate my work with the intention of passing it off as his or her own. This dissertation has not been submitted to any other tertiary institution for examination.



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This piece of work is dedicated to my mother, Rahat Begum Ramgoolam, whose insatiable appetite for learning and teaching is what inspired my passion for education, and will continue to do so for all my years.

08/05/1957 – 14/08/2015

Acknowledgements

There were many people who made this achievable for me through their support and guidance.

Thank you foremost to my supervisor, Prof. G.J. Louw for his infinite wisdom, patience, advice and unwavering support. I have never encountered an individual with more passion for sharing knowledge and facilitating learning, and I can honestly say that my decision to undertake this Masters degree was an easy one, knowing that he would be taking me under his wing. I cannot express my appreciation for his guidance through this thesis. Thank you for sharing my excitement and passion for this topic with me, Graham. You are a formidable force in the world of anatomy education.

To my family, my very own cheerleaders. Thank you for always believing that this was within my grasp, even when I doubted myself. Dad, thanks for your direction and sage advice, for being the voice of reason always. Simi and Saira, you have been incredible, not only as sisters, but as listeners and advisors.

To my dear friends, thank you for your help, never ending support and for being on call for me 24/7. I sought so much comfort in the fact that I knew you were all there for me, all of the time, no matter what. Special thanks to Yoshlin for going above and beyond in acquiring incentives for me in order to boost my response rate, and to Kashen who went through the painstaking process of formatting my document.

Rushil, thank you from the bottom of my heart for anchoring me through this time. This was the most mammoth task I've probably ever undertaken by myself, and you were in the trenches with me from the beginning, right up until the end. There are no words that I could possibly use to explain how much it has meant to me.

To Niel, "my" statistician, if patient had a name it would have yours! Thank you for all the hours you put into making my work have statistical relevance. Thanks for explaining the same simple thing over and over again, and redoing analyses for me as many times as I asked, always with a smile.

Thank you to the staff and students of the faculty for taking personal time to complete my survey. This study would be absolutely meaningless without your honest input. Thanks, also, to Greg Doyle and the I.T. department for handling all the administration around the survey, for sending out reminders and making sure everything ran smoothly.

To my employer, Old Mutual, thank you for believing in me enough to fund my study, and for nurturing my passion for academia through the years. Special thanks to Peter for taking the time to proofread my work.

Finally, thank you to the donors who have dedicated themselves to this remarkable science, without whom, we would never know what we know today. Thank you for affording newer generations the opportunity to discover the wonder that is the human body through their very own experiences.

Abstract

The purpose of this study was to explore the perceived value of supplementing the traditional cadaver dissection course at the University of Cape Town's Faculty of Health Sciences (UCT FHS) with alternatives in order to aid students in their learning of anatomy. The study aimed to collect information which could be used to provide insight into facilitating a deeper educational experience for students and teachers alike in the future with the aim of better retention of knowledge over time. The intention of the study was to obtain results which could potentially provide insight into the feasibility of adopting a contemporary view on anatomy education at UCT FHS and thus inform the anatomy course in the future by acquiring feedback directly from the students and staff of the university.

Data was collected by way of a 22 question survey delivered to second to sixth year MBChB students as well as the staff and postgraduate students at UCT FHS. The survey was entirely voluntary. A total of 190 complete responses were collected.

The results of the study indicate that both staff and students feel that the cadaver dissection course is an irreplaceable part of the curriculum, and if the faculty chose to use any technological alternatives to teach anatomy, that they should supplement and not replace traditional dissection. Furthermore, the study showed that the staff and students are comfortable with technology in general, and are open to the use of various technologies such as online material, virtual software, media sites, applications and the like in order to bolster their learning.

These results may provide insight into the viability of adopting a contemporary view on anatomy education at UCT FHS and may thus inform changes to the anatomy curriculum in the future.

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Chapter 1 - Introduction

1.1 Students in the age of Internet and technology

In this age of constant progression, advancement and discovery, we have little choice but to embrace the World Wide Web and harness its power to teach, direct learning and instil knowledge. While a great deal of the content available on the Internet may not be deemed reliable, there is a quantum of easily accessible information available which informs a huge proportion of the world's technologically savvy population on a daily basis, minute by minute. It makes sense, then, to explore just how big an impact the Internet has had on today's tertiary students, and use that information to guide learning interventions in those tertiary institutions that still rely heavily on traditional educational resources as teaching tools.

It is apparent in the literature that student learning styles are a topic of great interest for researchers, with the suggestion that in order to achieve the optimal teaching-learning experience, it is necessary to understand the way in which learners of today assimilate knowledge. To this end, there has been considerable debate around and research into articulating the definition or profile that accurately describes today's student.

One of the findings is that today's student is deeply involved in and almost reliant on the Internet and associated technologies (Oblinger, 2003; Mangold, 2007; Gurung & Rutledge, 2014). Various phrases have been coined to describe students, with the "Net Generation," the "Google Generation," "Generation Y" and the "Millennials" being used most widely and interchangeably. While each group may have its own nuances as described in the literature, this collective group is described as all having been born post-1980, into an age of rapid technological advancement, and who therefore slot in with the Internet age in that they deem this technology to be a regular part of life (Oblinger, 2003; Prensky, 2005; Mangold, 2007; Rowlands *et al.,* 2008; Ashraf, 2009; Jones *et al.*, 2010). These are believed to be the students who enter university as technologically-savvy individuals, who have a natural affinity towards and all-round understanding of the World Wide Web, social media platforms, and technology in general (Oblinger, 2003; Prensky, 2005; Thompson, 2007).

This theory, although powerful, has faced much scrutiny since it was first suggested in the early 2000's, with the opposition mainly questioning the notion that these "digital natives" have adapted their learning styles and preferences by virtue of their technological prowess. Recent research has shown that, in fact, that there is insufficient evidence to support that this group of young people is an homogenous one with similar inclinations towards technological means to support their learning. (Bennett & Maton, 2010; Brown & Czerniewicz, 2010; Czerniewicz & Brown, 2010; Kennedy *et al*, 2010; Akçayır *et al*., 2016).

In the South African context in particular, arguments have arisen as a result of the "digital native" debate which indicate that, in fact, our students present with a diverse range of technological capabilities and do not all fit into the "digital native" mould. This is often as a result of limited access to technological resources owing to previously disadvantaged circumstances. (Molawa, 2010; Thinyane; 2010). It is therefore not always realistic to superimpose this developed world view on the broader developing world situation. This view excludes those South African students who exist in the "elite" developed world type category and do have full access to the Internet and various

technologies. Just by looking at the demographics of the undergraduate students at the University of Cape Town's Faculty of Health Sciences (UCT FHS), one will see that two thirds of the MBChB programme are typically female, one third are male; there are a mixture of school leavers and students transferring from other degrees as well as a variety of postgraduate students entering various programmes, all of who come from a range of backgrounds. This heterogeneity is owed to the increasing range of cultural and educational backgrounds entering into tertiary qualifications in South Africa (G.J. Louw, personal communication, 8 August 2016).

A review of 127 articles covering the "digital native" topic was undertaken by Eliana Esther Gallardo-Echenique and colleagues in 2015. The authors concluded that, while it is true that we exist in a technologically driven era, it is not accurate to have a generalist view of the learners born into this era, given that there are a wide range of interdependencies at play that influence and impact learners, including social, regional, global, economic and cultural factors. They further concluded that more emphasis should be placed on technological advances and access to technology in the developing world as opposed to the developed world. They suggested that the overarching description of students born into this technological age should be that of "digital learners" rather than "natives." They believe that this description will cater for the diversity which exists within this wide population of learners while still recognising the place that technology has in learning and teaching today (Gallardo-Echenique *et al*., 2015).

It will be remiss to ignore the global impact of technology on the youth of today. It may prove worthwhile for South Africa in particular to track how our tertiary students will respond to the ongoing initiatives for improved access to technology, and whether teaching methods can evolve over time as comfort and interaction levels with various types of technologies increase.

A number of studies have been aimed at decoding the way in which technologically capable youths prefer to learn, interrogating what exactly it is they use the various technologies for. It is known that the vast majority of university students either own or have access to a desktop computer, a laptop computer or a notebook (Junco, 2014). Many institutions, including certain faculties at the University of Cape Town, have made laptops a prerequisite for new students, and have facilitated and aided in the purchase of personal laptops for students via various price plans (Elwood *et al*., 2006). Further to this, the majority owns smartphones and/or media devices such as iPods and iPads. Each of these devices facilitates accessibility to the Internet, and as such, provides the user with a world of technological capability at the click of a button (Aiken *et al.*, 2003; Bongey *et al.,* 2006*;* Jacob & Issac, 2008; Jones *et al.*, 2010; Junco, 2014). The smartphone is a multifunctional digital device that has gained popularity in recent years and dramatically increased in sales due to its mobile capabilities (Park & Chen, 2007; Gartner, 2010). University students are among the highest contributors to smartphone sales, supporting the theories that connectivity to Internet via modes such as 3G and Wi-Fi has become part of daily life for this generation of learners. The smartphone is able to facilitate this access anywhere, anytime. (Woodcock *et al.,* 2012; Bomhold, 2013; Suki, 2013). A recent study on first year students in two South African universities by Hannah Thinyane (2010) has shown that, even in the South African context, smartphone ownership and usage by first year students is higher than any other device or medium (for example desktop computers, MP3 players, etc.), which suggests that exposure to and use of technology is on the increase. This is a positive indication that there is potential in technology to enhance South African student learning through improvements in teaching resources and methodologies.

The last few decades have seen the evolution of the Internet into Web 2.0, a newer version of the World Wide Web which promotes user participation as opposed to simply providing information via an Internet search (as with Web 1.0). This has meant that people are now not only able to seek information, but are also encouraged to share and collaborate all within the virtual realm (Thompson, 2007; Ng & Hussain, 2009; Jones *et al.*, 2010). Ownership of these devices enable an on-the-go, always-connected culture, the greatest example of which is probably social networking. This occurs via websites and applications such as *Facebook* (a social networking site where friends are made and various information shared), *WhatsApp (*a messaging service which allows for free messaging between all smartphone brands as long as the user is in a Wi-Fi zone or has 3G enabled), *Twitter* (a social networking site where "tweets" limited to 140 characters and pertaining to one's interests are shared) and *YouTube* (a video sharing website) and *Instagram* (a photograph sharing platform) to name but a few (Jaffar, 2012; Salomon, 2013; Junco, 2014). These social media sites promote engagement and a culture of information sharing and distribution. Due to their design simplicity and instantaneous results, users are able to get involved with ease (Boulos *et al.*, 2006).

The collaborative information distribution power of Web 2.0 is further displayed in *Wikis*, *Blogs* and *Podcasts*, each of which gives the user the option to share personal as well as educational information with the Internet audience. *Wikipedia* is an online encyclopaedia of anything and everything. The word "Wiki" is derived from the Hawaiian word for "fast." All content available on the website can be edited and added to in real time by all users, and as such, reliability of information may be questionable. However, this website is a remarkable example of virtual online collaboration towards a common goal (Skiba, 2005; Sauer *et al.*, 2005; Boulos *et al.*, 2006). *Blogs* (contracted from the term "web logs") refers to electronic entries on a portal that are representative of journal entries in date order. These can range from personal experiences, to recipes, to lifestyle information, to educational information – the list is endless. A *blog* can be owned and managed by a single person or by a group of "*bloggers*" as they are called. The popularity of the content and bloggers on any particular *blog* is directly quantified through the number of people following it. In short, the power of reaching targeted audiences through *blogging* is vast, and *blogs* can be powerful learning tools if used appropriately (Boulos *et al.,* 2006; Downes, 2009). *Podcasting* is the recording of audio (or video) clips which can then be made available via download onto devices with playback capability, such as an iPod, smartphone or computer. The value of *Podcasts* lies in the fact that almost anything can be recorded, stored and played back whenever needed. It cuts out the furious writing of notes during a lecture, for example, which could contribute to the efficiency of the student learning experience (Boulos *et al.*, 2006; Jham *et al.*, 2008). Many universities have already tapped into the potential of the *Podcast* for delivery of educational information in order to reinforce student learning (Bongey *et al.* 2006; Patasi *et al.*, 2009; Walls *et al.,* 2010).

This ever-increasing level of interaction with technology has meant that the students of today are potentially equipped to be self-sufficient active learners, who with the guidance of a staff member (or mentor), will be able to direct their own learning beyond the classroom if empowered to do so (Landbeater, 2004; Ng & Hussain, 2009; Woodcock *et al.*, 2012).

1.2 The role of dissection as a teaching tool

Dissection of the human body has been at the very core of anatomy learning for centuries. It is considered the fundamental basis for medical education and clinical skills development of any

clinician in training, and has been the primary means for teaching anatomy from as early as the third century. The first ever systematic dissection on a human cadaver is said to have been performed by Herophilus, a Greek medical practitioner born in 335 BC / 335 BCE (Von Staden, 1992). He was later dubbed the "father of Anatomy," based on his extraordinary findings in anatomy and physiology. It is thought that Herophilus learnt from Praxagoras, born around 340 BC who was an influential medical practitioner in Ancient Greece (Von Staden, 1992; Elizondo-Omana *et al.,* 2005). Herophilus went on to become a pioneer in the anatomy world, and his breakthroughs shaped a foundation which later informed and guided subsequent anatomical discoveries. Many argue that he was perhaps the greatest anatomist of all time (Wiltse & Pait, 1998; Bay & Bay, 2010). He, together with his student Erasistratus (born ~ 310 BC), undertook methodical cadaver dissection in an age where it was considered taboo (Von Staden, 1992; Štrkalj & Chorn, 2008). Herophilus is said to have been the first to discover and describe the ventricles of the brain, the valves of the heart, the male and female reproductive systems, differences between sensory and motor neurons, differences between cranial and spinal nerves, membranes of the eye, the accurate anatomy of the liver and pancreas, the functional differences between arteries and veins, and was also responsible for building on and demystifying a host of anatomical discoveries which predated him (Von Staden, 1992; Wiltse & Pait, 1998; Bay & Bay, 2010).

After Herophilus' death, human cadaver dissection ceased entirely, and was only to begin again some 18 centuries later. This was attributed to the fact that during that time in Ancient Greece, and having lost the strong influence of Herophilus, the act of dissection was once again considered sacrilegious, immoral and offensive (Von Staden, 1992; Wiltse & Pait, 1998; Elizondo-Omana *et al.,* 2005).

The works of Galen (born ~129 AD / ~129 CE) went on to add to the legacy left behind by Herophilus. Galen practiced medicine in medieval Rome and was a prestigious and prominent physician. His work was centred around animal dissection, particularly that of Barbary monkeys and pigs, and he penned his findings in a manuscript called *Treaty of Anatomy.* There were a number of errors in Galen's descriptions, particularly pertaining to the anatomy of the organs he described, but in spite of this, his work was taught extensively to physicians in training for centuries to come. It is believed that the Catholic Church forbade any criticisms of Galen's work, which perpetuated the teaching of erroneous information and diminished progress in the anatomical field through until the 16th century (Elizondo-Omana *et al.,* 2005).

Mondino de Liuzzi (1270–1326) produced work which could be considered as the first insights into early modern Anatomy. He was born in Bologna into a time where academia began to flourish, and took up a full-time career in anatomy at the University of Bologna in a time when Galen's works were taught exclusively (Rengachary *et al.*, 2008). His refreshing and somewhat controversial take on anatomy earned him the title "Restorer of Anatomy." Even though Mondino's goal was to confirm those findings penned by Galen, it can be seen in his publication *Anathomia* that he had no choice but to refute some of Galen's theories through his own findings. He took a bold step and introduced dissection as an integral part of the medical curriculum, and performed dissections solely on cadavers, which exposed Galen's many oversights (since the majority of Galen's work was done on animal dissections). Despite this, Mondino still followed a Galenic approach through all his teachings (Crivellato & Ribatti, 2006; Rengachary *et al.*, 2008). His publication *Anathomia* is regarded as the first dissection manual, in that it is a book of pure anatomy, with painstaking documentary of

images and descriptions of each systematic dissection. Although Mondino made a gallant move to reintroduce dissection as the primary source of anatomy study, his apprehension to move past Galen's gospel meant that the study of anatomy would only be elevated in years to come by the anatomists subsequent to him. Interestingly, many of Mondino's findings were also flawed and thus perpetuated the cascading of misguided anatomical learning built on from Galen's work. One of the potential reasons for his inaccurate discoveries cited in the literature (over and above his allegiance to Galenism) is attributed to the fact that Mondino and his apprentices performed public dissections in large anatomical theatres, which was the standard university practical setup of that time, as all students learnt through observation primarily (Andrioli & Trincia, 2004; Crivellato & Ribatti, 2006). In an age where preservation techniques and refrigeration were unprecedented, this meant that the sequential dissections had to be performed quickly to minimise the viewers' exposure to the unpleasant odour and experience of putrefying human material. The dissections were therefore rapid and often rudimentary, which would no doubt compromise the integrity of the structures that Mondino would later document and describe post-dissection. That being said, Mondino's observations did play a large role in guiding successive anatomical findings.

It was during the Renaissance (approximately 1400 CE to 1600 CE), in a time of literary, artistic and academic revival, that age-old beliefs were challenged across all disciplines. It was amid this time that the greatest breakthroughs in anatomy post-Herophilus were made, and that the study of anatomy moved swiftly in the direction of modern anatomy as we know it today. This leap was spearheaded by Andreas Vesalius (1514-1564), who is considered the founder of modern anatomy and was pivotal in revealing the multitude of flaws in Galen's work. Vesalius described all his findings in the book *De humani corporis fabrica* (On the fabric of the human body) which was to become the most reliable reference point for all anatomists thereafter (Elizondo-Omana *et al.,* 2005; Gunderman & Wilson, 2005). Vesalius' belief was that anatomy could only be learnt through direct observation of the human body via dissection. His theories and teachings would go on to become the basis for the scientific method as we know and apply today (Benini & Bonar, 1996). His work on *De humani corporis fabrica w*as pivotal in overcoming the overarching authority of the Church and the deeply entrenched teachings of the anatomists before him, and this led to anatomy being approached and viewed in an objective manner once more, and for the first time in centuries (Gregory & Cole, 2002). Leonardo Da Vinci (1452-1519) shared similar sentiments with Vesalius, and he too played a significant role in swaying the traditionalist mind-sets towards a more modernistic approach to learning anatomy. Da Vinci's talents were plenty. He may have been an artist by trade, but showed exceptional talent in many fields, including engineering, science, music, mathematics, philosophy and most notably, anatomy and physiology. His intricate and complex drawings of various anatomical structures were only matched by Vesalius years later, when *De humani corporis fabrica* was published (Shoja *et al.*, 2013; Cothern, 2015). It is thought that Da Vinci made the most significant contribution to uncovering the mystery of the cardiovascular system before Vesalius took centre stage with his own discoveries (Shoja *et al.*, 2013). In fact, Vesalius is said to have utilised Da Vinci's drawings as reference material during his research, only some 24 years after Da Vinci had died (Cothern, 2015).

Following on from these fundamental works, the study of anatomy flourished and major contributions were made by William Harvey, Johann Friedrich Meckel and by Henry Gray, whose publication *Gray's Anatomy* became a gold standard reference book for anatomists and artists alike.

Through the centuries, and to this day, it is the cadaver dissection course that provides what is considered to be the single most significant introduction to a career as medical practitioner. It is the most consistent feature throughout the evolution of medical education over the years, and as such, does carry immense merit from an educational perspective (Dyer & Thorndike, 2000; Gunderman & Wilson, 2005). This close encounter with the human form is what serves as the initial rite of passage into the medical fraternity, and is probably the deepest form of anatomy learning in that it is tangible from the beginning right through to the end (Aziz *et al,* 2002; McLachlan *et al.*, 2004; Pawlina & Lachman, 2004).

It begins with teaching the student to be compassionate and respectful towards what once was a living being, and as such informs the student about matters surrounding death and dying (Marks *et al*., 1997). Through close and regular engagement with the cadaver, the student is able to relate life to death, to appreciate and respect the magnitude of dying and to come to grips with the reality that life is finite (Ellis, 2001; Rizzolo, 2002; Granger, 2004; McLachlan *et al.*, 2004). This interaction with the cadaver contributes as a first step towards developing the sensitivity, empathy, compassion and professionalism necessary for doctor-patient relationships that are essential for qualified and successful medical practitioners (Marks & Bertman, 1980; Aziz *et al,* 2002; Gregory & Cole, 2002; Rizzolo, 2002; McLachlan *et al.*, 2004).

Through systematic dissection, starting superficially, the human body reveals itself to the student layer by layer, guided by the experts who did the very same dissection in previous years. In using this methodical technique, the body is appreciated in three dimensions, and the immaculate human design is exposed, physically and mentally mapped using multiple senses, and understood step by step (Dinsmore *et al.,* 1999; Marks, 2000; Rizzolo, 2002; Granger, 2004; Guttman *et al.* 2004, McLachlan *et al.*, 2004, Gunderman & Wilson, 2005). The student becomes familiar with every organ and facet of the cadaver, through delicate dissection techniques, which develop manual dexterity. Dissection could be thought of as the first lesson in surgical skills, in that fine motor skill is tested, albeit rudimentary at this early stage (Ellis, 2001; Older, 2004; Gunderman & Wilson, 2005; McLachlan & Patten, 2006).

Each tissue, organ and system of the body is observed, examined, probed and classified, and by way of this direct contact, structures are named and remembered (Older, 2004; McLachlan & Patten, 2006). As such, the fundamental language of medicine is first learnt from inside the dissection laboratory (Ellis, 2001; Granger, 2004). During the dissection course, students are able to appreciate that structure and function are interlinked, and that pathology is intertwined between the two (Ellis, 2001; Aziz *et al.*, 2002). In addition, human anatomical variation is observed when comparing two or more cadavers in the dissection laboratory, something that can only be achieved through comparing actual human bodies, and so the understanding that no two bodies are exactly the same is entrenched (Granger, 2004; McLachlan, 2004, Older, 2004). Further to this, the concept of “normal” is learnt, and that some variations in the way anatomical structures appear are not necessarily abnormal (Willan & Humpherson, 1999; Miller *et al.*, 2002; Benninger *et al.*, 2014).

Team work is encouraged through group dissection and discussion in the laboratory. Not only does this facilitate valuable interactions regarding anatomical variations and identifying pathologies, it also enables students to engage on the same level as medical professionals in training, and thus creates a sense of community and support. This is especially important for those who may struggle

with the emotional component and sensitivity of working with cadavers (Granger, 2004; McLachlan & Patten, 2006). When faced with a problem during the dissection, they are able to seek guidance from each other as well as from mentors and lecturers who are present in the lab and who have the expertise and experience to provide sound advice and counsel where necessary (Ellis, 2001; Older, 2004).

Ultimately, the outcome of a cadaver dissection course is to give the student a firm foundation upon which to build the skills which will finally deem him or her an independent and confident professional clinician, regardless of the speciality that is chosen within the field (Rizzolo, 2002; Pawlina & Lachman, 2004; Collins, 2008).

1.3 Advances in anatomy education

With global advances in technology and innovation across all industries and disciplines, it makes sense that tertiary education curricula follow suit so as to ensure that today's education remains current and relevant. What this has meant is that more and more tertiary institutions are introducing and implementing electronic and various other methods as alternatives to traditional teaching methods. The same holds true for medical curricula. For anatomy in particular, certain institutions have seen a shift towards using innovative ways of learning, either supplementary to or in place of traditional dissection (Reidenberg & Laitman, 2002; Kerby *et al.,* 2011; Chapman *et al.*, 2013). It is appropriate to consider the various sentiments here.

Amidst the change in the mind set of educators, there has been much debate into the necessity of a cadaver dissection programme as part of medical school curricula, and some institutions have done away with it all together, favouring alternative teaching methods. The school of thought in favour of removing dissection from the core anatomy module argues that the disadvantages of the overall dissection experience outweigh the value. A general feeling is that learning anatomy using aged cadavers (who represent the bulk of donor society) may not represent what the clinicians in training will encounter later on once they are qualified. The belief is that the emotional response to dissection of a cadaver is far reaching for some, who display anxiety throughout the course and are never able to come to terms with the issues around death and dying (Warner & Rizzolo, 2006; Collins, 2008). At the other extreme, some students are desensitised to a point of not caring and therefore have trouble gaining that respect for the human body that is crucial to carving out a successful professional medical career (McLachlan *et al.*, 2004; McLachlan & Patten, 2006). Other research reports that the look and smell of the cadaver is off-putting for students (Miller *et al.,* 2002; McLachlan, 2004) and that there are clear health and safety issues attached to working with preserved human material, such as exposure to certain infectious diseases (especially prions) and vulnerability to the chemicals (formaldehyde, for example) used to embalm the cadaver (Aziz *et al.*, 2002, Demiyurek *et al.*, 2002). There are also some legalities and ethical issues around obtaining human material for educational purposes (for example, obtaining permission for the use of the remains of indigent people). Finally, the practicalities surrounding acquisition of cadaver material is cited as a hindrance to the success of the dissection module, such as the steady decline in the numbers of bequeathed bodies in the absence of an active drive to encourage members of the public to donate their bodies to a medical school, which increases the student-to-cadaver numbers. This is exacerbated by the pressure that universities are experiencing to dramatically increase student numbers globally. In addition, there are practicalities around the costs associated with

preserving, storing and transporting cadavers as well as the great deal of time devoted to teaching and learning anatomy through the practical dissection course, which presumably could be used in a different way (Aziz *et al.,* 2002; McLachlan & Patten, 2006; Bergman *et al.*, 2014).

Based on the decrease in dissection time, or removal of the dissection course altogether, greater emphasis has been placed on using alternative methods to aid in the teaching and/or learning of anatomy in various schools, as explored in the following section.

1.3. a) *Prosection, Plastination, Models*

The challenge with cadaver dissection is overcome in many schools to some extent by using prosected specimens, plastinated specimens and plastic models to guide anatomy learning interventions (Dinsmore *et al.*, 1999; Winkelmann *et al.*, 2007; Collins, 2008; Craig *et al.*, 2010; Attardi & Rogers, 2015). Prosected cadaveric material is beneficial in that similar learning outcomes can be achieved without having to perform a full body dissection, and areas of interest are focused on as opposed to a generalised dissection course, as is the case with the Health and Rehabilitation Sciences students at the University of Cape Town. Some studies advocate that using prosected material in anatomy learning is adequate for undergraduate medical students, and that deeper and more thorough dissections are only necessary for specialist surgical training (Dinsmore *et al.*, 1999; Collins, 2008). Plastination of specimens is a relatively new method of isolating tissues and preserving anatomical structures effectively and accurately (Riederer, 2014). This technique was pioneered by Günther Von Hagens in 1977 (Von Hagens, 2006), and has become one of the most widely used preservation methods today. The advantage of this technique is that the tissues and organs are preserved in a way such that the plastinated specimen can be handled with minimal damage by virtue of the polymer that is injected into the cadaver material during the preservation process, and the preserved material is free of any odour (Sugand *et al.*, 2010). The downside of using plastinates is that the preservation outcome is a rigid structure which makes it difficult to visualise concealed or obscure anatomical structures, and the authenticity of plastinated material has been questioned, given that water and fat make up eighty percent of the human body (Korf *et al.*, 2008; Riederer, 2014). Plastic models provide lifelike representations of anatomical structures which last a long time and can be handled without any damage. The advantage of using plastic models is that the student is able to view regions of the body that are not dissected easily or at all (for example, the inner ear or pelvis). The disadvantage of plastic models is that human variation cannot be seen as with prosection and plastination (Sugand *et al*., 2010). Another downside of using plastic models is that they are not always realistic representations of anatomical sites (Korf *et al*., 2008). Further to prosections, plastinates and plastic models, there has been a rebirth into using "living anatomy," which refers to using live subjects to direct anatomy learning. The advantage of using live human models is that the student is able to view anatomy as it occurs in the living, and learning outcomes are achieved by directly inspecting, palpating, percussing and auscultating, in much the same way as a doctor would his or her patient. There is, however, little emphasis and reference to the learning outcomes on the use of living models, both historically and currently, and further study needs to be done in this area to test and interrogate the feasibility of using this approach (McLachlan & Patten, 2006; Ganguly & Chan, 2008).

1.3. b) *Imaging techniques, Clinical Simulations*

The advances in imaging technologies in the medical field over recent decades have meant that we are now able to view, monitor, and treat the human body in various ways that were never possible before (McLachlan & Patten, 2006). Building on from the advent of the x-ray, imaging technologies today enable a view of the interior of the body in many dimensions without invasive procedures. These views include magnetic resonance imaging (MRI) and recent advances on this technology such as diffusion weighted imaging (DWI), computed tomography (CT), positron emission technology (PET), ultrasound (including rapid advances within this technology) and laparoscopic techniques which create a visual image of the body in 3D without having to operate, or using only minimally invasive procedures (Reidenberg & Laitman, 2002; Guttman *et al.*, 2004; Glasgow *et al*., 2006). The educational value of these techniques is insurmountable. Radiological imaging is used widely in anatomy education, providing anatomical information as it is seen in a living subject (Benninger *et al*., 2014). This is advantageous to the medical practitioner in training, in that it allows for the student to recognise and identify anatomical structures in the living subject as well as from medical images, thus enriching the anatomy learning experience (Schramek *et al.,* 2013). Simulation of clinical procedures takes digital imagery and videography to the next level, and is considered a safe substitute for clinicians in training to practice their surgical skills (Kneebone, 2005). The benefit of utilising surgical simulators lies in the fact that students can perform real surgeries on simulated virtual reality "patients" repeatedly and with minimal risk, and are therefore able to practice until they are comfortable (Seixas-Mikelus *et al.*, 2010; Khan *et al*., 2011). Similarly, simulations performed in the dissection lab have been found to at least aid in, if not enhance, anatomy learning in a classroom environment (Hariri *et al.,* 2004; Barry Issenberg *et* al., 2005). The great advantage of learning through simulations is that various reproductions of real structures and/or procedures can be performed or viewed with minimal cost and no risk, by virtue of an array of pre-designed software options available. An added benefit of simulations is that students' proficiency can be assessed repeatedly using a simulated environment before the student moves into the real environment (Scalese *et al*., 2008). Combining traditional teaching with digital imaging techniques and simulations may prove to be a cost-effective, practical and reliable means of learning anatomy into the future (Kneebone, 2005; Kunkler, 2006; Schramek *et al.,* 2013).

1.3. c) *Computer-assisted learning, Multimedia, Virtual Reality*

Everything that we know thus far about the anatomy of the human body has been directly observed and uncovered through systematic dissections. There is not much more to discover directly from cadaver material, apart from potential human variations which have yet to be uncovered. Even with this, many structural features that were previously considered to be anomalies are now seen as falling within a range of normal human variation. It is therefore in keeping with advances in education and technology to utilise computerised methodology to guide learning of anatomy. The possibilities are endless from a technology point of view due to the multitude of modalities out there. While the use of human specimens, either cadaveric or living, does no doubt provide vital anatomical information, this is not necessarily considered the most modern means of learning anatomy. There has been a surge in research over recent years dedicated to investigating and developing contemporary means of learning human anatomy, building on the in-depth knowledge gained from dissection, while aiming to maintain the core principles that one would attain from a cadaver dissection course (Collins, 2008; Papa & Vaccarezza, 2013). Computer-assisted, multimedia

learning has been the focus of many medical education studies, and sound groundwork has been done to establish the feasibility of different technologies and their role in medical education. With the rapid increase in availability and considerable decrease in cost of computer hardware and software, as well as the diminishing time devoted to anatomy learning by dissection in many institutions, it is only logical to explore the inherent value here (Inwood & Ahmad, 2005).

Virtual anatomical models incorporated into computer software provide 3D representations of anatomical structures which can be rotated in space and observed from different orientations. The recent focus on alternatives to teaching and learning anatomy has seen an increase in utilisation of this type of software, and some publishing houses have even tapped into the market by making fully interactive 3D anatomical models available for institutions and individuals to purchase (Sugand *et al.*, 2010; Kour, 2012; Attardi & Rogers, 2015). One software programme dubbed "Yorick – the VR skull" was developed using QuickTime® virtual reality (QTVR), a technology introduced by Apple inc. in the early 1990's. The developers used high resolution photographic images of the skull and incorporated them into the virtual reality programme, which enabled students to rotate and manipulate the skull using a mouse cursor. This programme was used in first and second year gross anatomy courses at Wright State University School of Medicine in Ohio, and the student feedback showed that the programme was beneficial in preparing for practical and written examinations, and was easy to use whilst providing useful and relevant information (Nieder *et al.,* 2000). The versatility of QTVR in the past decade has been illustrated further by virtual light microscopy slides which can be imported into QuickTime® and viewed or manipulated using the programme. Further to this, QTVR has been used to create simulated electron microscopy views in a virtual environment, a capability that could assist students to familiarise themselves with the intricate views under an electron microscope using simulated technology at a fraction of the cost (Trelease *et al.* 2000).

These modes of computer-assisted learning could prove beneficial when looking at structures too small to dissect effectively (as an unskilled student) such as the inner ear anatomy, which is embedded in bone. A study by Nicholson *et al.* (2006) showed that a computerized 3D model of the ear anatomy did in fact aid in students' learning of these tiny structures. Sinav and Ambron (2004) took a similar approach to the pterygopalatine fossa, which is difficult to expose via dissection or to visualise by fixed images. They developed an animated web programme which facilitated teaching of the functional anatomy of the fossa, and showed that it promoted understanding of this otherwise difficult to grasp practical component of functional anatomy via interactive 3D modelling (Sinav & Ambron, 2004). On a larger scale, the Visible Human Project has consolidated the entire anatomy of a male and a female human body into a single digital collection via images of actual cross-sectional slices through a human body stored in a reference database (Ackerman, 1999; Spitzer & Scherzinger, 2006). The database is made up of multiple digital CT and MRI images, as well as cryosections imported into the digital dataset, which then constitute an entire digital human body. A great advantage of this database is that it is available at no cost directly from the National Library of Medicine, which makes it an easily accessible and cost effective means of learning anatomy.

The Visible Human Project has, in essence, set the foundation for the development of more innovative virtual frameworks with which to learn anatomy without the cadaver. Temkin *et al.* (2002) built on the Visible Human Project and designed a system they refer to as "Web-based three-dimensional Virtual Body Structures (W3D-VBS)." This programme took the library of information stored in the Visible Human database and heightened the educational potential by employing virtual

reality, voice recognition and haptic technology to create a fully interactive package, taking the user on a "virtual tour" of the human body. The developers claim that users do not have to be medically inclined or have any prior anatomy learning in order to utilise or learn from the programme effectively, the advantage of which is that it will be straightforward to implement in any institution and user-friendly across the board.

More recently, virtual reality modalities were employed to build an interactive 3D atlas of the human body. Hamrol *et al.* (2013), together with design experts, used existing frameworks upon which to build a digital representation of a three-dimensional human body. The accuracy of the anatomical structures was reviewed and audited by medical specialists, thereby ensuring the feasibility of the atlas. The outcome was an interactive programme that allowed for manipulating organs in multiple orientations, hiding chosen body systems, changing others from transparent to opaque on a sliding scale, and viewing different cross-sectional planes of the body. This prototype was tested by lecturers and students, and the results of the exercise were positive overall.

It is encouraging to see that new and contemporary virtual methods are being conceived and tested on an ongoing basis to continue the advancement of medical and anatomy education.

1.4 Feedback straight from the source

There are an increasing number of publications addressing the use of technological and other alternatives as additional resources to dissection of the body in the teaching and learning of anatomy (e.g. Reidenberg & Laitman, 2002; Inwood & Ahmad, 2005; Kerby *et al.,* 2011; Chapman *et al.*, 2013). There is no doubt that the introduction of technology into the anatomy curriculum has proven beneficial to the overall student learning experience and outcome (e.g. Tam *et al.*, 2009; Choudhury & Gouldsborough, 2012; Kish *et al.*, 2013; Papa & Vacarrezza, 2013; Attardi & Rogers, 2015). As such, there is enormous potential in combining dissection with technology to produce what could become the new standard in anatomy education. The most effective way to measure the viability and efficacy of technological alternatives or supplements to learning anatomy is arguably via feedback straight from the source (Davis *et al.*, 2014). To this end, a great number of studies have evaluated student perceptions and attitudes towards novel and non-traditional ways of learning anatomy. A few of these are described below.

McNulty and colleagues designed an integrated, virtual, online application called "LUMEN dissector" to supplement laboratory dissection (McNulty *et al,* 2000). A study of the first year cohort at Stritch School of Medicine, Illinois, was conducted over 2 years to establish the usefulness of this application. Feedback was collected by way of questionnaires completed by the students who used it over the 2 years, as well as by monitoring the level of use of the application (McNulty *et al*., 2004). The results of the study showed that students who regularly chose to use the application outperformed those who used it less or not at all, again, supporting the theory that computer-assisted learning is an effective means of learning anatomy (McNulty *et al.*, 2009). A similar study was conducted in 2007/2008 at the University of Munich, where students were granted access to a multimedia anatomy learning tool, the usage of which was entirely optional. Those who elected to use the tool reported a generally positive experience. The drawbacks of the tool included difficulty in navigating and searching, which can be viewed as minor, easily remedied issues (Adamczyk *et al.*, 2009). John Hopkins University tested the feasibility of using radiological images via a web portal to supplement a first-year dissection and lecture course. Student feedback by way of a survey was

reviewed and, while the portal was reported as being helpful and useful, the study indicated that more work needed to be done to improve the student experience. This feedback may not have been overwhelmingly positive, but is important, in that it is vital to the ongoing improvement of these teaching modalities (Marker *et al.*, 2012). In another study, the blood vessel anatomy was incorporated into a virtual reality programme (using QTVR) and introduced to students at Linköping University, Sweden, in May of 2007. Advantages and disadvantages were discussed, and the overall student impression was that the 3D virtual reality programme was useful in facilitating learning and understanding of the vasculature. Again, the authors do appreciate that more work needs to be done to get the programme to the level it needs to be at to address all student needs (Petersson *et al.,* 2009).

While the evidence thus far strongly suggests that technological alternatives to dissection are indeed helpful, it is important to consider student (or "user") perceptions as the pivotal factor that should guide new methods of teaching anatomy. While it is progressive to introduce various new ways of learning anatomy, unless there is buy in from the learners themselves, the best learning outcomes will simply not be achieved. Research in this area has shown that, generally, students rank the dissection course very highly in terms of educational value. While the examination of prosections, models and plastinated specimens is cited as useful, cadaver dissection still comes out on top in that it facilitates a deeper, if not the deepest, learning experience (Dinsmore *et al*., 1999; Azer & Eizenberg, 2007; Smith & Mathias, 2007; Winkelmann *et* al., 2007; Chapman *et al*., 2013; Van Wyk & Rennie, 2015). The student opinion therefore corroborates the wealth of literature penned by the proponents for dissection as indispensable and invaluable to the learning of anatomy (Dyer & Thorndike, 2000; Aziz *et al,* 2002; McLachlan *et al.*, 2004; Pawlina & Lachman, 2004; Gunderman & Wilson, 2005; Korf *et al.*, 2008; Adamczyk *et al*., 2009). Further to this, traditional books (textbooks and atlases) are generally favoured over digital or e-books, probably based on the ease of reading a classical book versus an online/digital one (Shepperd *et al.,* 2008; Woody *et al.,* 2010). From a class perspective, e-learning or online lectures are not as well received as face-to-face interactions. This could be attributed to the fact that there is little or no interaction, active discussion and motivation in the virtual realm, unless the student is actively involved or has prior experience with virtual discussion forums or chat groups, and may result in the student feeling alienated and unsupported (Cook, 2007; Svirko & Mellanby, 2008). However, research strongly suggests that elective or pilot e-learning and web-based modules and courses have been well received by students who make use of these options, with several papers showing better performance as compared with groups who choose not to utilise the alternatives, i.e. act as control groups (Hallgren *et al.,* 2002; Cook *et al.,* 2008; Gormley *et al.,* 2009; Tam *et al.,* 2009; Seixas-Mikelus *et al.,* 2010; Kish *et al.,* 2013).

1.5 A marriage of two minds

To date, there has been no solid evidence in support of the replacement of traditional cadaver dissection in its entirety. However, what has clearly been demonstrated is that alternatives to dissection certainly do bolster the traditional anatomy teaching method (Quinn *et al.*, 2003; Elizondo-Omana *et al.*, 2004; Jastrow & Holliderbaumer, 2004; Biasutto *et al.*, 2006; Tam *et al.*, 2009). There is no reason why one method of teaching should take centre stage over another in this era of innovation and creative thinking, especially when technology is fast becoming the new natural order of things. Even students themselves consider alternative teaching methods as useful supplements to, rather than substitutes for dissection (Adamczyk *et al*., 2009). Why then, can

traditional and modern strategies not meet halfway to conceive the most innovative and contemporary teaching methodologies, which could become the new gold standard for anatomy education?

The concept of "blended learning," an approach which has rapidly gained popularity in higher education in recent years, is described as face-to-face instruction and technology-driven teaching used in combination to achieve meaningful educational outcomes. This contemporary method could prove beneficial in that it harnesses the power of technology together with traditional learning, instead of purely using one mode of learning over another. In this way, it caters for students who are more comfortable with technology and prefer online or e-learning, while still maintaining core teaching/learning principles of a traditional classroom, especially for those students who are less inclined to make use of technological means to aid their learning (Garrison & Kanuka, 2004). While this approach is being used quite extensively in higher education institutions, further research needs to be carried out to establish the positive impact on students, that is, whether this approach does in fact result in improvements in academic scores (López-Pérez *et al*., 2011).

A novel example of the blended learning approach has been seen at Mount Sinai University, New York. The anatomy module combines dissection with imaging, simulations, audio-visual lectures and computer assisted instruction. In addition, surgeons and physicians are invited to actively participate in both lecturer and classroom support capacities, on a volunteer basis (Reidenberg & Laitman, 2002). The power of collaboration comes through strongly in using a model such as this one, where the knowledge comes from a vast array of proficiencies, and the onus is not on a single person or department to facilitate a valuable, quality learning experience.

Indeed, putting together an open-minded, multi-modular, integrated anatomy course, combining the traditional with the contemporary whilst looking to the future, will be a great task. It will require solid groundwork, collaboration with other institutions from around the world, meticulous research and fully capable technological infrastructure. Most importantly, the first consideration should be that a journey such as this cannot be embarked upon without commitment from Faculty and students alike, who will be the teaching and learning ambassadors, and will be central to taking anatomy education as we know it to new heights.

1.6 Purpose of Study

The purpose of this study was to explore the perceived value of supplementing the traditional cadaver dissection course at the University of Cape Town's Faculty of Health Sciences (UCT FHS) with alternatives in order to aid students in their learning of anatomy. The study aimed to collect information which could be used to provide insight into facilitating a deeper educational experience for students and teachers alike in the future with the aim of better retention of knowledge over time. The intention of the study was to obtain results which could potentially provide insight into the feasibility of adopting a contemporary view on anatomy education at UCT FHS and thus inform the anatomy course in the future by acquiring feedback directly from the students and staff of the university.

Chapter 2 - Materials and Methods

2.1 Study Design

Data was collected by way of the results of a questionnaire designed using the online survey design website eSurveyCreator (www.esurveycreator.com). The questionnaire was exclusively designed using the tools available on this website. The survey was accessible via a custom online link and all data was stored on the website via a personal student account. The data set was available throughout the duration of the survey for perusal and ongoing monitoring.

An online survey was selected as the means of obtaining data for the study by virtue of the campus Internet access granted to all registered students and staff of the University of Cape Town (UCT), as well as their formal registration with Vula, UCT's online portal, which is used to convey a variety of information to students and staff of the university on a daily basis.

The study was designed with the intention of answering the following research questions:

1. How comfortable are UCT students and staff with information technology, recent technological advances in this area, and technological devices?
2. What is the perceived value of cadaver dissection as a teaching tool for anatomy?
3. How receptive are UCT staff and students to the idea of implementing supplementary resources for learning anatomy?
4. How do UCT staff and students feel about hybridising anatomy learning by using traditional dissection together with technological alternatives?

2.2 Questionnaire Design (Appendix A)

The survey was constructed by the researcher with the aim of establishing to what degree students use technology as an aid in engaging with the study of human anatomy. A variety of publications about such questionnaires were consulted in order to inform the type of questions that would be compiled.

The survey comprised two parts, the first of which focused on the collection of demographic information pertaining to year of study, age, sex, and the participants' geographical regions of origin. The second part asked a series of 22 questions, including single answer selections, multi-answer selections with free text fields, and 3- and 5-point Likert scale selections. The rationale for using 5-point Likert Scale options for questions 5, 6, 7, 8 and 9 of the survey was to obtain as broad a range of opinions/perceptions as possible. The 3-point Likert scale used for questions 4 and 10 satisfied the requirements for these questions.

All questions were mandatory, and a participant could only move onto the next question once the previous one was fully answered, in order to ensure complete responses for data analysis.

Question 1 of the survey addressed whether the participants used the Internet for study, leisure or both. Questions 2 and 3 asked whether they owned technological devices and whether they engaged in social media. These questions were posed to gain insight into the cohort's appetite for

technology in general, as well as their engagement with a sample of popularly utilised media platforms. This information was gathered in order to answer research question 1: *How comfortable are UCT students and staff with information technology, recent technological advances in this area, and technological devices?*

Various papers on students' interaction with social media and associated technologies formed the basis of this research question (e.g. Aiken *et al.*, 2003; Oblinger, 2003; Bongey *et al.,* 2006*;* Mangold, 2007; Jacob & Issac, 2008; Ashraf, 2009; Jones *et al.*, 2010; Thinyane, 2010; Gurung & Rutledge, 2014; Junco, 2014).

In addition to the six popularly utilised media platforms (see 1.1) which formed the basis of question 3, the cohort reported the use of the media listed below, which will be covered again in the results and discussion sections.

- *Tumblr*, a platform allowing users to post and share short blogs on their own personal dashboards
- *Snapchat*, a photo/video messaging application
- *9Gag*, an image and video sharing platform
- *Reddit*, an online social networking and news sharing community
- *LinkedIn*, a social networking platform directed at business people/professionals
- *StumbleUpon*, an Internet web search engine
- *Vines*, 6 second videos which can be stitched together and uploaded/shared
- *BBM (Blackberry Messenger)*, an instant messaging service for Blackberry users
- *Khan Academy*, a non-profit organization aimed at providing free education opportunities to subscribers via YouTube video lectures
- *WeHeartIt*, an online platform for users to share (or "heart") inspirational images
- *Vimeo*, a video sharing website
- *Soundcloud*, an audio distribution platform for artists to share and promote their own sounds
- *TED Talks*, global conferences aimed at educating the audience on various topics
- *Skype*, a video or audio platform for conversations between two or more parties
- *Coursera*, an educational technology company that offers online material on various
- disciplines
- *Imgur*, an online image sharing platform
- *Google*, an Internet search engine

Questions 4, 5 and 6 of the survey were asked in order to gauge the cohort's view on full body dissection as a whole, as well as the value they find in dissection, and whether the primary learning objectives of dissection aid in the learning of anatomy. These questions were asked to provide answers to research question 2: *What is the perceived value of cadaver dissection as a teaching tool for anatomy?*

The options for this series of questions were selected based on previous studies which investigated the perceptions of students or teachers towards cadaver dissection, and from research papers identifying, discussing and debating the objectives of the cadaver dissection course in learning anatomy (e.g. Dinsmore *et al.,* 1999; Marks, 2000; Rizzolo, 2002; Granger, 2004; Guttman *et al.*

2004, McLachlan *et al.*, 2004, Gunderman & Wilson, 2005; Winkelmann *et al.*, 2007; Patel & Moxham, 2006; Sugand *et al*., 2010; Chapman *et al*., 2013).

Question 7 was posed in order to obtain information on the perceived helpfulness of an assortment of learning aids in preparation for anatomy assessments. The rationale for including this section in the questionnaire was to ascertain the cohort's level of interaction with various learning methods which are available as part of the MBChB programme at UCT to gain insight into preferred methods of learning anatomy, as well as to provide further evidence to answer research question 1.

The options for question 7 were selected based on the current structure and make-up of the human anatomy component of the MBChB programme at UCT as outlined in the University of Cape Town's undergraduate handbook which is published annually per Faculty, as well as from previous research which discussed the various resources available to facilitate the learning of anatomy at university level (e.g. Craig *et al*., 2010; Kerby *et al*, 2011).

Questions 8 to 13 were asked in order to answer research question 3: *How receptive are UCT staff and students to the idea of implementing supplementary resources for learning anatomy?*

Questions 14 to 22 were asked in order to ascertain the level of interaction with material other than that provided by Faculty, to provide further answers to research question 1 as well as to answer research question 4: *How do UCT staff and students feel about hybridising anatomy learning by using traditional dissection together with technological alternatives?*

These questions were influenced by previous studies on various alternative or supplementary resources (electronic, online, computer-based or traditional) that students used to aid in their learning of anatomy, and some studies showing the students' opinions on the efficacy of these resources (e.g. Nieder *et al.,* 2000; McLachlan & Patten, 2006; Nicholson *et al.*, 2006; Tam *et al.*, 2009; Choudhury & Gouldsborough, 2012; Hamrol *et al.*, 2013; Kish *et al.*, 2013; Attardi & Rogers, 2015).

2.3 Characteristics of the Study Population

The MBChB programme at UCT is offered to school leavers (majority of the class) who have met the criteria for entry to the medical school based on their secondary school academic performance. There are a small group entering the programme, who are students who either transfer from or are graduates of other degrees. The programme takes place over six or seven years. The seven year programme includes an additional year, known has the Intervention Programme, for students who struggle with the pace of their first year. They are identified either halfway through or at the end of their first year, and then move into the Intervention Programme which covers all the first year content and study skills over an extended period. These students then re-enter first year halfway through the following year.

The first half of the MBChB curriculum (first, second and third years) involves the study of the basic sciences and, broadly, covers the human life cycle and key principles of anatomy, physiology, medical biochemistry, the various pathologies, clinical skills, public health and family medicine. Central to achieving learning outcomes in this foundation phase of the course is PBL (problem-based learning), where students are assigned to PBL groups who meet regularly to discuss and analyse carefully designed paper-based cases which illustrate the core objectives of the course. Teaching and

learning activities, some of which are compulsory and carry a “DP” (duly performed) requirement, include lectures, practical sessions, ward activities, small group tutorials and workshops, and form the basis of instruction and knowledge gathering in this phase. Various informal resources are available to the students to enhance/facilitate learning (e.g. e-learning modules, online forums on the university web portal, computer-based learning modules).

Assessment of students in their first year occurs both during and at the end of the course by way of written (case-based) and practical components. The in-course assessment component carries a weight of 40% (practical tests 10% and written class tests 30%) while the end-of-course assessments are weighted 60% (written theory examination 50% and practical examination 10%).

Students are first exposed to dissected specimens in the second half of their first year, and begin full body dissection at the beginning of their second year, as part of their course on the basic structure and function of all organ systems of the human body. They learn the core material in basic health sciences (gross anatomy, embryology, histology, cell biology, medical biochemistry, molecular biology and physiology) and infectious diseases (anatomical pathology, medical microbiology, chemical pathology and haematology).

Again, assessment of students comprise both in-course and end-of-course examination. Here, however, assessment includes written (case-based), practical and computer-based components, as well as oral clinical examinations. There are also regular online self-assessment opportunities during the course in order for students to obtain feedback on their progress in their own time. In order to progress to third year, students are required to complete a series of in-course assessments which contribute 60% of the total year mark, and a summative assessment at the end of the year which carries a weighting of 40%.

The third year of the MBChB programme ties prior learning together with the disciplines to follow in subsequent years by providing a detailed structure of the human body and consequences of disease, and introducing principles of pharmacology/therapeutics and early management. Relevant aspects of family medicine, primary healthcare, public health and mental wellbeing are drawn in here, and students are guided to develop the key skills that are required in order to become effective healthcare professionals.

Third year assessments include written papers, computerised tests, practical examinations, and a portfolio of evidence that comprises written assignments, multiple-choice question tests, oral examinations and practical book work. There are regular self-assessment activities for ongoing progress feedback. The in-course assessments make up 45% of the total year mark (March class test 25%, neurosciences class test 15%, portfolio of evidence 5%) and the final examination at the end of the year make up 55% of the total year mark.

The fourth, fifth and sixth years of the MBChB programme cover the clinical sciences and focus on the various specialities within Medicine and clinical application of the skills acquired via the treatment of patients. As such, all prior learning in the foundation phase is drawn together and integrated during this phase of the training.

The formal resources made available to students throughout the MBChB (or postgraduate) programme include whole class lectures, PBL sessions, pre-practical talks, cadaver dissection,

practical demonstrations, dissection manuals, commercially available models and wet or plastinated prosections.

Various informal resources include flash cards, atlases of anatomy, posters, charts, online modules for self-evaluation, computer-based resources, recordings of lectures via *Podcasts*, radiological images and a variety of practical demonstrations.

All second, third, fourth, fifth and sixth year students enrolled in the MBChB programme in 2014 (totalling 996) were invited to participate in the survey, as well as all staff and postgraduate students who had completed the full cadaver dissection module at UCT FHS, which would be a substantially smaller group. Health and Rehabilitation students were not included in light of the fact that they only participate in partial dissection of the body, and first year MBChB students were not included as they would not yet have commenced cadaver dissection at the time of the survey. The potential number of participants was thus in the region of ±1020.

2.4 Recruitment and Enrolment

Potential participants were made aware of the survey via an announcement on Vula. The link, together with a notice providing the context and intention of the study, were posted on Vula fortnightly to all eligible participants for a period of two months so as to maximise the response rate and act as a reminder for those who had seen it and intended to participate, but had not yet done so. Small tokens of appreciation (all acquired as donations e.g. flash drives, stationery, DVD's, lanyards, books) were offered to those who elected to participate in order to boost the response rate, as the survey was entirely voluntary. These were available on a first come, first serve basis, and only upon proof of full completion of the survey (which was printed at the end of the survey).

2.5 Informed Consent Process (Appendix A)

An informed consent disclaimer was provided at the beginning of the survey, and participants could only proceed if they agreed to do so, via a tick box. Any participant who did not agree to continue with the completion of the survey at any point was directed to the closing page of the questionnaire and did therefore not participate.

2.6 Ethical Approval and Permission to Survey Students and Staff

Ethical approval to commence with the study was granted by the Human Research Ethics Committee (HREC) of UCT, reference 763/2013 (Appendix B). Permission for access to survey students (Appendix C) and staff (Appendix D) was granted by UCT's Executive Director of Student Affairs and Executive Director of Human Resources respectively.

2.7 Data Analysis

A descriptive statistics method was employed to analyse the information contained within the entire data set. A segmented analysis of each year of study, postgraduate and staff was performed to establish the similarities and differences in responses between each year group. This was done using the entire raw data set (not included here due to the size of the file but which is available upon request from the author).

A contingency table was formulated in order to determine relationships between certain variables across the questionnaire and the full analysis not included due to considerable size. Excerpts of analyses are included within Chapter 3 and the full contingency table is available upon request from the author.

Kruskal-Wallis one-way analysis of variance tests were used to determine whether the respective study year cohorts shared similar sentiments ($p > 0.05$) towards certain questions (Appendix F). A Kruskal-Wallis one-way analysis of variance test was used to determine whether males and females shared similar sentiments ($p > 0.05$) (Appendix G). The data set was analysed using Microsoft Excel and statistical packages in Python™.

Chapter 3 – Results

3.1 Survey response rate

A total of 198 interactions with the survey were noted. Of these, 190 were fully completed, and 8 were abandoned. There were no trends identified pertaining to age, year of study or sex for those who abandoned the questionnaire, however, this indicates that these individuals did have access to the questionnaire, but elected not to participate. Furthermore, it is safe to assume that all eligible potential participants as noted in Chapter 2 did have access to complete the survey by virtue of their Internet access on campus, as well as their formal student accounts with and resulting access to Vula. The results and subsequent discussion represent data from the 190 fully completed questionnaires.

3.2 Demographic information

This information was collected with the intention of observing trends relating to year of study, age, sex or geographic region of origin.

3.2 a) *Year of Study*

Table 1: Year of Study

	%
Second Year	33
Third Year	23
Fourth Year	13
Fifth Year	9
Sixth Year	12
Postgraduate	8
Staff	2

Table 1 shows the study cohort divided by year of study. Further analyses were done on each year of study against each other via pairwise testing using the Kruskal-Wallis one-way analysis of variance (Appendix F - this will be expanded upon later in the results).

3.2 b) *Age*

Figure 1 shows the age distribution of the study participants. The age range of participants was from 18 to 60 years of age, with the highest participation seen between the ages of 19 and 24. Minimal participation was seen from ages 25 to 60. The mean age of the survey population was 22, and the median age 21. This right-tailed distribution of age was in light of the fact that there were 4 participants who were between 40 and 60 years old and who formed part of the staff complement. There were no noteworthy trends with regard to age.

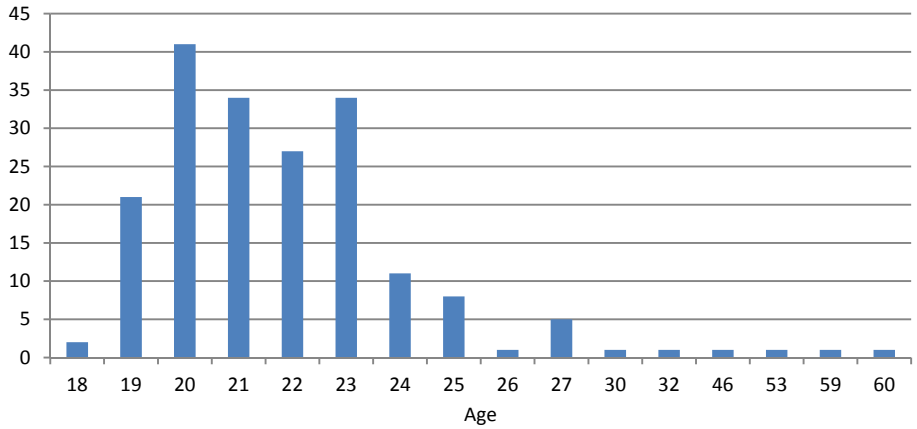

Figure 1: Distribution of Age

3.2 c) *Sex*

Female respondents were in the majority (Table 2), which corresponds with the female-to-male ratio at UCT FHS during 2014 (Appendix E). A Kruskal-Wallis one-way analysis of variance was applied to test whether males and females shared similar or had differing sentiments (Appendix G), and it was found that they shared largely similar sentiments across the questionnaire ($p > 0.05$).

There were a few differing sentiments between females and males which will be expanded upon in the discussion. Generally, females had a more positive response to those learning objectives as listed in Table 3 below.

Table 2: Sex of participants

	%
Female (*n* = 134)	71
Male (*n* = 56)	29

Table 3: Differing sentiments females (*n* = 134) versus males (*n* = 56)

	Negative F (%)	Negative M (%)	Neutral F (%)	Neutral M (%)	Positive F (%)	Positive M (%)
Appreciating the human body in 3D	0	2	0	2	100	96
Gaining respect for the human body	1	5	10	18	89	77
Developing an ethical approach to treating patients	8	11	26	41	66	48
Appreciating the issues around death and dying	7	11	25	36	68	53

3.2 d) *Geographic region of origin*

The majority of respondents were South African. Table 4 below shows the split of geographic region of origin expressed as a percentage of the total (*n* = 190).

Table 4: Region of origin

	%
South Africa	96
SADEC	3
International	1

3.3 Reasons for Internet usage

The majority of respondents reported that they use the Internet for the purposes of both leisure and studying. Only 1 respondent (1%) reported use of the Internet for studying alone. Refer to Table 5 below, with results expressed as a percentage of the total (*n* = 190).

Table 5: Reasons for Internet usage

	%
Study	1
Leisure	0
Both	99

3.4 Ownership of Devices

Table 6 shows the ownership of devices (either smart phones, iPods, iPads or tablets, laptops or desktop personal computers) across the study cohort, expressed as a percentage of the total sample size (*n* = 190).

Table 6: Ownership of Devices

	%
Laptop	96
Smart Phone	88
iPad or tablet	56
iPod	30
Desktop PC	18

A contingency table analysis (Table 7) was performed to ascertain the proportion of the smart phone owners who also owned other devices, expressed as a percentage of the smart phone owner population (*n* = 167).

Table 7: Smart phone owners (*n* = 167) also owned the following devices:

	%
Laptop	96
iPad or tablet	59
iPod	32
Desktop PC	18

3.5 Media and Social Media Usage

Table 8 shows the participants' usage of various media and social media platforms, expressed as a percentage of the total sample size (*n* = 190).

Table 8: Popular media used by cohort

	%
YouTube	97
Facebook	92
Twitter	42
Instagram	42
Pinterest	25
Podcasts	12

Analysis of the segmented group showed that *YouTube* was the most used medium across the cohort (second, third, fourth, fifth, sixth year, postgraduates and staff alike). A contingency table analysis (Table 9) was performed to ascertain the proportion of *YouTube* users who also engage in other media platforms, expressed as a percentage of the *YouTube* user population (*n* = 184).

Table 9: *YouTube* users (*n* = 184) who engaged in other media

	%
Facebook	92
Instagram	42
Twitter	42
Pinterest	27
Podcasts	13

New social media applications, sites and ways of communicating and connecting via virtual means are being developed all the time, therefore, an "other" field was provided for respondents to share some of those they frequently use. A small proportion of participants (15%, *n* = 29) reported use of media other than those described above. These were not analysed further owing to the small proportion of users. Table 10 shows usage of these other types of media, expressed as a percentage of the total sample size (*n* = 190).

Table 10: Other media used by cohort (*n* = 29)

	%
Tumblr	4
WhatsApp	4
Snapchat	3
9Gag	1
Reddit	1
LinkedIn	1
StumbleUpon	1
Vines	1
BBM (Blackberry Messenger)	1
Khan Academy	1
WeHeartIt	1
Vimeo	1
Soundcloud	1
TED Talks	1
Skype	1
Coursera	1
Imgur	1
Google	1

3.6 Perceived value of whole body dissection

The participants were asked to respond to Question 4 via a Likert-Scale type rating scale, with 3 selection options:

- not valuable (1)
- neutral (2)
- valuable (3)

The vast majority considered the dissection experience to be a valuable one. A minority of respondents, mostly from second and third year, felt neutral towards dissection. Refer to Table 11 below. Again, the results are expressed as a percentage of the total sample size.

Table 11: Perceived value of whole body dissection

	%
Not valuable	0
Neutral	7
Valuable	93

3.7 Feelings towards replacement of full body dissection with electronic resources

A 5-point Likert Scale was used for this question, with the options:

- strongly against this (1)
- against this (2)
- neutral (3)
- support this (4)
- strongly support this (5)

The overwhelming response was that both staff and students are against the replacement of the dissection course at UCT FHS. There were a minority of respondents who supported the replacement of traditional dissection with electronic alternatives (8%, *n* = 15). Table 12 shows the responses to question 5 expressed as a percentage of the total sample, with 1 & 2 responses grouped as "support replacement of dissection" and 4 & 5 responses grouped as "against replacement of dissection."

Table 12: Question 5 - Feelings towards replacement of dissection with electronic alternatives

	%
Support replacement of dissection (*n* = 15)	8
Neutral (*n* = 24)	13
Against replacement of dissection (*n* = 151)	79

3.8 Contingency table analysis of responses to Questions 4 and 5

For this analysis, the respondents who were neutral towards full body dissection (question 4) were tested via a contingency table analysis to establish their feelings towards the replacement of dissection with electronic resources (question 5). The 1 & 2 responses to question 5 were grouped together as "against replacement of dissection" and the 4 & 5 responses were grouped as "in support of replacement of dissection." Results are shown in Table 13 below.

Table 13: Individuals who felt neutral towards dissection (*n* = 17*)* also reported the following feelings towards the replacement of dissection with electronic resources:

	%
Against replacement of dissection	17
Neutral	35
In support of replacement of dissection	48

3.9 Success of dissection module in achieving various objectives

For this series of 15 questions, a 5-point Likert scale was used, with options:

- very unsuccessful (1)
- unsuccessful (2)
- neutral (3)
- successful (4)
- very successful (5)

Table 14 below shows the response to Question 6 of the survey, expressed as a percentage of the total sample size (*n* = 190). 1 & 2 responses were grouped as "negative" and 4 & 5 responses were grouped as "positive."

Table 14: Question 6 - Success of dissection module in achieving objectives

	Negative (%)	Neutral (%)	Positive (%)
Providing a vocabulary of anatomical structures	2	11	87
Learning the details of anatomical structures in the body	3	8	89
Classifying the components of each body system	2	10	88
Appreciating the human body in 3D	1	1	98
Gaining respect for the human body	2	13	85
Developing an ethical approach to treating patients	9	30	61
Appreciating the issues around death and dying	9	30	61
Relating structure to embryological development	21	28	51
Relating structure to function	5	16	79
Relating structure and function to pathology	6	17	77
Providing a micro to macro view of anatomy	7	16	77
Facilitating team work and group learning	6	14	80
Recognising and appreciating anatomical variation	2	4	94
Providing a basis for clinical skills training	9	25	66
Developing surgical skills through dissection techniques	18	23	59

Further analysis of the segmented group showed that 25% (*n* = 16) of second years, 36% (*n* = 16) of third years and 36% (*n* = 9) of fourth years felt neutral towards dissection in "developing an ethical approach to treating patients." The feeling towards dissection in "appreciating issues around death and dying" was similar as above, with the majority of those who felt neutral towards this falling into the second (29%, *n* = 18), third (34%, *n* = 15) and fourth year groups (24%, *n* = 6).

In light of the fact that the second and third year groups have more involvement with dissection than any other year groups (either directly or indirectly), a Kruskal-Wallis one-way analysis of variance was applied to the dataset (Question 6) to ascertain whether there were any objectives towards which the second and third year groups felt differently, via pairwise analysis of each year (Appendix F). Since fourth, fifth and sixth year are entirely hands-off with the focus exclusively on clinical training, these years were compared in the same manner to observe any differences in sentiments here. The fourth year group was compared with the fifth and sixth years, as students in their fourth year are relatively junior in the clinical environment and will be drawing more frequently on knowledge obtained in the early years simply because it was more recent. The fifth and sixth

years have been in the clinical environment longer and are consolidating knowledge and applying skills developed through the entire training programme. Staff and postgraduate students were not analysed in this manner, since their focus is more on the facilitation of learning and guidance through the cadaver dissection course, as opposed to dissection itself.

3.9 a) *Second Year versus Third Year*

The differing sentiments ($p < 0.05$) between second and third year students pertained to:

- Learning details of anatomical structures in the body ($p = 0.04$)
- Gaining respect for the human body ($p = 0.01$)
- Developing an ethical approach to treating patients ($p = 0.0009$)
- Relating structure to function ($p = 0.02$)
- Providing a basis for clinical skills training ($p = 0.005$)

A small proportion of the third year group felt that dissection was unsuccessful in learning details of anatomical structures in the body (9%, *n* = 4), while no second years felt this way. In terms of gaining respect for the human body, there were more third years than second years who felt neutral towards this (23%, *n* =10 versus 10%, *n* =6), and a small proportion of third years who thought this was unsuccessful (while no second years reported that dissection was unsuccessful in achieving this objective). When looking at the differences between the groups in developing an ethical approach to treating patients, it is revealed that, again, more third years find that dissection is unsuccessful in achieving this objective (23%, *n* = 10 versus 6%, *n* =4). In terms of relating structure to function, more third years felt that dissection was unsuccessful here (14%, *n* = 6 versus 2%, *n* = 1). Lastly, 21% of third years (*n* = 9) felt that dissection was unsuccessful in providing a basis for clinical skills training, while only 5% of second years found it to be unsuccessful (*n* = 3).

3.9 b) *Fourth Year versus Fifth & Sixth Years*

The fourth, fifth and sixth years, having concluded their course in anatomy, shared largely similar feelings towards dissection. The only differing sentiment ($p < 0.05$) between fourth and fifth/sixth year students pertained to:

- Classifying the components of each body system ($p = 0.03$)

While it was observed that the majority of both groups found dissection to be successful in achieving this objective, there were more fifth/sixth years than fourth years who felt neutral towards this (13%, *n* = 5 versus 4%, *n* = 1).

3.10 <u>Helpfulness of various learning aids in preparation for anatomy assessments</u>

There are a host of learning aids which are readily available to students to augment their study of anatomy and to facilitate retention of knowledge, deep understanding and overall appreciation of this science. Some of these are formally provided by Faculty, while others are elective and/or pursued by the students themselves, with or without the guidance of members of staff. Question 7 of the questionnaire asked the group to rate the helpfulness of various learning aids in preparation for anatomy assessments.

For this series of 23 questions, a 5-point Likert scale was used, with options:

- very unhelpful (1)
- unhelpful (2)
- neutral (3)
- helpful (4)
- very helpful (5)

Table 15 below shows the response to Question 7 of the survey, expressed as a percentage. Again, 1 & 2 responses were grouped as "negative" and 4 & 5 responses were grouped as "positive."

Table 15: Question 7 - Helpfulness of learning aids for anatomy assessments

	Negative (%)	Neutral (%)	Positive (%)
Textbooks (text + graphic representations)	2	2	96
Anatomy atlas (graphic representations)	2	5	93
Lectures and lecture notes	5	14	81
Pre-practical talks	3	14	83
Dissection	2	8	90
Using the dissection manual	7	13	80
Practical demonstrations using models	2	11	87
Examination of prosected material	2	15	83
Demonstrations in museum (labelled)	4	19	77
Pinned/labelled specimens in dissection hall	2	8	90
e-learning modules	8	52	40
Group study with peers	9	21	70
PBL (Problem-based learning) sessions	23	31	46
One-on-one with tutor	2	25	73
Group study with tutor	6	28	66
Formative assessments	4	16	80
Blogs	28	59	13
Online forums on your web portal (Vula)	26	47	27
Images (radiological slides, MRI, etc)	5	20	75
Past examination papers on Vula	4	14	82
Flash cards	5	32	63
Self-evaluation tests online	4	27	69
Self-evaluations at the back of each chapter in Anatomy textbook	6	36	58

The general feeling across the entire group was that the various learning aids helpful in preparing for anatomy assessments. There were a few learning aids towards which respondents across the group felt neutral. These were e-learning modules, PBL (problem-based learning) sessions, Blogs, online forums on Vula, flash cards and self-evaluations at the back of textbooks.

Further analysis of these results via a Kruskal -Wallis one-way analysis of variance (across the entire study cohort) support the findings that the entire group shared largely similar sentiments towards the majority of the learning aids, and felt that they were generally helpful in preparation for anatomy assessments ($p > 0.05$). There were a few learning aids towards which the group had differing sentiments, and these are described below, by way of a Kruskal-Wallis one-way analysis of variance applied to each year group pairwise (Appendix F). Again, the fifth and sixth years were

grouped together, owing to the fact that the curriculum in the last two years of the MBChB is largely similar, in that it is a consolidation and application of skills developed through the entire training programme. The staff and postgraduates were grouped together in light of their teaching and facilitating roles (as opposed to the students who are required to achieve learning objectives). The groupings were also done in this fashion so as to increase each sample size to ensure reliability of results.

3.10 a) *Second Year versus Third Year*

Second and third year students felt differently ($p < 0.05$) towards:

- One-on-ones with a tutor ($p = 0.02$)
- Group study with a tutor ($p = 0.04$)
- Images (radiological slides, MRI etc.) ($p = 0.04$)

More third years found one-on-ones with a tutor helpful, with a large proportion of second years feeling neutral towards this. Similarly, most second years felt neutral (38%, $n = 24$) towards group study with a tutor, with 11% ($n = 7$) even feeling that this was unhelpful as a learning aid, while the majority of third years (73%, $n = 32$) reported that group study with a tutor was helpful. There were more third years who were either neutral towards images (27%, $n = 12$), or felt that they were unhelpful (12%, $n = 14$).

3.10 b) *Second Year versus Fourth Year*

There were differing sentiments ($p < 0.05$) between the second and fourth year groups towards:

- Dissection ($p = 0.04$)
- Using the dissection manual ($p = 0.04$)
- One-on-ones with a tutor ($p = 0.01$)
- Group study with a tutor ($p = 0.003$)

While the majority of both second and fourth year students found the dissection course to be of help as a learning aid, there were significantly more fourth years who considered this to be helpful (76%, $n = 19$ versus 49%, $n = 31$). A similar situation was observed between the second and fourth year students with using the dissection manual, where more fourth years found this to be helpful (52%, $n = 13$ versus 27%, $n = 17$). The vast majority of fourth years considered one-on-ones with a tutor to be helpful (76%, $n = 19$), while just under half of the second year group felt they were helpful (45%, $n = 48$). Similarly, the bulk of the fourth year group felt that group study with a tutor was helpful (80%, $n = 20$) while only half the second year group felt the same (50%, $n = 32$), and more second than fourth years felt neutral towards this (38%, $n = 24$ versus 16%, $n = 4$).

3.10 c) *Second Year versus Fifth & Sixth Years*

The differing sentiments ($p < 0.05$) between the second and fifth/sixth year groups pertained to:

- One-on-ones with tutors ($p = 0.001$)
- Formative assessments ($p = 0.01$)
- Blogs ($p = 0.04$)
- Past examination papers on Vula ($p = 0.01$)

More second than fifth/sixth years felt neutral towards one-on-ones with tutors (38%, $n = 24$ versus 13%, $n = 5$). With regard to formative assessments, although the majority felt that these assessments were helpful, the results showed that more fifth/sixth years felt neutral towards this (20%, $n = 8$ versus 9%, $n = 6$). Most of the second and fifth/sixth years felt neutral towards the use of *blogs* as learning aids, however, it was found that many more second years than fifth/sixth years considered *blogs* to be helpful (14%, $n = 9$ versus 2%, $n = 1$). Lastly, more fifth/sixth years than second years felt neutral towards past examination papers on Vula as a learning aid (20%, $n = 8$ versus 8%, $n = 5$).

3.10 d) *Second Year versus Staff & Postgraduates*

Second years felt differently from staff/postgraduates towards:

- Dissection ($p = 0.02$)
- Past examination papers on Vula ($p = 0.0002$)
- Self-evaluation tests online ($p = 0.03$)

There were no staff/postgraduate respondents who felt neutral towards dissection, however, 5% of the second year respondents ($n = 3$) were neutral towards this. When looking at the differences in sentiments towards past examination papers on Vula, it appears that there were many more second years than staff/postgraduates who found these to be helpful (90%, $n = 57$ versus 53%, $n = 10$). The last difference in sentiments pertained to self-evaluation tests online, where more of the staff/postgraduate group felt neutral towards this than the second year group (37%, $n = 7$ versus 29%, $n = 18$) and more second years than staff/postgraduates considered this to be helpful (71%, $n = 45$ versus 63%, $n = 10$).

3.10 e) *Third Year versus Fourth Year*

Third and fourth year students had differing sentiments towards:

- Dissection ($p = 0.01$)
- Examination of prosected material ($p = 0.04$)
- Online forums on Vula ($p = 0.04$)

More fourth years than third years felt that dissection was helpful as a learning aid (92%, $n = 23$ versus 73%, $n = 32$). Similarly, more fourth than third years considered examination of prosected material this to be helpful (88%, $n = 22$ versus 77%, $n = 34$). Looking at online forums, 36% of third

years found this to be helpful as a learning aid (n = 16) while 20% of fourth years considered this helpful (n = 5).

3.10 f) *Third Year versus Fifth & Sixth Years*

The differences in sentiments between third and fifth/sixth year students pertained to:

- Dissection (p = 0.04)
- Blogs (p = 0.02)
- Images (radiological slides, MRI etc.) (p = 0.04)

More third years than fifth/sixth years felt neutral towards dissection (18%, n =8 versus 8%, n = 3) and many more fifth/sixth years found that dissection was helpful as a learning aid (93%, n = 36 versus 73%, n = 20). No fifth/sixth years found *blogs* to be helpful, while 14% of third years (n = 6) found them helpful. Furthermore, more fifth/sixth years felt that *blogs* were unhelpful than third years (39%, n = 15 versus 21%, n = 9). Lastly, more of the fifth/sixth years than third years found images (radiological slides, MRI etc.) to be helpful (74%, n = 29 versus 59%, n = 26).

3.10 g) *Third Year versus Staff & Postgraduates*

There were differing sentiments (p < 0.05) between the third year group and staff/postgraduates towards:

- Dissection (p = 0.006)
- Images (radiological slides, MRI etc.) (p = 0.04)
- Past examination papers on Vula (p = 0.008)

The total staff/postgraduate complement felt that dissection was helpful as an anatomy learning aid (100%, n = 19), while 73% of third years found this to be helpful (n = 32). The remainder of third year respondents felt either neutral towards dissection (18%, n = 8) or thought that it was unhelpful (9%, n = 4). The bulk of staff/postgraduates felt that images were helpful as a learning aid (89%, n = 17), while 59% of third years felt this way (n = 26), with some third years even reporting that images were unhelpful as a learning aid (14%, n = 6). Past examination papers on Vula were found to be helpful by many more third years than staff/postgraduates (82%, n = 36 versus 53%, n = 10).

3.10 h) *Fourth Year versus Fifth & Sixth Years*

The fourth and fifth/sixth year groups all shared similar sentiments (p > 0.05) towards the helpfulness of the 23 learning aids as set out in the questionnaire.

3.10 i) *Fourth Year versus Staff & Postgraduates*

The differing sentiments (p < 0.05) between fourth year students and staff/postgraduates pertained to:

- Demonstrations in the museum (p = 0.04)
- Pinned/labelled specimens in the dissection hall (p = 0.03)
- Past examination papers on Vula (p = 0.004)
- Self-evaluation tests online (p = 0.03)

More fourth years than staff/postgraduates found demonstrations in the museum to be helpful (84%, *n* =21 versus 63%, *n* = 12). Similarly, more fourth years than staff/postgraduates found pinned/labelled specimens to be helpful (92%, *n* = 23 versus 84%, *n* = 16). Past examination papers on Vula were deemed unhelpful by 10% of the staff/postgraduate group (*n* = 2) while no fourth years found these to be unhelpful. There were more fourth years than staff/postgraduates who felt that past papers were helpful (88%, *n* = 22 versus 53%, *n* =10). Lastly, many more fourth years than staff/postgraduates felt that self-evaluation tests online were helpful (80%, *n* = 20 versus 53%, *n* = 10).

3.10 j) *Fifth & Sixth Years versus Staff & Postgraduates*

The only differing sentiment between the fifth/sixth years and staff/postgraduates pertained to:

- Demonstrations in the museum ($p = 0.03$)

More of the fifth/sixth year group found demonstrations to be helpful (90%, *n* = 35% versus 63%, *n* = 12), None of the fifth/sixth years felt that demonstrations were unhelpful, while 11% of the staff/postgraduate group found these to be unhelpful (*n* = 2).

3.11 Simulated clinical procedures performed on cadavers

A 5-point Likert Scale was used for this question, with the options:

- very unhelpful (1)
- unhelpful (2)
- neutral (3)
- helpful (4)
- very helpful (5)

Table 16 below shows the responses to Question 8 of the survey, expressed as a percentage. Here, 1 & 2 responses were grouped as “unhelpful” and 4 & 5 responses were grouped as “helpful.”

Table 16: Question 8 - Perceived helpfulness of simulated procedures in dissection hall

	%
Unhelpful (*n* = 5)	3
Neutral (*n* = 13)	7
Helpful (*n* = 171)	90

3.12 Computer-assisted learning using digital images (e.g. MRI, CT images, endoscopy)

A 5-point Likert Scale was used for this question, with the options:

- very unhelpful (1)
- unhelpful (2)
- neutral (3)
- helpful (4)
- very helpful (5)

Table 17 below shows the responses to Question 9 of the survey, expressed as a percentage of the total. Again, 1 & 2 responses were grouped as "unhelpful" and 4 & 5 responses were grouped as "helpful."

Table 17: Question 9 - Perceived helpfulness of computer-assisted learning in dissection hall

	%
Unhelpful (*n* = 1)	1
Neutral (*n* = 12)	6
Helpful (*n* = 177)	93

3.13 Video demonstrations of dissection techniques

A 3-point Likert Scale was used for this question, with the options:

- never (1)
- occasionally (2)
- frequently (3)

Table 18 below shows the responses to Question 10 of the survey, expressed as a percentage of the total.

Table 18: Question 10 - Frequency of use of video demonstrations of dissection techniques

	%
Never (*n* = 6)	3
Occasionally (*n* = 72)	38
Frequently (*n* = 112)	59

3.14 Elective anatomy module online for self-study and evaluation

This was a single answer yes/no question. Table 19 shows the response expressed as a percentage of the total sample. The majority showed interest in an elective online module for anatomy study.

Table 19: Question 11 - Interest in elective online modules for anatomy study

	%
Yes (*n* = 162)	85
No (*n* = 28)	15

3.15 Online material for studying anatomy and whether this should replace or supplement dissection

The responses to Questions 12 and 13 are shown in Tables 20 and 21 below. As can be seen from Table 20, the majority of respondents would like to see more online material for anatomy study.

Table 20: Question 12 - View on making more online material available for studying anatomy

	%
Yes (*n* = 183)	96
No (*n* = 7)	4

Those who were in favour of online material were asked whether this should replace or supplement dissection in the laboratory, and as can be seen from Table 21, the majority view is that this should supplement and not replace dissection.

Table 21: Question 13 - Should this online material replace or supplement dissection? (*n* = 183)

	%
Replace dissection (*n* = 3)	2
Supplement dissection (*n* = 180)	98

3.16 Preferred method of cadaver dissection

Question 14 of the survey asked whether the cohort's preferred method of cadaver dissection was one that encompassed both traditional and virtual dissection, one that was entirely traditional, or one that was entirely virtual. Table 22 below shows that the majority prefers a dissection experience that has both traditional and virtual components.

Table 22: Question 14 - Preferred method of cadaver dissection

	%
Traditional and virtual (*n* = 146)	77
Traditional (*n* = 38)	20
Virtual (*n* = 6)	3

3.17 Supplementary material to prepare for academic tasks

Tables 23, 24 & 25 below show the cohort responses to questions 15-22 of the survey. Table 23 portrays the proportion of respondents who did/did not use supplementary material to prepare for dissection/practicals, PBL, assessments and anatomy lectures. As can be seen from the table, the majority of respondents did utilise extra-faculty information to aid in their preparation for the various academic tasks.

Table 23: Use of material (not provided by Faculty) to prepare for:

	Yes (%)	No (%)
Dissection and other practicals	75	25
PBL	83	17
Assessments	86	14
Anatomy lectures	51	49

Table 24 shows the proportion of those who used online material, textbooks, private tuition or other material as supplements to prepare for these academic tasks. Online material and textbooks were the most utilised extra-faculty material.

Table 24: Material (not provided by Faculty) used to prepare for:

	Online Material (%)	Textbooks (%)	Private Tuition (%)	Other (%)
Dissection and other practicals (*n* = 142)	90	63	3	8
PBL (*n* = 157)	97	72	2	2
Assessments (*n* = 153)	94	74	5	4
Anatomy lectures (*n* = 97)	86	65	1	5

Table 25 shows the proportion of those who used "other" material as supplements to prepare for these academic tasks. Applications or "apps" and videos were the most utilised media.

Table 25: Other material used to prepare for:

	Apps (%)	Videos (%)	Study with friends (%)	Computer Software (%)	Journals (%)	Past Papers (%)
Dissection and other practicals (*n* = 11)	4	3	1	1		
PBL (*n* = 2)	1	1				
Assessments (*n* = 5)		1	1			1
Anatomy lectures (*n* = 5)	1	4				

3.18 Are those in support of the replacement of dissection more technologically inclined?

This analysis was performed to ascertain whether those respondents who were in support of the replacement of dissection with electronic alternatives were also partial to electronic and online resources for learning anatomy, or whether traditional learning resources were among their learning preferences. Table 26 below shows the response of this group, expressed as a percentage of the total (*n* = 15).

Table 26: Proportion of individuals in support of replacing dissection with electronic alternatives (*n* = 15) in favour of electronic/online/traditional resources as listed below:

	%
Simulations on cadaver	100
Computer-assisted learning (digital images)	100
Elective anatomy module online	100
Online material - anatomy study	100
Dissection - Appreciating the human body in 3D	100
Dissection - Gaining respect for the human body	80
Dissection - Recognising and appreciating anatomical variation	80
Textbooks	93
Anatomy atlas (graphic representations)	80
Lectures and lecture notes	80
Pre-practical talks	80
Practical demonstrations using models	80
Examination of prosected material	93
Demonstrations in museum (labelled)	87
Group study with tutor	80
Past examination papers on Vula	87

Chapter 4 – Discussion

Attitudes toward dissection and the perceived value of the dissection module in tertiary institutions have become a theme of interest in recent years. This is partly due to the notion that there has been an evolution of learning preferences among certain student groups, which purportedly have begun to change in keeping with our technologically driven world (Oblinger, 2003; Prensky, 2005; Thompson, 2007). There has been strong debate into the acceptability of automatically classifying today's student as a "technologically ready" one who favours technology over traditional means of learning, given the diverse range of backgrounds that make up tertiary student bodies across the globe (Bennett & Maton, 2010; Brown & Czerniewicz, 2010; Czerniewicz & Brown, 2010; Kennedy *et al*, 2010; Molawa, 2010; Thinyane; 2010; Akçayır *et al*., 2016). Be that as it may, a paradigm shift may be necessary to ensure that the teaching and learning of anatomy stays abreast with advances in and accessibility to technology. To this end, a large amount of research has gone into student learning preferences and viewpoints on the various technologies available to aid in teaching and learning anatomy (Oblinger, 2003; Mangold, 2007; Gurung & Rutledge, 2014).

This study aimed to explore the perceptions of UCT staff and students (both undergraduate and postgraduate students) in an effort to gain insight into their preferred methods of learning by way of a survey delivered to staff and students at the University of Cape Town's Faculty of Health Sciences (UCT FHS). The objective here was to gather data which could potentially inform future learning interventions that combine technology with traditional cadaver dissection, and thus advance the anatomy learning experience for healthcare practitioners in training, as well the teaching experience for those responsible for guiding students along their learning paths.

4.1 The Internet, social media, technology

The results of this study endorse that modern technological capabilities do have a place in the anatomy education syllabus at UCT FHS, as perceived by the very people who will benefit from utilising these alternatives to teach and learn anatomy, namely the staff and students.

The vast majority of survey respondents use the Internet for the purposes of studying and leisure which is consistent with the theories around the Internet age and learning in the newer generations. The Internet has become commonplace in everyday life, and this result supports that. (Oblinger, 2003; Prensky, 2005; Mangold, 2007; Rowlands *et al.*, 2008; Ashraf, 2009; Jones *et al.*, 2010). Only a single respondent reported the use of the Internet for studying alone. Upon closer investigation, it was revealed that this respondent was a 20-year-old female in her second year of study. While she reported the use of the Internet for studying alone, she also noted that she makes use of the media sites *Twitter* and *YouTube*. While these sites may very well be used for study purposes alone, this would be rather anomalous given the responses of the rest of the cohort. She may have misinterpreted the question and understood use of the "Internet" as the utilisation of web search facilities for study purposes, not realising that the Internet encompasses all websites (including social media sites), however, this is an assumption and may be open to debate (although the likelihood that this particular respondent misinterpreted the question is great, given that 99% of the participants reported the use of the Internet for both study and leisure).

Laptops, smartphones and iPads/tablets are the most commonly owned devices in the study cohort. It is interesting to note that desktop personal computers (PCs) are in the minority, which talks to the

"on-the-go" culture entrenched in today's learners, with mobile devices enabling accessibility to the World Wide Web anywhere and at any time. Gone are the days where a learner (or teacher for that matter) needed to be bound to a workstation in order to complete a piece of work or engage in social networking. The same holds true for the students and staff at UCT FHS, it would seem. The spread across age/year of study was vast, again, supporting the theories that ownership of technological devices has become the norm for society today (and importantly, that this is observed worldwide, and is not exclusive to the realm of academia). Another note of interest is that ownership of desktop PCs feature slightly more so than iPads/tablets or iPods in the postgraduate and staff groups. This is explained by the fact that each postgraduate student and staff member is assigned a desktop PC and dedicated desk/office space for the duration of their tenure at UCT FHS. Consequently, the bulk of their work time will be deskbound.

Not surprisingly, *YouTube*, *Facebook*, *Twitter* and *Instagram* come out as the top most used media. Using this information to envisage and implement innovations in the anatomy curriculum at UCT FHS would be the expedient thing, given that these technologies are already being widely used. It is even safe to extrapolate this result to the broader UCT community, in that the usage and tendency towards reliance on technology and social media is a consistent theme globally, and across a number of studies of this nature (Woodcock *et al.,* 2012; Bomhold, 2013; Suki, 2013; Junco, 2014).

YouTube has proven itself in the last decade to be a dependable means of transmitting information to a large audience, and has immense educational potential in that entire video (or audio) clips can be uploaded to the site free of charge. It is encouraging to see that it is already being used by a large proportion of UCT FHS members, in that this will make introducing a learning opportunity via this medium that much easier (since there will be minimal to no training required together with cost-effective implementation). The ease and value of transmission of anatomy learning material via *YouTube* has been the subject of a limited number of studies to date, which have shown that it has the potential to be an adequate means of anatomy instruction if it is used effectively with appropriate focus on the learning objectives and outcomes (Azer, 2012; Azer *et al.,* 2012 & Jaffar, 2012). For the purposes of anatomy learning at UCT, entire anatomy lecture series or practical demonstrations could be uploaded and archived as part of a UCT FHS "*YouTube* anatomy library" of sorts, which could be at the disposal of any student who needed a quick reference while studying for examinations or assessments, or in preparation for anatomy practical sessions.

Facebook needs no introduction. It has become the powerhouse in social networking since its inception in 2004. As of August 2015, the number of registered active users worldwide has grown to beyond 1.18 billion (Facebook, Inc., 2015). It therefore makes sense that *Facebook* would be amongst the most utilised media within the study cohort. While there is minimal research providing meaningful evidence into the value of *Facebook* as an anatomy learning aid, there is no doubt that there is immense power in using a medium of this nature to promote learning, based solely on the fact that it already has such a massive established following, spanning the globe. The way in which *Facebook* can be used at UCT FHS is extensive. Groups and pages focusing on a vast array of topics can be created with ease, by any registered user. It is promising to note that the University of Cape Town (UCT) already has an active footprint on *Facebook*, with various groups and pages, ranging from societies to faculties, all sharing and spreading university news and information instantly to the masses. In the same vein, an anatomy learning group could be created, either specific to a year of study, or across the entire Faculty, where an assortment of information can be shared pertaining to

study groups, important news, examination dates, study tips and tricks, and where members of the group are able to contribute in various ways. This group format is not dissimilar to Vula (UCT's student portal), however, this means of sharing information could prove advantageous in that it is accessible from anywhere as long as the user is a registered *Facebook* user. The potential of *Facebook* as an educational tool has been tested by Dr Akram Abood Jaffar, in his recent learning intervention known as "The Human Anatomy Education Page," a *Facebook* page dedicated to anatomy. While this is an open page, meaning that any public member of *Facebook* can join, he tested the feasibility of this over two years by studying a cohort of 157 second-year medical students at the University of Sharjah. Their attitudes towards the incorporation of the Facebook page into their anatomy learning material were surveyed, and data on the usage of the page was collected. The results of the study indicated that *Facebook* could be an excellent tool for directing anatomy learning if used appropriately (Jaffar, 2014). The utilisation of this page continues to be studied by Dr Jaffar and his team and it will be interesting to see how the educational experience via *Facebook* develops into the future.

Twitter, the third most utilised social media site by the entire study cohort, is a relatively newer platform, having been launched in 2006. The drawback of the functionality on the site is that each tweet is limited to 140 characters, meaning that only short messages can be sent out at any point. There is power in this, though, as short, punchy messages are able to be sent out to followers with only pertinent information. In fact, *Twitter* has recently been referred to as "electronic word of mouth" by way of the rapid cascading of information from the "tweeter" (the person delivering the tweet) to the masses (Jansen *et al*, 2009). Studies to date have shown that *Twitter* is advantageous as a learning tool for students both on and off campus (Kassens-Noor, 2012; Dhir *et al*., 2013). The fact that *Twitter* is being used by most of this study cohort means that the learning group ought to be receptive to implementation of a *Twitter* "handle" (or username) specific to the Faculty, where quick and short bursts of pressing information can be shared so as to reach the targeted audience with minimal effort. All it takes is 140 characters, after all.

Instagram is the newest of the "big four" social media sites and was launched in 2010. While the application is centred round the editing and sharing of photographs, there is the option to add captions to the pictures that are posted in order to create context and provide information pertaining to the photograph/picture that is posted. There has been very little research into the teaching-learning potential of *Instagram* to date, however, the studies that have been done indicate that there is great value in using *Instagram* as a learning tool, in that the level of user engagement is already enormous, even if from a social perspective (Salomon, 2013; Tekulve & Kelly, 2013; Mao, 2014). Using *Instagram* as a supplement to the anatomy curriculum at UCT FHS could provide a novel way of learning and retaining knowledge around anatomy and anatomical regions. For example, in preparation for a dissection session (and following the sequence of the dissection manual), an image of the region to be dissected could be posted on *Instagram*, with a question pertaining to that region, which will create dialogue and discussion by way of comments attached to the picture. This could create excitement and enthusiasm around preparation for dissection, as an example, which could otherwise be an intimidating task. An added benefit of using *Instagram* is that a repository of images is generated, which all followers will have unlimited access to for reference purposes. This could facilitate self-testing in much the same way as flash cards would, except that instead of physically using flash cards, the student engages with images digitally.

One of the most recent and highly popular social applications is *Pinterest*. This is a place where the user is able to create mood boards and collections of *blog*s, web pages, videos, articles and information around a specific area of interest all in one place by way of virtually "pinning" information onto a virtual pin board. It operates on the premise of inspiring users to engage in activities and begin projects that they have always wanted to, and promotes creativity and imagination. In this way, it has become a personalised platform as opposed to a group forum. The extent of the social engagement is limited to pinning another person's images, web pages or videos. While *Pinterest* may not seem relevant from an academic perspective, it could be used as a mind-mapping tool or a personal digital study space, where the student is able to draw information from various media into a single place, to create a consolidated view of an array of information. There have been a limited number of studies to date on the efficacy of using *Pinterest* as an educational tool (e.g. Hansen *et al*., 2012; Baggett & Gibbs, 2014). However, for the purposes of anatomy learning, *Pinterest* could be used to pin links to anatomic atlases, anatomy textbooks in e-book format, digital images, past examination papers, *YouTube* video links, Faculty *blog*s and other study material to create a rich, customised and personalised study tool. It is worth exploring this further, by virtue of the fact that UCT staff and students who made up this study group are already utilising this application, for whatever the purpose. A curious anecdote (of no relevance to this study) is that the usage of *Pinterest* was highest in the fifth year group, who were predominantly female. It appears that *Pinterest* is more popular with ladies, and this may be an interesting topic to investigate as part of a social study the future.

The least utilised medium in the study cohort is the *Podcast*. A number of studies have shown that there is great value in using *Podcasts* to deliver information to students via these compact and easy to use audio clips (Bongey *et al.* 2006; Patasi *et al.*, 2009; Walls *et al.,* 2010). The reason for this low usage rate in the UCT FHS study group is unclear, however, it may have to do with the abundance of new, modern audio and video streaming applications which were developed subsequently to the *Podcast*, which can be used on any smart device. Interestingly, since approximately 2010, each anatomy lecture has been recorded and made available via *Podcasts* on the UCT FHS student portal. This proved to be of value in previous years, with students reporting that they felt less anxious going into lectures with the knowledge that they could always refer back to areas of misunderstanding without missing out on subsequent information delivered during a lecture, and that the *Podcasts* created a sense of security and reassurance (G.J. Louw, personal communication, 8 January 2016). The low usage of *Podcasts* in the study cohort indicates that there has been a tapering off of utilisation of this facility, even though lectures are still being recorded and stored. This could be attributed to inadequate administration of the *Podcast* digital library*,* students not being adequately informed of the availability of the recordings, or diminished student interest over time. Whatever the reasons, it is certainly worth researching further in order to establish whether this is in fact a beneficial anatomy study tool for students, given that the infrastructure is already there. It may be worthwhile in the future to identify a dedicated resource who will be responsible for recording, uploading, promoting and tracking the usage of anatomy lecture *Podcasts* over a period of time in order to establish feasibility of this learning aid at UCT FHS. That being said, it is not necessary to rely solely *Podcasting* to deliver audio (or video) clips to students. Rather, the focus should be on producing or utilising high quality and relevant anatomy learning material (audio, video or otherwise) for distribution. The value here lies in the fact that a student need not be present in a classroom to have access to the lecture or demonstration material at any point in time. This could

contribute to a blended learning approach, if UCT chose to go that route, using both classroom attendance and self-study off site to direct the study of anatomy and promote a culture of independent learning. The methods of anatomy instruction at UCT FHS have evolved over the past few years, moving from a top-down instructional approach to a more learner-directed approach. This has meant that learners are more empowered to lead their own learning, having been provided with the tools to do this together with the knowledge that there is always a tutor or lecturer available to assist.

The benefit of instruction via video, social media, and virtual applications has been underestimated and underutilised in most tertiary institutions to date, and there is no reason why these tools should not be used to their full advantage. Whether separately or in conjunction, they can be used to enrich the anatomy learning experience, as well as the teaching experience, for students and lecturers respectively. While there is an abundance of options, it is of utmost importance to be mindful of the cost implications when choosing to implement a technological alternative. With the increasing pressure on tertiary institutions to reduce costs and increase efficiencies, it will not be feasible to consider hugely expensive options such as purchasing instructional video series or virtual software programs. Fortunately, there is an assortment of free tools available on the World Wide Web. It is as simple as typing "anatomy" into a *YouTube*, *Google*, *Instagram* or *Facebook* search, where hundreds of links to videos, images and pages become available instantaneously. This is the power of the Internet – it is a bounty of cost-effective educational possibilities, at the disposal of all learners and teachers across the world. While the content on the Internet is often uncensored or unverified (Flanagin & Metzger, 2000; Metzger *et al*., 2003; Vedder & Wachbroit, 2003), and as such could lead to potential ethical implications, such as coming across posts of cadaveric material online, this is something which cannot be influenced directly, and it will thus be the responsibility of the Faculty to promote the responsible use of online material as far as possible, and to reinforce the importance of ethical conduct when utilising any free content available on the Internet, should students wish to make use of these resources. There are inherent risks in engaging in many web-based or social media activities, but the key here is to create awareness upfront by educating the students in this regard and to encourage responsible usage of the material.

4.2 The perceived value of cadaver dissection

The respondents' feeling towards full body dissection corroborates the myriad research that has gone into perceptions around cadaver dissection and the reality that dissection is the backbone of anatomy learning (e.g. Dyer & Thorndike, 2000; McLachlan *et al.*, 2004; Pawlina & Lachman, 2004; Gunderman & Wilson, 2005; Aziz *et al,* 2002). Only a minority felt neutral towards the dissection experience, most from second and third year. The reason for this could be owed to the way in which the anatomy curriculum at UCT FHS is structured for the MBChB degree. It occurs in the following sequence:

Students are exposed to the body systems in the second half of their first year, and move straight into dissection in the first half of second year, with focused dissection sessions almost every day (covering trunk and limb anatomy). The first week of third year is spent on the female reproductive system, thereafter two weeks are spent on head and neck anatomy, and finally ten weeks are spent

on the neurological system. In total, around three hundred hours are spent on cadaver dissection, the bulk of which takes place intensively during second year.

It makes sense, then, that some of the second and third year groups could suffer a "dissection fatigue" of sorts and as such feel neutral towards the entire experience. In addition, the third year experience is less hands-on than second year and this could explain why they have no strong feeling towards the experience at this stage of their learning paths. Anatomy learning during the third year is very much instructional, and learning outcomes are achieved by direct observation of a tutor performing dissection demonstrations rather than students dissecting by themselves. In the fourth, fifth and sixth years of study, the focus moves away from dissection entirely, and is placed on clinical skills training by way of clinical rotations and exposure to actual patients. Dissection is therefore no longer foremost in the minds of students and this could explain why some of these respondents reported feeling neutral towards this.

Furthermore, the overwhelming feeling of this cohort towards the replacement of dissection in its entirety reinforces the general feeling in the literature that physical cadaver dissection cannot simply be replaced or simulated and has yet to be rivalled as the supreme tool for complete anatomy learning (Dyer & Thorndike, 2000; McLachlan *et al.*, 2004; Pawlina & Lachman, 2004; Gunderman & Wilson, 2005; Aziz *et al,* 2002; Patel & Moxham, 2006; Azer & Eizenberg, 2007; Chapman *et al*., 2013; Benninger *et* al., 2014; Van Wyk & Rennie, 2015).

That being said, it is appropriate to consider the minority response to these questions in an attempt to understand the reasons for this disparate view. Upon closer examination, it was found that most of the respondents who indicated ambivalence towards full body dissection also felt that dissection should be replaced by electronic resources (refer to Table 8). This group of students, although small, may be representative of a technologically reliant student group that exists within the broader UCT community, a group that represents the "digital learner" as described extensively in studies on students and their learning preferences as discussed previously (Oblinger, 2003; Prensky, 2005; Mangold, 2007; Rowlands *et al.,* 2008; Ashraf, 2009; Jones *et al.*, 2010; Gurung & Rutledge, 2014). However, this cannot be confirmed purely from the results of this study, given the very small response, and will have to be explored further in future studies of this nature. This will be touched on again in section 4.5 of the discussion.

As was expected, the majority of participants feel that the human dissection course is successful in achieving the objectives as listed in the questionnaire, which further supports several studies which have investigated the benefits of human dissection, as perceived by those who have participated in a dissection module in previous years (e.g. McLachlan *et al.*, 2004; Pawlina & Lachman, 2004; Aziz *et al.,* 2002). This seems the obvious result, in that each anatomical structure is physically isolated and scrutinised, which promotes knowledge retention as well as appreciation of the many facets of the human body through tangible examination.

A large number of respondents felt neutral towards the success of dissection in "developing an ethical approach to treating patients" as well as "appreciating the issues around death and dying." While the cadaver may be considered the first "patient," it could be difficult for students to think from the perspective of ethics, especially early on in their medical careers, more so since the cadaver is not in fact a living patient. The large proportion of second and third year students who felt neutral here supports the argument that this group of students is still fresh and have yet to develop the

skills required of a clinician, however, the reasons for the fourth year sentiment is not as easy to unpack. These results are unusual, in that practically every study of this nature, particularly pertaining to the ethics of treating patients and issues around death and dying reveal that exposure to the cadaver does in fact prove to be essential in achieving these objectives (Marks *et al*., 1997; Ellis, 2001; Rizzolo, 2002; Granger, 2004; McLachlan *et al.*, 2004). While the second and third year groups may have some apprehension or are still coming to grips with their feelings towards the cadaver, by fourth year, students should have gained deep insight into the ethical treatment of their patients as well as an appreciation around death and dying. It appears that the evidence from this particular segment of the study cohort does not support the general findings in the literature. While it is difficult to identify the precise reasons for this inconsistent response, it could perhaps be attributed to Faculty not placing direct emphasis on these matters during dissection sessions. While there are modules on ethical conduct and death/dying which form part of the MBChB programme, these are not topics that are actively discussed during dissection sessions. Another theory here could be that the students are not realising that they are being exposed to ethical issues since this is so implicit in the teaching of anatomy via cadaver dissection, and as such may indicate some neutrality towards this. Furthermore, the information shared about the cadaver assigned to each group of students is limited to age at death and cause of death as noted on the death certificate, the latter of which is often very general (for example "natural causes") and as such, it may be difficult for students to consider the cadaver as a person (or having been a person). It has no name, no background and no personal information to share with the students, and this may contribute to feelings of ambivalence towards the ethics of treating patients and matters surrounding death or dying. In the future, it may be useful to build something into the curriculum that places ongoing emphasis on the fact that each cadaver was once a living being, and carry this theme throughout the dissection phases of the MBChB programme, so that the students are always conscious and appreciative of this. This will tie in well with ethical treatment of patients, in that it will facilitate an inherent appreciation of life and death and of compassion towards, as well as fair treatment of patients from the very beginning of their training.

The noteworthy differences in sentiments between each group pertaining to the success of dissection in achieving various objectives as outlined in Chapter 3 are discussed and expanded upon below. The discussion and potential explanations for these responses are based on the UCT FHS context and the way in which this particular programme is structured.

4.2 a) *Second Year versus Third Year*

It may be appropriate to consider where in the MBChB programme each year group is in order to gain insight into reasons for their differing sentiments towards dissection. A small proportion of the third year group felt that dissection was unsuccessful in learning details of anatomical structures in the body, while no second years felt this way. This may be due to the third years being less actively involved in dissection and their reliance on learning through observation of tutors performing dissections as opposed to hands-on dissection, which could leave them feeling distanced from the process. In terms of gaining respect for the human body, as discussed previously, the most ambivalence was seen in second and third year, but it is interesting to note that there are also differences within this segmented group. The third year group could be feeling that they are not able to gain respect for the human body without directly engaging with the cadaver, since their hands-on dissection time has diminished, or could be feeling neutral towards this in light of their exhaustive

second year (as outlined previously). When looking at the differences between the groups in developing an ethical approach to treating patients, it is revealed that, again, more third years find that dissection is unsuccessful in achieving this objective. The reasons for this are probably similar as with gaining respect for the human body, in that these objectives go hand in hand. In terms of relating structure to function, the third year feeling, too, could be attributed to them not physically dissecting and therefore finding it difficult to connect structure with function. This could be particularly difficult for the third year students when it comes to the nervous system. While, with the rest of the body, the structure and function can be visualised and interlinked, the brain's structure and function proves to be very difficult to grasp purely by observation. Further to this, it is an extremely complex and difficult structure to dissect even for experts (Gunderman & Wilson, 2005; Brewer *et al*., 2012). Lastly, many more third years felt that dissection was unsuccessful in providing a basis for clinical skills training. This may be due to the third year group, having only begun clinical rotations, not yet being able to see the value of dissection in the application of clinical skills, as this will only come later in their training. It may also be that their clinical rotations were out of synch with the anatomy being taught at the time of the survey. The second year response is probably due to the fact that they have not yet been exposed to clinical skills at all and therefore don't see its worth at this stage.

4.2 b) *Fourth Year versus Fifth & Sixth Years*

The reason for the fifth and sixth year group feeling more neutral towards "classifying the components of each body system" could be attributed to the fifth and sixth year groups having already embedded this knowledge, and therefore no longer viewing cadaver dissection as the primary tool for classification of body systems. At this stage in their training, there is greater exposure to a vast array of tools for the purposes of clinical examination, the most important of which is the living patient. These students therefore place emphasis on viewing and examining living body systems via x-ray, CT scan, MRI, laparoscopy and the like, and could therefore feel ambivalent towards dissection as a means of classifying body systems, while the fourth year group will still be making reference to dissected or prosected material as part of their training. It is promising to note, however, that the fourth, fifth and sixth years largely share positive sentiments towards dissection and its success in achieving all the objectives it sets out to achieve in anatomy learning.

4.2 c) *Females versus Males*

The response of students to cadaver dissection has been extensively explored in order to better understand as well as improve the dissection experience for students around the world (e.g. Dinsmore *et al*., 2001; Miller *et al.,* 2002; McLachlan, 2004; Dempster *et al*., 2006; Warner & Rizzolo, 2006; Collins, 2008; Boeckers *et al*., 2010; Mohammad, 2011). However, there have been few studies specifically interrogating the differences between the responses of female and male students to cadaver dissection. The most apparent finding in the studies to date based on the sex of students is that females tend to experience higher levels of anxiety and display a more emotional response when encountering the cadaver for the first time (e.g. Snelling *et* al., 2003; Hancock *et* al., 2004; Arora & Sharma, 2011; Bati *et al*., 2013; Karau *et al*., 2016).

The findings from this survey show that females had a more positive experience with certain objectives of dissection, which is difficult to corroborate with other experiences as there is limited literature available on this topic (refer to Table 3). While sex differences in responses to the cadaver

dissection course were not crucial to the outcome of this particular study, there were some differences between the female and male student responses which produced significant results. The entire female complement felt that the dissection course did aid in appreciating the human body in 3D, while a few males felt negative or neutral towards this. This could possibly be due to the female complement having a deeper appreciation for the tactile experience with the cadaver in three dimensions. Since males are generally more adept at processing visuospatial and mental rotation tasks in three dimensions, they may have taken the three-dimensional structure of the actual cadaver before them for granted. (e.g. Moffat *et al*., 1998; Vecchi & Girelli, 1998; Weiss *et al*., 2003). More females than males felt that dissection was helpful in gaining respect for the human body, developing an ethical approach to treating patients and appreciating the issues around death and dying. Again, as mentioned above, there is very little literature on this topic to validate or debate these findings. The questions of this survey were not framed in order to obtain information on sex differences specifically, however, gauging from the limited literature around this topic, this could be a valuable area of study in the future.

4.3 Learning aids and their usefulness in anatomy learning

There was a significant ambivalent response to several of the learning aids as outlined in question 7 of the questionnaire. There are a few potential reasons for this ambivalence. For one, e-learning modules, *blog*s, online forums, flash cards and self-evaluations are not formally provided by Faculty, and therefore may not be viewed in the same light as other formal learning aids. Another factor could be that there are other learning aids which have more of a direct impact on learning outcomes, such as dissection, past examination papers and group study, and as such, could hold more merit for students. A range of studies have interrogated whether compulsory educational resources have an impact on student academic performance. It has been found that while performance may improve, by making resources compulsory, academic institutions take on responsibility that should essentially be that of the student (e.g. Maloney & Lalley, 1998; St Clair, 1999; Mattick *et al*., 2007; Newman-Ford *et* al, 2008; Barlow & Fleischer, 2011). Furthermore, it has been shown that students do want to direct their own learning, as opposed to have it directed for them via an instructional approach from tertiary institutions (e.g. Lockwood *et al*., 2012). In this vein, UCT FHS has adopted a “formal” versus “informal” approach to academic resources, endeavouring to enforce less and motivate more, in this way empowering the student to lead his/her own learning (G.J. Louw, personal communication, 8 August 2016). The neutral response to those informal learning aids, then, could be due to the students placing emphasis only on those learning aids which they deem beneficial to achieving their academic outcomes.

It is interesting to note that almost a third of the study cohort felt neutral towards PBL, which forms a large formal component of the MBChB programme. It has been shown that PBL does contribute to improvements in academic performance worldwide, as well as in South Africa in particular (Iputo & Kwizera, 2005). Academic outcomes are achieved via small-group collaborations and a self-directed learning approach, and this is considered more meaningful than performing rote tasks or relying on recall of information via written assessments (Hmelo-Silver, 2004; Iputo & Kwizera, 2005). While the reasons for this response are unclear and do not correlate with the evidence in the literature on the value PBL, this group at UCT FHS may feel that PBL is an onerous component of their training, or may feel ambivalent towards it as there is no active assessment and academic outcome (for example, a

written or practical examination). It will be interesting to delve further into this in the future, and conduct a study on student perceptions of PBL at UCT FHS in order to gain further insight here.

The significant differences in sentiments between each year group towards the usefulness of the various learning aids are discussed and expanded on below. Again, the discussion is based on the UCT FHS MBChB programme in particular.

4.3 a) *Second Year versus Third Year*

Here, it may be appropriate again to consider where in the MBChB programme each year group is in order to ascertain the reasons for their differing opinions. In terms of one-on-ones and group study with a tutor, third years will have more appreciation towards this as they have begun clinical rotations and therefore see the value in enlisting the help of a senior or interacting in small groups. Second years have limited clinical exposure and are still finding their feet, which could explain their feeling towards these learning aids. The response of the third years towards images (where more felt they were neutral or unhelpful) could be attributed to the greater emphasis that is placed on images in second year, especially those of histological slides during practical sessions. This is not an area of particular focus in third year, and for this reason, the third year group may not deem images valuable – it may well be that images were of no relevance to the third year clinical block at the time of the survey, and were therefore not an area of importance for them.

4.3 b) *Second Year versus Fourth Year*

While the fourth year response to dissection and the dissection manual may not be the most obvious result, in that the second years are more active with hands-on dissection than the fourth year group, the fourth years may be drawing from their experience in previous years and appreciating the knowledge they gained and retained during their time dissecting/using the dissection manual. They are very much involved in patient examination and as such would need to recall anatomical structures regularly. Another theory is that they are using their dissection manuals as reference material during their clinical rotations. The fourth year response to one-on-ones and group study with a tutor is a similar scenario to the one above (second versus third years) where fourth years clearly see the value of one-on-ones and group work in achieving their learning outcomes, and appreciate that these interactions are essential to their clinical education in that clinical rotations and examining patients have become regular parts of their training.

4.3 c) *Second Year versus Fifth & Sixth Years*

The second year group's more neutral stance towards one-on-ones with a tutor is consistent with second versus third and fourth years, and the potential reasons for this have been covered above. With regard to formative assessments, the fifth/sixth year group could be feeling neutral towards this as this particular group of students, nearing the end of their time at university, have changed their measure of success to that of clinical practice outcomes rather than theoretical formative assessment outcomes. Looking at the second year sentiment towards *blog*s, where more felt that these were helpful, in light of the fact that the general feeling across the cohort was neutral towards *blog*s as a learning aid, this result seems anecdotal. It may have something to do with the second years in this particular cohort being more active with *blogging*, however this is an assumption and may be a potential area to focus on for future studies. There have been a number of studies looking

at the potential of *blogs* as resources for learning, and for this reason, it may be worthwhile to explore further (e.g. Williams & Jacobs, 2004; Boulos *et al*., 2006; Churchill, 2009; Downes, 2009). The fifth/sixth year stance towards past examination papers on Vula, again, can be explained by the fact that theoretical examinations are not the primary focus area for the fifth/sixth years and they therefore feel neutral, in that these are not of relevance to their progress and performance.

4.3 d) *Second Year versus Staff & Postgraduates*

The small group of second years who felt neutral towards dissection may fall into the cluster of students who are ambivalent at a particular stage of their studies, trying to find their feet, and are not quite sure yet of how they feel towards the dissection course. In contrast, the staff and postgraduate group feel strongly that dissection is beneficial in learning anatomy, more so since they have already been through the dissection course and have a deep appreciation of the value it adds to the learning experience. The second year response to past papers makes sense, in that second years are much more likely to look to past papers for clues and guidance on what to expect in their written examinations. Staff members and postgraduates, however, have little (if any) need for past examination papers. Naturally, more of the staff/postgraduate group will feel neutral towards self-evaluation tests online, largely for the same reasons as with past examination papers, since online evaluations are not a specific requirement for staff members and postgraduates, and they therefore have no strong feeling towards this.

4.3 e) *Third Year versus Fourth Year*

The third year response to dissection may talk to the third year "dissection fatigue" (as discussed previously) in light of their intensive previous year, and the fourth years are drawing on their previous years even though they do not actively dissect in order to draw clinical correlations as part of their clinical rotations. Again, more fourth years than third years considered examination of prosected material to be helpful, which could indicate that fourth years find examination of prosected material to be beneficial in drawing conclusions pertaining to clinical examinations and identifying pathologies and abnormalities. Third years would not find this as valuable in that they are yet to be exposed to that level of clinical skills training, and are still more involved in dissection than their fourth year peers, which is known to supersede examination of prosections in terms of learning outcomes (Sugand *et al.*, 2010). The greater third year response towards the usefulness of online forums makes sense, as this could be due a higher level of engagement within the third year group when it comes to online forums, while the fourth years are engrossed in the practical component of their training (through their clinical blocks).

4.3 f) *Third Year versus Fifth & Sixth Years*

The third year and fifth/sixth year difference in sentiments towards dissection is a very similar result to the third year versus fourth year experience with dissection, as discussed above, and the same conclusion will be drawn, since the fifth/sixth years are very much clinically orientated at this stage in their training. The more positive response towards *blog*s by the third year group could be attributed to the third years being more actively involved in b*logging* as suggested with the second year group, and the fifth/sixth years focusing more on their practical training. Again, it may be worthwhile to explore this further in the future. Lastly, fifth and sixth years found images more useful than third years. This could be due to the fifth/sixth years having come full circle in a sense, in

that they are consolidating all their years of training and thus see the value in using images regularly to draw clinical correlations and formulate diagnoses during their patient examinations, while third years may not yet have built an appreciation for the use of images at this stage in their training. Alternatively, as with the second versus third year result, third years may have been in a clinical rotation at the time of the survey which did not require the use of images, and therefore did not consider them as favourably.

4.3 g) *Third Year versus Staff & Postgraduates*

The reasons for the difference in sentiments between these groups towards dissection (with a proportion of third years finding it to be unhelpful or feeling neutral towards it) in all likelihood, are similar to the third year group versus fourth and fifth/sixth years and have been covered above. The third year response towards images as compared with the staff/postgraduate group, again, talks to the probability of images not being necessary or as relevant during the third year clinical rotation at the time of the survey, while staff and postgraduates have an all-round understanding of the way in which images can be used to aid in clinical examination. Past examination papers on Vula were viewed more positively as learning aids by the third year group, since third years will have much more use for past papers in their preparation for theoretical examinations.

4.3 h) *Fourth Year versus Fifth & Sixth Years*

The similar sentiments shared by the fourth and fifth/sixth year groups towards the usefulness of the 23 learning aids as set out in the questionnaire suggests that, from fourth year onwards, there is a general comfort with the use of all learning material and aids, and indicates that as clinical skills develop, so too does the appreciation of anatomy, with examination of patients becoming more comprehensive and demanding.

4.3 i) *Fourth Year versus Staff & Postgraduates*

The fourth year feeling towards demonstrations in the museum and pinned/labelled specimens proved to be more positive than that of the staff/postgraduate group. This indicates that fourth years may find reference material of this nature more useful as they go about their training, and probably make more use of the material than staff and postgraduates would. The assumption here could be that staff/postgraduates are using specimens and demonstrations to guide learning rather than using them for their own learning, and are therefore reporting how helpful they perceive these to be in achieving student learning outcomes. It may be interesting to consider this angle in a future study, where the focus is exclusively on the teachers' feelings towards particular learning aids and their opinions of the usefulness of these aids in guiding learning. The staff/postgraduate feeling towards past papers as compared with that of the fourth years, again, shows that staff members and postgraduates will have little (if any) need for past examination papers. Lastly, many more fourth years than staff/postgraduates felt that self-evaluation tests online were helpful, and as with the feeling towards past papers, staff and postgraduates have less need for self-evaluation tests than fourth years for the purposes of their learning (or teaching).

4.3 j) *Fifth & Sixth Years versus Staff & Postgraduates*

The explanation for the difference in sentiments between these groups towards demonstrations in the museum this is similar to fourth year versus staff and postgraduates, as considered above.

4.4 Alternatives to dissection – are these worth exploring?

It has already been established that the cadaver dissection course at UCT FHS is deemed tremendously valuable and that students and staff are strongly opposed to replacing dissection with technological alternatives. The next section considers the student and staff views around introducing alternatives as supplements to, rather than replacements for, traditional dissection.

4.4 a) *Simulations*

The overwhelming majority felt that simulations of clinical procedures performed on cadavers in the dissection hall this would be helpful as an aid in anatomy learning. While it is true that simulations are beneficial in enriching the anatomy learning experience (Hariri *et al.,* 2004; Barry Issenberg *et al*., 2005; Kneebone, 2005), they have yet to be introduced as a learning aid at UCT FHS. This could be implemented in the dissection laboratory by inviting specialists as guests to dissection sessions, where they could perform some of the simpler simulated procedures on a cadaver and talk the class through the objectives and outcomes of said procedures, and how these will guide a clinical examination. This will begin to expose the newer students to the ultimate objective of their medical training early on, which is, building clinical skills through investigative procedures and examinations (e.g. Reidenberg & Laitman, 2002). While, in theory, this seems to be easy enough to put into place, there are various interdependencies which may affect implementation of an addition to the curriculum of this nature. First and foremost is the availability of specialists. It is known that clinicians are under immense pressure and time constraints as they perform their specialities, and this together with cost implications may prove difficult for UCT FHS to enlist specialists for these teaching interventions. That being said, it is worth exploring further, building up research on the value-add of simulated procedures in the dissection laboratory, and potentially approaching clinicians (both public sector and private practice) to offer their services free of charge.

4.4 b) *Computer-Assisted Learning*

Here again, the majority of the study cohort feel that computer-assisted learning via digital images such as MRI, CT scans or endoscopy would be helpful in facilitating a deeper understanding of anatomy, a result which corroborates the wealth of research which has gone into assessing the value of these modes of learning anatomy (e.g. Nieder *et al.,* 2000; Sinav & Ambron, 2004; Nicholson *et al.*, 2006; Hamrol *et al.*, 2013). Images are already being used to some extent as part of the anatomy curriculum, particularly during histology practical sessions, where screens are dotted around the laboratory showing amplified views of histological slide images pertaining to that particular session. This set up can be easily replicated in the dissection laboratory, and at minimal cost, in that projectors linked to a laptop or PC (which are all readily available for use within the Faculty) can be used to achieve the same result as with a computer or television screen. Images of various anatomical regions can be obtained easily either online, or from Faculty material, and in this way a repository of curriculum-specific images can be built up over time. The value here, again, lies in the potential for students to begin formulating anatomical and clinical correlations early on in their training. A nice way of testing the feasibility of this will be to enlist the assistance of, for example, lecturers in anatomical pathology, who begin lecturing students from their second year and in conjunction with their clinical rotations during third year. These and other lecturers, time permitting, could join in on dissection sessions as guests and talk the students through images indicating various

pathologies or could walk around and spend time with each cadaver pointing out pathologies and human variations, in an effort to generate discussion, provoke thought, and facilitate knowledge retention amongst the student group. Another advantage is that the clinician educator is able to begin shaping and preparing the students for what is to come in subsequent years, and in this way, firm foundations can be built.

There is great value in procuring the assistance of clinicians, lecturers and individuals from other related specialities not traditionally directly linked to the anatomy or dissection programme, in that it fosters a culture of integration of knowledge, collaboration and team work across disciplines, specialities and faculties, and can only strengthen the educational experience at UCT for students and teachers alike.

4.4 c) *Videos*

Just over half of the group noted that they would make use of video demonstrations frequently, a result that ties in perfectly with their tendency towards the utilisation of *YouTube* and its rapidly increasing popularity (Azer, 2012; Azer *et al.,* 2012 & Jaffar, 2012). The educational potential of *YouTube* can be tested at UCT FHS by recording dissection demonstrations (perhaps performed by staff and/or postgraduate students) and playing them back during or after dissection sessions, from where students are able to take cues and obtain guidance on a regular basis. Alternatively, links to *YouTube* video clips can be included in the dissection preparation material in order to give the student a feel of what to expect from that particular dissection. Video clips can be recorded by the Faculty or obtained from the abundance of anatomy video clips available on *YouTube*; however, it may be worthwhile to create a video series which is tailor-made in order to achieve the specific objectives of the anatomy curriculum at UCT FHS, which could make the dissection experience more rewarding for the students and personal to the Faculty.

Additionally, it was found that the cohort used videos (not provided by Faculty) as supplementary aids in preparation for dissection, assessments and anatomy lectures. While the use of learning supplements based on individual preference should be encouraged by the Faculty, again it is important that this material is vetted by a staff member in order to ensure that the content is accurate and relevant, based on the array of Internet-based content that is often either inaccurate or incomplete (Flanagin & Metzger, 2000; Metzger *et al*., 2003).

The perceived success and value of each of these innovations discussed above, if piloted within UCT FHS, can be collected by way of a survey, much the same as this one. A more quantifiable measure of success would, of course, be improvement in student academic performance.

4.4 d) *Online Material*

Online modules, purely for self-evaluation, with the pace and amount of time devoted to this based on the individual were of interest to the majority of the group. Those who showed no interest in online modules are probably of the opinion that the workload as it stands is already too great to consider taking on any additional work. Interesting to note that those who were against this comprised mostly second and third year students, which again talks to this group being in the early stages of their learning paths and possibly feeling inundated with the existing amount of work they are required to get through. An online elective module can be easily acquired from the abundance of

material available on the Internet, so this could prove to be a cost effective method of encouraging self-directed learning. It will be important, however, for staff members within the Faculty to validate the online learning material and then recommend it, especially since there is a huge proportion of erroneous material available online (as discussed previously). It is also important to be mindful of student workloads and pressure, meaning that if the Faculty chose to utilise elective online modules, it must be explicitly stated that these are entirely optional. That being said, the most utilised supplementary learning aid (outside of Faculty material) as reported by the study cohort was online material. Adding to this, the vast majority of the cohort felt that more material should be made available online for the purposes of anatomy study, and that it should supplement, rather than replace laboratory cadaver dissection. It was also found that applications (or "apps" as they are referred to) were popular supplementary learning aids. This substantiates the theory that the student of today, in particular this group of South African students, is part of a "smartphone generation" where social media and educational applications on practically any topic of interest are readily available for download, and often at no cost (Payne & Watts, 2012; Bomhold, 2013).

These results indicate that there is an opportunity to explore the enormous and diverse online capabilities for teaching anatomy, especially in that the study group already shows interest here. Once again, this highlights that online capabilities have a definite place in facilitating learning and acquisition of knowledge, and as such could have a more permanent place in the anatomy curriculum at UCT FHS.

4.4 e) *Hybridising the teaching of Anatomy*

As predicted, the response of the sample representing UCT FHS in this study confirms that the preferred method of cadaver dissection would be one that encompasses both traditional and virtual dissection, and this further supports the general interest in technological advances to bolster anatomy learning and willingness to engage in educational practices that push the boundaries of tradition. It is apparent from the results of this study that the staff and students at UCT FHS are comfortable with various technologies and are open to the idea of implementing alternatives to traditional dissection, but view the cadaver as an irreplaceable part of the anatomy course. The opinions of this study cohort correspond with the results obtained across numerous studies on the topic of anatomy learning and dissection (e.g. McNulty *et al.*, 2009; Tam *et al.*, 2009; Choudhury & Gouldsborough, 2012; Kish *et al.*, 2013; Papa & Vacarrezza, 2013; Attardi & Rogers, 2015). This is more than enough cause to begin thinking around potential innovations in this field, and considering the future appearance of the anatomy course.

4.5 Is there any evidence of a "technologically driven" student presence at UCT FHS?

There was a minority of survey participants who were in support of replacing the traditional cadaver dissection course at UCT FHS with technological alternatives. These were the same students who thought that simulations, computer-assisted learning and elective online modules would be beneficial, and were of the opinion that more material should become available online for the purposes of studying anatomy. However, this group also rated dissection highly in achieving many learning objectives, and did find value in several of the traditional learning aids. It cannot be concluded for certain then, that there exists a group of students who favour technological means of

learning exclusively over traditional means, however small the group may be (Refer to Table 26). This endorses the argument that learning preferences are diverse and that we cannot simply label a learner as "digital native" by virtue of the time into which they were born (Bennett & Maton, 2010; Brown & Czerniewicz, 2010; Czerniewicz & Brown, 2010; Kennedy *et al*, 2010; Gallardo-Echenique *et al*., 2015; Akçayır *et al*., 2016). If the group of students who were neutral towards dissection and felt that it should be replaced by electronic resources (Table 8) are representative of a technologically reliant group of people, then this minority response further supports the argument that the bulk of students today do not necessarily rely on technology to direct their learning, and are not inevitably "digital natives." Rather, these students have provided insight into a potential hybrid anatomy module which combines traditional and contemporary methods and resources to teach this science.

4.6 Reflections

There are noteworthy areas for improvement, should this study be expanded upon or reworked in the future. By virtue of the fact that this was an investigation into attitudes, opinions and perceptions on various facets of anatomy education, it may have been useful to have taken note of the study block that each year was in during the time they were surveyed (for example, the specific phase of dissection or the particular clinical rotation at the time). This would have provided insight into the potential reasons for their feelings towards particular parts of their anatomy course.

It may have been of value to include a focus group or interview component in the study in order to obtain a deeper understanding of the reasons for the differences in sentiments across the questionnaire, as well as to obtain suggestions for improvement and enhancement of the anatomy curriculum at UCT FHS.

A larger study cohort would have provided much more information. Perhaps the response rate would have been higher if the survey was delivered multiple times throughout the academic year. This would not have been possible, though, given the time constraints and the cohort's academic responsibilities.

The perceptions of the teaching staff could be an area of focus in a future study, with the intention of improving the ease of anatomy instruction and delivery of learning material through feedback from the facilitators themselves. Taking it a step further, it may be worthwhile in the future to embark on a study of this nature which encompasses a collaborative research approach across universities, both locally and internationally to gain more profound insight into the possibilities for enhancement of anatomy education globally. The beauty of anatomy study lies in the fact that it is taught and learnt using a universal language, and it therefore makes sense for efforts for improvement to be aligned as far as possible across institutions.

All questions of the survey were compulsory and a participant could not move onto the next question if the previous one was not answered. While this approach was taken as part of the study design to ensure complete responses for analysis, it may have been a limitation in that respondents may have been "forced" to answer a question, especially pertaining to the use of various supplementary resources, in order to make progress with the survey. If this was the case, then a respondent who indicated "neutral" or even "unhelpful" to certain of the questions could have done so out of a lack of awareness rather than making an informed decision, or could have done so

perhaps due to the respondent not having access to that particular resource, or feeling ambivalent towards it. This will be an important consideration should this study be expanded on in the future.

4.7 Future research areas

A few potential areas for future research opportunities were identified during the course of this study. They were as follows:

- It was found in the literature that there has not been much research into the usefulness of living models in the study of anatomy. It will be interesting to see whether incorporation of live models into anatomy courses will have any impact on retention of anatomical knowledge and student academic performance.
- The results of the social media usage component of the survey revealed that females seem to be more avid *Pinterest* users than males. This could be the focus of a study within the social sciences, where the reasons for this could be explored and the value of this particular social media application can be evaluated.
- As there seemed to be some ambivalence towards the ethics around cadaver dissection and gaining respect for the human body through dissection, a study could be carried out to test if this feeling would change if the Faculty placed ongoing emphasis on these matters and actively discussed them during the MBChB programme.
- It may prove useful to embark on a study in the future that focuses on the individuals who struggle with the cadaver dissection course or anatomy in general in order to gain insight here. The proportion of students who would like to see the dissection course replaced by technological alternatives, albeit a small number, can be included in this study in order to establish the reasons for this.
- A few differing sentiments between males and females towards the learning objectives of dissection were identified during this study, and while this was not a focus area here, it may be valuable to explore a sex-related study of this nature in order to obtain insight on these sex differences in the South African context. This may contribute to the limited literature available on sex differences in perceptions of cadaver dissection and the associated learning objectives specifically.
- The cohort's response to PBL was an interesting one. A study focusing on perceptions on the success and value of PBL in the future may provide valuable information which could be used to enhance the experience for future medical students.
- As *blogs* are already widely used across the globe, it makes sense to explore the potential of *blogs* as learning aids at UCT FHS in order to ascertain whether there is an appetite for this medium as a tool for learning anatomy .

Chapter 5 - Conclusions

The value of the anatomy course in medical curricula is a topic which receives a great deal of attention across the globe. Over the years, the necessity of an anatomy course in tertiary institutions that encompasses both anatomical theory as well as practical cadaver dissection has come under scrutiny, with the number of hours devoted to anatomy education beginning to dwindle in many institutions. Using surgical training as an example, students who are not exposed to anatomical structures and relationships via anatomy lectures and cadaver dissection will go into practice lacking the foundation of anatomical instruction and by virtue of this, the confidence that is so fundamental to their success as surgeons. It is for reasons such as this that the teaching of anatomy is held in high regard as part of a medical training programme, and considered vital to the overall success of the curriculum.

In addition, it is important for universities to review curricula regularly in order to formulate learning material that is relevant to students' academic expectations in this ever-evolving world of technology, and to stay abreast of the rapid and continuous advances in online capabilities, so that educational outcomes are as successful and effective as they can be. Various studies have explored the way in which students of today prefer to learn and assimilate knowledge, as well their level of interaction with technology. It is therefore in keeping with these advances, that any anatomy course improvements take these factors into consideration in order to achieve the greatest outcome.

The anatomy course at UCT FHS has last undergone a review approximately a decade ago. A review, some ten years later, will be undertaken shortly at the request of the Deputy Dean in order to assess the methodologies and clinical content being used to direct anatomy learning, as well as the depth of the anatomy instruction as part of the MBChB programme. The content of the course need not be re-evaluated, since the complete anatomy of the human body has already been described. This study was designed to obtain information directly from the staff and students in order to inform potential future anatomy course improvements which will be relevant to staff and students and towards which they will be receptive, and which may aid in this imminent review.

The participants of this study were able to provide valuable insight into their learning preferences and attitudes towards cadaver dissection and various technologies. It was found that, in much the same way as the rest of the world, UCT FHS has seen a shift towards the utilisation of technology for various interactions, including social engagements and efforts in achieving academic learning outcomes.

Furthermore, in keeping with the general feeling across all medical schools globally, the study cohort places immense value in the cadaver dissection course as a teaching tool for anatomy, and would not like to see it replaced by technological alternatives. Rather, they would prefer to see alternatives which are supplementary to cadaver dissection in order to bolster their learning. They also feel that, if possible in the future, the anatomy course should encompass an experience that involves both virtual and traditional dissection, in order to achieve the greatest learning outcomes.

The information collected during this study marks the onset of a golden opportunity to begin designing the optimal anatomy teaching and learning experience, one which completely engages the student from beginning to end by virtue of the relevance to student learning preferences. While this study has only scraped the surface of the potential improvements that could be made to the

curriculum, it has provided great insight into the student and staff attitudes towards their anatomy learning experience. This information is vital in that feedback straight from the source is the most powerful tool for facilitating enhancements to any curriculum.

An additional comment outside of the scope of this study is that, by making members of the general public aware of how much the students value dissection of the human body in their training to become healthcare professionals, the body donation project of the university would benefit immensely.

This study was designed with the intention of generating debate and discussion around the anatomy curriculum at UCT FHS and to inspire creative thinking around options for enhancement of teaching and learning activities. These supplementary options do not detract from dissection of the cadaver as part of the course. The cadaver remains a necessity as it is the student's first encounter with the meaning of being human as well as death and dying, and is a significant rite of passage for each medical practitioner in training. This exercise is something that should remain constant amidst any conceived changes or enhancements to anatomy education both in South Africa and globally.

Chapter 6 - References

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Chapter 7 - Appendices

Appendix A – Informed Consent and Survey Questionnaire

An investigation into the educational value of supplementing dissection of the human body with alternative resources: perceptions of students and staff at UCT

Consent Form

Thank you for participating in this study entitled "An investigation into the educational value of supplementing dissection of the human body with alternative resources: perceptions of students and staff at UCT."

By proceeding with this questionnaire, you consent to your response being used as part of this MSc(Med) study, which aims to assess the value of using web-based and online learning material to supplement traditional dissection in a laboratory setting. With global advances in technology, social media and accessibility to the World Wide Web, it seems appropriate to investigate the possibilities of using readily available technology as an aid to obtaining an in-depth and holistic understanding of the human body together with dissection.

Your response will be anonymous. It is entirely your choice whether to participate in this study or not. If you choose not to be a part of the study, there will be no effect whatsoever on your standing as a staff member or student of UCT Faculty of Health Sciences.

There are no risks involved in participation in this study.
The benefits of your participation include providing insight into the preferred methods of anatomy learning as perceived by you – the students and staff of UCT – as well as the potential value of using web-based and online learning material to supplement traditional dissection in a laboratory setting. Your feedback will be given to the faculty and may be of great value in curriculum development in the future.

This survey should take you no longer than 10 minutes.

For any questions related to this survey or study, contact:
Prof. Graham Louw - graham.louw@uct.ac.za
Shakira Ramgoolam – shakiraramgoolam@gmail.com

For any questions regarding your rights or welfare as research participants, contact:
Human Research Ethics Committee
021 – 4066336
shuretta.thomas@uct.ac.za

I agree to continue with this survey *

- ○ yes
- ○ no

Demographic Information

Please select your year of study

Please choose...

How old are you? *

Age: _____ years old

Sex *

Please choose...

Please select the region you are from:

- ○ South Africa
- ○ SADEC
- ○ Other (International)

Question 1

What do you use the internet for? Please select: *

- ○ Leisure
- ○ Studying
- ○ Both

Question 2

Do you own any of the following? (please check relevant boxes) *

- ☐ Smart Phone
- ☐ iPod
- ☐ iPad or tablet
- ☐ Laptop
- ☐ Desktop PC

Question 3

Do you use any of the following media? (Please tick all relevant boxes)

- ☐ Facebook
- ☐ Twitter
- ☐ Pinterest
- ☐ Podcasts
- ☐ YouTube
- ☐ Instagram
- ☐ Other - please specify

Question 4

UCT students learn anatomy through whole body dissection.
How valuable do you find this experience? *

	Not Valuable	Neutral	Valuable
Whole body disscetion is	○	○	○

Question 5

How would you feel about doing away with whole body dissection?

	strongly agree	agree	neutral	disagree	strongly disagree
I	○	○	○	○	○

Question 6

Please rate how successful your dissection module has been in achieving the following objectives: *

	very unsuccessful	unsuccessful	neutral	successful	very successful
Providing a vocabulary of anatomical structures	○	○	○	○	○
Classifying the components of each body system	○	○	○	○	○
Appreciating the human body in 3D	○	○	○	○	○
Gaining respect for the human body	○	○	○	○	○
Developing an ethical approach to treating patients	○	○	○	○	○
Appreciating the issues around death and dying	○	○	○	○	○
Relating structure to embryological development	○	○	○	○	○
Relating structure to function	○	○	○	○	○
Relating structure and function to pathology	○	○	○	○	○
Providing a micro to macro view of anatomy	○	○	○	○	○
Facilitating team work and group learning	○	○	○	○	○
Recognizing and appreciating anatomical variation	○	○	○	○	○
Providing a basis for clinical skills training	○	○	○	○	○
Developing surgical skills through dissection techniques	○	○	○	○	○

Question 7

How helpful have you found the following in your preparation for anatomy exams? *

	Very unhelpful	Unhelpful	Neutral	Helpful	Very helpful
Textbooks	○	○	○	○	○
Lectures and lecture notes	○	○	○	○	○
Pre-practical talks	○	○	○	○	○
Dissection	○	○	○	○	○
Using the dissection manual	○	○	○	○	○
Anatomy atlas	○	○	○	○	○
Practical demonstrations using models	○	○	○	○	○
Examination of prosected material	○	○	○	○	○
Demos in museum (labelled)	○	○	○	○	○
Pinned/labelled specimens in dissection hall	○	○	○	○	○
e-learning modules	○	○	○	○	○
Group study with peers	○	○	○	○	○
PBL (Problem-based learning) sessions	○	○	○	○	○
One-on-one with tutor	○	○	○	○	○
Group study with tutor	○	○	○	○	○
Formative assessments	○	○	○	○	○
Blogs	○	○	○	○	○
Online forums on your web portal (Vula)	○	○	○	○	○
Images (radiological slides, MRI etc.)	○	○	○	○	○
Past exam papers on Vula	○	○	○	○	○
Flash Cards	○	○	○	○	○
Self-evaluation tests online	○	○	○	○	○
Self-evaluations at the back of each chapter in Anatomy textbook	○	○	○	○	○

Question 8

How helpful do you think simulated clinical procedures performed on the cadavers in your dissection lab would be in aiding in your learning of anatomy and its clinical application? *

	Very unhelpful	Unhelpful	Neutral	Helpful	Very helpful
They would be	○	○	○	○	○

Question 9

How helpful do you think computer-assisted learning using digital images (e.g. MRI, CT images, endoscopy) in the dissection lab would be in facilitating a deeper understanding of anatomy? *

	Very unhelpful	Unhelpful	Neutral	Helpful	Very helpful
They would be	○	○	○	○	○

Question 10

If video demonstrations of dissection techniques became available, how often would you use them as a study aid? *

	never	occasionally	frequently
I would use them	○	○	○

Question 11

Would you consider participating in an elective anatomy module online for self-study and evaluation? *

- ○ yes
- ○ no

Question 12

Do you think that material should become more available online for the purposes of studying anatomy? *

- ○ yes
- ○ no

Question 13

If you answered yes to question 13, would this study material (tick appropriate): *

- ○ Replace dissection in a lab
- ○ Supplement dissection in a lab

Question 14

Please select your preferred method of cadaver dissection, if all of these options were available to you: *

- ○ Traditional cadaver dissection in dissection lab
- ○ Virtual dissection online using an online software programme
- ○ Both traditional dissection and virtual dissection

Question 15

Have you used any material to aid your preparation for dissection and other practicals, other than that provided by your faculty? *

- ○ yes
- ○ no

Question 16

If you answered yes to question 15, please select where appropriate: *

- ☐ Online material
- ☐ Textbooks not prescribed by your curriculum
- ☐ Private tuition
- ☐ Other - please specify

Question 17

Have you used any material to aid your preparation for PBL (Problem Based Learning), other than that provided by your faculty? *

- ○ yes
- ○ no

Question 18

If you answered yes to question 17, please select where appropriate: *

- ☐ Online material
- ☐ Textbooks not prescribed by your curriculum
- ☐ Private tuition
- ☐ Other - please specify

Question 19

Have you used any material to aid your preparation for assessments, other than that provided by your faculty? *

- ○ yes
- ○ no

Question 20

If you answered yes to question 19, please select where appropriate: *

- ☐ Online material
- ☐ Textbooks not prescribed by your curriculum
- ☐ Private tuition
- ☐ Other - please specify

Survey complete! Thank you very much for your contribution to this study!

You may now close the window.

Appendix B – Human Research Ethics Committee Approval of Study

UNIVERSITY OF CAPE TOWN
Faculty of Health Sciences
Human Research Ethics Committee

Room E52-24 Old Main Building
Groote Schuur Hospital
Observatory 7925
Telephone [021] 406 6338 • **Facsimile** [021] 406 6411
Email: shuretta.thomas@uct.ac.za
Website: www.health.uct.ac.za/research/humanethics/forms

18 February 2014

HREC REF: 763/2013

Prof G Louw
Human Biology
Anatomy Building

Dear Prof Louw

PROJECT TITLE: *AN INVESTIGATION INTO EDUCATIONAL VALUE OF SUPPLEMENTING DISSECTION OF THE HUMAN BODY WITH ALTERNATIVE RESOURCES: PERCEPTIONS OF STUDENTS AND STAFF AT UCT*

Thank you for your letter to the Faculty of Health Sciences Human Research Ethics Committee received on 12 February 2014.

The HREC has **approved** the above-mentioned study, subject to the approval to access UCT staff and students being obtained from the UCT Executive Directors of Human Resources and the Department of Student Affairs respectively.

Approval is granted for one year until the 28th February 2015

Please submit a progress form, using the standardised Annual Report Form if the study continues beyond the approval period. Please submit a Standard Closure form if the study is completed within the approval period.
(Forms can be found on our website: www.health.uct.ac.za/research/humanethics/forms)

Please note that the ongoing ethical conduct of the study remains the responsibility of the principal investigator.

We acknowledge that the student, Shakira Ramgoolam is also involved in this study.

Please quote the HREC reference no in all your correspondence.

Yours sincerely

Signed

PROFESSOR M BLOCKMAN
CHAIRPERSON, FHS HUMAN ETHICS
Federal Wide Assurance Number: FWA00001637.
Institutional Review Board (IRB) number: IRB00001938
This serves to confirm that the University of Cape Town Human Research Ethics Committee complies to the Ethics Standards for Clinical Research with a new drug in patients, based on the Medical Research Council (MRC-SA), Food and Drug Administration (FDA-USA), International Convention on Harmonisation Good Clinical Practice (ICH GCP) and Declaration of Helsinki guidelines.

HREC REF 763/2013

Appendix C – Permission to access students for research purposes

	RESEARCH ACCESS TO STUDENTS	DSA 100

NOTES

1. This form must be **FULLY** completed by applicants that want to access UCT students for the purpose of research.
2. Return the fully completed **(a) DSA 100** application form **by email**, in the **same word format**, together with your: **(b) research proposal inclusive of your survey, (c) copy of your ethics approval letter / proof (d) informed consent letter** to: Moonira.Khan@uct.ac.za. You application will be attended to by the Executive Director, Department of Student Affairs (DSA), UCT.
3. The turnaround time for a reply is **approximately 10 working days.**
4. NB: It is the responsibility of the researcher/s to apply for and to obtain **ethics approval** and **to comply with amendments that may be requested;** as well as **to obtain** approval to access UCT staff and/or UCT students, from the following, respectively: (a) **Ethics:** Chairperson, Faculty Research Ethics Committee' (FREC) for ethics approval, (b) **Staff access:** Executive Director: HR for approval to access UCT staff, and (c) **Student access:** Executive Director: Student Affairs for approval to access UCT students.
5. **Note:** UCT Senate Research Protocols requires compliance to the above, even if prior approval has been obtained **from any other institution/agency. UCT's research protocol requirements applies to *all* persons, institutions and agencies from UCT and external to UCT who want to conduct research for academic, marketing or service related reasons at UCT.**

SECTION A: RESEARCH APPLICANT/S DETAILS

Position	Staff / Student No	Title and Name	Contact Details (Email / Cell / land line)
A.1 Student Number	RMGSHA001	Miss Shakira Ramgoolam	email: shakiraramgoolam@gmail.com tel: 0798843921
A.2 Academic / PASS Staff No.			
A.3 Visitor/ Researcher ID No.			
A.4 University at which a student or employee	UCT	Address if *not* UCT:	
A.5 Faculty/ Department/School	Faculty of Health Sciences		
A.6 APPLICANTS DETAILS If different from above	Title and Name	Tel.	Email
	Same as above		

SECTION B: RESEARCHER/S SUPERVISOR/S DETAILS

Position	Title and Name	Tel.	Email
B.1 Supervisor	Prof. Graham Louw	021 4066302	graham.louw@uct.ac.za
B.2 Co-Supervisor/s			

SECTION C: APPLICANT'S RESEARCH STUDY FIELD AND APPROVAL STATUS

C.1 Degree (if a student)	MSc Med
C.2 Research Project Title	An investigation into the educational value of supplementing dissection of the human body with alternative resources: perceptions of students and staff at UCT
C.3 Research Proposal	Attached: Yes ☑ No ☐
C.4 Target population	The potential number of participants is in the region of +/-1000. This is taking into account the medical students from each class (years 2 through to 6) as well as the staff and postgraduate students of the Human Biology Department. In view of the fact that the survey is voluntary, a definite number of participants cannot be confirmed. Calculated sample size = 278.
C.5 Lead Researcher details	If different from applicant:
C6. Will use research assistant/s	Yes ☐ No ☑ If yes- provide a list of names, contact details and ID no.
C.7 Research Methodology and Informed consent:	Research methodology: attached - survey Informed consent: attached – written informed consent will be obtained; participation is voluntary and confidentiality is assured by the researcher.
C.8 Ethics clearance status from UCT's Faculty Ethics Research Committee (FREC)	Approved by the FREC Yes ☑ With amendments: Yes / No ☐ (a) Attach copy of your ethics approval. Attached: YES (b) State date and reference no. of ethics approval: Date: 18/02/2014 Ref. No.: 763/2013

SECTION D: APPLICANT/S APPROVAL STATUS FOR ACCESS TO STUDENTS FOR RESEARCH PURPOSE

(To be completed by the ED, DSA or Nominee)

D.1 APPROVAL STATUS	Approved / With Terms / Not	* Conditional approval with terms		Applicant/s Ref. No.:
	Yes ■	(a) Access to students for this research study must only be undertaken after written ethics approval has been obtained. (b) In event any ethics conditions are attached, these must be complied with before access to students.		RMGSHA001/ Ms Shakira Ramgoolam
D.2 APPROVED BY:	Designation	Name	Signature	Date
	Executive Director Department of Student Affairs	*Dr Moonira*	Signed	*25 February 2014*

Version. 2013 (6) Page 1 of 1 DSA 100

Appendix D – Permission to access UCT staff for research purposes

HR194	ACCESS TO UCT STAFF FOR RESEARCH PURPOSES	UNIVERSITY OF CAPE TOWN IYUNIVESITHI YASEKAPA • UNIVERSITEIT VAN KAAPSTAD

RECEIVED
18 MAR 2014
ED: HR OFFICE

NOTES

- Forms must be downloaded from the UCT website: http://www.uct.ac.za/depts/sapweb/forms/forms.htm
- This form must be completed by applicants who are requesting to access UCT staff for the purpose of research.
- A copy of the research proposal as well as the Ethics Committee approval must be attached.
- It is the **responsibility of the researcher/s to apply for ethical clearance** fromthe relevant Faculty's Research in Ethics Committee (RiEC).
- If you are requesting staff information, you are required to complete the HR Information Request Form (HR190) and submit it together with all the required documentation.
- The turnaround time for a reply is **approximately 10 working days unless specified as urgent.**
- Return the completed application form and all the above documentation to Joy Henry via email: joy.henry@uct.ac.za; or deliver to: For the Attention: Executive Director, Human Resources Department, Bremner Building, Room 214, Lower Campus, UCT.

SECTION A: APPLICANT DETAILS

Title	Miss	Name	Shakira Ramgoolam
Telephone number	0798843921	Email address	shakiraramgoolam@gmail.com
Student number	RMGSHA001	Staff number	n/a
Visiting researcher ID / passport number	n/a		
Faculty Officer contact details	Ms Carlette Hlungwani		
	carlette.hlungwani@uct.ac.za		
University or institution at which employed or a registered student	UCT		
Faculty or department in which you are registered or work	Faculty of Health Sciences		
Address (if not UCT)			

SECTION B: SUPERVISOR DETAILS

	Title and name	Telephone number	Email address
Supervisor	Prof. Graham Louw	021 4066302	graham.louw@uct.ac.za
Co-Supervisor			

SECTION C: APPLICANT'S FIELD OF STUDY (if applicable) / TITLE OF RESEARCH PROJECT / STUDY

Degree	MSc Med		
Research project or title	An investigation into the educational value of supplementing dissection of the human body with alternative resources: perceptions of students and staff at UCT		
Research proposal attached	☒Yes	☐No	
Target population (number of UCT staff)	6		
Amount of time required for an interview and/or questionnaire	10 minutes		
Lead Researcher details	Miss Shakira Ramgoolam, email: shakiraramgoolam@gmail.com, tel: 0798843921		
Proof of ethical clearance status attached	☒Yes	☐No	

SECTION D: FOR OFFICE USE (Approval status to be completed by the Executive Director, Human Resources or Nominee)

Support or approval			Role	Signature	Date
Supported?	☑Yes	☐No	Joy Henry (Office Co-Ordinator)	Signed	17/3/2014
Approved?	☑Yes	☐No	Miriam Hoosain (Executive Director: HR)		18/03/14

15 November 2011 Page 1 of 1 HR194

Appendix E – MBChB Students registered for 2014 academic year – female/male split

		Academic Year						
Programme	**Gender**	**First Year**	**Second Year**	**Third Year**	**Fourth Year**	**Fifth Year**	**Sixth Year**	Total
MBChB	F	155	142	138	126	124	112	**797**
	M	100	97	77	62	57	61	**454**
		216	239	215	188	181	173	1251
MBChB Total		255	239	215	188	181	173	**1251**

Appendix F – Kruskal-Wallis one-way analysis of variance applied to each year pairwise

	Second vs Third		Second vs Fourth		Second vs Fifth/Sixth		Second vs Staff/PG		Third vs Fourth		Third vs Fifth/Sixth		Third vs Staff/PG		Fourth vs Fifth/Sixth		Fourth vs Staff/PG	
	H-Statistic	P-Value	H-Statistic	P-Value	H-Statistic	P-Value	H-Statistic	P-Value	H-Statistic	P-Value	H-Statistic	P-Value	H-Statistic	P-Value	H-Statistic	P-Value	H-Statistic	P-Value
Q4	1.5627	0.21128	0.4531	0.50086	0. 1403	0.70798	1.6129	0.20408	2.1739	0.14037	0.5677	0.45118	3.3466	0.06734	0.8150	0.36664	0.7600	0.38333
Q5	4.1736	0.04106	0.0564	0.81235	0.0335	0.85478	6.2109	0.0127	3.2056	0.07339	2.7152	0.09939	13.0406	0.0003	0.1120	0.73788	4.6068	0.03185
Q6a	3.1397	0.07641	2.0742	0.14981	0.0361	0.84929	0.7326	0.38204	6.4750	0.01094	2.2656	0.13313	3.5814	0.05843	2.4477	0.1177	0.0827	0.77372
Q6b	6.1968	0.0128	1.7429	0.18677	0.0350	0.8517	8.8513	0.00293	7.9521	0.0048	4.2335	0.03963	16.4451	5E-05	1.8702	0.17145	1.9197	0.16589
Q6c	3.6223	0.05701	4.5470	0.03298	0.0405	0.84054	0.7058	0.40065	10.6943	0.00107	2.2173	0.13647	3.9303	0.04742	4.2570	0.03909	0.7621	0.38267
Q6d	1.4306	0.23167	2.1123	0.14611	0.5266	0.46804	2.1823	0.13961	5.0041	0.02529	3.0160	0.08245	4.4358	0.03519	0.7477	0.38721	0.0890	0.76551
Q6e	5.4830	0.0192	3.8470	0.04984	0.0402	0.84102	1.0351	0.30897	10.2377	0.00138	4.3178	0.03772	5.5776	0.01819	2.5798	0.10824	0.5272	0.46779
Q6f	10.8925	0.00097	0.1094	0.74086	0.5770	0.44748	1.4326	0.23134	5.3639	0.02056	6.6924	0.00988	10.7201	0.00106	0.0507	0.82193	1.5562	0.21222
Q6g	1.0022	0.31677	0.0009	0.97649	0.3767	0.53937	1.1602	0.28143	0.7295	0.39305	1.9701	0.16044	3.0537	0.08056	0.2623	0.60851	0.8801	0.34818
Q6h	0.0473	0.82776	0.8781	0.34872	0.0038	0.95089	0.0510	0.8214	1.0360	0.30875	0.0516	0.82023	0. 1285	0.71994	0.6807	0.40935	0.1773	0.67368
Q6i	4.9066	0.02675	0.1661	0.68364	2.3336	0.12661	5.0187	0.02508	1.7545	0.18531	0.4057	0.52417	11.2422	0.0008	0.6316	0.42676	4.5085	0.03373
Q6j	0.8135	0.3671	0.0302	0.86201	0.1071	0.74345	1.0345	0.3091	0.6983	0.40334	0.2829	0.59482	2.3017	0.12923	0.1565	0.69242	0.6066	0.43606
Q6k	0.5118	0.47436	0.8400	0.35938	0.2483	0.6183	1.3559	0.24426	1.7132	0.19057	0.8996	0.34289	2.2621	0.13257	0.1394	0.70886	0.0593	0.8076
Q6l	3.3684	0.06646	0.3319	0.56453	1.6733	0.19582	0.3183	0.57261	0.4576	0.49875	0.2064	0.64956	0.4825	0.48731	0.1206	0.72834	0.0014	0.96974
Q6m	0.0001	0.9913	0.0630	0.80185	0.6048	0.43677	4.9264	0.02645	0.0484	0.82582	0.4983	0.48026	4.3574	0.03685	0.7107	0.39821	3.3073	0.06897
Q6n	7.5640	0.00595	0.1491	0.69937	0.0257	0.87276	5.2412	0.02206	3.0201	0.08224	4.8740	0.02726	13.5703	0.00023	0.0443	0.83327	4.4293	0.03533
Q6o	0.0216	0.88324	0.1201	0.72891	0.4845	0.4864	0.0034	0.95376	0.0430	0.83563	0.2329	0.62941	0.0001	0.99379	0.0184	0.89213	0.0055	0.94104
Q7a	0.0212	0.88418	0.0178	0.89395	0.5642	0.45255	0.6947	0.40456	0.0002	0.98869	0.3224	0.57017	0.7997	0.37119	0.2235	0.63639	0.6617	0.41598
Q7b	1.5916	0.2071	1.0348	0.30904	0.2639	0.60744	0.3761	0.53968	3.3673	0.0665	0.4157	0.51907	0.1540	0.69474	1.7133	0.19056	1.8100	0.17851
Q7c	0.9035	0.34185	0.0605	0.80572	0.4038	0.52511	0.7121	0.39876	0.1374	0.7109	1.8656	0.17198	1.8053	0.17907	0.4496	0.50255	0.6096	0.43493
Q7d	0.5473	0.4594 3	0.5629	0.45307	1.4757	0.22445	0.0897	0.76456	1.4901	0.2222	2.7487	0.09733	0.6283	0.42798	0.0603	0.80595	0.1585	0.69056
Q7e	2.0063	0.15684	4.1862	0.04075	1.1115	0.29175	5.6478	0.01748	6.5634	0.01041	3.9583	0.04684	7.4468	0.00635	1.1571	0.28206	0.1275	0.72103
Q7f	0.6429	0.42265	4.0796	0.0434	0.3462	0.55624	0.1699	0.68017	0.8733	0.35005	0.0595	0.80728	0.7431	0.38866	2.3269	0.12715	3.0115	0.08268
Q7g	0.0166	0.89734	1.8317	0.17593	1.2751	0.25881	0.0075	0.93106	1.7233	0.18927	1.2280	0.26779	0.0270	0.86951	0.1535	0.69525	1.2169	0.26998
Q7h	1.9647	0.16101	0.7183	0.39669	0.7147	0.39789	0.0401	0.84123	3.8563	0.04956	0.3403	0.55967	1.0165	0.31334	2.5225	0.11223	0.9617	0.32675
Q7i	0.0007	0.97825	2.7462	0.09749	2.6891	0.10104	0.8119	0.36755	2.6611	0.10283	2.3443	0.12574	0.8020	0.3705	0.2468	0.61793	4.0445	0.04432
Q7j	0.3352	0.56261	1.1501	0.28353	0.5604	0.45409	2.8002	0.09425	1.7766	0.18257	0.0025	0.95997	1.0234	0.31171	2.5078	0.11329	4.5743	0.03245
Q7k	1.8719	0.17126	0.2301	0.63147	0.5625	0.45325	3.4883	0.06181	0.2963	0.5862	0.2814	0.59581	0.8690	0.35122	0.0111	0.91607	1.3627	0.24308
Q7l	0.7100	0.39943	0.4922	0.48295	0.9287	0.33519	0.3248	0.56876	2.0291	0.15431	0.0534	0.81732	0.0089	0.9249	1.9969	0.15762	0.9073	0.34082
Q7m	0.0177	0.89407	0.1549	0.69393	1.2780	0.25828	0.0012	0.97237	0.1846	0.66745	1.4759	0.22442	0.0089	0.92479	0.3304	0.56542	0.0500	0.82313
Q7n	5.0697	0.02435	6.4863	0.01087	10.8338	0.001	0.9934	0.31892	0.9726	0.32404	1.5520	0.21284	0.6230	0.42995	0.0021	0.9638	2.0188	0.15536
Q7o	4.0880	0.04316	8.3906	0.00377	2.7811	0.09538	0.7962	0.37224	2.8338	0.0923	0.0250	0.87429	0.4484	0.50307	2.9913	0.08371	3.5734	0.05871
Q7p	2.7870	0.09503	0.1743	0.67635	5.7655	0.01634	0.2813	0.59582	0.5571	0.45541	0.4626	0.49641	0.5220	0.46998	1.6165	0.20358	0.0026	0.95938
Q7q	0.0578	0.80999	0.4951	0.48165	4.2889	0.03882	0.5706	0.45004	0.7216	0.39561	4.7819	0.02876	0.6393	0.42396	0.9513	0.32938	0.0332	0.85548
Q7r	1.6742	0.19569	1.2086	0.27161	0.8550	0.35514	0.3232	0.56967	3.9113	0.04796	3.2286	0.07236	1.9621	0.16129	0.0635	0.80103	0.1100	0.74019
Q7s	4.1384	0.04192	0.5105	0.47492	0.2216	0.63783	0.5090	0.47557	1.1818	0.27689	3.9899	0.04577	4.1461	0.04173	0.7447	0.38815	1.4075	0.23547
Q7t	0.5863	0.44387	0.0770	0.78145	6.0367	0.01401	13.1752	0.00028	0.1356	0.71271	1.8932	0.16884	6.9226	0.00851	2.7415	0.09777	8.0725	0.00449
Q7u	0.0096	0.92188	0.8325	0.36155	0.2476	0.61879	0.7923	0.37341	0.7561	0.38457	0.2181	0.64048	0.6771	0.41059	0.1418	0.70647	1.7363	0.18761
Q7v	0.6789	0.40996	0.5382	0.4632	0.6288	0.42778	4.2318	0.03967	1.7366	0.18757	0.0015	0.96928	1.9438	0.16326	1.4390	0.2303	4.5905	0.03215
Q7w	1.3258	0.24955	0.5201	0.47081	0.0540	0.8163	0.0312	0.85988	0.0561	0.81277	0.5762	0.44782	0.9555	0.32832	0.1701	0.68005	0.4987	0.48009
Q8	0.8333	0.36132	1.1243	0.289	1.2217	0.26903	0.2644	0.60708	0.1289	0.71962	0.1127	0.7371	1.9348	0.16326	0.0036	0.95246	0.0596	0.80718
Q9	0.0806	0.77653	0.4064	0.52381	3.1034	0.07813	1.0435	0.307	0.1615	0.68778	3.8730	0.04907	0.6745	0.41149	4.0955	0.043	0.1431	0.70519

Appendix G – Kruskal-Wallis one-way analysis of variance applied to males versus females

	H-Statistic	P-Value
Q4	0.0009	0.97644
Q5	1.0695	0.30106
Q6a	0.0043	0.9477
Q6b	0.3212	0.57087
Q6c	1.6311	0.20156
Q6d	5.4292	0.0198
Q6e	8.2277	0.00413
Q6f	6.0280	0.01408
Q6g	5.0622	0.02445
Q6h	0.0068	0.93448
Q6i	0.5260	0.46829
Q6j	0.7008	0.40251
Q6k	0.5783	0.44698
Q6l	2.2522	0.13342
Q6m	3.0933	0.07862
Q6n	2.6801	0.10161
Q6o	2.8713	0.09017
Q7a	0.0505	0.82227
Q7b	0.0015	0.9695
Q7c	0.1912	0.66188
Q7d	0.4446	0.50489
Q7e	1.0982	0.29466
Q7f	2.4878	0.11473
Q7g	4.2720	0.03874
Q7h	0.0964	0.75618
Q7i	2.2776	0.13125
Q7j	1.7294	0.18849
Q7k	1.5613	0.21148
Q7l	0.7137	0.3982
Q7m	6.1797	0.01292
Q7n	0.8357	0.36062
Q7o	0.2253	0.63504
Q7p	0.7706	0.38003
Q7q	0.2397	0.62439
Q7r	1.5916	0.2071
Q7s	1.5457	0.21377
Q7t	0.1161	0.73325
Q7u	1.2230	0.26877
Q7v	0.5636	0.45281
Q7w	0.0074	0.93122
Q8	0.0003	0.98708
Q9	0.2176	0.64086