Anatomy "Peer Teaching" in Medical School: A literature review

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Abstract

Medical schools in the twenty first century, have undergone drastic changes in their teaching methodologies worldwide, more specifically in the teaching of anatomy. The main goal of any educational institution is the transfer of knowledge from educator to student in an effective manner. This review attempts to bring together the different teaching methodologies used in medical schools in this new era.

Medical institutions have a wide variety of different approaches in teaching anatomy. Tradition dictates that cadaveric dissection and prosected specimens are the gold standard in providing medical students a solid foundation upon which they can build their knowledge and understanding. However, some medical schools use other educational tools, such as anatomical models, computer programs and medical imaging. Moreover, the recent introduction of non-conventional teaching techniques such as problem based learning, encourage cognitive thinking, teamwork and professionalism.

Peer teaching is an innovative way of education, and it's success is thought to lie in cognitive congruence; having shared learning experiences and capabilities, cognitive congruence allows students to ask questions in confidence and make any clarifications, without fear of being judged. Other advantages include, enhanced teamwork and communication skills, for both the peer teacher and the students being taught.

When viewing the whole spectrum of teaching tools and learning techniques, there are none that appear to be more superior to others, but rather that they should be used in conjunction with one another, in order to enhance learning.

Introduction

The adequate knowledge of anatomy is an essential aspect in becoming a competent physician, however the transfer of anatomical knowledge from educator to student in higher education has been in decline over a period of years (Turney, 2007). The most common pedagogy of theoretical anatomy is passive and ineffective (Schwerdt & Wupperman, 2011), with the practical aspect being the use of cadaveric dissection; this is thought to be the "gold standard" of teaching anatomy to medical students, although prosections appear to be just as effective (Ashdown et al., 2013). As technology has developed, it has been incorporated as a tool to enhance learning at all stages of the educational system.

Dissections

In an age where time is not a luxury, learning has progressed from being passive to active, and so contact time in the form of lectures has reduced significantly over time. Even the practical aspect of anatomical teaching has evolved from complete dissections into prosections; by making this change, contact time in the anatomy lab has been dramatically reduced. However, the use of cadaveric dissections has its advantages. The exploration of cadavers in its dissection allows understanding of spatial relationships between structures and three dimensionality to develop as well as understanding the idea that physiological variations exist between individuals. Cadavers also allow...
the student to practice surgical skills without the risks that working on a live patient carries. Although the use of a cadaver has its advantages in the teaching and learning of anatomy in medical schools, evidence verifies that students achieve the same results when comparing conventional teaching i.e. dissections to the use of prosections along with the reduction of formal hours by half in the anatomy lab (Wilson et al., 2011). It is evident from a study carried out in 2007 by Brenton et al., that students perform just as well when taught using prosections as a tool for teaching, if not significantly better when compared with cadavers. Another article by Patel & Moxham (2008), shows that acquiring anatomical knowledge does not vary significantly with various teaching methods, even though they suggest that the learning of anatomy is best when using cadavers in relation to learning outcomes. A reduction in the number of hours in the dissection hall affects the quality and retention of gross anatomical knowledge, thereby resulting in an overall decrease in student results; this therefore suggests that an improvement in dissection quality will lead to higher student performance (Nwachukwu, Lachman & Pawlina, 2013).

Contrary to what was previously thought about learning through dissections, it is nonetheless a self-directed way of exploring and building up knowledge about the human body. It includes a component of three dimension as well as allowing the haptic appreciation of structures (Turney, 2007). By working with cadavers in a way to explore and understand every aspect of the human body, medical students have the opportunity not only to build up their knowledge of anatomy but also to better understand the intrinsic aspect of the human physiology, in addition to familiarising students with death and important internal anatomical variations between individuals. (Brenton et al., 2007).

A recent study carried out by Ashdown et al in 2013 shows that students who learnt anatomy through the use of cadavers performed better in exams than those students who did not; unfortunately, this difference in results is not statistically significant. This is not the only benefit of incorporating dissection of cadavers into the medical curriculum; research and scientific reviews imply that dissection will not only aid students in building up their anatomical knowledge, but also enhance other skills such as communication, teamwork and the appreciation of the human body in life and in death (Elizondo-Orma-ña, Guzmán-L’ope & De Los Angeles García-Rodríguez, 2005).

In the 1970’s, although dissection used to take up over a total of 700 hours of teaching time in Australian medical schools, it still plays a vital role in the teaching of anatomy in pre-clinical years (Parker, 2002). Although learning through dissections is not enforced as much as it was in the past, the Royal Australian College of Surgeons have in fact decided to run training courses which are greatly based on dissection (Stone, 2001).

Dissection also allows students to develop vitals surgical skills, appreciation of pathology as well as teaching ethical and moral values which are an essential quality of a physician (Parker, 2002).

Are cadavers essential in the teaching of anatomy (Korf, 2008)? Even though the use of a cadaver in medical schools and its benefits has been under scrutiny over the past few years (McLachlan, 2004), no one has suggested that dissections should be completely dispensed in pre-clinical years (McLachlan, 2004). As many medical faculties have transitioned from dissections to prosections, one university in the United Kingdom has removed any use of cadavers from their curriculum, and have instead introduced an organized syllabus, which includes living anatomy through peer examination, life models and medical imaging which is taught by radiologists (McLachlan, 2004). This is reasonable to do, even though it is against convention. These students will come across anatomy in their careers and in clinical practice in the context in which they are being taught anatomy, so early on in their medical education (McLachlan, 2004). Prosections are increasingly being substituted for dissections. The benefits of prosections include: it is cheaper where funding is sparse and high student numbers, lasts longer and it takes less time to gain the same anatomical knowledge (Schwerdt & Wuppermann, 2011). When comparing dissections, prosections and plastinated models of anatomical structures in a subjective study, many students chose dissections to be most useful in the acquisition of knowledge (Reilly, Wearn & Riordan, 2013). To further support this, a recent study shows that traditional teaching groups that were taught using a cadaver gave better results than the technological support group (Biasutto, Causa & Criado del R’ío, 2006); this suggests that the computer resources cannot replace the unique teaching tool of the cadaver (Winkelmann, 2007), as the direct appreciation of tissues and anatomical structures is lost (Biasutto, Causa & Criado del R’io, 2006). This study took place from 1999 to 2004, and involved a total of 873 medical students. The group of students who had acquired their knowledge of anatomy through dissected specimens i.e. traditional teaching, showed to produce statistically significantly higher marks in both their mid-term and final exams, when compared to those students who carried out the acquisition of anatomical knowledge via technological resources. In addition to these two groups, was a third group of students who undertook their undergraduate anatomical education through the use of both dissected specimens as well as technological resources. These students achieved significantly better marks in their final exams when compared to the results of the technological supported group. All other teaching sessions such as lectures and lecturers remained the same for all three groups of students (Biasutto, Causa & Criado del R’ío, 2006).

By dissociating the human body from the medical curriculum, humanistic values may be reduced (Gregory & Cole, 2002). There is increased integration of clinically relevant aspects of anatomy in pre-clinical years, such as radiographs, computer topography and MRI (Gregory & Cole, 2002). However, many experienced anatomists have voiced their opinion on this matter and strongly believe that the act...
of the dissection procedure develops a spatial understanding of the human body, which cannot be accomplished by prosections or computer aids alone (Gregory & Cole, 2002). Other qualities that can be gained from the active study of cadaveric dissections include teamwork and professionalism in addition to a diverse anatomical knowledge improvement (Nwachukwu, Lachman & Pawlina, 2013) and the opportunity to practice surgical skills in a risk free environment (Elizondo-Ormaza, Guzmán-López & De Los Angeles García-Rodríguez, 2005).

From the Renaissance period, anatomy has been considered an art as well as a science, and so practical experience is an essential part of basic medical education. Nevertheless, it was only by the late seventeenth century when practical and clinical experience was being introduced to some medical students. Medical education enhanced and flourished from that time onwards, and large anatomical demonstrations were supplemented by small group dissection sessions. With this growth in medical knowledge came problems; although doctors had a vast amount of scientific training, the clinically relevant aspects were missing from their education (Louden, 1997).

The change in the teaching of anatomy has come about for a variety of different reasons; reduction in the number of cadavers, limited time and resources as well as recent developments in technology such as 3D modelling and computer assisted learning, that have shown to be beneficial in the learning of anatomy (Brenton et al., 2007).

The more recent developments and changes to the medical curricula in countries such as America and the United Kingdom, has brought concern to medical professionals and academics. Leung et al, published an article in 2006, which describes the reduction of gross anatomical teaching hours in the US medical courses in the twentieth century. Data from this article has been summarised in a table:

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<td>Mean teaching time (Hours)</td>
<td>549</td>
<td>330</td>
<td>190</td>
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The reduction in anatomical teaching time both in America and the UK is due to the alternative and innovative methods of teaching and learning, which includes problem based learning as a more effective method of teaching. The teaching of anatomy in pre-clinical years is becoming more focused and orientated towards understanding basic concepts and then being able to apply them in a clinical scenario (Wilhelmsson et al., 2010). Teaching for knowledge and not vast amount of detailed information will help retain relevant anatomical knowledge in clinical years (Bolander & Laksov et al., 2008). In 2008, a study was carried out by Fitzgerald et al, asking the opinions of newly qualified doctors, whether they felt that anatomy was taught sufficiently at their medical school, The University of Nottingham. The results showed that 53.8% of students felt as though anatomy was taught in a sufficient amount, whereas 44.3% did not, with 1.9% of students not responding.

There is concern about this as teaching time has decreased, there has been a negative effect on the anatomical knowledge of newly graduated medical students (Pandey & Zimitat, 2007). Statistics show that over a period of five years, between 1995 to 2000, there has been a seven fold increase of the claims associated with anatomical errors (Turney, 2007). This acknowledgement that basic science must be revisited in clinical practice are shaping the way in which the teaching of anatomy is evolving (Wilhelmsson et al., 2010). Some academics are suggesting that the teaching of undergraduate anatomy has fallen below a level that can be deemed safe in practice (Turney, 2007). There has been a decline over time in the content of anatomy that is taught in the curricula in a vast number of medical faculties; this is reasonable as it allows more time to be spent on developing more.

By dissociating the human body from the medical curriculum, humanistic values may be reduced (Gregory & Cole, 2002). There is increased integration of clinically relevant aspects of anatomy in relevant skills that are needed for the future (Turney, 2007). However, recent evidence shows that there has been such a decline in the teaching of anatomy that no matter what the methodology i.e. conventional vs. modern, the safety of patients and clinical practise is compromised, and this is a major issue (Turney, 2007). However, it has been noted by Turney (2007), that anatomy should be taught in much greater detail when specialist training is carried out, as well as incorporating clinically relevant cases into it (Turney, 2007).

**Learning through Lectures**

Another way of visualizing anatomical structures without the access to a cadaver is the ability and skill to draw; a drawing or diagram portrays the organization of a three dimensional structure as a two dimensional organization. Having the ability to draw, one is able to build up a structure from the very basic components (Mavridis, 2013). The morphology of human anatomy is developed as a visual representation coming to life, enabling students to appreciate the relations of structures fully. This outstanding form of a visual representation is widely used in France, in a way where the anatomy teacher will build up a structure or represent an anatomical organization in a lecture hall, using a assortment of colours to stress specific structures (Clavert, 2012). Visual representation (hand
drawings) of anatomical structures is effective in improving student retention and anatomical knowledge (Babin & Koba, 2012).

As previously stated, the use of cadavers is thought to be the “gold standard” in the teaching of anatomy in a practical setting; in a similar manner, “face-to-face” education remains the gold standard in developing a theoretical knowledge and understanding of anatomy (Clavert, 2012). In order to teach, one must be effective at maintaining the students attention and stimulating their understanding of the subject area (Clavert, 2012). A construction of an anatomical region allows a “live” creation, upholding the students focus (Clavert, 2012). Drawing and other visual representations must also be accompanied by verbal descriptions and commentary in order to be effective at developing knowledge; drawings alone will be counter productive and go against its purpose as a tool in the transfer of knowledge (Clavert, 2012). Great skill is required to keep an entire group of students attentive, whilst each student is learning independently in a lecture setting (Clavert, 2012).

Traditional teaching of theoretical anatomy has been in the form of lectures, and this is a passive way of learning (Schwerdt & Wuppermann, 2011). Information is lost soon after the lecture and the dominant form of learning is through listening and note taking; this is disadvantageous to those students who are not auditory learners (Schwerdt & Wuppermann, 2011). Because it is passive, it does not account for the different learning styles and does not lead to the retention of knowledge and information, as well as not allowing essential skills such as problem solving to develop. However, it could be said that lecturers are there as guides to encourage constructive thinking, discussions etc. (Penson, 2012).

Although teaching styles vary between individual teachers and their ability to improve student performance, this variation cannot be explained by any observable characteristics (Schwerdt & Wuppermann, 2011). Teaching styles are important to maintain student interest; a study carried out in the US suggests that students perform better when the teacher spends more time in front of a class in lecture style teaching (Klavern, 2010). Some literature suggests that those teachers who devote more teaching time to lecture style and presentation instead of permitting students to control their own learning or solve problems, actually learn more; this is contrary to what is thought with regards to enhancing knowledge and understanding (Schwerdt & Wuppermann, 2011). As well as laying the foundations of topics in lectures, it is important that medical students actively participate in practical’s, clinical placements, workshops and self study as these are ways by knowledge is gained, other than through the attendance of lectures. By taking reign on their own education, these active study techniques bring topics together and makes any misunderstandings clear (Penson, 2012).

Mark Twain stated: “College is a place where professor’s lecture notes go straight to the students’ lecture notes, without passing through the brains of either”(Miller, 1927).

As time has progressed, so has the teaching of anatomy. Evidence shows us that Mark Twain's famous quote may not entirely hold true for much longer.

The progress that has been taking place in the area of theoretical anatomy is the reduction in teaching time. Less contact time in the form of lectures has allowed for a greater amount of time to be dedicated to individual students learning modality; this is more effective in its purpose of acquiring and retaining knowledge, it is much more time consuming than lectures alone (Klavern, 2010). Because contact time is being condensed in terms of lectures, more focus is being placed on self study as well as the increased use of projections and plastinated specimens instead of the dissection of cadavers (Pandey & Zimitat, 2007). The term self study refers to less lectures and more time being spent in tutorials, peer learning and online resources (Pandey & Zimitat, 2007).

Lecturing does not have to be a passive way of learning in higher education. Lesson planning, spending time on lecture styles and testing students in an interactive way that benefits students in terms of their exam performance (Klavern, 2010). Evidence suggests that being able to visualize helps in memorization of anatomy. Surface approaches to learning anatomy is in the form of basic memorization but having a deeper approach includes fundamental understanding of basic concepts along with the ability to memorise (Pandey & Zimitat, 2007).

**New methods of teaching in medical schools**

In 2014, the Scottish Government published a statement regarding peer teaching. It states:

“Peer education is an approach which empowers young people to work with other young people, and which draws on the positive strength of the peer group. By means of appropriate training and support, the young people become active players in the educational process rather than passive recipients of a set message. Central to this work is the collaboration between young people and adults.”

An investigation carried out in 2011 by Wilson et al, showed that students had improved study habits and improved communication skills; many students believed that peer teaching was beneficial to them. The students who took part in peer teaching performed significantly higher than those who did not. In a way to make up for the lack of cadaveric use in the medical curriculum, its benefits can be achieved by various other methods (McLachlan, 2004).
It has been said many times before, that dissection is thought to be the best way of teaching anatomy in a practical setting, however an increasing number of medical faculties are making the transition towards the use of prosections as a tool for the teaching of anatomy (Ashdown et al., 2013). What is the reason behind this? Evidence suggests that the use of prospected models parallel to peer teaching is more beneficial that dissections and prosections alone, however this improvement in exam performance was not statistically significant. Nonetheless, peer teaching shows to improve anatomical knowledge attainment and communication skills of the peer teachers. In some cases, a small number of students did not benefit from teaching assistants, but in fact had a negative effect on student performance (Ashdown et al., 2013).

The popularity and success of peer teaching is thought to lie in the idea that students teachers are building the knowledge of their class mates from a common platform of previous understandings and experiences (Yu et al., 2011). All students, including the peer teachers begin their learning journey from the same start line, as they have shared learning capabilities; this is more commonly known as “cognitive congruence” (Yu et al., 2011). Cognitive congruence allows expression and explanations during a teaching session to be spoken at a more appropriate level (Yu et al., 2011). There is a greater sense of security among peers and a sense of not being judged or sounding “stupid”, so any questions, clarifications and misunderstanding can be ironed out and asked in confidence (Yu et al., 2011). As well as this, potential benefits for student teachers such as enhanced communication skills, team managements, public speaking etc. (Yu et al., 2011). With the peer teaching experience, independent learning is encouraged, enhanced teamwork and an increased student satisfaction (Lee et al., 2012). Peer teaching is associated with an improved quality of learning and higher order cognitive skills (Pandey & Zimitat, 2007).

Although performing dissections are a traditional way of visualising internal structures and their relations, when incorporated with peer teaching allow students to think critically, in a way to complement each others understanding and clear up any misunderstandings (Koba & Johnson, 2012). Detailed dissection manuals along with the use of student teachers as an educational tool has the potential to form the foundations of anatomical medical education in pre-clinical years (Koba & Johnson, 2012). Peer teaching may well be a solution to the increasing number of medical students in faculties short of funding and resources (Yu et al., 2011).

New and improved teaching methods along with the development in modern technology will “encourage interest and improve retention” of the vast amount of anatomical knowledge that is required by physicians to improve their understanding of clinical investigations. (Turney, 2007).

It is well known that dissection provides a three dimensional view of anatomical structures and organization and a haptic appreciation of the internal human body. In medical faculties where the use of cadavers are not incorporated in the curriculum, three dimensional understanding can still be achieved using medical imaging; each layer can be dissected layer by layer using different colours to give a visual of 3D construction of internal structures and transverse sections. The quality of these images is much more superior than those found during dissections (McLachlan, 2004).

A mix of both dissection which is supplemented by multimedia learning are more effective than either of the two methods alone in the acquisition of anatomical knowledge. Academics suggest that students should use both traditional cadaveric dissection as well as modern tools to enhance learning and understanding to maintain interest and develop skills and acquire anatomical knowledge (Winkelman, 2007).

By employing a blended learning strategy (traditional teaching plus online study material), studies show that students perform significantly better in examinations compared to traditional teaching alone (Pereira, 2007). This strongly suggests that the use of traditional teaching still has an important role to play, and student performance improves when it is supplemented by online additional resources. This style of synergistic learning has many benefits, as it facilitates active learning, reduces the number of contact hours and improves academic performance. It enhances communication between student and teacher, maintains interest, provides material that is always accessible and encourages self study. This type of teaching needs a great deal of organisation of the course material and syllabus (Pereira, 2007).

Looking at the effects of traditional anatomy teaching to computer assisted learning (CAL), there was a significant difference in final exam results with those students who had been taught traditionally with CAL than those with traditional teaching alone (Elizondo-Oma-na et al., 2004). However, medical students in Mexico who used online resources spent an extra 20 hours learning anatomy and Neuroanatomy (Elizondo-Oma-na et al., 2004); the difference in exam results and student performance improvement may be due to the fact that these students were exposed to learning material for longer period of time, rather than the mode of learning or the difference in teaching methods.

New methods such as CAL, mind- mapping and linking concepts, PowerPoint presentations and educational videos have shown an improvement in student performance, because it may be an efficient and effective way of learning (Elizondo-Oma-na et al., 2004).

YouTube is an online platform in which teaching videos can be uploaded and viewed worldwide to anyone with access to the internet. A study carried out by Duncan et al, in 2013 promotes and recommends that YouTube videos should be used as supplementary material to
Conclusion

Over time, the teaching of anatomy has been reduced to the bare minimum and has only been converging on clinically relevant aspects of anatomy. It is important to be efficient both in the teaching and in the learning of anatomy, and this can be achieved by using advances in modern technology as a tool in order to achieve this goal. It is also vital to bear in mind, that all students learn in different ways; therefore, in my opinion, retention of information improves when a variation of the senses are incorporated into the learning process.

Incorporating clinically relevant aspects of medicine such as radiographs etc. has allowed the average student to spend less time in the dissection hall and still have an adequate quantity and quality of anatomical knowledge. Even though there is a focus on relevant aspects of clinical anatomy rather than vast amounts of information, an adequate level of knowledge must be maintained, no matter what teaching methods are implemented. Each method should have the target of core knowledge and the assimilation of this knowledge throughout the medical course. If each method is used in the correct manner, many skills are obtained such as, self directed learning, the appreciation of 3D, cognitive skills, team work etc. This does not go to say that one method is more superior than another, but that a mixture will encourage interest and improve retention. Nonetheless, the factor that leads to success does not only depend on teaching styles or learning methodology, but the enthusiasm, motivation and the potential/ability of the medical student.

Testing students as a means of teaching as well as tracking progress is vital, as it improves recall of knowledge, reinforcing lecture material that has recently been taught, as well as allowing the opportunity to question their educators; for this reason, small group teaching sessions are important to identify any deficiencies in understanding and discussing principal concepts.

A new and innovative way of teaching and acquiring knowledge is through the so-called “peer teaching”. Peer teaching appears to have a positive effect on students’ ability to perform well in examinations; from a personal experience, students undertaking the role as teachers also benefit greatly from this activity, as well as those students being taught. The advantages of peer teaching have been explored and are recognized both in the US and UK; but why is it not prevalent in medical faculties? Peer assisted learning is a relatively new way of teaching along with problem- based learning.
PBL (problem based learning) has been introduced into universities as an attempt to encourage active learning, where clinical scenarios are applied in a way to understand the basic sciences. Previously, anatomy was taught purely in a descriptive way, but as time has progressed and technologies have improved, we have began incorporating and integrating the two. As I understand the importance of moving forward with time, I believe that resources that were used in the past still have their advantages. Although faculties have included new innovative ways of teaching, which is a step forward in the teaching and learning of anatomy, removing the use of cadavers and other conventional tools may not be wise; even though this may not be disadvantageous in terms of exam results, but other aspects such as communication, teamwork, higher order cognitive skills etc. Furthermore, the increased use of technology in the classroom should not replace the teacher but be used as a tool to enhance learning.

Following this, in my opinion, combining both PBL and peer teaching should have a positive effect on students’ education.

What we are currently undertaking at the University of Malta are video dissections, followed by small group teaching sessions, in combination with peer education and quizzing under pressure. The concept of dissections taking place in a larger lecture theatre where a live recording is taking place, can be compared with the anatomical teaching methods that used to be carried out in the sixteenth century (Louden, 1997).

Many studies suggest that the use of the cadaver is more beneficial, than prosections in acquiring anatomical knowledge. Students who study using the cadaver as a learning tool must spend a much longer time in the dissection hall, due to the nature of the activity. In my opinion, the cadaver as a tool for learning may not be the reason for improved student performance in examinations; but the fact that students who study using a cadaver in fact spend an increased number of hours studying anatomy than those students who use prosections, or any other tools for learning anatomy.

A study that was carried out to determine whether the cadaver can be replaced by technology indicated, that the cadaver and dissected specimens still have a place in medical schools in the twenty-first century; their role in the education of doctors, past, present and future is significant. However, this does not go on to say that technology should be discarded completely by medical institutions, as it appears to work hand-in-hand with the traditional forms of teaching.

There does not appear to be the best way of teaching anatomy, but the best way to enhance learning is the combination of all the techniques of teaching and learning anatomy, as each resource complements each other.

Anatomy is an essential asset to the physician in the diagnosis and treatment of conditions, and the teaching of anatomy should not be left to the “educational fashion of the day” (Winklemann, 2007).

Take Home Messages

Notes On Contributors

Halima Iqbal: I am responsible for the writing of the entire paper.

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Appendices

Declaration of Interest

The author has declared that there are no conflicts of interest.