Researching Innovative Methodologies For Teaching Anatomy, And Familiarizing With Established Teaching Practice

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Abstract
Anatomy, one of the prerequisite subject in medical education that enables students to excel in other basic medical courses. Anatomy encompasses systematic anatomy, regional anatomy, neuroanatomy, histology, and embryology. I am extremely enthusiastic about being part of a program that prioritizes innovation and excellence. Initially being interested in pursuing a career as a veterinarian, my curiosity expanded to encompass the various roles and responsibilities within the field, extending beyond direct clinical practice to encompass facets such as public health and biomedical research. My aspiration is to educate undergraduate and postgraduate students about the anatomical features and physiological processes of the body. In accordance with my philosophy, we must establish a high standard bar so that students have a strong basis for the rest of their clinical careers. The traditional practice of cadaver-based teaching has persisted for centuries, but its relevance in modern undergraduate training is a subject of debate. The limitations such as curricular constraints, scarcity of qualified anatomy faculty, and resource allocation for gross anatomy courses within combined or system-based syllabuses have prompted many medical institutions to replace laborious and expensive dissection-based teaching with alternative approaches, including living anatomy, prosection, medical imaging, and multimedia resources utilizing videos and other online tools. But we are convinced that, beside traditional methods these innovative teaching methods should be integrated into our educational system, because no single teaching method has been able to satisfy all curriculum demands. The use of diverse methodologies such as, traditional, and innovative methods of teaching anatomy are more effective, and essential for effective for comprehensive learning of anatomy education. In this study, we examine various innovative teaching methodologies utilized in the field of anatomy education, aiming to propose optimal teaching practices in this domain.

Keywords: Anatomy Education, Traditional Method of Teaching Anatomy, Innovative Method of Teaching Anatomy.

Introduction

Anatomy serves as a fundamental pillar in medical education, forming the basis for clinicians to develop their clinical expertise, especially in surgical disciplines. The effective teaching of anatomy necessitates continuous evaluation to determine the most suitable teaching tools and methodologies for the learning process. The significance ability of medical schools, colleges, and universities is to effectively teach anatomy has been a topic of debate for many years (Singh *et al.*, 2022). The recent trends indicate a reduction in traditional cadaver-based anatomy teaching, driven in part by the shift towards integrated and system-based curricula, influenced by factors such as religious beliefs, cost, and time constraints**.** There is a concern that anatomy teaching is inadequate according to some experts and they suggested the dissection, are being updated and improved in order to align with advances in modern medicine. In the past, there was a belief that dedicating significant time to dissecting bodies was essential for becoming a skilled doctor (Chan *et al.*, 2019).
However, now many colleges, and universities claim that dissections are no longer valid, and due to limitations such as curricular constraints, scarcity of qualified anatomy faculty, and resource allocation for gross anatomy courses within combined or system-based syllabuses, they are using models, medical imaging, multimedia resources such as videos, and other online tools instead of dissecting bodies. But presently, no singular teaching approach adequately fulfills curriculum requirements (Hunter, 2021). Our analysis indicates that certain educational methods or strategies may be better suited for specific professions. For example, full-body dissection is best suited for medical students, especially those with

ambitions for surgical careers, whereas teaching based on prosections and plastination is more appropriate for dental, pharmacy, and allied health science students. Profound knowledge about anatomy is crucial for competent clinicians, particularly those in surgical practice, as it contributes to safe clinical procedures (Qureshi, 2024). Medical colleges and universities in America, including John Hopkins University School of Medicine and Southern Illinois University School of Medicine, instruct students to display confidence when discussing anatomy, even when feeling stressed. This boosts their self-confidence, enhances their understanding of physiology, and improves their exam performance by aiding in the long-term retention of knowledge (Kumar, 2022).

There have been significant improvements in the training of doctors over the past few years. There is growing concern about students' understanding of anatomy declining in comparison to previous knowledge. The American Association of Clinical Anatomists (AACA) and the Education Committee of the Anatomical Society of Great Britain and Ireland (ASGBI) have proposed curricula on gross anatomy, histology, fertilization, and organogenesis to maximize the learning of future anatomy researchers, teachers, and students (Sugand *et al.*, 2010). In this review, we critically analyze literature from the viewpoints of anatomists, and clinicians, with the objective of providing recommendations for the best practices in anatomy education. Future research should be directed towards evaluating the appropriateness of new teaching methodologies within updated curricula, exploring student perceptions of integrated and multimodal teaching paradigms, and assessing their efficacy in achieving learning objectives.

Methodology

The present study was designed with an exhaustive and systematic search of the literature about several studies that were published between 2010 and 2024. We examined a range of articles in search of the most suitable materials for educating anatomy teachers. The most crucial findings about the professional teaching of anatomy were compiled through an extensive analysis of numerous publications and their comparisons. The explorations were performed using databanks, including Google Scholar (http://www.scholar.google.com/ (accessed on 05 April 2024), Science Direct (http://www.sciencedirect.com/ (accessed on 08 April 2024) Scirus (http://www.scirus.com/ (accessed on 10 April 2024) and PubMed (http://www.ncbi.nlm.nih.gov/pubmed (accessed on 11 April 2024). In our literature review, we focused on the latest research papers using the keywords: Anatomy Education, Histology, Dissection, etc.

Different Methods and the Challenge of Teaching Anatomy

In many medical schools, colleges, and universities, students primarily acquire knowledge about the anatomy of the body through lectures delivered by their instructors. These lectures encompass the structure and function of the body, utilizing visual aids such as pictures and digital images. Additionally, students are expected to utilize visual resources such as illustrated anatomy books and skeleton models for their learning. However, some medical programs are neglecting to prioritize anatomy in their curriculum compared to other subjects. Consequently, they allocate less time to the dissection of bodies and instead utilize alternative techniques such as prosections, plastic models, and multimedia learning. There exist various approaches for teaching anatomy across different colleges and universities, yet there is a lack of standardized approaches for teaching anatomy to graduate and postgraduate students (Ortadeveci *et al.*, 2022).

The Aspects of Studying Anatomy

Medical students must acquire knowledge about fundamental anatomy and physiology at the beginning of their medical studies. Their learning process should involve the dissection of the body, along with visual aids such as videos and images, to enhance their understanding of the basic anatomical features of the body. Anatomy is an essential subject for all healthcare professionals to grasp the structure of the human body, not solely for those students aiming to pursue a career as a surgeon. Students must be assessed to demonstrate their knowledge of human anatomy and physiology because it is crucial for them to gain knowledge about general systemic anatomy and the growth and development of the body in order to comprehend conditions such as birth defects (Nyemb and Manyacka, 2017). It is imperative for students to maintain their knowledge of anatomy by studying and taking tests, especially as they transition to working with patients. Even after completing their education, doctors must continue to apply their knowledge of anatomy. Regardless of their experience, patients expect doctors who are fully trained and skilled (Singh *et al.*, 2019).

Advancement of Anatomy Education via Modernization and Technological Developments

Teaching of Anatomy is changing day by day, instead of relying on traditional dissection methods, because we are introducing innovative ways to teach, and learn anatomy. Nowadays, there are more innovative methods for teaching anatomy, such as videos, multimedia, and virtual surgical simulations. Some educational institutions are beginning to question the necessity of dissection and are exploring alternative methods. Dissection labs are being modernized to better meet the needs of modern students and medical procedures. Certain educational institutions are utilizing embalmed cadavers for surgical training. Nevertheless, issues such as a shortage of cadavers and ongoing discussions about the necessity of dissection labs persist (Hu *et al.*, 2018). Several teachers hold the opinion that technology is equally effective in teaching the anatomy of the human body. However, discussions persist as a result of differing perspectives among people. Furthermore, medical colleges are allocating less time in teaching anatomy, because other subjects of medical related field are being added to the curriculum. In spite of this, students insist on the significance of anatomy and seek further education in this area of field. As surgery becomes more specialized, anatomy is becoming even more important, but the focus on it in medical schools is not matching up with this trend. Medical schools are not giving adequate attention to the field of anatomy (Swinnerton *et al.*, 2017).

Curriculum Development and Implementation for Anatomy Education

According to Raftery, 2007, it is essential to conduct rigorous anatomy exams at the onset of medical studies. Anatomy, being a challenging subject, may be overlooked by students as they prioritize other medical-related subjects. During the initial two semesters of medical study, students acquire extensive knowledge about anatomy and physiology. However, upon completion of their education, they may not retain all the information and knowledge acquired through dissecting bodies in dissection labs (Raftery, 2007).

According to Collins, 2008emphasizes the importance of anatomy education in promoting continuous learning, with universities ensuring that their students meet specific standards established by organizations such as the GMC. Various strategies can be employed to aid students in gaining a better understanding of anatomy, such as assigning specialized research tasks or allowing them to pursue a Bachelor of Science degree in anatomy while continuing their regular studies. At Warwick University in the UK, there is a program that allows students to visit Grenada for handson dissection experience (Collins, 2008).

Anatomy should be integrated throughout the entire duration of the medical school program rather than solely in the initial two semesters. Acquiring knowledge about the anatomy and function of the body proves beneficial for students as they interact with actual patients. Concerns exist among some individuals regarding students' preparedness for medical rotations due to a potential lack of anatomical knowledge. Even as students specialize in specific areas of medicine, certain schools like Brighton and Sussex Medical School in the UK still include anatomy in their curriculum. Another critical concern is the proper management of deceased bodies. It is imperative for schools to consider the legal and health hazards associated with animal dissections (Smith and Border, 2017). Demiryurek and others (2002) explored strategies for reducing the risk of illness from working with cadavers and maintaining health while handling deceased remains (Demiryürek *et al.*, 2002).

Recommended Content of a Modern Anatomy Curriculum

The American Association of Clinical Anatomists (AACA) provided suggestions for key topics to include in a modern anatomy curriculum. Their studies involve understanding the gross anatomy (learning about the big parts of the body), fertilization (how babies are made), and organogenesis (how organs develop). In order to maximize learning in a brief period, curriculum can be segmented to include activities such as dissection/prosection (cutting up bodies or using models), multimedia (using videos and computer programs), practical procedures (learning how to do things like surgery), surface and clinical anatomy (learning about the outside of the body and how it relates to health), and radiological imaging (using scans like X-rays to see inside the body). These subjects are essential for understanding the about the system, and function of the body and caring for patients (Sparacino *et al.*, 2019).

Traditional Methods of Teaching Anatomy

Dissection

Cadaveric dissection is the traditional method of teaching anatomy, typically following theoretical lessons and discussions based on atlas images. For over 400 years, dissection has been the primary approach, offering unique advantages that are challenging to quantify. These include fostering active and in-depth learning, preparing students for clinical practice, familiarizing them with mortality, honing manual skills, and aiding comprehension of the correlation between patients' symptoms and pathology (Ghosh, 2017). When instructing on the fundamentals of gross anatomy, it is recommended to utilize actual cadaver dissection, prosections, or anatomical models with guidance from educators. Active participation of students during dissections improves their comprehension of 3D forms and also promotes social skills and medical professionalism, including teamwork skills, coping mechanisms for stress, and empathy (Wessels *et al.*, 2014).

Many experts believe that prosections or demonstrations alone are sufficient for students learning about anatomical features, and dissections are only performed once they have progressed in their surgical training. The method of plastination utilizes polymers to preserve bodies for study, maintaining the appearance of bodies as lifelike specimens. Certain UK medical schools have incorporated palatinate prosections into their teaching methods. Palatinate models are highly favored by students, and employing them could potentially improve their test performance (Akamatsu *et al.*, 2014). However, it is vital for medical professionals to utilize cadavers to develop and enhance their skills. Dissecting a body provides students with a deeper understanding and appreciation for the human body, as well as the opportunity to apply their knowledge in practical medical scenarios. The combination of rephrasing technology and dissection can improve our understanding about the general and systemic anatomy of the body (Ghosh, 2017).

Unlike plastination, cadaver dissections provide a sense of surprise regarding anatomical variations, showcasing more intricate details and preserving a texture akin to that of a living body, thus simulating an operating theatre experience. Many anatomists continue to endorse dissection as the preferred teaching method. However, there is a prevailing debate on the suitability of full cadaver dissection in modern undergraduate education (Heise, 2021). Factors such as cost, time constraints, and perceptions of obsolescence have led to the decline of dissection-based courses in numerous medical schools. This shift has been driven by curriculum overcrowding, the transition from a regional-based to a system-based approach, and concerns about health risks associated with formalin exposure. These developments have prompted the replacement of full-body dissection with prosection-based courses, often integrated with alternative teaching modalities. The move away from dissection courses is justified by the argument that only a minority of medical students, specifically those pursuing surgical careers, truly require this form of instruction (Naidoo *et al.*, 2021).

Prosections

A prosection involves the dissection of a cadaver (human or animal) or part of a cadaver by an experienced anatomist to demonstrate anatomical structures to students. A prosection typically refers to a pre-dissected and often palatinate specimen. Historically, cadaver prosections were integral to anatomy education during the Middle Ages and early Renaissance. Due to the reduction in time allocated to gross anatomy within integrated curricula and a decline in body donations, many programs have shifted from full-body dissection to prosections. Prosections offer learners exposure to structures that might otherwise require extensive time to locate. Certain complex structures, such as the heart and major vessels deep within the thorax and abdomen, are impractical to dissect layer by layer, making prosections a more suitable approach, especially within system-based educational frameworks (Gummery *et al.*, 2018).

In Australia and New Zealand, most medical schools utilize prosections as the primary method for teaching gross anatomy within their systemic, integrated, case-based learning curricula. Prosection-based courses provide flexibility, contextual relevance, and time efficiency, enabling easy observation of anatomical structures and their relationships. Additionally, prosections facilitate the study of multiple anatomical variations across different specimens, enhancing students' learning experiences. Despite the benefits, the preparation of prosected specimens demands considerable time and skilled personnel, as each body region requires multiple prosections (Estai and Bunt, 2016).

Lectures

Old-fashioned anatomy lectures may feel antiquated to certain students, but they continue to impart crucial knowledge. On the other hand, technology has made lecture more captivating and encouraged greater involvement of the student. The use of Audience Response Systems (ARS) to actively participate and engage in lectures and class discussions. Many students appreciate ARS as a way to assess their understanding of anatomy, and it has gained popularity among a wide audience. The use of ARS with immediate feedback demonstrated a strong correlation with improved student performance on final exams (Alexander *et al.*, 2009).

Anatomy classes have employed formal lectures and the dissection of cadaver since the 1600s. However, a large number of people believe that this conventional approach is outdated and passive. The revolution of medical education has been influenced by pedagogical shifts and resource constraints, leading to the exploration of alternative teaching methods. According to Brown (2016), the blended learning combines traditional face-to-face instruction with online resources and tools, is considered an effective method for instruction. Blended learning can increase student participation and may lead to improved academic performance. This method of teaching is unique compared to traditional classroom instruction. Nevertheless, a significant challenge lies in ensuring that students actively engage in the assigned activities both pre-class and in-class activities, often resulting in increased preparation workload for educators (Brown, 2016).

Autopsy

Medical students are frequently requested to observe autopsies during their training. Freshly deceased patients are realistic, and more preferable for educational learning as compared to preserved cadavers. They present their medical records and display symptoms that assist in establishing a diagnosis and prognosis. The use of a microscope allows students to observe how diseases and injuries affect the body through examining microscopic tissue samples (Miller and Fyfe, 2024). An overview of the benefits, drawbacks, and applicability of traditional anatomy teaching methodologies shown in Table 1.

Table 1: Summary of the Advantages, Limitations, and Relevance of Traditional Methodologies of Teaching Anatomy

Teaching Methods	Advantages	Limitation	Relevance to Anatomy Education	Associated Modalities	References
Cadaver Dissection	Active and in depth learning Preparation for clinical practice. Development of medical professionalism	Costly and time-consuming. Health risks associated with formalin exposure	Best suited for medical trainees, particularly those pursuing surgical careers	Anatomical models. Virtual dissection software	(Ghosh, 2017)
Prosections	Exposure to complex structures. Time efficiency. Flexibility in observation.	Requires skilled personnel and time for preparation. May lack surprise element compared to dissection	Suitable for dental, nursing, and allied health science students within system-based curricula	Computer-based learning materials. Anatomical models	(Ghosh, 2017)
Lecture-Based Teaching	Long-standing method for conveying information. Complementing other teaching approaches	Criticized for being out dated and passive	Commonly used in conjunction with other teaching methodologies, especially in blended learning approaches	Interactive lecture materials. Multimedia resources	(Ghosh, 2017)
Autopsy	Realistic presentation of freshly deceased patients	Limited availability of fresh specimens, emotional impact on students	Valuable for understanding disease manifestations, diagnosis, and prognosis	Microscopes, Cadavers	(Miller and Fyfe, 2024)

Innovative Methods of Teaching Anatomy

Plastination

Plastination is an innovative method introduced by Von Hagens for the preservation of organs and body parts using chemical agents. In 1987, synthetic body parts were created from substances such as polyester, silicone, and resin, which are utilized in anatomical education. These models are ideal for demonstrating X-ray procedures and the anatomy of the body due to their durability and odorless nature. This new approach was adopted for teaching anatomy by the University of Warwick in the UK. Additionally, St George's and Nottingham University in the UK have implemented the use of

these techniques. Proper preservation and dissection of specimens allow students to view them repeatedly without causing damage. The technique is similar to using plastic models but incorporates natural blemishes that plastic models do not possess. By using plastination, we can gain a more comprehensive understanding of intricate anatomy compared to solely discussing it (Adds *et al.*, 2024).

Plastinated prosections are best used in conjunction with cadaveric dissection to gain a comprehensive understanding of the body's interconnected systems and to view the body as a unified whole. It is essential to keep in mind that utilizing a deceased body for training remains valuable for acquiring crucial abilities required to become a physician (Milian *et al.*, 2024). According to Bafarasat (2024), dissection allows students to bridge the gap between theoretical knowledge and its practical implementation in medical contexts. It would be counterproductive to ignore the potential of technology in assisting with reviewing material from dissection classes (Bafarasat, 2024). Additionally, health and safety concerns arise from the use of substantial amounts of flammable chemicals during the preparation of plastinated specimens. Over time, plastinated sections lose their novelty, as students become accustomed to the exposed variations, eventually mastering them thoroughly. Previous studies have demonstrated that students find plastinated specimens useful and accommodating at various levels. However, due to the gradual loss of unique characteristics, the efficacy of plastination diminishes over time (Yunus *et al.*, 2022; Ottone, 2023b, a).

Plastic Models

Many educational institutions have shifted to using plastic models instead of animal dissection for educational purposes. The plastic models have a durable nature and maintain consistent appearances over time. However, their structural appearance does not resemble to real organism bodies. Plastic models fail to accurately replicate the anatomical intricacies of living organisms, and as a result, they cannot effectively convey signs of illness, physical abnormalities, or anatomical variations. Those students who do not participated in animal dissection process may not acquire as much knowledge and may fail to comprehend the intricacies of the human and animal's anatomy. In the future, this may present difficulties for doctors in clinical practices and they may require additional training support, and resources during surgical procedure (Varner *et al.*, 2021).

Living Anatomy

This approach offers unique advantages over traditional methods by providing students with hands-on experience and opportunities for direct interaction with living anatomical structures.

Throughout history, artists and art historians have demonstrated a profound interest in the human body. When compared to cadavers, the advantages of studying the living body include its natural color, texture, and the ability to be palpated, auscultated, and repositioned. Various methods, such as peer physical examination (PPE), ultrasound, and body painting, have been employed to teach living anatomy to students (Hisley, 2023).

Integrated Curricula

Integrated Curricula would be classified under innovative method of teaching anatomy. The new method of teaching medical students differs from the traditional approach because traditional medical education programs typically emphasize basic sciences in the initial years and shift to clinical training in the later stages, resulting in limited exposure to anatomy during clinical training (Alharbi *et al.*, 2020). In this approach, Practical medical training is integrated with anatomy education in the beginning of medical education. This approach has drawn criticism from clinical tutors due to concerns about the inadequate anatomical knowledge of newly qualified doctors, potentially compromising patient safety. Reforms in medical education have prompted the development of vertically integrated curricula, integrating clinical sciences early on and emphasizing continued focus on anatomy and basic sciences in later years (Khalil *et al.*, 2021). For instance, at the Brighton and Sussex Medical School in the UK, students revisit the dissection room during specialized rotations, enhancing their understanding of anatomy pertinent to their field. This approach enables graduates to synthesize learned facts, fostering a holistic approach to patient care (Shapiro and Keenan, 2020).

System-Based Curricula

System-Based Curricula would also be classified under innovative method of teaching anatomy. This approach represents an innovative shift in medical education from the traditional region-based curriculum to a more integrated approach that focuses on understanding how different systems of the body work together. It aims to enhance students' ability to retain factual knowledge, apply anatomical knowledge to medical practice, and promote a comprehensive understanding of the human body (Smith *et al.*, 2022). Since the early 20th century, anatomy was taught separately, in the first preclinical year alongside other subjects like histology, physiology, and biochemistry, making it difficult for students, who often struggle to integrate fragmented information and knowledge within a region-based curriculum. Now, medical education focuses on understanding how different systems of the body work together. By learning about one system at a time and then seeing how it relates to other systems of the body, students find it easier to remember and understand the material for a long period of time. This shift allows learners to retain factual knowledge more effectively and apply anatomical knowledge to their medical practice, promoting a more comprehensive understanding of the human body (Yang, 2023).

Computer Based Learning (CBL)

Computer-based learning (CBL) is an innovative, and emerging method which is prevalently used for learning anatomy in medical colleges. CBL supplements traditional teaching methods, fostering independent learning, problem-solving skills, and flexibility. However, there is no conclusive evidence favoring CBL as a standalone approach. Rather, it appears to enhance learning when combined with traditional methods (Lee, 2006). Notably, students generally prefer conventional techniques such as dissection, prosection, lectures, and textbooks over CBL resources. The emergence of virtual reality (VR) and its applications in medical education has shown positive outcomes, offering students opportunities to visualize, dissect, and interact with simulated 3D structures. Platforms like Anatomage tables, BioDigital Human, Zygote Body, and Second Life are increasingly utilized. The use of Oculus Rift and similar 3D visualization tools enables students to engage in immersive learning experiences, utilizing motor skills and hand movements in a virtual environment (Chen *et al.*, 2020).

Interactive Multimedia

Interactive multimedia is also using as innovative method in anatomy education, because interactive multimedia is helpful for engaging student in learning process. Personal digital assistants (PDAs) could potentially store crucial anatomy books and images in the future.

Certain educational institutions utilize CD-ROMs and DVDs as teaching tools for anatomy. These contain videos depicting medical procedures and 3D images of anatomical structures. The University of California instructs students in emergency preparedness through the use of videos, lectures, and hands-on practice with cadavers or mannequins and models (Singh *et al.*, 2019). These alternative resources, including Acland's DVD Atlas of Human Anatomy and 3D Human Anatomy Software DVDs, can also prove to be valuable. Warwick Medical School offers 3D podcast videos that can be easily accessed for learning anatomy. There are special computer programs and phone apps available to assist in teaching about neuroanatomy, allowing students to access information about the nervous system. The use of virtual reality technology can also demonstrate vascular anatomy (blood vessels). Multimedia materials are beneficial for learning about microscopic anatomy such as histology and small biological components such as cells and tissues. Nonetheless, they ought to be incorporated alongside traditional teaching techniques rather than completely replacing them (Javaid, 2018).

Virtual Simulation

Teaching can improve the long-term memory retention of knowledge by focusing Interactive and problem-oriented teaching technique. Surgeons can practice in a clinical setting by simulating surgical operations with virtual reality technology. Haptic feedback technology allows users to comprehend the movement of their skeleton and muscles and perceive the feeling of touching nonexistent objects. Students will improve their understanding of various types of tissue and enhance their laboratory skills with hands-on experience. At the Royal Veterinary College, "The Haptic Cow" simulator was used by students to enhance their understanding of cow anatomy. The simulator was popular for its innovative teaching method (Leandro *et al.*, 2019).

Body Painting

Students at certain colleges, and universities have the option to pursue subjects unrelated to their primary coursework, such as art, literature, and drawing. These activities can help students to learn about anatomical relationships and ethical issues, what is right and wrong in the medical field. Body painting is also used in classes to study the surface anatomy and the systems underneath. Surveys have found that students like this technique enjoyable and effective for learning. Body painting provide student a learning, and enjoyable environment in form anatomical models. It is also significance for studying the surface anatomy and advantageous to manage ethical issues, encourages volunteer participation and relaxation (Estai and Bunt, 2016).

Medical Imaging

Medical imaging has become an integral component of anatomy education, providing insights into anatomical structures, physiological processes, and pathological conditions through in vivo visualization. Computed tomography (CT), magnetic resonance imaging (MRI), and ultrasound have enabled the display of intricate 2D and 3D reconstructions of internal anatomy.

Consequently, medical schools are increasingly incorporating imaging techniques into their curricula, facilitating the application of foundational anatomical knowledge in interpreting sectional scans and correlating clinical significance with anatomical understanding. While medical imaging serves as a valuable supplement to dissection-based instruction, it cannot fully replace the benefits of conventional dissection (Lauridsen *et al.*, 2011).

Table 2: Summary of the Advantages, Limitations, and Relevance of Innovative Methodologies of Teaching Anatomy

Teaching Methods	Advantages	Limitations	Relevance to Anatomy Education	Associated Modalities	References
Plastination	Odourless storage. Reduced costs and convenience	Shrinkage and loss of texture. Health and safety concerns during preparation	Preferred as an alternative to dissection, but with diminishing effectiveness over time	Virtual reality tools. Anatomical models	(Gummery *et al.*, 2018).
Computer-Based Learning (CBL)	Foster independent learning and problem-solving skills. Incorporation of VR and AR for immersive experiences	No conclusive evidence favouring standalone use. Student generally prefers traditional methods.	Commonly used as supplement to traditional teaching methods, teaching methods, especially in virtual reality and augmented reality applications	Virtual reality platforms. Augmented reality applications	(Chen *et al.*, 2020).
Medical Imaging	In vivo visualization of anatomical structures and pathological conditions. Correlation between clinical significance and anatomical understanding	Potential limitations in visualizing intricate structures. Abstraction compared to direct engagement with cadavers	Integral component supplementing traditional anatomy education, particularly in interpreting sectional scans	Computed tomography (CT). Magnetic resonance imaging (MRI)	(Lauridsen *et al.*, 2011)
Living Anatomy	Natural colour and texture simulation. Opportunity for skill development and empathy enhancement	Challenges related to sensitive areas and cultural considerations	Effective in teaching surface anatomy and clinical skills, though influenced by cultural and religious factors	Ultrasound technology. Body painting techniques	(Chen *et al.*, 2020).
Plastic Models	Durable nature, consistent appearance over time	Lack resemblance to real organism bodies, inability to indicate signs of illness or abnormalities	Widely used alternative to animal dissection, may hinder understanding of intricate anatomy in clinical practice	Anatomical models	(Chen *et al.*, 2020).
Virtual Simulation	Interactive and problem-oriented teaching, immersive experience	Potential for long-term memory retention, hands-on experience with haptic feedback technology	Effective in simulating surgical operations, enhancing understanding of tissue types and laboratory skills	Virtual reality technology	(Leandro *et al.*, 2019).
System-Based Curricula	Facilitation of long-term retention of knowledge. Smooth transition between different systems	Challenges in integrating different disciplines. Potential prioritization of clinical aspects over basic sciences	A contemporary approach promoting a comprehensive understanding of the human body	Case-based learning modules. Interdisciplinary teaching collaborations	(Chen *et al.*, 2020).
Body Painting	Engaging and enjoyable learning experience	Cultural and sensitivity considerations, potential for gender segregation in classroom settings	Effective in studying surface anatomy and ethical issues, encourages volunteer participation and relaxation	Art supplies, Models, Cultural sensitivity training	(Estai and Bunt, 2016).

Enhancing Anatomy Education Through Collaborative Approaches

Some of the advanced teaching methodologies in anatomy education used for fostering transferable skills in professionalism and leadership in student through collaborative approaches as shown in table 3. These approaches are used to improve the sympathetic and retention of anatomy knowledge, while promoting the communication skills in students. Problem-Based Learning (PBL) promotes self-directed or independent learning, empowers active participation, and preparing students for collaborative group discussions (Wang *et al.*, 2023).

Table 3: Implications and Significance of Collaborative Approaches

Key Points	Implications/Methods	Importance/Significance	References
Peer–Peer Partnerships	Reciprocal peer teaching (RPT) allows for alternating roles as students and chairpersons, fostering transferable skills in professionalism and leadership.	Enhances understanding, retention of anatomy facts, and communication skills.	(Sugand *et al.*, 2010)
Problem-Based Learning (PBL)	Encourages active participation, self-directed learning, and preparation for team-based discussions.	Improves examination performance, fosters curiosity, and promotes deeper understanding of anatomy.	(Sugand *et al.*, 2010)
Setting Projects and Multimedia Use	Familiarizes students with basic pathology and research opportunities, facilitating collaborative learning.	Promotes synergy, encourages curiosity beyond set learning objectives, and provides a protected environment for reflection and resource sharing.	(Sugand *et al.*, 2010)
Team-Based Learning (TBL)	Receives positive feedback for promoting teamwork and preference among students.	Cultivates effective teamwork and communication skills essential for medical professionals.	(Sugand *et al.*, 2010)
Near-Peer Tutoring	Senior students teach junior peers to reinforce and expand knowledge, develop teaching skills, and enhance communication.	Offers a solution to the shortage of anatomy demonstrators and positively impacts both tutors and students.	(Sugand *et al.*, 2010)

Nurturing Professionalism, Leadership, and Ethical Awareness in Anatomy Education

Professionalism and Leadership Skill by Anatomy Education

In addition to imparting knowledge, it's beneficial to foster professionalism and leadership qualities. Research has indicated that children who exhibit integrity and reliability generally score highly on tests. Gaining leadership abilities may help healthcare teams collaborate more successfully and communicate more effectively, which will eventually improve patient care. On the other hand, if students misbehave, and show unprofessional behave it can negatively impact their future career prospects. So there are rule and regulations for supervising and aiding students who display inappropriate behavior. Identifying and addressing these behaviors promptly can prevent problems from arising in their future. In general, teaching future doctors about professionalism and leadership from the beginning is crucial for them to develop into compassionate and reliable physicians. This will also help in preventing any behavior that may result in harm to patients (Waters *et al.*, 2024).

Student Commitment in Healthcare

Students undergoing medical training spend a significant amount of time gaining experience in real healthcare settings. Today, in a tradition known as the White Coat ceremony, new students make a commitment to provide care for patients. This assists in recollecting the responsibilities they have for future patients. When students commit to this promise, they become more dedicated to their work and take their learning with greater seriousness. Even if they are just beginning or on the verge of completing medical school, they have a plethora of opportunities to communicate with patients (Buja, 2019).

Medico-Legal Cases

Although doctors may not feel the urge to dedicate ample time to learning about anatomy during their final examinations, it is still essential for them to comprehend how to treat fundamental medical issues and not only the symptoms. Even after completing their formal education, doctors continue to acquire knowledge in the field of medicine. If there is insufficient time for anatomy study, the consequences of not knowing enough about it should be shown through real-life cases in subjects like Medical Ethics. People nowadays are aware of animal rights and welfare, particularly in the context of receiving medical treatment. Medical professionals may face lawsuits due to their lack of expertise in understanding anatomy and physiology. Mistakes during surgery can harm patients significantly and often result in lawsuits and large payments. This causes individuals to question the credibility of doctors and creates strain on the healthcare system (Pirri *et al.*, 2021).

Conclusion

Anatomy serves as a counter stone in medical education, forming the basis for clinicians to develop their clinical expertise, especially in surgical disciplines. Effective teaching of anatomy necessitates continuous evaluation to determine the most suitable teaching tools and methodologies for the learning process. Innovative methods of teaching anatomy are gaining popularity, shifting away from the use of traditional methods. This is due to changes in educational curriculums and other factors such as financial constraints, time constraints, and religious considerations. Increasing medico-legal litigations for surgical mistake highlight the significance of anatomical competence. Reports suggest that inadequate anatomical knowledge among new residents in surgery is contributing to avoidable deaths. Despite this, many medical colleges continue to reduce the time allocated for teaching anatomy, leading to a decline in anatomical knowledge among undergraduate and graduate students. We are convinced that these innovative teaching methods should be integrated into our educational system, because no single teaching tool has been able to satisfy all curriculum demands. The use of diverse methodologies for teaching anatomy is most effective, and essential for effective anatomy education, such as traditional, and innovative methods of teaching anatomy. A number of anatomists are in favor of implementing these methods for teaching anatomy.

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