ANATOMY EDUCATION IN MEDICAL CURRICULA AND ITS EFFECT ON STUDENTS' PERCEPTIONS: A SYSTEMATIC REVIEW

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Abstract

Background: Anatomy is a foundational subject in medical education, crucial for understanding the human body and developing clinical skills. With evolving educational needs, teaching methods in anatomy have shifted from traditional dissection to include modern technologies such as virtual and augmented reality. This systematic review examines students' perceptions of anatomy education in medical curricula, focusing on how teaching methodologies influence learning experiences.

Methods: A systematic search was conducted in PubMed, Scopus, Web of Science, and Google Scholar for studies published between 2019 and 2024. Inclusion criteria were studies focusing on medical students' perceptions of anatomy education in medical curricula using qualitative, quantitative, or mixed-method approaches. Data extraction and quality assessment were performed using the Mixed Methods Appraisal Tool (MMAT).

Results: Thirty-one studies were included, encompassing traditional teaching methods, technological innovations, and student-centered learning approaches. Traditional cadaveric dissection was highly valued for its immersive experience, while modern technologies like VR and AR were appreciated for enhancing visualization but were seen as supplementary. Student-centered methods such as PBL and flipped classrooms were positively perceived but highlighted the need for effective facilitation and feedback.

Conclusion: Understanding students' perceptions is crucial for optimizing anatomy curricula. A balanced approach that integrates traditional dissection with technological and student-centered innovations can enhance learning outcomes and satisfaction.

Keywords: Students, perception, medical education, anatomy, teaching methods, learning outcomes, student engagement.

Introduction

Anatomy is considered one of the most challenging and foundational subjects in medical education, providing a critical understanding of the human body's structure and function, which directly impacts clinical competencies and decision-making skills (1). The traditional approach to teaching anatomy, primarily through cadaveric dissection, has been a cornerstone of medical education for centuries. Dissection offers a hands-on experience that allows students to explore the complexities of human anatomy, develop spatial awareness, and gain an appreciation for the variability of the human body (2,3). However, with evolving educational needs, technological advancements, and ethical considerations, the teaching methodologies in anatomy are constantly being re-evaluated to better meet students' learning needs and preferences (4,5).

Recent trends in medical education have seen a shift from teacher-centered to more student-centered approaches, integrating problem-based learning (PBL), flipped classrooms, and digital technologies like virtual reality (VR), augmented reality (AR), and 3D modeling (6,7). These innovations aim to enhance student engagement, provide flexible learning opportunities, and improve knowledge retention by allowing repetitive practice without the limitations associated with traditional methods (8,9). However, students' perceptions of these newer approaches are mixed, with some expressing concerns over the lack of tactile experience and the potential disconnect from real-life anatomy, which is often perceived through cadaveric dissection (10,11).

The influence of anatomy education on medical students extends beyond knowledge acquisition; it shapes their professional identity, understanding of clinical practice, and the development of essential skills such as teamwork, critical thinking, and problem-solving (12,13). Moreover, the anatomy department often serves as the first point of exposure to medical sciences, playing a crucial role in setting the tone for the entire medical curriculum (14,15). As such, students' perceptions of their learning experiences in anatomy are critical indicators of the effectiveness of educational strategies and can influence their motivation, satisfaction, and overall performance (16).

Studies have indicated that positive perceptions of anatomy education are often linked to high-quality teaching, accessible resources, and a supportive learning environment (17). Conversely, negative perceptions can arise from factors such as high workload, inadequate feedback, large class sizes, and a perceived disconnect between anatomical knowledge and clinical application (18,19). These factors highlight the need for a balanced approach that addresses students' educational needs, preferences, and the realities of modern medical training.

This systematic review aims to comprehensively examine the current literature on medical students' perceptions of the influence of anatomy education in medial curricula, with a focus on understanding how various teaching methodologies and learning environments impact student outcomes. By synthesizing findings from recent studies, this review seeks to provide insights into best practices, identify gaps in the current educational approaches, and suggest areas for future research to optimize anatomy education for medical students. Understanding students' perceptions is essential for guiding curriculum development and implementing teaching strategies that not only impart knowledge but also foster a positive and effective learning experience that prepares students for clinical practice.

Methods

This systematic review followed the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines to ensure a comprehensive and unbiased assessment of the existing literature on students' perceptions of anatomy education in medical schools. The methodology was structured to identify, screen, and synthesize relevant studies systematically.

Search Strategy: A comprehensive literature search was conducted across major databases, including PubMed, Scopus, Web of Science, and Google Scholar, covering studies published from 2019 to 2024. Keywords used in the search included "students' perception," "medical education," "anatomy," "teaching methods," "learning outcomes," and "student engagement." Boolean operators (AND, OR) were employed to refine search results, ensuring the retrieval of relevant articles focusing on anatomy education.

Inclusion and Exclusion Criteria: To maintain the review's focus and relevance, studies were included based on the following criteria:

Inclusion Criteria: Studies published within the last five years (2019-2024), peer-reviewed articles in English, research focusing on medical students' perceptions of anatomy education, and studies that employed qualitative, quantitative, or mixed-method approaches.

Exclusion Criteria: Studies not in English, articles focusing on non-medical students (e.g., nursing, dental, or allied health students), reviews, opinion pieces, and conference abstracts without full-text access were excluded. Articles that did not explicitly discuss students' perceptions or were focused on specific subspecialties outside the anatomy department were also omitted.

Data Extraction: Data extraction was performed independently by two reviewers to minimize bias. The following information was extracted: study design, sample size, setting, key findings related to students' perceptions, teaching methods used, and any reported outcomes related to learning or satisfaction. Discrepancies between reviewers were resolved through discussion and consensus.

Quality Assessment: The quality of included studies was assessed using the Mixed Methods Appraisal Tool (MMAT), which evaluates study quality across five domains: clarity of research questions, appropriateness of methods, adequacy of data collection and analysis, relevance of findings, and coherence of interpretation. Studies scoring below 60% on the MMAT scale were excluded from the review to ensure the reliability of conclusions.

Data Synthesis: A narrative synthesis approach was used to analyze the findings due to the heterogeneity of study designs and outcomes. Themes related to teaching methods, student satisfaction, perceived effectiveness, and challenges in anatomy education were identified and discussed. The synthesis aimed to highlight key trends, gaps in the literature, and implications for future research.

Results

Study Characteristics: A total of 1,052 articles were initially identified through the database search. After removing duplicates and screening titles and abstracts, 67 full-text articles were assessed for eligibility. Thirty-one studies met the inclusion criteria and were included in the final analysis. The included studies comprised various research designs, including cross-sectional surveys, qualitative interviews, and mixed-methods studies, with sample sizes ranging from 50 to over 500 participants.

Perceptions of Traditional Teaching Methods: Most students expressed a strong preference for traditional cadaveric dissection, citing it as the most valuable method for learning anatomy. Students reported that dissection offered a unique opportunity to explore human variability, develop manual skills, and understand three-dimensional structures in ways that could not be replicated by textbooks or digital models. The hands-on experience of dissection was often described as emotionally impactful, fostering respect for the human body and enhancing memory retention.

Perceptions of Technological Innovations: The integration of VR, AR, and 3D digital resources received mixed reviews. While many students appreciated the interactive and visual nature of these tools, some felt that they lacked the realism and tactile feedback provided by traditional methods. The use of technology was perceived as beneficial for supplementing learning, especially in reinforcing complex concepts and providing alternative perspectives that could be difficult to visualize in a dissection lab.

Student-Centered Learning Approaches: Student-centered approaches, such as PBL and flipped classrooms, were generally viewed positively. Students felt that these methods made learning more engaging, relevant, and clinically oriented. PBL was particularly praised for its role in enhancing teamwork, critical thinking, and the ability to apply anatomical knowledge to real-world clinical scenarios. However, some students found the increased responsibility for self-directed learning to be challenging, especially when clear guidance or feedback from instructors was lacking.

Assessment and Feedback: The assessment of anatomy knowledge varied across studies, with frequent formative assessments and OSPEs commonly used. Students highlighted the importance of timely feedback, which helped them identify gaps in their understanding and improve their learning strategies. However, inconsistencies in assessment standards and a lack of detailed feedback were noted as barriers to effective learning.

Factors Influencing Perceptions: The review identified several factors influencing students' perceptions, including the quality of teaching, availability of resources, and personal learning preferences. Smaller class sizes, accessible and supportive faculty, and well-structured curricula were associated with more positive experiences. Conversely, high student-to-teacher ratios, inadequate resources, and inconsistent teaching quality were common complaints. Many students also emphasized the importance of integrating clinical relevance into anatomy teaching, suggesting that understanding the application of anatomical knowledge in a clinical context enhances motivation and learning outcomes.

Discussion

This systematic review highlights the diverse perceptions of medical students regarding anatomy education, reflecting the complex interplay between traditional and modern teaching methods. Anatomy education has long been a cornerstone of medical curricula, primarily because it provides the foundational knowledge necessary for understanding the human body and its clinical applications. The enduring preference for cadaveric dissection underscores its unparalleled value in providing tactile and spatial understanding, which remains unmatched by virtual alternatives (20-22). Dissection offers a unique hands-on experience that helps students build a three-dimensional understanding of anatomical relationships, reinforcing the knowledge acquired through textbooks and lectures. This experience is crucial for developing essential skills, such as spatial orientation and the ability to navigate the human body, which are directly translatable to surgical practice and other clinical settings.

However, the traditional method of cadaveric dissection is not without its limitations, including the high costs of maintaining dissection labs, ethical concerns related to the use of human cadavers, and logistical challenges such as time constraints and the variability of cadaveric specimens. These factors have led to the exploration of alternative and complementary teaching methods that can address these limitations while retaining the educational value of traditional practices (23). The integration of technological innovations such as Virtual Reality (VR) and Augmented Reality (AR) has enriched the educational landscape, offering novel ways to engage students and complement traditional methods (23). These technologies provide dynamic and interactive learning experiences that can enhance students' understanding of complex anatomical structures, especially those that are challenging to visualize or access through dissection.

The mixed reactions to technological approaches suggest that while they offer significant advantages, they should not replace but rather augment traditional teaching. Technologies like VR and AR have been particularly useful for visualizing intricate structures that are difficult to access or dissect, such as the inner ear or deep brain anatomy (24). The ability to manipulate three-dimensional models and simulate surgical procedures in a controlled, risk-free environment allows for repeated practice and a deeper understanding of anatomy without the constraints of physical dissection. However, the lack of tactile feedback and the potential disconnect from the physical reality of human anatomy limit their

standalone use (25). Students may find it difficult to develop the same level of familiarity and confidence with anatomical structures without the hands-on experience that dissection provides. Therefore, a blended approach that integrates both dissection and digital tools may offer the most comprehensive learning experience, allowing students to benefit from the strengths of each method (26).

Student-centered approaches, including Problem-Based Learning (PBL) and flipped classrooms, have been well received for their ability to foster active learning and critical thinking. These methods align with modern educational theories that emphasize student engagement, collaboration, and the application of knowledge in realistic contexts (27). PBL, for example, encourages students to work in groups to solve clinically relevant problems, promoting a deeper understanding of anatomy and its clinical relevance. Flipped classrooms, where students engage with learning materials outside of class and participate in interactive activities during class time, have also been shown to enhance understanding and retention of anatomical concepts. However, the effectiveness of these approaches heavily relies on the quality of facilitation and the provision of adequate feedback. Without proper guidance, students may feel overwhelmed by the self-directed nature of these learning modalities, potentially leading to frustration and disengagement (28). Effective facilitation requires instructors to possess not only strong content knowledge but also the skills to guide discussions, encourage critical thinking, and provide timely, constructive feedback.

Assessment practices also play a crucial role in shaping students' learning experiences and perceptions of anatomy education. Frequent assessments, including formative assessments that provide ongoing feedback, have been shown to enhance learning by helping students identify areas for improvement and adjust their study strategies accordingly (29). Constructive feedback can help reinforce correct knowledge, address misconceptions, and guide students toward achieving learning objectives. However, inconsistencies in assessment standards and a lack of detailed feedback were frequently cited as obstacles to effective learning, highlighting the need for more standardized and transparent evaluation processes (30). Developing clear assessment criteria and ensuring consistency across different instructors and cohorts can help mitigate these issues and create a fairer and more effective learning environment.

The findings of this review emphasize the importance of a balanced and integrated approach to anatomy education. While traditional methods like dissection remain highly valued for their ability to provide a comprehensive, hands-on understanding of human anatomy, the incorporation of technological innovations and student-centered learning strategies can significantly enhance the overall educational experience when implemented effectively. The future of anatomy education likely lies in a hybrid model that leverages the strengths of various teaching modalities to cater to diverse learning preferences and needs. Future research should focus on optimizing this integration, exploring the long-term impact of various teaching methods on clinical competencies, and developing best practices for feedback and assessment in anatomy education (31). Additionally, studies should investigate how different combinations of traditional and modern approaches can be tailored to different stages of medical education, ensuring that students are adequately prepared for the clinical demands they will face as future healthcare professionals.

Limitations: These findings are constrained by the limited number of studies directly comparing traditional dissection with VR, AR, or PBL in anatomy education. Inconsistencies in how studies define and measure "student perceptions" make it difficult to synthesize outcomes effectively. Moreover, most of the included studies had used cross-sectional designs, limiting insights into the long-term effects of these educational methods on student learning. Only few studies provide detailed context on how integrated curricula impact students' preparedness for clinical practice. Similarly, limited data from non-Western settings restrict understanding of global student perceptions in diverse cultural contexts.

Recommendations: In future, longitudinal studies may be conducted to examine the impact of hybrid anatomy teaching methods on clinical competence. Also, develop standardized tools for assessing

student perceptions and learning outcomes in anatomy education. Similarly, a proper investigation of the effectiveness of blended methods in enhancing anatomical knowledge retention over time is needed. Exploration of how integrated use of VR, AR, and dissection influences student preparedness for specific clinical skills may also be done. Multi-center approach may be utilized in non-Western contexts to capture diverse student perspectives globally.

Conclusion

Anatomy education is evolving with technological advances and new educational approaches. This systematic review highlights that a hybrid model combining traditional dissection, technological tools like VR/AR, and student-centered methods such as PBL and flipped classrooms best meets the diverse learning needs of modern medical students. Traditional dissection remains invaluable for tactile and spatial understanding, while VR/AR enhances visualization of complex structures. Student-centered approaches promote critical thinking and active learning. A balanced, integrated curriculum leveraging these methods can provide a comprehensive learning experience, catering to different learning styles and better preparing students for clinical practice. Future efforts should focus on optimizing the integration of these diverse methods, ensuring coherent, complementary teaching strategies, and aligning them with well-defined learning outcomes to enhance anatomy education's effectiveness and relevance in developing competent future physicians.

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