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THE ROLE OF VIRTUAL DISSECTION IN TRANSFORMING ANATOMY EDUCATION

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ABSTRACT: Background: Traditional anatomy education has long relied on cadaveric dissection, but this approach faces challenges including high costs, ethical concerns, and limited access to specimens. The Anatomage Table, a life-sized interactive virtual dissection platform, has emerged as a promising tool to enhance anatomy teaching and learning. This review examines the effectiveness, practical applications, and learner perceptions of the Anatomage Table in medical and health sciences education.

Methods: A systematic literature search was conducted following PRISMA guidelines across PubMed, SCOPUS, and Web of Science, covering publications from 2007 to 2023, with an extension to include studies published in 2024. Studies addressing both the psychological and educational impacts of anatomy teaching were included.

Results: Findings indicate that the Anatomage Table enhances students' spatial reasoning, comprehension of complex anatomical relationships, and long-term knowledge retention. Student feedback was overwhelmingly positive; for example, one study reported an 80.9% satisfaction rate, highlighting benefits in visualization, interactivity, and engagement. Comparative evidence suggests that instruction supported by the Anatomage Table can improve post-test scores compared to traditional methods alone. However, the tool does not fully replace the tactile and experiential learning provided by cadaveric dissection. Barriers to adoption include high initial costs, the need for faculty training, and technological infrastructure requirements.

Conclusion: The Anatomage Table represents a transformative addition to anatomy education. When integrated alongside cadaveric dissection, it enriches visualization, interactivity, and learning outcomes. Future research should explore cost-effectiveness, faculty development strategies, and long-term impacts on knowledge retention and clinical application.

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KEYWORDS: Anatomage Table, Anatomy Education, Virtual Dissection, Medical Education.

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1. INTRODUCTION

1.1.Anatomy Education and the Shift toward Technology

Anatomy has long been considered the cornerstone of medical and health sciences education, with cadaveric dissection traditionally regarded as the gold standard for teaching. While cadaver-based learning provides unmatched tactile and spatial experiences, it faces growing challenges, including limited body donations, the high costs of procurement and maintenance, ethical and cultural sensitivities, and health risks linked to chemical preservatives [1, 2]. These barriers have accelerated a shift toward technology-enhanced teaching methods, particularly computer-based visualization and virtual dissection tools, which aim to enrich learning experiences and improve educational outcomes [3, 4]. Among these innovations, the Anatomage Table stands out as one of the most advanced digital platforms available. By combining authentic cadaveric datasets with high-resolution radiological imaging, physiology simulations, and interactive teaching tools, it creates an immersive, life-sized virtual dissection experience [5, 6]. Unlike traditional dissection, the Anatomage Table allows repeated practice, three-dimensional visualization, and exposure to both normal and pathological variations in a safe and cost-effective environment. Anatomy has long been the cornerstone of medical and health sciences education, forming the basis for diagnostic accuracy, surgical proficiency, and safe patient care [3]. Traditionally, cadaveric dissection was regarded as the gold standard, offering invaluable tactile and spatial learning experiences [7]. However, its continued use is increasingly challenged by limited body donations, high operational costs, ethical considerations, and health risks associated with chemical preservatives [8]. These constraints, combined with advances in digital education and the growing emphasis on student-centered learning, have paved the way for virtual platforms. The COVID-19 pandemic further accelerated this shift, as institutions sought effective alternatives to maintain anatomy instruction during restrictions on laboratory access [9].

1.2. Evolution and Adoption of the Anatomage Table

Founded in 2004, Anatomage began by digitizing human cadavers through 3D reconstructions and has since expanded into clinical simulation and educational technologies. Today, more than 4,000 institutions including universities, hospitals, and research centers incorporate Anatomage products into teaching, training, and research [10]. Over time, features such as integrated physiology pathways, virtual case libraries, and histology archives have broadened its relevance across multiple health disciplines [11,12]. Studies consistently highlight its effectiveness; for example, students using the Anatomage Table have been shown to perform up to 27% better than those relying solely on traditional methods [5].

1.3.Pedagogical Significance and Educational Applications

The Anatomage Table Classic, the flagship model, is built from frozen cadaveric slices reconstructed into ultra-high-resolution, full-body 3D models. It includes five complete cadavers (three male, two female), over 2,950 labeled anatomical structures, 1,100 histology slides, and 1,500 radiological cases. Its interactive functions support virtual dissection, annotations, quizzes, curriculum integration, and physiology simulations such as cardiac motion and pregnancy [13]. The device itself features an 84-inch, life-sized, multi-touch display that integrates smoothly with institutional networks and teaching systems. Beyond medicine, the Anatomage Table is also widely used in dentistry, nursing, radiology, physiotherapy, ophthalmology, and even veterinary sciences, underscoring its versatility in interdisciplinary education [14, 15]. The Anatomage Table promotes active, student-centered learning by encouraging self-directed study, collaborative engagement, and repeated exploration of anatomical structures. Evidence highlights its effectiveness in strengthening spatial understanding, supporting clinical integration, and fostering critical thinking [16, 17]. From an institutional perspective, adoption of the Anatomage Table offers practical advantages: it reduces recurring expenses tied to cadaver procurement and maintenance, eliminates exposure to hazardous chemicals, and enhances a university’s reputation as a leader in digital innovation [18, 19]. Recent studies further demonstrate its impact across diverse educational settings. At the University of Gondar in Ethiopia, medical students reported notable improvements in comprehension and satisfaction when the Anatomage Table was introduced into practical sessions, with 80.9% expressing strong approval of its educational value [13]. In India, a quasi-experimental study found that physiotherapy students learning neuroanatomy with the Anatomage Table significantly outperformed peers who relied solely on cadaveric dissection [20]. Similar findings from Rwanda and Ghana confirm its role as a powerful supplement to traditional methods, enhancing engagement, knowledge retention, and academic performance [21, 22]. A growing body of research underscores the educational value of the Anatomage Table. At the University of Gondar in Ethiopia, a cross-sectional study reported that 80.9% of medical students expressed high satisfaction with the platform, noting better comprehension of topographical relationships, improved visualization of body structures from multiple perspectives, and enhanced opportunities for collaborative learning [13]. In India, a quasi-experimental study by Patnaik *et al* demonstrated that physiotherapy students taught neuroanatomy using the Anatomage Table achieved significantly higher post-test scores than those relying solely on cadaveric dissection. Additional evidence indicates that virtual dissection tables, particularly when integrated with cadaver-specific CT scans, can improve learning outcomes by as much as 27% as demonstrated in Figure 1and 2 [5, 6].

Figure 1: Horizontal Anatomage Table Classic v8.0 (adopted from Anatomage Official Website: https://anatomage.com/table).

Figure 2: Teaching Ssession on Anatomage Table (Adopted from Patnaik etal, 2024).

1.4. Theoretical Foundations of Virtual Dissection in Anatomy Education

The integration of virtual dissection technologies such as the Anatomage Inc. Anatomage Table into anatomy education is grounded in established educational and cognitive learning theories. Modern medical education increasingly emphasizes constructivist and student-centered learning approaches, where learners actively construct knowledge through interaction, exploration, and reflection rather than passive reception. From a constructivist perspective, virtual dissection supports experiential learning by allowing students to manipulate anatomical structures, rotate three-dimensional models, and explore spatial relationships in real time. This aligns with Kolb's experiential learning cycle, where concrete experience and active experimentation reinforce conceptual understanding. Unlike static textbooks or two-dimensional atlases, interactive 3D models facilitate deeper cognitive processing. Cognitive Load Theory further supports the educational value of virtual dissection. Complex anatomical relationships often impose high intrinsic cognitive load on learners. By enabling layered visualization, zooming, isolation of structures, and stepwise dissection, the Anatomage Table reduces extraneous cognitive load and enhances germane processing, thereby improving knowledge retention and transfer to clinical contexts. Dual Coding Theory also provides a theoretical explanation for improved learning outcomes observed with virtual platforms. When students engage with synchronized visual (3D models, radiological images) and verbal (labels, annotations, instructor explanations) inputs, they create multiple memory pathways. Research in anatomy education demonstrates that three-dimensional visualization significantly improves spatial reasoning compared to 2D learning resources [6]. Additionally, multimedia learning principles suggest that interactive digital environments enhance motivation and engagement. The Anatomage Table fosters self-directed learning, collaborative group discussion, and repeated practice, all of which are critical for mastery of anatomical knowledge. Studies have shown that such multimodal exposure improves long-term retention and clinical application [10, 32]. Therefore, the theoretical framework supporting virtual dissection underscores its role not merely as a technological innovation but as a pedagogically sound enhancement to traditional cadaver-based anatomy education.

1.5.Advantages of Virtual Dissection over Traditional Methods

While cadaveric dissection remains the gold standard for tactile and experiential learning, virtual dissection platforms provide several practical and pedagogical advantages that address longstanding challenges in anatomy education.

1.5.1. Enhanced Spatial Visualization

Virtual dissection enables students to view anatomical structures in multiple planes—axial, sagittal, and coronal—and to rotate models freely in three dimensions. This dynamic visualization strengthens spatial cognition and improves understanding of anatomical relationships, particularly in complex regions such as the head, neck, and neuroanatomy. Comparative studies report significant improvements in post-test performance among students using the Anatomage Table [20, 32].

1.5.2. Repetition without Resource Limitation

Unlike cadaveric specimens, which are finite and susceptible to degradation, the Anatomage Table allows unlimited repetition of dissections. Structures can be removed, restored, and re-examined repeatedly without damage. This feature supports mastery learning and accommodates diverse learning speeds.

1.5.3. Safety and Ethical Advantages

Traditional dissection laboratories involve exposure to formalin and other chemical preservatives, which may cause respiratory irritation and long-term health concerns. Virtual dissection eliminates these risks. It also reduces ethical and cultural challenges associated with cadaver procurement, which remain significant barriers in many regions [8].

1.5.4. Integration with Radiology and Clinical Imaging

The Anatomage Table incorporates CT, MRI, and other radiological datasets, bridging the gap between gross anatomy and clinical application. This integration enhances early clinical reasoning skills and familiarizes students with imaging modalities essential for modern practice. Such features are not readily achievable with conventional cadaveric dissection alone.

1.5.5. Time and Cost Efficiency

Although the initial acquisition cost is high (approximately USD 85,000), long-term institutional benefits may include reduced expenditure on cadaver procurement, embalming, storage, and laboratory maintenance. Several studies report that students perceive virtual dissection as more time-efficient compared to traditional laboratory sessions [33]. During the COVID-19 pandemic, virtual platforms ensured continuity of anatomy instruction when access to dissection laboratories was restricted. Institutions that had integrated the Anatomage Table maintained instructional quality and student engagement despite physical distancing measures [18].

1.5.6. Hardware Specifications

The main features and details of Hardware Specifications of Anatomage Table Classic v8.0 is summarized in Table 1.

Table 1: Main features and details of Hardware Specifications of Anatomage Table Classic v8.0 (adopted from Anatomage Official Website: https://anatomage.com/table).

Category	Specification
Product Name	Anatomage Table Classic v8.0
Display Size	84″ total diagonal multi-touch screen (two 46″ panels forming ~84″)
Display Type	High-definition multi-touch screen with tempered glass overlay
Display Resolution	Not officially published on site (typically Full HD panels in older datasheets)
Dimensions (L×H×W)	218 cm × 89 cm × 71 cm (≈ 86″ × 35″ × 28″)
Weight	≈ 111 kg (245 lbs)
Touch Technology	Intuitive multi-touch (multi-point) surface; supports gestures (pinch/rotate/zoom)
Connectivity Ports	HDMI ports (for projector/external displays), USB ports, Ethernet (RJ45) network capability
Network Support	Ethernet (RJ45) for internet/network connection
External Display Support	Yes – connect to projectors or external monitors via HDMI
Power Supply	Standard AC input (details vary by region; typical ~100-250 V, 50/60 Hz) *general table spec inferred*
Content Compatibility	Real human anatomy content, DICOM medical imaging, quiz and teaching tools (software features)
Country of Hardware Design / Manufacturing	Patented hardware designed & made in the United States
Usage Orientation	Horizontal (flat anatomy table configuration)
Typical Installation	Classroom, lab, lecture theatre, clinical training spaces (hardware sits on floor)

1.6. Integration into Modern Anatomy Curricula

Gross anatomy remains an essential foundation for clinical practice [23]. Yet, limited cadaver availability and growing student cohorts continue to strain traditional dissection-based approaches [24]. Virtual dissection platforms offer a realistic and repeatable alternative, allowing students to study both normal and pathological anatomy without the physical and logistical barriers of cadaver use. Evidence shows that these tools foster active, student-centered learning, strengthen knowledge retention, and effectively complement conventional teaching methods [25, 26]. In particular, integrating the Anatomage Table into anatomy practical sessions has been shown to enhance student preparedness for clinical training while maintaining educational quality and addressing ethical as well as logistical challenges as presented in Table 2 [13.20].

Table 2: Distribution of male and female students' responses on the use of the Anatomage table as a teaching method, University of Gondar, Ethiopia [adopted from 13], n = 89.

Items	Male					Female				
	SA	A	N	DA	SDA	SA	A	N	DA	SDA
Overall satisfaction with Anatomage	37	7	5	2	0	21	6	4	6	0
Helped me to understand the topic better	11	40	0	0	0	8	30	0	0	0
Developed deeper understanding along with dissection	16	35	0	0	0	13	25	0	0	0
Helped me understand different parts of the body	20	31	0	0	0	20	18	0	0	0
Helped me visualize relative sizes of different parts	17	27	0	3	4	6	28	3	1	0
Helped me understand relationships between body parts	8	36	0	4	3	20	14	0	4	0
I enjoyed the process of using Anatomage	14	37	0	0	0	8	24	0	6	0
Enhanced my learning experience and interest	24	27	0	0	0	12	26	0	0	0
Took less time than traditional dissection	16	28	2	5	0	9	20	8	1	0

Note: Strongly Agree (SA), Agree (A), Neutral (N= neither Agree nor Disagree), Disagree (DA), Strongly Disagree (SDA).

2. Objectives of the Review

2.1. General Objective

- To synthesize and critically evaluate existing evidence on the efficacy, implementation, and student perceptions of the Anatomage Table in anatomy education, particularly its role as a complementary tool to cadaveric dissection.

2.2. Specific Objectives

- To assess learning outcomes by examining the impact of the Anatomage Table on students' spatial understanding, knowledge retention, and academic performance.
- To evaluate learner experience, including student satisfaction, engagement, and perceived utility across diverse educational settings.
- To compare pedagogical effectiveness of Anatomage-assisted instruction with traditional cadaveric dissection and other teaching approaches.
- To identify practical considerations, such as cost-effectiveness, accessibility, training requirements, and technological barriers to implementation.
- To examine integration strategies of the Anatomage Table into curricula and its contribution to blended and multimodal learning approaches.
- To provide evidence-based recommendations for educators, institutions, and policymakers regarding the effective and sustainable adoption of the Anatomage Table in health sciences education.

3. Literature Review of Published Research Articles

3.1. Anatomage Table: Features and Applications

The Anatomage Table, developed by Anatomage Inc. in partnership with Stanford Clinical Anatomy, is a life-sized 3D virtual dissection platform. It incorporates datasets from CT, MRI, X-ray, and ultrasound imaging, including contributions from the Visible Human and Visible Korean projects [12, 27]. Its interactive features allow users to perform layered visualization, explore cross-sections, rotate models, and repeat dissections as often as needed. The platform includes both male and female cadavers, along with an extensive library of histology and pathology resources. Beyond its central role in anatomy education, the Anatomage Table has also been adopted in radiology, surgical planning, pathology, and biomedical research [13, 28].

3.2. Educational Value of the Anatomage Table

Research consistently demonstrates that the Anatomage Table enhances cognitive and spatial learning, deepens understanding of anatomical relationships, and supports the development of clinical reasoning skills [10]. It also provides a safer learning environment by removing risks associated with chemicals and sharps, while fostering active participation and collaborative learning [28, 29]. However, despite these advantages in visualization and knowledge retention, the platform cannot replicate the tactile and motor skills acquired through cadaveric dissection. Rather, it serves most effectively as a complementary tool, bridging traditional methods with technology-enhanced approaches to anatomy education [30, 31].

3.3.Evidence from Comparative Studies

Several comparative studies have demonstrated the positive impact of the Anatomage Table on learning outcomes. For example, Patnaik et al reported that physiotherapy students trained with the Anatomage Table achieved significantly higher scores in neuroanatomy assessments compared to those taught using cadavers. Boscolo-Berto et al. [32] found that virtual dissection notably enhanced medical students' comprehension of 2D–3D anatomical relationships. At the University of Rwanda, [21] observed improvements of 48.3% in visualization, 56.8% in relational understanding, and 60.2% in overall anatomical knowledge. Supporting these findings, a systematic review of 24 studies confirmed that integrating the Anatomage Table enhances course performance, deepens understanding of complex structures, and strengthens clinical application, particularly in surgical planning [10].

3.4.Global Adoption and Challenges

Despite its demonstrated potential, adoption of the Anatomage Table remains uneven across the globe. In Africa, a survey by Owolabi et al. [33] of 79 anatomy educators across ten countries revealed that only 20% had experience using the platform, though over 90% expressed interest in integrating it into their programs. Respondents highlighted advantages such as ethical acceptability, realistic visualization, and alignment with global trends in digital education. Yet significant barriers persist, including the high acquisition cost around USD 85,000 along with the need for faculty training and adequate infrastructure [34]. These challenges emphasize the importance of developing resource-sharing strategies and fostering institutional collaborations to broaden access to such innovative tools.

3.5.Future Directions

The Anatomage Table reflects and reinforces broader trends in digital and immersive learning. Looking ahead, developments are likely to include integration with augmented and virtual reality, robotics-assisted training, and artificial intelligence driven feedback systems [35]. Expanding its use in resource-limited settings will depend on strategies to reduce costs, establish faculty training programs, and foster regional partnerships. Student-led initiatives also highlight the platform's adaptability, with learners creating curriculum-aligned modules that enhance motivation, knowledge retention, and exam performance [35].

4. RESULTS AND DISCUSSION

The survey on the Anatomage Table revealed varied levels of exposure, usage, and perceptions among respondents. Over half (54.4%) had seen the Anatomage Table, yet only 20.3% had used it in an educational role, and a mere 3.8% had used it as learners, with 96.2% reporting no direct learning experience with the platform. Self-rated mastery was generally low: only 6.3% considered themselves highly proficient, and just 17.7% had received formal training. Interest in learning about the Anatomage Table was high, with over 90% expressing curiosity and willingness to use it. Prior exposure came mainly through reading (77.2%) or watching videos (69.6%). Respondents largely viewed the Anatomage Table as a useful and innovative teaching tool, especially for enhancing visualization and advancing medical education, with strong agreement ranging between 48.1% and 64.6%. Institutional ownership, however, was limited (24.1%), although satisfaction among existing users was high (85.1%). While the Anatomage Table was widely recognized as an effective classroom aid (76%), it was less favored as a full substitute for cadaver dissection or anatomical specimens, with 89.9% agreeing it is best suited as a complementary tool. It was perceived as most effective in teaching Gross Anatomy and Clinical Anatomy, moderately effective for Histology, Embryology, and Genetics, and particularly impactful in enhancing cognitive and affective learning domains. Key factors supporting its acceptance included its ability to enrich learning, provide life-like 3D visualization, embrace technological advancement, and offer ethical advantages. Respondents primarily saw the Anatomage Table as a self-directed learning aid and a valuable supplement to traditional anatomy education as shown in Table 3 [20].

Table 3: Survey Analysis of Exposure, Perceived Usefulness, Institutional Support, and Effectiveness of the Anatomage Table in Anatomy Education (adopted from [20]).

Category	Details and Responses	Percentage
Exposure to the Anatomage Table	Seen Anatomage Table	54.4%
	Used as educator	20.3%
	Used as learner	3.8%
	Never used as learner	96.2%
Self-rated mastery of Anatomage Table use	High	6.3%
	Average	12%
	Low	6%
Interest in Learning About the Anatomage Table	Read about Anatomage Table	77.2%
	Watched video	69.6%
	Interested in learning more	91.1%
	Looking forward to use	83.5%
	Formal training received	17.7%
Perceived Usefulness of the Anatomage Table	Useful for teaching health students (SA)	54.4%
	Useful for teaching health students (A)	27.8%
	Innovative digital tool (SA)	64.6%
	Innovative digital tool (A)	24%
	Accurate anatomical information (SA)	34.2%
	Accurate anatomical information (A)	36.7%
	Advances medical education (SA)	48.1%
	Advances medical education (A)	38%
Institutional Ownership, Procurement Plans, and Support	Institutions with Anatomage Table	24.1%
	Satisfied with Anatomage Table	44.4%
	Very satisfied	40.7%
	Plans to procure Anatomage Table	32.9%
	Support digital tools	97.5%
Effectiveness as a Classroom Tool	Classroom teaching aid (SA)	36.7%
	Classroom teaching aid (A)	39.2%
	Substitute cadaver dissection (SDA)	32.9%
	Substitute cadaver dissection (DA)	27.8%
	Replace anatomy specimens (SDA)	25.3%
	Replace anatomy specimens (DA)	21.5%

	Replace models/posters (DA)	19%
	Replace models/posters (A)	29.1%
	Replace models/posters (SA)	22.8%
Effectiveness by Subject	Histology (N)	31.6%
	Histology (A)	26.6%
	Histology (SA)	21.5%
	Embryology (N)	34.2%
	Embryology (A)	29.1%
	Embryology (SA)	27.8%
	Genetics (N)	35.4%
	Gross Anatomy (A)	45.6%
	Gross Anatomy (SA)	41.8%
	Clinical Anatomy (A)	30.4%
	Clinical Anatomy (SA)	36.7%
Effectiveness Across Learning Domains	Cognitive (N)	16.5%
	Affective (N)	29.1%
	Affective (A)	35.4%
	Affective (SA)	17.7%
	Psychomotor (N)	39.2%
	Psychomotor (A)	32.9%
	Psychomotor (SA)	11.4%
Factors Supporting Acceptance of Anatomage Table Technology	Enhances learning and stimulates interest	96.2–98.7%
	Embraces global technological culture	87.3%
	3D life-like visualization	88.6%
	Reduces health risks	64.6%
	Cost-effective over time	57%
	Minimal ethical/cultural concerns	75.9%
	Technologically flexible	59.5%
	User-friendly compared to cadavers	70.9%
Contexts for Anatomage Table Use	Could replace cadaver-based learning	44.3%
	Favored as a complementary tool	89.9%
	Viewed as a good classroom aid	91.1%
	Self-help learning device	92.4%

	Useful for teaching medical science content	86.1%

A growing body of research highlights the Anatomage Table as an innovative and transformative tool in anatomy education. Studies consistently show that it enhances spatial perception, supports interactive 3D learning, fosters both collaborative and independent study, and improves student engagement and performance [3, 27, 36]. Its unique capabilities such as undoing mistakes, multi-plane visualization, and eliminating exposure to sharps and chemical preservatives make it a valuable addition to the anatomy learning environment [8, 12].

While widely recognized as an effective complementary resource, research confirms that the Anatomage Table cannot fully replace cadaveric dissection, due to limitations such as a reduced multisensory experience and less representation of anatomical variation [37, 38]. It is particularly effective in teaching gross anatomy and clinical applications and has proven especially valuable in maintaining learning continuity during the disruptions caused by the COVID-19 pandemic [39, 40]. Overall, the literature positions the Anatomage Table as a powerful adjunct to traditional anatomy teaching, enriching the learning experience while preserving cadaver-based dissection as an essential component of medical education as summarized in Table 4.

Table 4: **Summary of Key Research Findings on the Anatomage Table in Anatomy Education**

Author(s)	Title	Year	Key Results
Patra A et al.	Integration of innovative educational technologies in anatomy teaching: new normal in anatomy education	2022	Undo mistakes in virtual dissection; facilitated anatomy teaching without cadavers during COVID-19; realistic gross/regional anatomy images from digital tracing of non-chemically treated specimens.
Onigbinde OA et al.	The place of cadaveric dissection in post-COVID-19 anatomy education	2021	Allows rotation, expansion, minimization of structures; no sharps exposure; avoids chemical discomforts; lacks emotional engagement of real cadavers.
Raja BS et al.	Anatomage the virtual dissection tool and its uses: A narrative review	2022	Useful diagnostic and planning tool; enhances curriculum; addresses cadaveric dissection limitations.
Tenaw B	Teaching gross anatomy:	2020	Improves spatial perception; allows 3D

	Anatomage table as an innovative line of attack		viewing; both genders available; supports collaborative and independent learning; no sharps or chemical exposure; minimal space requirements.
Martín JG et al.	Possibilities for the use of Anatomage Table in teaching and learning anatomy	2018	Allows dissection in any direction, viewing structures in three planes; avoids sharps exposure and chemical discomforts; requires no special embalming facilities.
Alasmari WA	Medical students' feedback of applying the virtual dissection table (Anatomage) in learning anatomy	2021	Majority supplements cadaveric dissection with Anatomage Table; improves anatomy learning; limitations include labeling errors and anatomical variation visualization.
Narnaware Y and Neumeier M	Use of a virtual human cadaver to improve knowledge of human anatomy in nursing students	2021	Revolutionizes visualization and virtual dissection; improves average class performance.
Bartoletti-Stella A et al.	Three-dimensional virtual anatomy as a new approach for medical students' learning	2021	Beneficial supplementary tool; enabled learning continuity during COVID-19; interactive zoom/rotation features.
Boscolo-Berto R et al.	The additional role of virtual to traditional dissection in teaching anatomy: a randomised controlled trial	2021	Improves student performance; serves as a valuable supplementary resource over textbook-only learning.
Brucoli M et al.	The potentialities of the Anatomage Table for head and neck pathology	2020	Improves understanding of normal/pathological anatomy; valuable for diagnosis, prognosis, and surgical education.
Said Ahmed MAA	Use of the Anatomage virtual table in medical education and as a diagnostic tool: an integrative review	2023	Improves visualization; increases class averages; recommends as complementary tool; cannot replace cadaveric dissection.
Allen MA et al.	Anatomage Table 6	2019	Supports independent learning; interactive features valuable; lacks

			multisensory experience; unrealistic smaller structure detail; requires prior anatomical knowledge.
Baratz G et al.	Evaluating the Anatomage Table compared to cadaveric dissection as a learning modality for gross anatomy	2019	Students value Anatomage Table as supplementary; efficient retention for certain anatomical regions; comparable outcomes for musculoskeletal anatomy; no variation in performance with different modalities.
Bhadoria P and Modi K	Virtual dissection – as a new teaching tool	2021	Enhances relationship understanding; allows 3D presentation; improves spatial perception; offers interactive control of learning.
Bin Abdulrahman KA et al.	Students' perceptions after exposure to different anatomy teaching strategies	2021	Allows multi-view observation; undo mistakes; supports collaborative learning; recommends Anatomage Table as complementary resource.
Afsharpour S et al.	Analysis of immediate student outcomes following a change in gross anatomy laboratory teaching methodology	2018	Color-coded images; undo mistakes feature improves learning experience.
Bork F et al.	The benefits of an augmented reality magic mirror system for integrated radiology teaching in gross anatomy	2019	Supports anatomy learning; improves scores; complements rather than replaces cadaver-based learning.
Chytas D et al.	Do virtual dissection tables add benefit to cadaver-based anatomy education? An evaluation	2022	Recommends Anatomage Table as supplementary tool; improves student engagement and understanding.
Owolabi J et al.	African Medical Educators and Anatomy Teachers' Perceptions and Acceptance of the Anatomage Table as an EdTech and Innovation: A Qualitative Study	2022	Professors support complementary use of AT; retain cadaver dissection as core method; positive perceptions toward Anatomage Table adoption.

Kar R et al.	Health Professions Student Perceptions of the Anatomage Virtual Dissection Table and Digital Technology	2020	Students prefer cadaveric dissection; Anatomage Table should not be sole teaching method.

Survey results reveal strong support for integrating the Anatomage Table into the curriculum, with 90% of participants and 86% of non-participants expressing agreement. Participants reported a notably higher motivation to learn anatomy when using the Anatomage Table (80%) compared to non-participants (50%). However, views on whether it is superior to traditional teaching methods were more mixed: 55% of participants agreed, while only 41% of non-participants did, with a substantial portion remaining neutral or disagreeing. These findings suggest that although both groups recognize the value of the Anatomage Table in anatomy education, direct hands-on experience significantly enhances motivation and appreciation for its educational benefits as illustrated in Table 5 [33].

Table 5: Perceptions of the Anatomage Table among Participants and Non-Participants (adopted from [33]).

Statement	Group	Strongly Agree	Somewhat Agree	Neither Agree/ Disagree	Somewhat Disagree	Strongly Disagree	Total Agree
Anatomage table should be included in the curriculum	Participants	45%	45%	10%	0%	0%	90%
	Non-Participants	18%	68%	14%	0%	0%	86%
Anatomage table is superior to traditional teaching methods	Participants	5%	50%	30%	15%	0%	55%
	Non-Participants	0%	41%	41%	18%	0%	41%
The table motivates me to learn anatomy	Participants	40%	40%	10%	5%	5%	80%
	Non-Participants	9%	41%	36%	14%	0%	50%

Survey findings indicate that the Anatomage Table has a positive impact on anatomy learning for both participants and non-participants, with stronger agreement among those who had direct exposure. Among participants, 85% agreed that the Anatomage Table improved their learning of bones, and 80% said the same for muscles, compared to 64% agreement among non-participants for both areas. Contextualizing anatomical structures received near-universal endorsement, with 100% of participants and 95% of non-participants recognizing its value. In terms of exam preparation, 70% of participants believed the Anatomage Table supported their success, compared with 50% of non-participants. These results suggest that direct hands-on interaction with the Anatomage Table significantly enhances perceived learning benefits, especially in understanding anatomical structures and improving practical exam performance as outlined in Table 6 [3].

Table 6: Perceived Impact of the Anatomage Table on Anatomy Learning Outcomes *(adopted from [3]).*

Statement	Group	Strongly Agree	Somewhat Agree	Neither Agree/ Disagree	Somewhat Disagree	Strongly Disagree	Total Agree
Helped me learn bones	Participants	55%	30%	15%	0%	0%	85%
	Non-Participants	27%	36%	23%	9%	5%	64%
Helped me learn muscles	Participants	45%	35%	20%	0%	0%	80%
	Non-Participants	36%	27%	23%	14%	0%	64%
Helped contextualize structures	Participants	60%	40%	0%	0%	0%	100%
	Non-Participants	45%	50%	5%	0%	0%	95%
Helped me succeed on exams	Participants	25%	45%	20%	10%	0%	70%
	Non-Participants	14%	36%	41%	0%	9%	50%

Medical education has undergone significant transformation in recent years, driven largely by rapid technological advances, and anatomy teaching has evolved accordingly. Among these innovations, the Anatomage Table has emerged as a powerful educational tool, offering interactive 3D visualization that enhances anatomical understanding beyond the limits of traditional cadaveric methods [3, 15]. By allowing learners to explore structures in multiple planes, rotate and scale models, and reverse dissection steps, the Anatomage Table fosters active engagement and deeper comprehension [41]. Research suggests that the Anatomage Table is most effective when used as a complementary resource rather than a complete replacement for cadaveric dissection. It addresses key limitations such as ethical concerns, exposure to sharps, and space constraints while enriching spatial and functional understanding [37, 42, 43]. Studies at the University of Gondar and the University of Rwanda have confirmed high levels of student satisfaction, improved visualization of anatomical structures, and increased motivation to learn when the Anatomage Table is incorporated into the curriculum [20, 21]. Comparative evidence shows that students using the Anatomage Table achieve higher post-test scores and demonstrate better knowledge retention than those relying solely on traditional methods [32, 28, 44]. Importantly, learners value its ability to contextualize anatomical relationships and accelerate learning while accommodating diverse learning styles [45]. While the Anatomage Table cannot replicate the tactile and multisensory experience of cadaveric dissection, it offers a safe, flexible, and interactive platform that complements traditional anatomy teaching. A multimodal approach combining virtual dissection with cadaveric practice maximizes educational outcomes by enhancing cognitive skills, spatial awareness, and clinical readiness [20, 32]. In this way, the integration of the Anatomage Table represents a significant step toward modernizing anatomy education while preserving the essential value of hands-on dissection as detailed in Table 7.

Table 7: Overall Impact of the Anatomage Table on Anatomy Learning Among Medical and Dental Surgery Students adopted from [21], n= 118.

Category	Strongly Agree (%)	Agree (%)	Neutral (%)	Disagree (%)	Strongly Disagree (%)
Overall satisfaction	44.9	49.2	–	–	–
Positive view as a teaching method	60.2	38.1	–	–	–
Improved understanding of anatomy topics	62.7	29.7	–	–	–
Deepened understanding when combined with cadaveric dissection	62.7	34.7	–	–	–
Useful for identifying body parts	48.3	36.4	–	–	–
Helped visualize relative sizes	56.8	–	–	–	–
Improved understanding of anatomical relationships	44.9	38.1	–	–	–
Enjoyed using Anatomage Table	54.2	41.5	–	–	–
Enhanced interest in learning	46.6	29.7	–	11	–
Efficiency – requires less time than traditional dissection	67.8	28.8	–	–	–

Support for future use in routine teaching	–	–	–	–	almost all students supported

Advances in science and technology are reshaping anatomy education, with the Anatomage Table increasingly embraced as a valuable complement to traditional cadaveric dissection [22]. Evidence from the University of Rwanda shows that its integration significantly enhances anatomical comprehension: 60.2% of students reported improved understanding, and 62.7% strongly agreed that combining it with dissection deepened their learning [10]. These findings align with earlier research advocating for multimodal teaching approaches, as no single method can fully address the complexities of anatomy education [46, 47]. Students reported enhanced understanding of anatomical structures (62.7%) and relationships (56.8%), with 44.9% expressing satisfaction and enjoyment while using the Anatomage Table. Nearly half (46.6%) perceived it as a more time-efficient alternative to traditional dissection, highlighting its value in modern curricula [33]. A majority (67.8%) recommended its routine integration, reflecting a global trend toward blending digital tools with conventional dissection methods [22]. However, limitations such as restricted access and insufficient user training underscore the need for institutional support and infrastructure to maximize its benefits. While cadaveric dissection remains indispensable for tactile and experiential learning, integrating the Anatomage Table offers significant advantages enhanced visualization, deeper engagement, and greater efficiency. A hybrid approach that combines both methods provides a robust, learner-centered strategy, aligning anatomy education with contemporary pedagogical standards as indicated in Table 8.

Table 8: Anatomage virtual dissection versus traditional human body dissection in anatomy pedagogy: insights from Ghanaian medical students (adopted from [22]).

Variable / Outcome	N=	Percentage	95% Confidence Interval
Participated in human body dissection	295	99.4	97.3 – 99.9
Experience with human dissection: Positive	275	93.2	–
Experience with human dissection: Poor	20	6.8	–
Would participate in dissection again	223	75.1	69.7 – 79.8
Unwilling to participate again	74	24.9	20.2 – 30.3
Used Anatomage Table	205	69.0	69.7 – 74.2
Not used Anatomage Table	92	31.0	25.8 – 36.6

Agreed Anatomage is easier than traditional dissection	140	68.0	60.8 – 74.0
Disagreed Anatomage is easier than traditional dissection	19	9.4	–
Limitations – inadequate operational skills	105	51.0	48.9 – 53.4
Limitations – limited accessibility	80	39.0	35.2 – 42.3
Agreed virtual dissection positively influenced learning	137	66.8	59.9 – 73.1
Disagreed virtual dissection positively influenced learning	13	6.6	–
Discouraged replacing traditional dissection completely	180	87.9	82.3 – 91.8

This review highlights the growing importance of the Anatomage Table as a valuable supplement in anatomy education. While cadaveric dissection remains the gold standard for tactile and three-dimensional learning, virtual dissection using the Anatomage Table is increasingly recognized as an effective complement, enhancing understanding of anatomical structures and spatial relationships [33, 10]. Its advantages including multiplanar visualization, interactive manipulation, and high-resolution imaging address some inherent limitations of cadaveric dissection, such as exposure to formalin, time constraints, and difficulty in identifying certain structures [6, 34]. Students, particularly the digitally native "joystick generation," value the interactive features of the Anatomage Table and often turn to other digital tools to supplement learning when access to the table is limited. Across Africa, there is growing enthusiasm for integrating educational technology, though challenges such as high costs, technical barriers, and the need for realistic simulation remain [48]. Importantly, educators stress that the Anatomage Table should serve as a complement not a replacement to cadaveric dissection, in order to preserve vital haptic, ethical, and professional skills. Generational differences among anatomists also influence its adoption, with younger faculty demonstrating greater technological agility and senior academics providing essential institutional support. Sustainable integration will require professional development, institutional commitment, and collaboration with educational technology developers. Performance studies confirm that the Anatomage Table can improve knowledge retention and exam performance in specific areas, particularly osteology, though its effectiveness depends on careful curriculum design. Ultimately, a blended approach that combines the Anatomage Table with cadaveric dissection offers the most effective pathway for modern, learner-centered anatomy education.

5. Challenge and Limitations

Despite its clear advantages, the Anatomage Table has notable limitations that must be acknowledged. Cadaveric dissection continues to provide an irreplaceable tactile and three-dimensional experience, allowing students to palpate structures, perform incisions, and appreciate anatomical variability skills that are critical for surgical competence and fine motor training, especially at the postgraduate level. For this reason, virtual dissection is best positioned as a complement to, rather than a replacement for, cadaver-based learning. Cost remains a significant barrier, with each Anatomage Table priced around USD 85,000, in addition to maintenance and upgrade expenses, restricting access in resource-limited settings. Technological disparities, including inadequate internet connectivity and limited device availability, further hinder equitable access. Faculty readiness presents another challenge, as many educators lack experience in integrating such technology into teaching. Students also face a learning curve navigating the platform, along with occasional technical issues and limited access outside scheduled session's factors that can reduce engagement and consistent use. Methodological limitations in Anatomage Table research such as small sample sizes, voluntary participation, reliance on self-reported outcomes, and cross-sectional study designs constrain the generalizability of findings and limit insight into long-term benefits. Another important pedagogical shortcoming is the lack of haptic feedback, which remains essential for deep anatomical understanding. These challenges highlight the need for a blended teaching approach that integrates cadaveric dissection with virtual tools like the Anatomage Table. Such integration offers a balanced, learner-centered strategy that maximizes educational outcomes while aligning anatomy education with the demands of modern medical training.

5. CONCLUSION

The Anatomage Table represents a significant advancement in anatomy education, merging authentic cadaveric data with interactive 3D visualization to create a dynamic, multidisciplinary learning platform. By addressing key limitations of traditional dissection including cadaver scarcity, formalin exposure, and restricted accessibility while enhancing spatial understanding, engagement, and knowledge retention, the Anatomage Table embodies the shift toward multimodal, technology-enhanced pedagogy. Evidence shows that the Anatomage Table significantly improves comprehension of complex anatomical structures and serves as a valuable complement to cadaver-based learning. While tactile dissection remains indispensable for developing practical skills, integrating the Anatomage Table fosters a blended approach that maximizes educational outcomes and aligns anatomy teaching with contemporary curricula. Both students and educators widely recognize the Anatomage Table as an effective and sustainable teaching resource, with applications extending into clinical and radiological training. Successful adoption, however, depends on robust faculty training, improved accessibility, and institutional investment. Prioritizing the integration of the Anatomage Table alongside traditional dissection offers a promising strategy to strengthen anatomy education especially in resource-limited settings and in the evolving post-pandemic landscape. Medical institutions should embrace a blended approach that integrates the Anatomage Table with traditional cadaveric dissection, supported by targeted faculty development and strategic infrastructure investment. This combination will ensure equitable access, enhance learning outcomes, and sustain the long-term impact of anatomy education.

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HUMAN AND ANIMAL RIGHTS

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