REVISTA OWL (*OWL Journal*)
www.revistaowl.com.br – ISSN: 2965-2634

COMPARATIVE ANALYSIS OF TEACHING RESOURCES IN PRACTICAL ANATOMY ASSESSMENTS: STUDENT PERFORMANCE

ANÁLISE COMPARATIVA DE RECURSOS DIDÁTICOS EM AVALIAÇÕES DE ANATOMIA PRÁTICA: DESEMPENHO DOS ESTUDANTES

DOI: 10.5281/zenodo.20079028

Edivaldo Xavier da Silva Júnior[1]

ABSTRACT

Human Anatomy represents a fundamental component of health sciences education, traditionally grounded in cadaver-based teaching. However, pedagogical and technological advancements have driven the incorporation of alternative instructional resources, highlighting the need for evidence regarding their effectiveness in student performance. This study aimed to analyze the performance of Physiotherapy students when exposed to different teaching resources in practical Human Anatomy assessments. An experimental, quantitative, and analytical study was conducted with 30 undergraduate students from a public state university. Five types of instructional resources were compared: cadaveric specimens, synthetic models, student-constructed models, three-dimensional software, and photocopied images, distributed across rotating stations. Student performance was assessed through the identification of anatomical structures, and scores were categorized into performance levels. The findings demonstrated a predominance of high achievement, with 60.0% of students classified as excellent and 33.3% as satisfactory. Interactive and three-dimensional resources, particularly digital software and student-constructed models, were more highly valued, whereas bidimensional materials showed high rejection rates. These results suggest that the integration of multiple instructional resources, combined with active methodologies and structured assessment, enhances meaningful

1 Docente do Curso de Fisioterapia da Universidade de Pernambuco, Campus Petrolina; Coordenador do Laboratório de Ensino e Pesquisa em Anatomia Humana (LABEPAH); e Integrante do Núcleo de Extensão e Pesquisa em História da Educação, Linguística e Literatura (NEPHEL) da Universidade de Pernambuco, Pernambuco, Brasil. E-mail: edivaldo.junior@upe.br

learning and academic performance in Anatomy. Therefore, hybrid pedagogical strategies emerge as effective approaches for optimizing teaching and learning processes in health education.

Keywords: Health Education. Active Learning. Competence-Based Education. Educational Techonology. Educational Measurement.

RESUMO

A Anatomia Humana constitui um eixo estruturante na formação em saúde, sendo seu ensino tradicionalmente centrado no uso de peças cadavéricas. Contudo, transformações pedagógicas e tecnológicas têm impulsionado a incorporação de recursos didáticos alternativos, demandando evidências quanto à sua efetividade no desempenho discente. O presente estudo teve como objetivo analisar o desempenho de estudantes de Fisioterapia frente à utilização de diferentes recursos didáticos em avaliações práticas de Anatomia Humana. Trata-se de um estudo experimental, de abordagem quantitativa e caráter analítico, realizado com 30 discentes de uma universidade pública estadual. Foram comparados cinco tipos de recursos: peças cadavéricas, modelos sintéticos, modelos confeccionados, softwares tridimensionais e imagens fotocopiadas, distribuídos em estações rotativas. O desempenho foi mensurado por meio da identificação de estruturas anatômicas, sendo os escores categorizados em níveis de desempenho. Os resultados evidenciaram predomínio de alto rendimento, com 60,0% dos estudantes classificados como excelentes e 33,3% como satisfatórios. Observou-se maior valorização de recursos interativos e tridimensionais, especialmente softwares digitais e modelos confeccionados, enquanto imagens bidimensionais apresentaram elevada rejeição. Conclui-se que a utilização integrada de múltiplos recursos didáticos, associada a metodologias ativas e avaliação estruturada, favorece a aprendizagem significativa e o desempenho acadêmico em Anatomia. Estratégias pedagógicas híbridas mostram-se, portanto, eficazes para o ensino em saúde.

Palavras-chave: Educação em Saúde. Aprendizagem Ativa. Ensino Baseado em Competências. Tecnologia Educacional. Avaliação Educacional.

INTRODUCTION

Human Anatomy constitutes one of the fundamental pillars of health sciences education, providing the essential structural basis for the integrated understanding of function, clinical practice, and pathological processes. Traditionally, its teaching has been grounded in descriptive approaches and the use of cadaveric specimens, which have long been regarded as the gold standard for anatomical learning. However, in recent decades, transformations in educational, technological, and ethical contexts have driven the reconfiguration of pedagogical practices in this field, demanding the adoption of more dynamic, integrative, and student-centered strategies.

Within this context, the teaching of Anatomy has faced significant challenges, including the reduction of curricular workload, the scarcity of cadaveric material, structural limitations of laboratory facilities, and inherent difficulties associated with the complexity of anatomical content. These factors are often linked to low levels of student motivation and engagement. Recent studies indicate that such challenges may compromise meaningful learning and the retention of anatomical knowledge, thereby reinforcing the need to revisit traditional teaching models (Estai & Bunt, 2016; Silva Júnior et al., 2025).

Concurrently, there has been a substantial expansion in the use of alternative educational resources, including synthetic models, student-constructed materials, three-dimensional digital technologies, as well as virtual and augmented reality, in addition to bidimensional resources such as atlases and photographic images. These tools have been increasingly incorporated to complement, and in some cases partially replace, cadaver-based teaching, aiming to enhance accessibility, interactivity, and alignment with contemporary learning profiles (Moraes, Schwingel, & Silva Júnior, 2016; Azer & Azer, 2016; Moro et al., 2017; Rodrigues & Silva Júnior, 2025; De Amorim et al., 2025).

Furthermore, active teaching–learning methodologies have gained prominence in health education by promoting student protagonism, fostering critical-reflective thinking, and strengthening the integration between theory and practice. Evidence suggests that student-centered approaches can enhance academic performance and support the construction of durable knowledge, particularly when associated with diversified educational resources (Freeman et al., 2014; Silva Júnior et al., 2026).

Despite these advances, the literature still presents heterogeneous findings regarding the comparative effectiveness of different teaching materials in Anatomy education, particularly concerning their direct impact on student performance in practical assessments. Although cadaver use remains highly valued, studies indicate that alternative resources can play a relevant complementary role; however, there is no consensus regarding the optimal combination of strategies for achieving superior educational outcomes (McMenamin et al., 2018; Lisboa et al., 2025).

In this context, a gap in the literature emerges regarding the comparative analysis of the effectiveness of different educational resources on academic performance in practical Human Anatomy assessments, particularly within health education settings in Brazil. Such investigation is especially relevant in light of the need to optimize pedagogical practices, considering both structural limitations and contemporary demands in professional training.

Therefore, the present study aims to analyze the performance of Physiotherapy students from a public state university when exposed to different teaching resources—including cadaveric material, synthetic models, student-constructed models, computer-based resources, and bidimensional images—in practical Human Anatomy assessments.

METODOLOGY

This study adopted an experimental design with a quantitative approach and an analytical focus, conducted in the Human Anatomy Laboratory of a public state university in Pernambuco, Brazil. The study design aimed to comparatively evaluate student performance in relation to different teaching resources employed in practical Human Anatomy assessments.

Participants were undergraduate Physiotherapy students who had previously completed and successfully passed the Human Anatomy course. Eligibility criteria included being enrolled in the Physiotherapy program, prior approval in the Human Anatomy course, and willingness to participate through the provision of written informed consent. Exclusion criteria comprised absence at any stage of data collection and incomplete completion of the assessment instruments.

Data collection involved five types of teaching resources available in the laboratory: human cadaveric specimens (dissected and prosected), synthetic anatomical models, student-constructed anatomical models, software featuring three-dimensional anatomical structures, and photocopied atlas images. These resources were distributed across 10 stations, organized into two rows (A and B), each containing the five types of teaching materials commonly used

in practical assessments of the discipline. The anatomical structures used in the evaluation were selected based on previously taught content and validated by three expert Anatomy faculty members to ensure content consistency and appropriateness for the participants' level of training.

The sample size was estimated based on a finite population of approximately 200 students enrolled in the program, considering a significance level of 5% ($\alpha = 0.05$), statistical power of 80% ($1–\beta = 0.80$), and a moderate effect size ($f = 0.25$) for comparisons among multiple groups. The calculation followed appropriate procedures for ANOVA, resulting in a minimum required sample of 28 participants. A total of 30 students were included, ensuring adequate statistical power for the proposed analyses.

Each station presented four previously selected and labeled anatomical structures, totaling 20 assessment items. Participants were allocated 2 minutes per station (30 seconds per structure) to individually identify the structures in a rotating system. The total score ranged from 0 to 20 correct responses and, based on previously established criteria in the literature (Soares et al., 2018), scores were categorized into four performance levels: 0–5 correct answers (unsatisfactory), 6–10 (moderate), 11–15 (satisfactory), and 16–20 (excellent), allowing for stratified analysis of student performance.

Quantitative data were analyzed using SPSS version 23.0 (IBM Corp., Armonk, NY, USA), adopting a significance level of 5% ($p < 0.05$). Descriptive statistics included means, standard deviations, medians, and interquartile ranges. Data normality was assessed using the Shapiro–Wilk test, and homogeneity of variances was evaluated using Levene's test.

Inferential analysis was performed using repeated-measures ANOVA to compare performance across the different teaching resources. When necessary, equivalent non-parametric tests (Friedman test) were applied, followed by Bonferroni post hoc tests for multiple comparisons.

The study was conducted in accordance with the ethical principles established by Brazilian National Health Council Resolution No. 466/2012. All participants provided written

informed consent. The research protocol was approved by the Research Ethics Committee of the University of Pernambuco under protocol number 1.374.415.

RESULTS AND DISCUSSION

The integrated analysis of the data revealed consistent patterns between students' perceptions of teaching resources and their performance in the practical Human Anatomy assessment. Regarding preference, three-dimensional visualization software was most frequently selected (40.0%), followed by student-constructed models (30.0%) and cadaveric specimens (23.3%). In contrast, photocopied images were not identified as the most effective method by any participant and, conversely, were the resource most frequently classified as least effective (43.3%). Notably, three-dimensional software also exhibited a considerable rate of rejection (23.3%), indicating variability in students' perceptions regarding its use (Tables 1 and 2).

Table 1. Distribution of teaching resources perceived as most effective by students (n = 30).

Teaching Resources	**n**	**%**	
Software (3D)	12	40,0	
Student-constructed models	9	30,0	
Cadaveric specimens	7	23,3	
Synthetic model	2	6,7	
Photocopied images	0	0,0	p = 0,237
Total	**30**	**100,0**	

Note: Data are presented as absolute (n) and relative (%) frequencies.

This pattern of acceptance and rejection suggests that students predominantly value resources that promote interactivity and three-dimensional visualization of anatomical structures, although the perceived effectiveness of these methods is not homogeneous. Studies such as those by Minouei et al. (2024) and Hammouda, Maoua, and Bouchahma (2025) indicate that digital technologies, including 3D software and virtual environments, can

enhance spatial understanding and academic performance in Anatomy, particularly when integrated into well-structured pedagogical strategies, as also supported by Odogwu et al. (2025). However, the presence of these resources among the most frequently rejected highlights that factors such as usability, technological familiarity, and instructional mediation directly influence their effectiveness in the learning process.

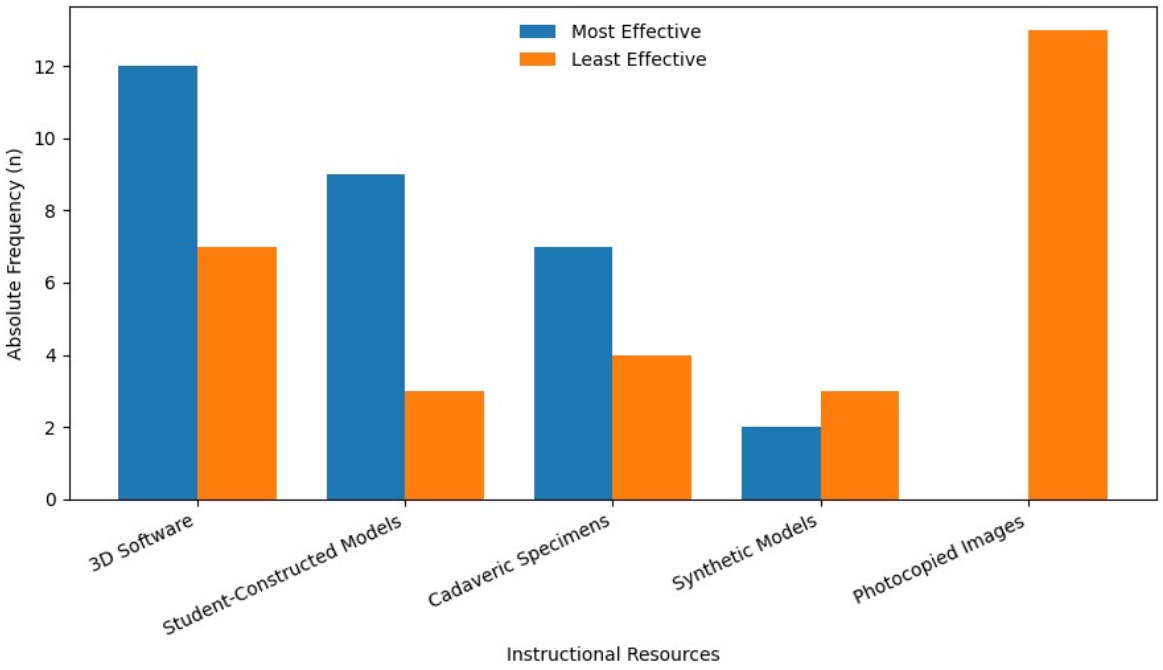
Table 2. Distribution of teaching resources perceived as least effective by students (n = 30).

Teaching Resources	**n**	**%**	
Photocopied images	13	43,3	
Software (3D)	7	23,3	
Cadaveric specimens	4	13,3	
Student-constructed models	3	10,0	p = 0,216
Synthetic model	3	10,0	
Total	**30**	**100,0**	

Student-constructed models demonstrated high acceptance and low rejection, standing out as a consistent teaching resource. This finding reinforces the role of active learning methodologies in health education, in which student engagement in the construction of knowledge promotes meaningful learning, enhances critical thinking, and improves knowledge retention (Saxena, Kulshreshtha, & Singh, 2024; Arráez-Aybar, 2025; Silva Júnior et al., 2026). Similarly, cadaveric specimens—traditionally regarded as the gold standard in anatomy education—exhibited a balanced pattern of acceptance and rejection, supporting their established role as an essential tool in anatomical teaching, particularly for the development of tactile skills and the understanding of structural variability, as emphasized by Silva Júnior (2019) and Alwis, Abeysuriya, and Salgado (2025).

Figure 1 illustrates the comparison between teaching resources perceived as most and least effective by students, highlighting greater acceptance of interactive methods and increased rejection of bidimensional resources.

Figure 1. Comparison between teaching resources perceived as most effective and least effective by students during a practical Human Anatomy assessment. Data are presented as absolute frequencies (n).



The analysis of student performance revealed a predominance of high achievement, with 60.0% of participants classified as excellent and 33.3% as satisfactory, while only 6.6% demonstrated moderate or unsatisfactory performance. This finding suggests that the assessment strategy adopted—based on rotating stations and multiple teaching resources—was effective in consolidating anatomical knowledge. Saxena, Kulshreshtha, and Singh (2024) and Rai et al. (2025) have demonstrated that structured assessments in the OSPE (Objective Structured Practical Examination) format enhance objectivity, reliability, and comprehensiveness in evaluating practical competencies, in addition to promoting improved

academic performance when compared to traditional methods, as observed in the present study (Table 3).

Table 3. Distribution of student performance in the practical Human Anatomy assessment (n = 30).

Score range	n	%	Performance level
0–5	1	3,3	Unsatisfactory
6–10	1	3,3	Moderate
11–15	10	33,3	Satisfactory
16–20	18	60,0	Excellent
Total	**30**	**100,0**	**—**

Note: Classification based on Soares et al. (2018).

When integrating the findings from the three tables, an indirect association emerges between the use of interactive methods and higher student performance. The resources most valued by students—such as three-dimensional software and student-constructed models—are aligned with pedagogical approaches that promote active and multimodal learning, which are recognized in the literature as more effective for Anatomy education, as demonstrated by Moro et al. (2017) and Kyaw et al. (2019). Conversely, the high rejection of photocopied images underscores the limitations of passive, bidimensional strategies, which exhibit a reduced capacity to foster spatial understanding and knowledge retention.

The simultaneous presence of three-dimensional software among both the most and least effective methods suggests heterogeneity in the learning experience, indicating that the mere introduction of technological tools does not guarantee improved educational outcomes. This finding highlights the need for appropriate pedagogical integration of such resources, taking into account students' profiles and instructional support, as emphasized in studies on digital health education by Radianti et al. (2020) and Kyaw et al. (2019). Furthermore, Adnan, Benson, and Xiao (2025) suggest that the positive impact of digital technologies in anatomy education depends not only on their availability but also on how effectively they are integrated into the pedagogical process. Similarly, Nikas et al. (2025) emphasize that

contemporary anatomy education has increasingly shifted toward hybrid models, integrating cadaveric material with digital technologies to optimize learning.

Additionally, the concentration of students within the higher performance categories may indicate the presence of a potential ceiling effect, thereby limiting the discriminative capacity of the assessment at higher levels of knowledge.

Taken together, the findings of the present study reinforce the importance of adopting hybrid pedagogical strategies in Anatomy education, integrating digital resources, physical models, and cadaveric material. Such a multimodal approach not only accommodates diverse cognitive needs among students but also enhances the teaching–learning process, contributing to the development of essential competencies in health education.

CONCLUSION

The present study demonstrated that the use of different teaching resources in practical Human Anatomy assessments promoted high student performance, with a predominance of satisfactory and excellent achievement levels. Interactive and three-dimensional resources, such as digital software and student-constructed models, were more highly valued, whereas bidimensional materials showed lower effectiveness.

These findings indicate that the combination of multiple teaching resources, associated with active methodologies and structured assessment, significantly contributes to the teaching–learning process in Anatomy. Therefore, hybrid pedagogical approaches represent an effective strategy to enhance academic performance and promote meaningful learning in health education.

REFERENCES

ALWIS, M. S. N.; ABEYSURIYA, V.; SALGADO, S. A Comparative Analysis of Cadaver and Virtual Dissection in Anatomy Education: Global Vs Sri Lanka. **South-East Asian Journal of Medical Education**, v. 19, n. 1, p. 3-12, 2025.

ARRÁEZ-AYBAR, L. A. Evolving anatomy education: bridging dissection, traditional methods, and technological innovation for clinical excellence. **Anatomia**, v. 4, n. 2, p. 9, 2025.

ATWA, H. S. *et al*. Implementing formative assessment in human anatomy practical sessions: medical students' perception and effect on final exam performance. **Advances in Medical Education and Practice**, p. 551-563, 2024.

AZER, S. A.; AZER, S. 3D anatomy models and impact on learning: a review of the quality of the literature. **Health Professions Education**, v. 2, n. 2, p. 80-98, 2016.

DE AMORIM, M. *et al*. Ensinar anatomia em tempos de escassez cadavérica: percepções e caminhos didáticos. **O Anatomista**, v. 4, p. 57-66, 2025.

ESTAI M.; STUART, B. Best teaching practices in anatomy education: a critical review. **Annals of Anatomy**, v. 208, p. 151-157, 2016.

FREEMAN, S. *et al*. Active learning increases student performance in science, engineering, and mathematics. **Proceedings of the National Academy of Sciences**, v. 111, n. 23, p. 8410-8415, 2014.

HAMMOUDA, S. B.; MAOUA, M.; BOUCHAHMA, M. The effectiveness of VR-based human anatomy simulation training for undergraduate medical students. **BMC Medical Education**, v. 25, n. 1, p. 816, 2025.

KYAW, B. M. *et al*. Virtual reality for health professions education: systematic review and meta-analysis by the digital health education collaboration. **Journal of Medical Internet Research**, v. 21, n. 1, p. e12959, 2019.

LISBOA, V. F. et al. Integração de recursos digitais ao ensino tradicional de Neuroanatomia: avaliação de uma metodologia híbrida e seus impactos aprendizagem discente. **O Anatomista**, v. 4, p. 68-78, 2025.

MCMENAMIN, P. G. et al. Do we really need cadavers anymore to learn anatomy in undergraduate medicine?. **Medical Teacher**, v. 40, n. 10, p. 1020-1029, 2018.

MINOUEI, M. A. et al. Effectiveness of virtual reality on medical students' academic achievement in anatomy: systematic review. **BMC Medical Education**, v. 24, n. 1, p. 1407, 2024.

MORAES, G. N. B.; SCHWINGEL, P. A.; SILVA JÚNIOR, E. X. Uso de roteiros didáticos e modelos anatômicos, alternativos, no ensino-aprendizagem nas aulas práticas de anatomia humana. **Revista Iberoamericana de Estudos em Educação**, v. 11, n.1, 2016.

MORO, C. et al. The effectiveness of virtual and augmented reality in health sciences and medical anatomy. **Anatomical Sciences Education**, v. 10, n. 6, p. 549-559, 2017.

NIKAS, D. *et al*. Virtual and Augmented Reality in Anatomy Education: Exploring New Horizons. **Acta Medica Academica**, v. 54, n. 2, p. 164-171, 2025.

NIU, S. *et al*. Enhancing anatomy education with virtual reality: integrating three-dimensional models for improved learning efficiency and student satisfaction. **Frontiers in medicine**, v. 12, p. 1555053, 2025.

ODOGWU, T. S. *et al*. Effect of virtual reality simulation on anatomy learning outcomes: a systematic review. **Cureus**, v. 17, n. 4, p. e81893, 2025.

RADIANTI, J. *et al*. A systematic review of immersive virtual reality applications for higher education: Design elements, lessons learned, and research agenda. **Computers & Education**, v. 147, p. 103778, 2020.

RAI, A. *et al*. Development Of Ospe Module In Anatomy For Phase I Medical Undergraduates. **The Review of Diabetic Studies**, v. 21, n. S9, p. 873-881, 2025.

RODRIGUES, V. A.; SILVA JÚNIOR, E. X. Importância da utilização das tecnologias digitais da informação e comunicação no ensino básico da anatomia humana. **O Anatomista**, v. 2, p. 42-49, 2025.

SAXENA, S.; KULSHRESHTHA, S.; SINGH, P. Evaluating OSPE as a Formative Assessment Tool for Medical Students. **Galician Medical Journal**, v. 31, n. 4, p. 1-7, 2024.

SILVA JÚNIOR, E. X. Advances and alternatives in human anatomy teaching: what next? **EC Clinical and Experimental Anatomy**, v. 2, n. 5, p. 171-174, 2019.

SILVA JÚNIOR, E. X. *et al*. Entre arte e ciência uso do teatro no ensino da neuroanatomia humana: relato de experiência. **O Anatomista**, v. 1, p. 67-78, 2026.

SILVA JÚNIOR, E. X. Métodos de ensino em anatomia humana: sugestões e propostas. **Arecê**, v. 7, n. 12, p. 1-29, 2025.

SOARES, B. O. et al. Are corpses the best method for practical anatomy assessment, according to health course students?. **Journal of Morphological Sciences**, v. 35, n. 01, p. 70-79, 2018.

SUNG, H. et al. Effectiveness of virtual reality in healthcare education: Systematic review and meta-analysis. **Sustainability**, v. 16, n. 19, p. 8520, 2024.

WOON, C. K. *et al*. The Utility of Anatomy Assessment in Preclinical Undergraduate Medical Curricula: A Scoping Review. **Clinical Anatomy**, v. 38, n. 5, p. 576-593, 2025.

Recebido em: 10/04/2026
Aprovado em: 23/04/2026
Publicado em: 08/05/2026