

Integrated pedagogical strategies in health sciences higher education: the influence of combining traditional teaching methods and three-dimensional technological resources on human anatomy learning ¹

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ABSTRACT

The advancement of digital technologies has expanded teaching and learning opportunities in higher education, particularly in visually complex fields such as Human Anatomy. This study compared the academic performance of health sciences students exposed to three pedagogical strategies in the discipline of Anatomical Bases of Organs and Systems: traditional teaching (TT), three-dimensional technological resources (TR), and traditional teaching combined with technological resources (TT+TR). Academic performance was assessed through the final course grade, composed of theoretical and practical examinations. Data were analyzed using one-way analysis of variance (ANOVA) followed by Tukey's test. The TT+TR group demonstrated superior performance compared with the TT and TR groups ($p < 0.001$), whereas TT and TR showed similar results. These findings suggest that integrating traditional and technological methodologies may enhance anatomical learning in health sciences higher education.

KEYWORDS: Higher education. Teaching methodologies. Educational technology. Human Anatomy. Learning.

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Estratégias pedagógicas integradas no ensino superior em saúde: influência da associação entre metodologias tradicionais e recursos tecnológicos tridimensionais na aprendizagem da Anatomia Humana

RESUMO

O avanço das tecnologias digitais tem ampliado as possibilidades de ensino e aprendizagem no ensino superior, especialmente em áreas de elevada complexidade visual, como a Anatomia Humana. Este estudo comparou o desempenho acadêmico de estudantes da área da saúde submetidos a três estratégias pedagógicas na disciplina de Bases Anatômicas de Órgãos e Sistemas: ensino tradicional (ET), recursos tecnológicos tridimensionais (RT) e ensino tradicional associado aos recursos tecnológicos (ET+RT). O desempenho foi avaliado pela nota final da disciplina, composta por avaliações teóricas e práticas. Os dados foram analisados por ANOVA de uma via, seguida do teste de Tukey. O grupo ET+RT apresentou médias superiores às observadas nos grupos ET e RT ($p < 0,001$), enquanto ET e RT apresentaram resultados semelhantes. Os achados sugerem que a utilização combinada de metodologias tradicionais e recursos tecnológicos esteve associada a melhor desempenho acadêmico nas turmas analisadas.

PALAVRAS-CHAVE: Ensino superior. Metodologias de ensino. Tecnologia educacional. Anatomia Humana. Aprendizagem.

Estrategias pedagógicas integradas en la educación superior en salud: influencia de la asociación entre metodologías tradicionales y recursos tecnológicos tridimensionales en el aprendizaje de la Anatomía Humana

RESUMEN

El avance de las tecnologías digitales ha ampliado las posibilidades de enseñanza y aprendizaje en la educación superior, especialmente en áreas de elevada complejidad visual, como la Anatomía Humana. Este estudio comparó el desempeño académico de estudiantes del área de la salud sometidos a tres estrategias pedagógicas en la asignatura Bases Anatômicas de Órganos y Sistemas: enseñanza tradicional (ET), recursos tecnológicos tridimensionales (RT) y enseñanza tradicional

asociada a recursos tecnológicos (ET+RT). El desempeño académico se evaluó mediante la calificación final de la asignatura, compuesta por evaluaciones teóricas y prácticas. Los datos se analizaron mediante análisis de varianza de una vía (ANOVA), seguido de la prueba de Tukey. El grupo ET+RT presentó un desempeño superior al de los grupos ET y RT ($p < 0,001$), mientras que ET y RT mostraron resultados similares. Los hallazgos sugieren que la integración de metodologías tradicionales y tecnológicas puede favorecer el aprendizaje anatómico en la educación superior en salud.

PALABRAS CLAVE: Educación superior. Metodologías de enseñanza. Tecnología educativa. Anatomía Humana. Aprendizaje.

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Introduction

Human Anatomy constitutes one of the fundamental pillars of health professions education, providing the structural foundation required to understand the physiological, pathophysiological, and clinical processes that underpin professional practice. Adequate anatomical knowledge is directly related to the development of clinical reasoning, the interpretation of diagnostic examinations, the safe performance of diagnostic and therapeutic procedures, and decision-making across different healthcare settings. Thus, anatomy education remains an essential component of undergraduate curricula in programs such as Physical Education, Physical Therapy, Psychology, Medicine, Nursing, and other health-related fields (Smith et al., 2016; Ghosh, 2017).

Despite its recognized importance, anatomy education faces significant challenges in the contemporary context of higher education. Over recent decades, several institutions have implemented curricular reforms that have resulted in reduced instructional time devoted to morphological disciplines, while simultaneously increasing the complexity of the content required for professional training. In parallel,

technological advances and changes in students' learning profiles have created a demand for pedagogical strategies capable of making the teaching and learning process more dynamic, interactive, and effective (Almen et al., 2025; Smith et al., 2016).

Historically, anatomy education has been based on traditional methodologies, including lectures, the use of anatomical atlases, observation of anatomical specimens, and, particularly, human cadaveric dissection. These approaches have made significant contributions to the establishment of anatomy as a scientific discipline and continue to be highly valued because they provide direct exposure to real anatomical structures and foster observational and professional skills relevant to health professions education (Ghosh, 2017; Ghosh et al., 2020). In addition, practical experience in anatomy laboratories promotes an understanding of human morphological variability and encourages ethical and professional reflection related to healthcare practice (Ghosh et al., 2019).

However, although traditional methods offer well-established pedagogical contributions, several limitations have been identified in the literature. These include difficulties associated with the three-dimensional visualization of anatomical structures, the availability of cadaveric material, the costs of maintaining specialized laboratories, and logistical constraints frequently encountered by higher education institutions (Keenan et al., 2019; Keenan et al., 2020; McMenamin et al., 2014). These challenges have stimulated the development and incorporation of technological resources capable of complementing or expanding the educational experiences provided to students.

In this context, there has been a substantial increase in the use of digital technologies in human anatomy education. Three-dimensional applications, interactive digital platforms, virtual models, three-dimensional printing, and virtual reality environments have been progressively incorporated into educational practices to promote active learning and improve the understanding of spatial anatomical relationships (McMenamin

et al., 2014; Organ et al., 2023). These tools allow students to explore anatomical structures from different perspectives, perform virtual manipulations, and review content independently, potentially increasing engagement and knowledge retention.

Several investigations have demonstrated promising outcomes associated with the use of these resources. Fonseca et al. (2022) observed that technology-supported learning strategies can improve academic performance in anatomy-related content when appropriately integrated into the educational process. Similarly, Fonseca et al. (2023) found that the use of immersive virtual environments facilitates anatomical understanding while optimizing the cognitive effort expended by students during learning. Additionally, studies involving three-dimensional printed models have demonstrated improvements in structural understanding and performance on anatomy assessments compared with conventional methods used in isolation (McMenamin et al., 2014; Lim et al., 2016).

Despite the benefits observed, the literature also suggests that technological resources should not be regarded as absolute substitutes for methodologies traditionally employed in anatomy education. Rather, recent evidence indicates that integrating different pedagogical strategies may produce better outcomes than those achieved through the isolated use of any single method (Martin, 2023; Organ & Comer, 2022; Almen et al., 2025). From this perspective, the concept of blended learning becomes particularly relevant, as it proposes combining traditional approaches with educational technologies to maximize the advantages of each resource while minimizing their limitations.

Anatomical learning strongly depends on the ability to construct complex mental three-dimensional representations and to integrate theoretical and practical information. Studies on spatial visualization have demonstrated that three-dimensional technologies significantly facilitate this process, particularly when used as a complement to in-person and laboratory-based activities (Keenan et al., 2020). Therefore, the integration

of lectures, practical activities, and interactive digital resources may represent a particularly effective strategy for promoting the acquisition and consolidation of anatomical knowledge.

Although interest in the use of educational technologies in anatomy has increased substantially in recent years, studies directly comparing the academic performance of students exposed exclusively to traditional teaching, exclusively to technological resources, or to a combination of these approaches remain relatively scarce, particularly within health-related undergraduate programs at Brazilian institutions. This gap limits the understanding of the actual pedagogical impact of different teaching methodologies and hinders evidence-based decision-making regarding curriculum planning and the adoption of new educational technologies.

Against this background, the present study aimed to compare the academic performance of students enrolled in health-related undergraduate programs who were exposed to three different human anatomy teaching strategies: traditional teaching, technological resources, and traditional teaching combined with technological resources. Based on the evidence previously reported in the literature, we hypothesized that the integration of traditional methodologies and digital technologies would result in greater academic performance than the isolated use of either approach.

Methods

Study Design

This was an observational, comparative, cross-sectional study conducted with students enrolled in the Anatomical Bases of Organs and Systems (BAOS) course at Universidade Professor Edson Antônio Vellano (UNIFENAS) during the 2023/1 and 2023/2 academic semesters. The study aimed to compare the academic performance of students exposed to different human anatomy teaching methodologies.

Participants

The sample comprised 116 students regularly enrolled in undergraduate programs in Physical Education, Physical Therapy, and Psychology, distributed across three classes previously established by the educational institution. Participants were allocated in a non-randomized manner, respecting the original composition of the classes. Students were recruited during the 2023/1 and 2023/2 academic semesters, with similar distributions across groups according to their undergraduate programs. The distribution of students by academic semester, undergraduate program, and group is presented in Table 1.

Students were grouped according to the pedagogical strategy employed during the course:

Traditional Teaching Group (TT): n = 35;

Technological Resources Group (TR): n = 42;

Traditional Teaching combined with Technological Resources Group (TT+TR): n = 39.

Table 1. Distribution of students by academic semester and undergraduate program.

Academic semester	Undergraduate program	TT	TR	TT+TR	Total
2023/1	Physical Education	4	6	5	15
	Physical Therapy	5	6	5	16
	Psychology	9	10	10	29
2023/2	Physical Education	4	5	4	13
	Physical Therapy	5	6	6	17
	Psychology	8	9	9	26
TOTAL		35	42	39	116

Note: TT: Traditional Teaching; TR: Technological Resources; TT+TR: Traditional Teaching combined with Technological Resources.

Source: Authors' own elaboration.

Eligibility Criteria

Students who fully completed the theoretical and practical activities and assessments specified in the course syllabus were included. Students who did not complete all assessments or who did not have a final grade recorded at the end of the semester were excluded.

Course Characterization

The Anatomical Bases of Organs and Systems (BAOS) course had a total workload of 80 hours, consisting of 40 hours of theoretical activities and 40 hours of practical activities. Throughout the academic semester, students in all three groups had access to two hours per week of theoretical and practical tutoring sessions conducted by previously trained tutors under the supervision of the instructor responsible for the course.

All activities were taught by the same instructor to minimize potential interference resulting from methodological differences associated with instructor characteristics.

Teaching Strategies

Traditional Teaching Group (TT)

Students in the TT group participated in interactive lectures using conventional teaching resources, including multimedia presentations, anatomical atlases, study guides, and practical activities conducted in an anatomy laboratory.

Technological Resources Group (TR)

Students in the TR group conducted their learning process predominantly through the Anatomy Learning – 3D Anatomy application, using interactive three-dimensional anatomical models to explore body structures, perform anatomical identification, and study the topographical relationships between organs and systems. The resource was used throughout the academic semester during course activities, with no minimum or maximum usage time specified. In addition, students had unrestricted access to the application for out-of-class use.

Traditional Teaching Combined with Technological Resources Group (TT+TR)

Students in the TT+TR group received the strategies employed in both the TT and TR groups simultaneously. Thus, lectures and laboratory-based practical activities were systematically complemented by the use of the Anatomy Learning – 3D Anatomy application, allowing the integration of physical and digital anatomical resources throughout the teaching and learning process. The application was used throughout the academic semester, with no minimum or maximum usage time specified, and remained available for students to access outside class.

Assessment of Academic Performance

Academic performance was determined based on the final grade obtained in the BAOS course, expressed on a scale from 0 to 10 points.

The final grade was calculated as the sum of two assessments:

Theoretical examination: 0–5 points;

Practical anatomy examination: 0–5 points.

All three classes were assessed using the same theoretical and practical examinations, covering the same syllabus content and applying identical grading criteria to ensure comparability of results across groups.

Successful completion of the course was defined as a final grade of ≥ 6.0 points, in accordance with the institution's academic criteria in effect at the time of the study.

Statistical Analysis

Data normality was initially assessed using the Shapiro–Wilk test. Quantitative variables were expressed as means, standard deviations, 95% confidence intervals, minimum and maximum values, and ranges.

Final grades were compared among the three groups using one-way analysis of variance (one-way ANOVA). When statistically significant differences were identified, post hoc analysis was performed

using Tukey's multiple-comparisons test to determine which groups differed from one another.

A significance level of 5% was adopted ($p \leq 0.05$). All statistical analyses were performed using GraphPad Prism®, version 8.0 (GraphPad Software, Inc., San Diego, CA, USA).

Results

The descriptive statistics of the final grades obtained by the students according to the teaching methodology employed are presented in Table 2. The TT and TR groups showed similar mean academic performance (6.20 ± 0.78 and 6.23 ± 0.76 points, respectively), whereas the TT+TR group showed a higher mean score (7.99 ± 0.57 points). In addition, lower data dispersion was observed in the TT+TR group, as indicated by its lower standard deviation and narrower range of scores.

Table 2. Comparison of final grades among the Traditional Teaching (TT), Technological Resources (TR), and Traditional Teaching combined with Technological Resources (TT+TR) groups.

Variable	TT (n=35)	TR (n=42)	TT+TR (n=39)	p
Final grade Mean $\pm$ SD	6,20 $\pm$ 0,78	6,23 $\pm$ 0,76	7,99 $\pm$ 0,57	<0,001**
95% CI	5,93–6,46	6,00–6,47	7,80–8,17	
Minimum score	4,7	4,6	6,8	
Maximum score	7,4	7,4	8,8	
Range	2,7	2,8	2,0	

Note: TT = Traditional Teaching; TR = Three-Dimensional Technological Resources; TT+TR = Traditional Teaching combined with Three-Dimensional Technological Resources. Data are presented as mean $\pm$ standard deviation. Differences between groups were analyzed using one-way ANOVA followed by Tukey's multiple-comparisons test. ** $p \leq 0.001$.

Source: Authors' own elaboration.

The minimum and maximum values observed also differed among the groups. Whereas the TT and TR groups had scores below the institutional passing criterion (6.0 points), the lowest score observed in the TT+TR group was 6.8 points. Additionally, this group had the

highest maximum score recorded (8.8 points), indicating consistently superior academic performance.

The comparison of final grades among the groups revealed a statistically significant difference (one-way ANOVA; $p < 0.001$), as presented in Table 2. The TT+TR group showed superior performance compared with the TT and TR groups. In contrast, the mean scores observed in the TT and TR groups were virtually identical, suggesting no relevant differences between the strategies when used in isolation.

Table 3. Multiple comparisons among the evaluated groups (Tukey's multiple-comparisons test).

Comparison	Mean difference	p
TT × TR	0,03	ns
TT × TT+TR	1,79	$\leq 0,001^{**}$
TR × TT+TR	1,76	$\leq 0,05^{*}$

Note: TT = Traditional Teaching; TR = Three-Dimensional Technological Resources; TT+TR = Traditional Teaching combined with Three-Dimensional Technological Resources. Data are presented as mean $\pm$ standard deviation. Differences between groups were analyzed using one-way ANOVA followed by Tukey's multiple-comparisons test. ns: not significant; $p \leq 0.05$; $*p \leq 0.001$.

Source: Authors' own elaboration.

Taken together, the results indicate that students in the TT+TR group had higher mean academic performance compared with those in the TT and TR groups, whereas the isolated use of these approaches was associated with similar outcomes.

Discussion

The main finding of the present study was the observation of higher mean academic performance in the group that used traditional teaching strategies combined with three-dimensional technological resources, compared with the groups that used these approaches in isolation. Although the Traditional Teaching (TT) and Technological

Resources (TR) groups showed similar academic performance, the combination of both methodologies (TT+TR) resulted in significantly higher mean scores, as well as lower variability in the results and no students performing below the institutional passing criterion. These findings suggest that the pedagogical benefit does not necessarily lie in replacing one strategy with another, but rather in integrating different tools capable of enhancing complementary cognitive processes involved in anatomical learning.

This interpretation is supported by the narrative review conducted by Rosa et al. (2025), which describes a progressive transformation in the methodologies used to teach Human Anatomy over recent decades. According to the authors, advances in digital technologies have significantly expanded teaching possibilities; however, the available evidence does not support the complete replacement of traditionally employed methods. On the contrary, the literature indicates that the best outcomes tend to occur when technological resources are incorporated as complementary tools to in-person teaching and practical activities. The findings of the present study reinforce this perspective by demonstrating that the integration of methodologies was more effective than the isolated use of either approach.

The superiority of the TT+TR group may be explained, in part, by the ability of the different strategies to simultaneously address multiple dimensions of anatomical learning. Anatomy does not depend exclusively on memorization of structures but requires the construction of complex mental representations involving shape, location, spatial orientation, and topographical relationships among organs and systems. In this context, Fonseca et al. (2022) demonstrated that technology-enhanced learning environments favor academic performance when combined with prior processes of content orientation and demonstration. The authors observed that the combination of strategies reduces initial difficulties in comprehension and promotes the progressive construction

of anatomical knowledge. This interpretation is consistent with the findings of the present study, as students in the TT+TR group had simultaneous access to theoretical explanations, practical activities, and three-dimensional resources.

Similarly, Fonseca et al. (2023) found that the use of immersive technologies in anatomy education can improve learning without significantly increasing students' cognitive load. In courses characterized by a high volume of information and substantial spatial complexity, the ability to reduce unnecessary cognitive demands represents an important pedagogical advantage. From this perspective, the three-dimensional application used in the present study may have contributed to facilitating the understanding of anatomical structures, allowing students to direct a greater proportion of their cognitive resources toward assimilating the fundamental concepts addressed during the classes.

Another relevant aspect concerns spatial visualization, recognized as one of the major challenges in anatomy education. Keenan et al. (2020), when investigating the transition between two-dimensional and three-dimensional representations in anatomy learning, demonstrated that many students have difficulty converting flat images into coherent three-dimensional mental models. According to the authors, three-dimensional visualization technologies can facilitate this process by promoting a better understanding of spatial relationships among body structures. Considering that many of the difficulties reported by students in anatomy courses are precisely associated with the interpretation of these spatial relationships, the superiority observed in the TT+TR group may be related to the ability of technological resources to complement the information provided through theoretical and practical classes.

The results also converge with the observations of Organ et al. (2023) regarding the integration of three-dimensional technologies into anatomy education. The authors argue that digital resources provide additional opportunities for interaction with content, promoting active

learning, student autonomy, and content review outside the formal educational environment. However, they emphasize that these benefits tend to be maximized when technologies are incorporated into a structured pedagogical context. This observation is particularly relevant to the interpretation of the present study's findings, as it helps explain why the TR group did not outperform the TT group. Although technological resources offer important advantages, their effectiveness appears to depend on the presence of a pedagogical framework capable of appropriately guiding the learning process.

The absence of significant differences between the TT and TR groups constitutes one of the most interesting findings of the present investigation. In a context of increasing emphasis on educational technologies, there is often an expectation that digital tools will be capable of replacing traditional teaching methods. However, the data obtained do not support this hypothesis. Smith et al. (2016) emphasize that anatomical learning involves processes that extend beyond the simple identification of structures, including clinical reasoning, functional contextualization, and knowledge integration. These competencies are often developed through interaction between students and instructors, classroom discussions, and practical experiences provided by conventional teaching. Thus, although digital resources may expand access to information, they do not necessarily reproduce all the pedagogical elements present in traditional teaching.

This interpretation is also supported by the work of Ghosh (2017), who emphasizes the role of traditional methodologies in the construction of anatomical knowledge. Although the author acknowledges the advances provided by educational technologies, they argue that anatomy learning remains strongly associated with direct exploration of structures and pedagogical mediation provided by the instructor. From this perspective, the results of the present study suggest that technology should be understood as a complementary element of the educational

process rather than as a complete substitute for historically established practices in anatomy education.

The findings also converge with studies conducted by McMenamin et al. (2014) and Lim et al. (2016), which demonstrated educational benefits associated with the use of three-dimensional printed models. Although the technology employed in these studies differs from that used in the present investigation, the underlying pedagogical principle is similar: to enhance spatial visualization and promote an understanding of anatomical relationships. In both contexts, three-dimensional resources were found to contribute to improved academic performance when incorporated into the teaching process. These findings reinforce the hypothesis that anatomical visualization constitutes a central component of learning and that tools capable of enhancing this ability tend to produce consistent educational benefits.

Another aspect that deserves attention is the lower dispersion of scores observed in the TT+TR group. In addition to having the highest mean performance, this group exhibited a smaller range and lower variability in its results. However, because the study did not assess participants' baseline performance or other factors potentially associated with learning, these findings should be interpreted with caution. The lower dispersion observed indicates only greater homogeneity of scores within this group and does not, by itself, allow the conclusion that inequalities in learning were reduced.

The results of this investigation have important implications for curriculum planning in anatomy courses. In a context characterized by the progressive reduction in the instructional time allocated to morphological sciences and the increasing incorporation of digital technologies into higher education, identifying strategies capable of maximizing student learning is essential. The data obtained suggest that blended teaching models may represent a pedagogically more effective alternative than exclusively traditional or exclusively technological approaches. This interpretation is consistent with the recommendations presented by Rosa et al. (2025), Smith et al. (2016), and Almen et al.

(2025), who advocate the integrated use of different educational resources as a means of enhancing the teaching and learning process.

Several limitations should be considered. The use of pre-existing classes prevented randomization of participants and may have allowed the influence of uncontrolled factors on academic performance. Although the participants were enrolled in Physical Education, Physical Therapy, and Psychology programs, information regarding prior anatomical knowledge, previous academic performance, familiarity with three-dimensional technological resources, study habits, or time available for extracurricular activities was not collected. In addition, subjective and relational aspects potentially involved in the learning process, such as interest in the course, academic engagement, interaction among students, student–instructor relationships, interaction with tutors, and characteristics specific to the pedagogical environment of each class, were not assessed. Therefore, it is not possible to determine the influence of these variables on the differences in performance observed among the groups. Furthermore, the study was conducted at a single higher education institution, which limits the generalizability of the findings to other educational contexts. Future investigations may incorporate experimental designs, pre- and post-intervention assessments, long-term knowledge-retention analyses, and indicators related to academic profiles, relational aspects of the teaching and learning process, and the development of spatial skills.

In conclusion, the results demonstrate that the combination of traditional teaching and three-dimensional technological resources promoted superior academic performance compared with the use of these strategies in isolation. The findings reinforce the growing evidence that technological innovation produces its best outcomes when integrated with established pedagogical principles, contributing to more efficient, consistent anatomy learning that is aligned with the contemporary demands of health professions education.

Conclusion

The results of the present study demonstrate that the integration of traditional teaching and three-dimensional technological resources was associated with higher mean academic performance compared with approaches used in isolation for Human Anatomy education. The combined model resulted in higher mean performance, lower variability in the results, and greater consistency in academic achievement, indicating its potential to optimize the anatomy learning process.

The absence of relevant differences between traditional teaching and the exclusive use of technological resources suggests that digital tools, although offering important pedagogical contributions, do not fully replace traditional methods but rather act as complementary resources. Thus, the findings reinforce the importance of blended teaching models in which educational technologies are integrated with established pedagogical strategies to promote spatial understanding and the acquisition of anatomical knowledge.

Therefore, the combined use of traditional methodologies and three-dimensional technological resources represents a promising strategy for Human Anatomy education, contributing to more effective training of students in health-related fields.

References

- ALMEN, Josie et al. Student and educator perceptions of asynchronous anatomical education and a digital anatomy learning resource. In: *Enhancing Biomedical Education: Integrating Digital Visualization and 3D Technologies*. Cham: Springer Nature Switzerland, 2025. p. 43-73. DOI: https://doi.org/10.1007/978-3-031-73270-6_3.
- FONSECA, Guilherme Reis Borges Coelho; TIPOE, George Lim; GANOTICE JR, Fraide Augustin. Comparing the outcomes of the technology-enhanced learning of sectional anatomy with and without preceding demonstrations: A study about the worked-example effect in anatomy education. *Anatomical Sciences Education*, 2026. DOI: <https://doi.org/10.1002/ase.70267>.

DOS REIS BORGES COELHO DA FONSECA, Guilherme; YANG, Jian; CECOT, Tomasz Stanislaw. The effectiveness and required mental effort of using virtual reality in anatomy learning. In: Anatomical Society Summer Meeting 2023 (25/07/2023-27/08/2023, Bangor, United Kingdom). Wiley, 2023.

GHOSH, Sanjib Kumar. Cadaveric dissection as an educational tool for anatomical sciences in the 21st century. *Anatomical Sciences Education*, v. 10, n. 3, p. 286-299, 2017. DOI: <https://doi.org/10.1002/ase.1649>.

GHOSH, Sanjib Kumar. Paying respect to human cadavers: We owe this to the first teacher in anatomy. *Annals of Anatomy-Anatomischer Anzeiger*, v. 211, p. 129-134, 2017. DOI: <https://doi.org/10.1016/j.aanat.2017.02.004>.

GHOSH, Sanjib Kumar; KUMAR, Ashutosh. Building professionalism in human dissection room as a component of hidden curriculum delivery: a systematic review of good practices. *Anatomical Sciences Education*, v. 12, n. 2, p. 210-221, 2019. DOI: <https://doi.org/10.1002/ase.1836>.

KEENAN, Iain D.; BEN AWADH, Abdullah. Integrating 3D visualisation technologies in undergraduate anatomy education. *Biomedical Visualisation: Volume 1*, p. 39-53, 2019. DOI: https://doi.org/10.1007/978-3-030-06070-1_4.

KEENAN, Iain D.; POWELL, Megan. Interdimensional travel: visualisation of 3D-2D transitions in anatomy learning. In: *Biomedical Visualisation: Volume 6*. Cham: Springer International Publishing, 2020. p. 103-116. DOI: https://doi.org/10.1007/978-3-030-37639-0_6.

LIM, Kah Heng Alexander et al. Use of 3D printed models in medical education: A randomized control trial comparing 3D prints versus cadaveric materials for learning external cardiac anatomy. *Anatomical sciences education*, v. 9, n. 3, p. 213-221, 2016. DOI: <https://doi.org/10.1002/ase.1573>.

MARTIN, Jason. Evaluating Learning Resource Selection to Support Gross Anatomy Education. 2023. Tese de Doutorado. Colorado State University. DOI: <https://doi.org/10.25675/3.04878>.

MCMENAMIN, Paul G. et al. The production of anatomical teaching resources using three-dimensional (3D) printing technology. *Anatomical sciences education*, v. 7, n. 6, p. 479-486, 2014. DOI: <https://doi.org/10.1002/ase.1475>.

ORGAN, Jason M.; COMER, Amber R. Evolution of a discipline: The changing face of anatomy. *The Anatomical Record*, v. 305, n. 4, p. 766-771, 2022. DOI: <https://doi.org/10.1002/ar.24901>.

ORGAN, Jason M. et al. Personal autonomy and self-determination are crucial for professionalism in healthcare. *Anatomical sciences education*, v. 16, n. 4, p. 571-573, 2023. DOI: <https://doi.org/10.1002/ase.2278>.

ROSA, Bruno Barbosa et al. Metodologias de ensino aplicadas à Anatomia Humana: uma revisão narrativa. *REVISTA DELOS*, v. 18, n. 71, p. e6856-e6856, 2025. DOI: <https://doi.org/10.55905/rdelosv18.n71-155>.

SMITH, Claire F.; FINN, Gabrielle M.; BORDER, Scott. Learning clinical anatomy. *Eur J Anat*, v. 21, n. 4, p. 269-278, 2017.

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