

Remote observation of surgeries in the study of anatomy in medical students: A systematic review.

La observación de cirugías de forma remota en el estudio de la anatomía en estudiantes de medicina: Una revisión sistemática.

Verónica Garrido¹, María José Sáez², Catalina Salinas³, Marcos-Rojas, MD⁴

1 Programa Ayudantes Docentes, Centro de Enseñanza y Aprendizaje, Facultad de Medicina, Universidad de Chile. Santiago, Chile; veronicagarrido@ug.uchile.cl <https://orcid.org/0000-0002-3895-5131>

2 Programa de ayudantes docentes, Centro de Enseñanza y Aprendizaje, Facultad de Medicina, Universidad de Chile. Santiago, Chile; maria.saez.t@ug.uchile.cl. <https://orcid.org/0000-0002-3370-6195>

3 Programa Ayudantes Docentes, Centro de Enseñanza y Aprendizaje, Facultad de Medicina, Universidad de Chile. Santiago, Chile; catalina.salinas.l@ug.uchile.cl. <https://orcid.org/0000-0002-5372-3064>

4 Ph.D. student, Learning Sciences and Technology Design, Graduate School of Education, Stanford University, USA; marcosrp@stanford.edu <https://orcid.org/0000-0001-6352-4547>

Recibido: 5/10/22; Aceptado: 1/12/22; Publicado: 2/12/22

Abstract.

As a result of globalization and the global health context due to the Covid-19 pandemic, the study of anatomy in medical students has had to reinvent itself by incorporating new techniques to enhance learning, among which the observation of surgical videos stands out. The objective of this review is to determine whether remote observation of surgeries complements anatomy learning in medical students. Methods: A systematic review of the existing literature in the WOS and SCOPUS databases was carried out using the PRISMA protocol. Studies published in English and Spanish were considered. Three authors reviewed the full texts and selected data related to the visualization of surgical videos and their effect on anatomy learning. Subsequently, the information obtained was synthesized and reviewed according to the PRISMA protocol. Results: Four studies met the inclusion criteria. In all the selected studies, the students' perception of this new methodology was evaluated, to which they stated that it was useful and a positive experience. Two of the studies carried out an objective evaluation of the knowledge acquired and in both there were better results in the group that applied this methodology. In addition, all the studies recommended using video viewing in a complementary way to the methodologies used today. Conclusions: Remote observation of surgeries can be a good complement to the methodologies currently used in anatomy teaching. It is necessary to continue investigating the possible effects of this new methodology in order to determine whether its implementation is effective, since the literature on this subject is limited.

Keywords: Anatomy teaching, Learning, Medical program, Medical education, Surgery videos, Tertiary Education, University, Higher education, Postsecondary education.

Resumen.

Producto de la globalización y del contexto sociosanitario mundial por la pandemia de Covid-19, el estudio de anatomía en estudiantes de medicina ha tenido que reinventarse incorporando nuevas técnicas para potenciar el aprendizaje, entre las que destaca la observación de videos de cirugía. El objetivo de esta revisión es determinar si la observación de cirugías en forma remota complementa el aprendizaje de anatomía en los estudiantes de medicina. Métodos: Se realizó una revisión sistemática de la literatura existente en las bases de datos de WOS y SCOPUS mediante el protocolo PRISMA. Fueron considerados estudios publicados en inglés y español. Tres autoras revisaron los textos completos y seleccionaron datos relacionados con la visualización de videos de cirugía y su efecto en el aprendizaje de anatomía. Posteriormente, se sintetizó y revisó la información obtenida

según el protocolo PRISMA. Resultados: Cuatro estudios cumplieron los criterios de inclusión. En todos los estudios seleccionados se evaluó la percepción de los estudiantes frente a esta nueva metodología, a lo cual manifestaron que fue útil y una experiencia positiva. Dos de las investigaciones realizaron una evaluación objetiva de los conocimientos adquiridos y en ambos hubo mejores resultados en el grupo que aplicaba esta metodología. Además, todos los estudios recomendaban emplear la visualización de vídeos de forma complementaria a las metodologías de enseñanza utilizadas hoy en día. Conclusiones: La observación de cirugías de forma remota puede ser un buen complemento en las metodologías utilizadas actualmente en la enseñanza de anatomía. Es necesario seguir investigando los posibles efectos de esta nueva metodología para así determinar si es efectiva su implementación, puesto que además la literatura respecto a este tema es escasa.

Palabras clave: enseñanza de anatomía; aprendizaje; carrera de medicina; educación médica; videos de cirugía; educación terciaria; universidad; educación superior; educación postsecundaria.

1. Introduction

The learning process in higher education depends on many factors, which are not only related to students and institutions, but also depend on the context of each country and the world. Among these are technological advances, uncertain work environments, the need to include new technologies and the use of ICT, social demands that require open-mindedness, and natural disasters (1).

In Chile, for four years the educational experience of medical students has been affected by a series of events that have altered the traditional format of classes. First, in October 2019 there was a historical event called "social outbreak", which corresponded to a series of massive demonstrations throughout Chile, in which the discontent of the population was exposed due to the country's socioeconomic inequalities. . Due to the disturbances caused by the demonstrations, the government decreed a state of emergency and a curfew in order to control the situation (2). University students were not exempt from this situation and several belonging to different universities voluntarily stopped their classes to support social discontent (3). Once the stoppage ended, in some universities and careers in the country, what is currently known as "emergency remote teaching" (4) was established with the use of video calls, viewing of recorded classes and online evaluations. The foregoing, due to the fact that there was a temporary change in the form of teaching development to an alternative mode with the use of totally remote teaching solutions due to crisis circumstances, but once resolved, it will return to normality, thus falling within the definition of this emerging concept and differentiating it from what is known today as "distance education" (5).

Second, in December 2019 on the Asian continent, a case of the new SARS-COV-2 virus was reported for the first time, which has wreaked havoc on people's health and the collapse of health care centers due to its great contagion capacity, so in a short period of time this virus was able to start the pandemic that currently affects the world (6). In March 2020, the first case of Coronavirus was confirmed in Chile, and as in the rest of the world, one of the measures adopted to reduce contagion was the confinement of the population (7). The universities of the world changed the modality of their classes by implementing "emergency remote teaching" (8), and our country resumed, deepened and generalized this methodology adopted in the period after the social outbreak. The medical career was no exception, and they were adapted from some internships to the most basic subjects of the career, one of them being anatomy.

Anatomy consists of the study of the structure of the human body, framed in the context of the analysis of morphology, which is why it is closely related to other subjects such as histology and embryology (9). This discipline has different aspects such as surface, image, descriptive, topographic and functional anatomy (10). A study carried out in Madrid reveals that the greatest importance given by doctors to medical practice is found in anatomy by imaging, followed by functional anatomy. Similarly, medical students highlighted the need for a correct anatomical study to obtain better performance in clinical subjects such as radiology and surgery (10).

Considering medical practice and the perception of medical professionals, the study of anatomy is one of the most relevant subjects for providing knowledge and skills for the practice of medicine (9). This course is the gateway to medical language for students, as well as providing the bases for correct physical examination, image interpretation, symptomatology, and therapeutic procedures for patients (9). In recent years, the teaching of anatomy has consisted of the integration of different methods, among which expository classes, cadaveric dissections, use of virtual anatomy platforms and instances of physical interaction to carry out teaching and research activities stand out (11). However, today as a result of the global socio-sanitary context, the largest number of students per classroom, and thanks to the advancement of technology and globalization, it has been necessary to reinvent and adapt due to the dynamic demands in this matter (12-13). For this reason, new means and techniques have been incorporated to support what is already being done to promote learning about anatomy, among which the observation of surgery videos stands out (14-17). Specifically, one of the complementary benefits that watching surgery videos can provide is the motivation of students, since, by offering a link between the theoretical and the future practical work of the profession, it can increase interest and make students take awareness of the reason and the need to learn anatomy (18).

Currently, the usefulness of the traditional teaching methodologies used in this subject for learning anatomy is recognized (19), however, it is in this context that the question arises as to whether remote observation of surgeries complements the learning of anatomy. In medical students, since there is little literature on the subject. For this reason, this systematic review seeks to answer the question raised, because it is a topic that could generate important contributions in the study and teaching of this science in medical students around the world. It should be noted that this paper will not delve into the effects of watching surgery videos on the teaching of other subjects or at other levels of the career, such as postgraduate, since it is beyond the objectives of this review.

2. Methods

The present review was carried out in November 2021. This study did not require approval by the ethics committee, because it corresponds to a review of published literature. To guarantee the quality of the articles, only those published in indexed databases were selected. The systematic search was performed in two databases (ISI: Web of Science and SCOPUS) for articles or reviews published in English or Spanish, in any year. For the selection of keywords, the "BEME Guide no. 3: systematic search for evidence in medical education" and the ERIC Thesaurus. The selected concepts were "Anatomy" AND "Learning" AND "Medical Education" AND "Surgery video*" AND "Higher Education". Each of these concepts was expanded using synonyms through free search and using the ERIC Thesaurus (20). Table 1 shows the combination of keywords used in the aforementioned databases. And in table 2, the inclusion and exclusion criteria applied in the search.

Table 1. Identification and expansion of search concepts: algorithm applied in the databases

Search 1: Expansion of the concept "Anatomy" (words combined with OR)	
Thesaurus	anatomy
free search	anatomy teaching
Search 2: Expansion of the concept "Learning"	
Thesaurus	learning
Search 3: Expansion of the concept "Medical education" (words combined with OR)	
Thesaurus	medical education
free search	Medical program
Search 4: Expansion of the concept "Surgery video"	
Thesaurus	-
free search	Surgery video (ERIC's Thesaurus was used, the one that corresponds in education, where there is no concept of Surgery videos or synonyms.
Search 5: Expansion of the concept "Higher education" (words combined with OR)	
Thesaurus	Higher education - Postsecondary education - University
free search	tertiary education
search 6	1, 2, 3, 4 and 5 combined with AND and with the delimiters of full text, articles or reviews published in English or Spanish, in any year.

Table 2. Inclusion and exclusion criteria applied in the bibliographic search.

Inclusion criteria	Exclusion criteria
Empirical or primary studies and reviews focused on the use of surgical video viewing in anatomy learning.	Non-empirical or secondary studies, such as editorials, commentaries, and books.
Studies reporting research on medical students.	Studies in populations other than medical students.
Quantitative or qualitative studies with adequate definitions, reliable methods, operationalization of concepts and data analysis.	Studies focused on the validation and/or construction of instruments.
Studies available in Spanish or English.	Studies published in languages other than Spanish or English.

The titles and abstracts of the publications identified in the search were independently reviewed, distributing them equally among the authors. Discrepancies were resolved by discussion between them. Empirical or primary studies focused on the use and/or viewing of videos for the study of anatomy in medical students were included. Non-empirical or secondary studies and/or focused on a population other than medical

students were excluded. For the selection of the studies, empirical or primary studies and reviews focused on the use of viewing videos of surgery in learning anatomy were included, since the objective is to identify if there is a relationship between the use of videos as a complement in the study of anatomy and an improvement in learning. In the same way, studies that report research on medical students were included, since it seeks to analyze this relationship around careers that have a leading role in the surgical area. Likewise, quantitative or qualitative research with adequate definitions, reliable methods, operationalization of concepts, and data analysis were sought to obtain reliable data that would allow evidence-based conclusions to be drawn. For the collection of information from the selected studies, three of the authors reviewed the full texts, and data related to the viewing of surgery videos and their effect on anatomy learning were selected. Subsequently, one of the authors prepared Table 3 with the selected studies, which was later reviewed by three of the authors for its final edition.

Among the limitations of data collection is the scant information that exists on this subject, which makes the discussion and conclusions of this systematic review difficult. Associated with this, not all the selected studies have a representative or exclusive sample of undergraduate medical students, which may cast doubt on the data obtained in these investigations due to sample bias. In addition, all of them have very different methods from each other, highlighting the study design, study time and evaluations, which can be beneficial, but also generates objections in terms of obtaining data and conclusions.

3. Results

The systematic review identified a total of 59 studies. Of these, 10 articles were selected based on title and abstract, also excluding duplicates. A full text reading of the selected texts was performed, of which 6 did not meet the inclusion criteria. Finally, 4 studies that met the inclusion criteria were chosen (Table 3).

Study characteristics

The selected studies were published between 2012 and 2020, half of them coming from the United States, with a focus mainly on the perception of the students themselves in relation to the applied techniques. The methodology used in the studies was quantitative and qualitative. For data collection, multiple-choice questionnaires, objective structured clinical examinations (OSCE), Likert-type personal perception questionnaires, and focus group discussions were used. A summary of the selected studies is presented in Table 3.

Common Themes Found in Studies

In all the selected studies, the perception of the students regarding the impact on knowledge and understanding and interest in the method was evaluated. Three of the studies measured perception through questionnaires designed with the Likert Scale, and only one of them used the analysis of comments obtained in focus groups. Thanks to the results obtained, it was possible to observe that the students manifest a positive experience of the new method implemented, since they considered that the viewing of surgery videos or live surgical procedures have a positive impact on their knowledge and understanding of anatomy. In addition, they considered that the new methodology used should be implemented again.

On the other hand, only two of the studies performed an objective assessment of knowledge of anatomy through the viewing of surgery videos. In the study by AlNassar et al (15), a pre-test was applied to assess the students' prior knowledge and a post-test to measure the subsequent knowledge obtained from the thoracoscopy videos, while in the study of Knobe et al (14) evaluated the knowledge after the shoulder and knee arthroscopy

simulations through the evaluations already given in the Medicine course of the RWTH Aachen University. Both studies show better results, but with moderate changes. An important point to consider is that all the mentioned studies recommend the use of videos in the teaching of anatomy, but in a complementary way to the methodologies used today. Furthermore, in the studies by AlNassar et al. (15) and Saberski et al. (17) favorable results were obtained in relation to the increased interest of students in careers in the surgical area.

Curricular and training experience

In the studies by Saberski et al (17) and Knobe et al (14), students were allowed to interact with specialists during the procedure or its simulation, generating immediate feedback regarding the live surgical process. On the other hand, in the study by AlNassar et al, students were able to consult while viewing an already recorded video. In addition, three of them (14-15, 17) allowed students to get an early approach to other subjects in the curriculum, such as surgery.

4. Discussion

In the opinion of the authors, this systematic review answers the question of whether the remote observation of surgeries complements the learning of anatomy in medical students, which could generate a significant effect in the study of this science worldwide.

The benefits of watching surgery videos in the anatomy subject were reflected in different settings in the studies selected for this systematic review (14-17). In relation to the learning obtained and evaluated objectively, it can be affirmed that this new methodology improves the results in the anatomy evaluations (14-16), which could indicate that there is a greater knowledge of this science. Although the results were not significant, viewing videos can be a very important complementary tool to improve the medical curriculum, because it allows students to observe colors, shapes, and anatomical relationships in a living body, in addition to providing dynamism and panoramic vision of the structures (14-17).

It is relevant to note that this new way of learning received very good opinions from the students who were able to experience it, who considered it interesting to watch videos of surgeries to learn anatomy, also expressing that it was beneficial for their understanding and knowledge of the observed structures (15, 17). . This could correspond to a point in favor of using this new methodology as a complement in the teaching of anatomy, since it has been described that motivation is an influential factor in the academic performance of students (21).

In relation to the economic field, it is thought that this methodology could have a positive effect, since currently not all universities have access to cadaveric material, and some of those that do have have had a decrease in the number of bodies donated (22). In addition, even in some educational establishments large sums of money are invested to make use of this material (23). This is how the remote observation of surgeries could be a complementary methodology in the teaching of this subject, since it would be somewhat more accessible. In addition, most of the technological adaptations required for its implementation are already present due to the world socio-sanitary context and the phenomenon of globalization, so there would not be a large financial outlay in this area either.

Regarding the scope of the video compilation, a limitation for the different universities may be the association or agreements that they have with medical centers where the recorded surgeries are performed, since it is necessary to have access to this material to implement this new methodology. . In addition, time is required on the part of the surgical team to be able to record the different videos to be used, a process that could be affected due to the care overload.

This review has various limitations, some of which have already been mentioned above. In addition, the selected studies come from countries that have large investments in research and education, in which it is easier to obtain data and implement this new methodology (24). This makes it difficult to extrapolate it to other territories.

Analyzing a complementary method of how a subject of this magnitude is taught requires an exhaustive study of the implications and its effects. It would be relevant to generate a case-control study with medical students where what was proposed in this study can be tested and whether there are differential effects between the two groups. It would be extremely important to replicate this study in various countries to obtain more representative results that may be applicable to different universities around the world. Also, this review proposes the use of surgery videos as a complementary methodology in teaching anatomy, but it would be interesting to investigate whether this could be a better way of teaching than what is currently done (23).

In the same way, it would be necessary to determine the true benefit in resource management, both human and economic, that the implementation of this methodology would imply, considering the establishment of possible agreements with medical centers, the incorporation of new professionals in the health area and the training of the teaching staff in relation to this new methodology.

5. Conclusions

- The advance of globalization and the global socio-sanitary context has given way to reconsidering the methodologies used to teach anatomy to medical students.
- The remote observation of surgeries could be a good complement to the methodologies currently used in the teaching of anatomy, since, according to what was reviewed, it would enhance the learning of this science in future medical professionals.
- It is necessary to continue investigating the possible effects of this new methodology in order to determine if its implementation is effective, since the literature on this subject is also scarce.

Table 3. Summary of the selected studies.

Title	Author (Year, Country)	The purpose of the study	Study Design	Participants	Studying time	information collection	Findings
Arthroscopy or ultrasound in undergraduate anatomy education: a randomized cross-over controlled trial (14)	Knobe et al, (2012, Germany)	To determine if musculoskeletal ultrasound (MSUS) or methods Arthroscopic procedures can increase the acquisition of anatomical knowledge.	Quantitative	242 second-year medical students	Two 75-minute classes and two 150-minute tutorials in one semester	Multiple choice questionnaire and structured clinical examination objective (EEOC).	Through the questionnaire it was evidenced that those students who made use of simulations of arthroscopic methods obtained a greater advantage in regarding the acquisition of anatomical knowledge and greater spatial imagination compared to the group that used the ultrasound tutorial and the dissection control group. In contrast, in the OSCE there were no major differences between the arthroscopy and ultrasound groups and the control group.
The use of thoracoscopy to enhance medical students' interest and understanding of thoracic anatomy (15)	AlNassar et al, (2012, Saudi Arabia)	Develop an educational tool designed to learn anatomy based on captured thoracoscopic video segments during live surgery and determine if it increases students' knowledge and/or motivates them to learn anatomy with a future interest in surgical specialties.	Quantitative	119 first-year medical students for the perception questionnaire and 26 students for the multiple choice test	A class of 30 to 45 minutes	Likert-type personal perception questionnaire and multiple-choice test	The incorporation of live surgery through thoracoscopic videos in the teaching curriculum of Gross Anatomy had high student acceptance and satisfaction scores, increasing their interest in learning, in the clinical application of anatomical data, and in surgery as a future career. Similarly, a moderate (but not significant) increase in student knowledge was evidenced.
Teaching Middle Ear Anatomy and Basic Ear Surgery	Anschuetz et al, (2020, United)	Investigate the perception and preference for the endoscopy versus	Qualitative	19 total participants including ENT residents, 6th year	5 or more discussion sessions	Discussion in focus groups with a guideline of	Endoscopy offers a better overview than microscopy, by recognizing anatomical details. In

<p>Skills: A Qualitative Study Comparing Endoscopic and Microscopic Techniques (16)</p>	<p>States)</p>	<p>microscopy at different levels educational programs for the treatment of diseases of the middle ear.</p>		<p>medical students, and staff members.</p>		<p>questions</p>	<p>addition, it allows better topographic knowledge of the middle ear anatomy, thus improving the understanding of the distances between the structures. Also, the use of endoscopic techniques provides greater anatomical knowledge regardless of the educational level of the participant.</p>
<p>Real-time Cadaveric Laparoscopy and Laparoscopic Video Demonstrations in Gross Anatomy: An Observation of Impact on Learning and Career Choice (17)</p>	<p>Saberski et al, (2015, United States)</p>	<p>Expand the role of surgical and laparoscopy instructors in the standard instruction in gross anatomy, along with determining whether it helps in the three-dimensional understanding of the abdominopelvic anatomy, In addition to improving the opinion of the students about surgery with the consequent increase in interest in surgical careers.</p>	<p>Quantitative</p>	<p>102 first-year medical students.</p>	<p>Two classes</p>	<p>Multiple Choice Quizzes</p>	<p>The use of surgical techniques in the anatomical teaching create a clinical context that increases the educational power of gross anatomy classes with increased knowledge and understanding of the abdominopelvic anatomy. In addition, laparoscopic demonstrations heightened student interest in the surgical area and generated enthusiasm for this type of career.</p>

Supplementary material: none

Funding: There has been no funding.

Acknowledgments: The authors thank their families for their support during the research and writing process.

Declaration of conflict of interest: The authors declare that they have no conflict of interest.

Contributions of the authors: Verónica Garrido, María José Sáez and Catalina Salinas contributed to the preparation and analysis of the review, as well as to the writing and revision of the manuscript. Marcos Rojas contributed to the supervision and revision of the manuscript. All authors read and approved the final manuscript.

References

1. Escorcía Caballero, R. E., Gutiérrez Moreno, A. V., & Henríquez Algarín, H. de J. (2009). La educación superior frente a las tendencias sociales del contexto. *Educación Y Educadores*, 10(1), 63–77. Recuperado a partir de <https://educacionyeducadores.unisabana.edu.co/index.php/eye/article/view/677>
2. Spyer T, Alvarado, V. El Estallido Social en Chile: ¿rumbo a un Nuevo Constitucionalismo?. *Revista Katálysis*, 2021, 24(1), 43-52. <https://doi.org/10.1590/1982-0259.2021.e73555>
3. Mejías S. A un año del salto de los torniquetes: ¿Qué pasa con las orgánicas de representación estudiantil?. *Revista Análisis* 2020, 2021, 1, 97-118. https://www.uchile.cl/documentos/revista-analisis-del-ano-2020-pdf_172656_0_0411.pdf
4. Area-Moreira, M. La enseñanza remota de emergencia durante la COVID-19. Los desafíos postpandemia en la Educación Superior. *Propuesta Educativa*, 2021, 30(56), 57-70. <http://www.scielo.org.ar/pdf/pe/n56/1995-7785-PE-56-00057.pdf>
5. Hodges C et al. The Difference Between Emergency Remote Teaching and Online Learning. Disponible en: <https://er.educause.edu/articles/2020/3/the-difference-between-emergency-remote-teaching-and-online-learning>. (Visitado en 16 de noviembre de 2022)
6. Liu YC, Kuo RL, Shih SR. COVID-19: The first documented coronavirus pandemic in history. *Biomed J*, 2020, 43(4), 328-333. <https://doi.org/10.1016/j.bj.2020.04.007>
7. Ponce T, Vielma C, Bellei C. Experiencias educativas de niñas, niños y adolescentes chilenos confinados por la pandemia COVID-19. *Revista Iberoamericana De Educación*, 2021, 86(1), 97-115. <https://doi.org/10.35362/rie8614415>
8. Sosa MJ. Emergency Remote Education, Family Support and the Digital Divide in the Context of the COVID-19 Lockdown. *International Journal of Environmental Research and Public Health*, 2021, 18(15), 7956-7971. <https://doi.org/10.3390/ijerph18157956>
9. Introducción a la anatomía humana. Anatomía Humana I. Disponible en: <https://www.studocu.com/es-mx/document/universidad-tecnologica-del-suroeste-de-guanajuato/anatomia/introduccion-locomotor-kine-2012/9011468>. (visitado en 20 de enero de 2022)
10. Relevancia de la anatomía humana en el ejercicio de la medicina de asistencia primaria y en el estudio de las asignaturas de segundo ciclo de la licenciatura en medicina. Disponible en: https://scielo.isciii.es/scielo.php?script=sci_arttext&pid=S1575-18132003000100006. (visitado en 20 de enero de 2022)
11. Byrnes KG, Kiely PA, Dunne CP, McDermott KW, Coffey JC. Communication, collaboration and contagion: “Virtualisation” of anatomy during COVID -19. *Clinical Anatomy*, 2020, 34(1), 82–9. <https://doi.org/10.1002/ca.23649>
12. Jiménez AM, Aguilar J-FN. Laparoscopy: Learning a new surgical anatomy? *Anatomical Sciences Education*, 2009, 2(2), 81–3. <https://doi.org/10.1002/ase.75>
13. Cárdenas J. Enseñanza de la Anatomía. Uso de Medios en el Aula. *International Journal of Morphology*, 2019, 37(3), 1123-1129. <https://dx.doi.org/10.4067/S0717-95022019000301123>
14. Knobe M, Carow JB, Ruesseler M, Leu BM, Simon M, Beckers SK, et al. Arthroscopy or ultrasound in undergraduate anatomy education: a randomized cross-over controlled trial. *BMC Medical Education*, 2012, 12(1). <https://doi.org/10.1186/1472-6920-12-85>

15. AlNassar S, Hajjar W, Rahal S, Clifton J, Finley R, Sidhu R. The use of thoracoscopy to enhance medical students' interest and understanding of thoracic anatomy. *Annals of Thoracic Medicine*, 2012, 7(3), 145-<https://doi.org/10.4103/1817-1737.98847>
16. Anschuetz L, Siggemann T, Dür C, Dreifuss C, Caversaccio M, Huwendiek S. Teaching Middle Ear Anatomy and Basic Ear Surgery Skills: A Qualitative Study Comparing Endoscopic and Microscopic Techniques. *Otolaryngology-Head and Neck Surgery*, 2020, 165(1), 174-81. Disponible en: <https://doi.org/10.1177/0194599820977191>
17. Saberski ER, Orenstein SB, Matheson D, Novitsky YW. Real-time cadaveric laparoscopy and laparoscopic video demonstrations in gross anatomy: an observation of impact on learning and career choice. *The American Surgeon*, 2015, 81(1), 96-100. <https://doi.org/10.1177/000313481508100137>
18. Cardozo R., Loaiza L., Guevara H. et al. La motivación de los estudiantes de medicina de la Universidad de Carabobo. Una aproximación teórica. Disponible en: <https://www.redalyc.org/articulo.oa?id=375740246004> (visitado en 25 de noviembre de 2022)
19. Van Wyk J, Rennie C. Learning Anatomy Through Dissection: Perceptions of a Diverse Medical Student Cohort. *Int. J. Morphol*, 2015, 33(1), 89-95. <http://dx.doi.org/10.4067/S0717-95022015000100015>.
20. Haig A, Dozier M. BEME guide no. 3: systematic searching for evidence in medical education--part 2: constructing searches. *Med Teach*, 2003, 25(5), 463-84. <https://doi.org/10.1080/01421590310001608667>
21. Jaquinet M, Rivero M, Garnache A. La motivación en el rendimiento académico de los estudiantes de medicina. *Revista Médica Electrónica*, 2016, 38(6), 910-915. <http://dx.doi.org/10.4067/S0717-95022015000100015>
22. Iwanaga J, Loukas M, Dumont A, Tubbs R. A review of anatomy education during and after the COVID-19 pandemic: Revisiting traditional and modern methods to achieve future innovation. *Clin Anat*, 2021, 34: 108-114. <https://doi.org/10.1002/ca.23655>
23. Martínez F, Martinelli L, Neirreitter A, López Braganca L, Loaces I. Uso de cadáveres en la enseñanza de anatomía en el pregrado: Los muertos que vos matáis gozan de buena salud. *Revista Argentina de Anatomía Online*, 2021, 12(2), 76-81 . <https://www.revista-anatomia.com.ar/archivos-parciales/2021-2-revista-argentina-de-anatomia-online-e.pdf>
24. Gasto en investigación y desarrollo (% del PIB). Disponible en: <https://datos.bancomundial.org/indicador/GB.XPD.RSDV.GD.ZS>. (Visitado en 22 de noviembre de 2022)



© 2023 Universidad de Murcia. Enviado para su publicación en acceso abierto bajo los términos y condiciones de la licencia Creative Commons Reconocimiento-NoComercial-Sin Obra Derivada 4.0 España (CC BY-NC-ND) (<https://creativecommons.org/licenses/by-nc-nd/4.0/>).