Teaching-Learning Process of Medical Students with Real Anatomical Parts: A Practical Intervention Strategy

Proceso de Enseñanza-Aprendizaje de los Estudiantes de Medicina con Piezas Anatómicas Reales: Una Estrategia de Intervención Práctica

Natanias Macson da Silva[1,2]; André Moura de Britto[1]; Andressa Paiva Porto[1,2]; Luis Marcos de Medeiros Guerra[1,3]; Hosana Mirelle Goes e Silva Costa[1,3]; Antônio Carlos Queiroz de Aquino[1,4]; Micássio Fernandes de Andrade[4,5]; Allyssandra Maria Lima Rodrigues Maia[1] & José Rodolfo Lopes de Paiva Cavalcanti[1,2,3,4]

SUMMARY: The COVID-19 pandemic caused several changes in the teaching of human anatomy, among them the use of different teaching methodologies based on E-learning. However, studies evaluating electronic tools have not provided clear evidence of effective student learning. Thus, this was the first study to evaluate medical students after completing human anatomy courses in the E-learning modality. We recruited first term (Group A, n=25) and second term (Group B, n=13) medical students. We applied a practical assessment based on 50 human anatomy markingson real anatomical specimens and cadavers, to be completed in Questionnaire 01 (Phase I). After detecting low scores on Questionnaire 01 by both groups, we applied a practical and face-to-face tutoring system for 14 days (Phase II). Afterwards, we re-evaluated both groups by repeating the same scores (Questionnaire 02, Phase III). According to the paired analysis of questionnaires 01 and 02 by Student's T-test, both groups showed significant increase in the final scores obtained in questionnaire 02 (Phase III). The evidence showed that the remote format lecture system weakened the learning and retention process of basic anatomical knowledge by medical students. On the other hand, in-person practical teaching proved to be efficient in the formative process of the students, a fact proven by the significant increase in the scores of the students in the 02 questionnaire, for both groups.

KEY WORDS: COVID-19; Anatomy Education; Learning; Students; Undergraduate Medical Education.

INTRODUCTION

Practical human anatomy classes are fundamental in medical training, which has been widely discussed by several studies. According Zargaran *et al*. (2020), even in face of multiple pedagogical and technological tools that are used for learning anatomy, traditional teaching with cadavers remains the first choice for medical students. The successful evidence on practices with cadaver and real anatomical specimens enable better anatomy understanding and superior performance when compared other non-traditional resources (Drake *et al*., 2014).

Lately, with pandemic COVID-19, the pedagogical gaps inherent in teaching of human anatomy have worsened, especially in access to real anatomical structures (Franchi, 2020). This panorama also shows that other areas of human knowledge have probably been compromised, such as development in ethics and humanity (Souza *et al*., 2020).

The social distancing caused by the pandemic of COVID-19 proved to be a challenge for medical education in Brazil and worldwide. In this scenario, teaching strategies were used, such as video study and online surveys (Iwanaga *et al*., 2021) and application of Emergency Remote Learning (Rahiem, 2020). However, there are still no studies ratifying that these teaching methodologies offer greater benefits students when compared to dissection and/or direct

[1] College of Health Sciences – State University of Rio Grande do Norte, UERN, Brazil.
[2] Graduate Program in Health and Society - PPGSS/UERN, Brazil.
[3] Multicentric Graduate Program in Physiological Sciences - PPGMCF/UERN, Brazil.
[4] Multicentric Graduate Program in Biochemistry and Molecular Biology - PMBqBM/UERN, Brazil.
[5] Federal Rural University of the Semi-Arid, Mossoró – RN, Brazil.

visualization of real anatomical specimens (Chytas *et al.*, 2021).

However, the insertion of new technologies is fundamental during scenarios of social isolation, although it is imperative the contact with cadaveric practices as soon as possible, because the face-to-face modality aims to ensure skills systematically evaluate the patient and thereby establish most appropriate conduct (Araújo Júnior *et al.*, 2020).

There are few studies evaluating the gaps in the teaching-learning process of practical human anatomy as a result of remote teaching caused by COVID-19 pandemic, as well the repercussion of physical distance from human anatomy laboratories on medical education. This study allowed examining possible gaps left by remote teaching confronting medical students through: (1) practical experiences in anatomy laboratory; (2) direct contact with real anatomical specimens and cadaver; (3) basics on clinical and surgical correlations.

MATERIAL AND METHOD

This is an epidemiological study of quantitative cross-sectional and crossover design with medical students from the State University of Rio Grande do Norte (UERN), Brazil. Based on data provided by the Department of Biomedical Sciences (DCB) the Faculty of Health Sciences (FACS-UERN), we recruited the entire target population of the intervention, that is, all students who completed the subjects Morphofunctional Module I (n=29, Group A) and Morphofunctional Module II (n=29, Group B) in remote teaching modality (no direct contact with real specimens). Included in the study: (1) students regularly enrolled in the UERN medical course; (2) who completed the Morphofunctional Module I or II; (3) and who agreed to participate in the study by signing the Informed Consent Form (ICF). Students enrolled in advanced periods (3rd to 12th periods) and those who gave up on participating in the study at any of the study phases were excluded.

Two questionnaires standardized by authors of this study were applied. Each one was structured with 50 response fields on thematic axes of the subject Morphofunctional Module I and II, applied to Groups A and B, respectively. The questionnaires were applied before and after human anatomy tutoring with real anatomical specimens.

In Phase I of the project, before using the mentoring system, we positioned the real anatomical specimens on benches, with 50 highlighted markings to be recognized by students. The pieces were distributed thematic axes (Table I) and on 10 available benches (5 anatomical markings per bench).

This follow-up, the participant started evaluation by the first marking and, after one minute, moved on to second marking; at the end fifth minute (fifth marking), the learner migrated to next bench (questions 6, 7, 8, 9, and 10), so as to follow this same logistics until completing the ten benches.

In Phase II, we performed group tutorials, which took place in the Anatomy Laboratory of FACS-UERN for period of 14 days. Supervised by experts in human anatomy and cadaver dissection, students participated in tutorials with discussion of topics related to disciplines of Morphofunctional Module I and II, with visualization and handling of real anatomical specimens. We ensured all the biosecurity and preventive measures against COVID-19.

Tutorials were taught by senior instructors with teaching experience and the necessary skills to integrate anatomical knowledge with real pieces and correlations with other areas of knowledge, such as physiology, clinical medicine and surgery. Each tutorial was planned with the development of detailed study guide with the main anatomical structures and their respective thematic axes, as well bibliography recommendations for students study before the tutorial.

Table I. Characterization of thematic axes and order of anatomical markings.

Morphofunctional Module I		Morphofunctional Module II	
Thematic Axes	Mark	Thematic Axes	Mark
Axial Skeleton I	01-05	Bones, Muscles and Nerves of the ULM*	01-06
Axial Skeleton II	06-10	Bones, Muscles and Nerves of the LLM*	07-12
Telencephalon	11-16	Muscles and Nerves of the Head, Thorax and Abdomen	13-18
Diencephalon and Cerebellum	17-22	Cardiovascular System	19-28
Brainstem	23-28	Digestive System	29-39
Cranial Nerves	29-34	Urinary Tract, Pelvic Muscles and Nerves	40-45
Endocrine and Reproductive System	35-50	Respiratory System	46-50

Source: Prepared by the authors, 2022. Caption*: ULM - Upper Limb Muscles; LLM - Lower Limb Muscles.

In Phase III, we repeated the initial evaluation, with same pre-established conditions, such as start and finish time, number of markings, time to solve each question, location and exposure formaldehyde (which could not be avoided, due to direct visualization of the real anatomical pieces), and other environmental conditions.

Evaluations mediated by Questionnaires 01 and 02 were carried out individually and without any kind of consultation by the student. Thus, the application methodology guaranteed the confidentiality, individuality and veracity the data collected. The whole evaluation process was supervised by senior tutors. After completing questionnaire, students were instructed to fold sheets and place them in an urn near the anatomy lab exit.

Regarding correction of the answer keys (template), we assigned a score of two points for each question, according to degree of accuracy the answer: organ (33 % score), marked structure on the organ (33 % score), and antimery (33 % score). In cases where the answer key did not include antimeria, the score was divided between the organ (50 % score) and the marked structure (50 % score).

The data collected from questionnaires were stored in Excel software file (version 2019) and submitted to descriptive statistical analysis, based absolute and relative frequencies. In addition, upon verification of normal distribution and homogeneous variation through Shapiro-Wilk and D'Agostino-Pearson tests, the data were evaluated using Student's t-test paired samples, with all the aforementioned tests performed with aid of Real Statistics software. This research was approved by Ethics and Research Committee of State University of Rio Grande do Norte, under opinion number 5.236.796, on February 10, 2022.

RESULTS

The teaching-learning process was analyzed in thematic axes of the subjects Morphofunctional Module I (Group A) and Morphofunctional Module II (Group B), with a crossover design. 25 students from Group A and 13 students from Group B participated in all phases of study.

In the evaluation of Group A, the mean final score of the students in Questionnaire 01 was 36.8 points (SD±13.3), and in Questionnaire 02 was 70.4 points (SD±12.9). Thus, there was an increase in the overall average of 33.6 points (191.3 %) after the tutoring. The analysis by thematic axes showed a varied performance according to theme, with lower scores in Diencephalon and Cerebellum, as well in the Endocrine and Reproductive System scores. There was a higher hit rate in Axial Skeleton I and Telencephalon (Table II).

Other hand, in the evaluation of Group B, average of the students final score Questionnaire 01 was 31.2 points (SD±12.6), while Questionnaire 02 the class obtained an average of 71.0 (SD±10.2). Thus, there was increase in the overall average of 39.8 points (128.0 %) after intervention. Regarding the highest hit rates, these occurred Digestive System in Questionnaire 01 (40.7 %) and Respiratory System in Questionnaire 02 (87.5 %). The lowest hit rate was concentrated in Bones, Muscles, and Nerves Upper

Table II. Analysis of the average scores of Groups A and B in questionnaires 01 and 02 according to the thematic axes.

Morphofunctional Module I	Questionnaire 01		Questionnaire 02		Morphofunctional Module II	Questionnaire 01		Questionnaire 02	
Thematic Axis	Points	Hits (%)	Points	Hits (%)	Thematic Axis	Points	Hits (%)	Points	Hits (%)
Axial Skeleton I	7,9/14	56,1	11,9/14	85,1	Bones, muscles and nerves of the ULM.	1,7/12	14,1	3,3/12	27,4
Axial Skeleton II	3,9/8	48	6,3/8	78,6	Bones, Muscles and Nerves of the LLM.	4,5/12	37,2	9,6/12	79,9
Telencephalon	7,6/16	48,5	11,3/16	70,8	Bones, Muscles and Nerves of the Head, Thorax and Abdomen	2,9/12	24,0	6,4/12	53,1
Diencephalon and Cerebellum	1,9/12	15,7	6,3/12	52,6	Cardiovascular System	5,7/20	28,3	15,5/20	77,5
Brainstem	3,2/10	31,6	6,3/10	62,7	Digestive System	9,0/22	40,7	18,5/22	84,3
Cranial Nerves	3,5/8	43,5	5,4/8	67,4	Urinary System	4,3/12	36,2	9,0/12	74,7
Endocrine and Reproductive System	8,8/32	27,6	22,9/32	71,5	Respiratory System	3,2/10	31,5	8,8/10	87,5
Score General Average	36,8/100 (SD = 13,3)		70,4/100 (SD = 12,9)		Score General Average	31,2/100 (SD = 12,6)		71,0/100 (SD = 10,2)	

Source: Prepared by the authors, 2022. Caption*: ULM - Upper Limb Muscles; LLM - Lower Limb Muscles; SD - Standard Deviation.

Limbs, with 14.1 % in Questionnaire 01 and 27.4 % in Questionnaire 02 (Table II).

For both groups, the samples were considered to have normal distribution by Shapiro-Wilk and D'Agostino-Pearson tests. According to paired analysis of questionnaires 01 and 02 by Student's T test, both groups showed significant increase in the final scores obtained questionnaire 02 (Phase III). In Group A, the data showed statistical significance of $p = 3 \times 10^{-\partial}$?, while for group B, the statistical significance was $p = 8.6 \times 10^{-\partial}$? (Fig. 1).

Evidence found in this study shows that, although students have had contact with the evaluated thematic axes, in E-learning modality, by several remote teaching methodologies, there was intense teaching gap of human anatomy visualized in Questionnaire 01, for both groups. One of the possible factors that may justify such a gap is the lack of manipulation real anatomical parts. Because of this, we conducted an investigation with a crossover design, which showed that face-to-face human anatomy classes were able to increase academic performance of students, presented in the final scores of Questionnaire 02.

Limiting factors of study: (1) level of difficulty the content covered; (2) resolution time; (3) environmental conditions of anatomy lab, such as contact with formaldehyde impregnated in anatomical specimens; (4) emotional factor, seeing real specimens for first time; (5) discrepancies found between structures observed in anatomy atlases and those found in real specimens.
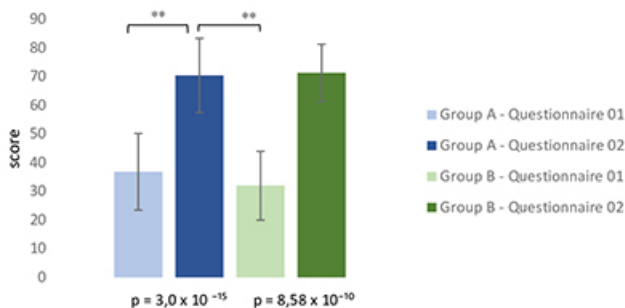

Fig. 1 Final Scores from questionnaires 01 and 02 for gropus A and B.

DISCUSSION

Anatomical study serves foundation upon which medical courses and subsequent clinical practices are built (Saverino, 2021), ensuring the development of skills in clinical and surgical settings, as well a better understanding pathological affections and morphofunctional nuances human body (Ross *et al.*, 2021).

However, a reduction in teaching with cadavers in several medical schools has been evidenced lately; and this is due to increasing number of students, as well decrease in body donation (Saverino, 2021). According to Zhang *et al.* (2019), the expansion "medical education" limits the time and space of anatomical study laboratories, which can seriously impair teaching human anatomy. This fact has stimulated the insertion of complementary technologies to anatomical teaching; although there are no studies proving a better medical education after substitution of classes with handling of real anatomical parts in detriment study based on technological resources (Chytas *et al.*, 2021).

During pandemic COVID-19, some approaches are shown efficient in the provisional practical teaching human anatomy, such as videoconferences with open board schematics (Kim *et al.*, 2022), gamification (Stambuk-Castellano *et al.*, 2022) and use digital platforms (Rojos *et al.*, 2021; Khasawneh *et al.*, 2021).

However, the perceptions of professors and medical students show that remote teaching with alternative methodologies is not superior face-to-face teaching; and this should be seen essential ensure adequate learning (Rojos *et al.*, 2021; Khasawneh *et al.*, 2021; Rodríguez-Luengo *et al.*, 2022). Such perceptions seem justified lack of personal contact, face-to-face learning between student and faculty, sharing of ideas among classmates, handling real anatomical specimens cadavers, and decreased motivation after one year of exclusive E-learning practice (Martinez *et al.*, 2022).

In the field medical education, studies evaluating alternative teaching methodologies in E-learning modality have not provided clear evidence that effective learning by students; and whether basic concepts about anatomical morphology remain in the short and long term. Thus, this is first study to evaluate medical students after completion of human anatomy courses in E-learning modality. After detecting initial diagnosis of the learning retained by students, seen as insufficient, we applied a system of practical and face-to-face tutoring after the period social distance.

Our results showed encouragement of study guided face-to-face anatomy practical classes allowed students to have a collective formation intrinsic the teaching-learning process, in turn, was based on a systematized clinical vision from practical classes using preserved anatomical specimens. Furthermore, this allowed to partially solve learning gaps left by e-learning, during social distance.

Thus, modern anatomy teaching is more effective when there a combination of pedagogical resources, which complement face-to-face practical teaching, in order

guarantee a multimodal approach. Therefore, our results suggest that e-learning should complement and not a substitute for practical teaching using real anatomical specimens and/or cadaver dissection.

CONCLUSION

Evidence showed that the system of classes in remote format weakened the learning process and retention of basic anatomical knowledge by medical students, a reality perceived in Phase I this study. Other side, face-to-face practical teaching proved to efficient in the students' formative process; a fact proven by significant increase students' scores in questionnaire 02, after systematized tutoring. The mentoring scheme adopted allowed greater autonomy of the student in morphological teaching process, as well acquisition of professional skills such teamwork, interpersonal skills, self-awareness, and practice medical ethics with real specimens and cadavers.

DA SILVA, N. M.; BRITTO, A. M.; PORTO, A. P.; GUERRA, L. M. M.; COSTA, H. M. G. S.; AQUINO, A. C. Q.; ANDRADE, M. F.; MAIA, A. M. L. R. & CAVALCANTI, J. R. L. P. Proceso de enseñanza-aprendizaje de estudiantes de medicina con piezas anatómicas reales: una estrategia práctica de intervención. *Int. J. Morphol., 41(3)*:705-710, 2023.

RESUMEN: La pandemia por COVID-19 provocó varios cambios en la enseñanza de la anatomía humana, entre ellos el uso de diferentes metodologías de enseñanza basadas en E-learning. Sin embargo, los estudios que evalúan las herramientas electrónicas no han proporcionado evidencia clara de un aprendizaje efectivo de los estudiantes. Este fue el primer estudio que evaluó a estudiantes de medicina luego de cursar cursos de anatomía humana en la modalidad E-learning. Reclutamos estudiantes de medicina de primer término (Grupo A, n=25) y segundo término (Grupo B, n=13). Se aplicó una evaluación práctica basada en 50 marcas de anatomía humana sobre especímenes anatómicos reales y cadáveres, para ser completado en el Cuestionario 01 (Fase I). Tras detectar puntuaciones bajas en el Cuestionario 01 por parte de ambos grupos, se aplicó un sistema de tutorías prácticas y presenciales durante 14 días (Fase II). Posteriormente, reevaluamos ambos grupos repitiendo las mismas puntuaciones (Cuestionario 02, Fase III). Según el análisis apareado de los cuestionarios 01 y 02 por la prueba T de Student, ambos grupos mostraron aumento significativo en los puntajes finales obtenidos en el cuestionario 02 (Fase III). La evidencia mostró que el sistema de conferencias en formato remoto debilitó el proceso de aprendizaje y retención de conocimientos anatómicos básicos por parte de los estudiantes de medicina. Por otro lado, la docencia práctica presencial demostró ser eficiente en el proceso formativo de los alumnos, hecho que demuestra el aumento significativo de las puntuaciones de los alumnos en el cuestionario 02, para ambos grupos.

PALABRAS CLAVE: COVID-19; Enseñanza de la anatomía; Aprendiendo; Estudiantes; Educación Médica de Pregrado.

REFERENCES

Araújo Júnior, J. S. D.; Cardoso, L. M.; Silva, A. F. D.; Morais, M. G. D. F.; Araújo, A. S. P. R. D.; Oliveira, T. B. S. D.; Costa, R. R. O. & Lucena, E. E. D. S. The teaching of human anatomy in the context of medical education: a historical retrospective. *Res. Soc. Dev., 9(7)*:e958975173, 2020.

Chytas, D.; Piagkou, M.; Salmas, M. & Johnson, E. O. Three-dimensional digital technologies in anatomy education: Better than traditional methods, but are they better than cadaveric dissection? *Clin. Anat., 34(8)*:1122-3, 2021.

Drake, R. L.; McBride, J. M. & Pawlina, W. An update on the status of anatomical sciences education in United States medical schools. *Anat. Sci. Educ., 7(4)*:321-5, 2014.

Franchi, T. The impact of the Covid-19 pandemic on current anatomy education and future careers: A student's perspective. *Anat. Sci. Educ., 13(3)*:312-5, 2020.

Iwanaga, J.; Loukas, M.; Dumont, A. S. & Tubbs, R. S. A review of anatomy education during and after the COVID-19 pandemic: Revisiting traditional and modern methods to achieve future innovation. *Clin. Anat., 34(1)*:108-14, 2021.

Khasawneh, R. R. Anatomy education of medical students during the COVID 19 pandemic. *Int. J. Morphol., 39(5)*:1264-9, 2021.

Kim, C. Y.; Park, J. S.; Lee, J. H.; Ha, H. M. & Chung, B. S. Effects of open board lecture videos on anatomy. *Int. J. Morphol., 40(4)*:1117-22, 2022.

Martinez, E. G.; Padrón, R. R. & Villalba, P. J. The students' point of view on the teaching of anatomy at the Universidad del Norte, Colombia, amid the Covid-19 pandemic. *Int. J. Morphol., 40(1)*:46-50, 2022.

Rahiem, M. D. H. The emergency remote learning experience of university students in Indonesia amidst the COVID-19 crisis. *Int. J. Learn. Teach. Educ. Res., 19(6)*:1-26, 2020.

Rodríguez-Luengo, M.; Goset-Poblete, J.; Pérez-Cárdenas, N.; Niklander-Ebensperger, S. & Luengo-Mai, D. Perception of teachers and students about the experience in the use of the Hyflex model in anatomy. *Int. J. Morphol., 40(5)*:1253-60, 2022.

Rojos, F.; Stambuk, M.; Neyem, A.; Farfán, E. & Inzunza, O. Cloud-based mobile platform to enhance the learning experience in human anatomy. *Int. J. Morphol., 39(4)*:1153-9, 2021.

Ross, C. F.; Pescitelli, M. J.; Smith, H. F. & Williams, J. M. Teaching anatomy with dissection in the time of COVID-19 is essential and possible. *Clin. Anat., 34(8)*:1135-6, 2021.

Saverino, D. Teaching anatomy at the time of COVID-19. *Clin. Anat., 34(8)*:1128, 2021.

Souza, A. D.; Kotian, S. R.; Pandey, A. K.; Rao, P. & Kalthur, S. G. Cadaver as a first teacher: A module to learn the ethics and values of cadaveric dissection. *J. Taibah Univ. Med. Sci., 15(2)*:94-101, 2020.

Stambuk-Castellano, M. S.; Contreras-McKay, I.; Neyem, A.; Inzunza, O.; Ottone, N. E. & del Sol, M. Gamified educational software platform: experience with anatomy students at Universidad de La Frontera. *Int. J. Morphol, 40(2)*:297-303, 2022.

Zargaran, A.; Turki, M. A.; Bhaskar, J.; Spiers, H. V. M. & Zargaran, D. The role of technology in anatomy teaching: striking the right balance. *Adv. Med. Educ. Pract., 11(1)*:259-66, 2020.

Zhang, X.; Yang, J.; Chen, N.; Zhang, S.; Xu, Y. & Tan, L. Modeling and simulation of an anatomy teaching system. *Vis. Comput. Ind. Biomed. Art., 2(1)*:8, 2019.

Corresponding author:
Prof. Dr. José Rodolfo Lopes de Paiva Cavalcanti
Laboratório de Neurologia Experimental
Faculdade de Ciências da Saúde FACS/UERN
Rua Miguel Antônio da Silva Neto, S/N
Mossoró-RN/
BRAZIL

E-mail: rodolfolopes@uern.br