

# Active Methodologies in Teaching Human Anatomy: An Integrative Review

**Paola de Lima<sup>1</sup>, Denis Guilherme Guedert<sup>2</sup>, Renata Sousa e Silva<sup>3</sup> and Gilberto dos Santos Cerqueira<sup>3</sup>.**

<sup>1</sup> Postgraduate Program in Morphofunctional Sciences, Faculty of Medicine, Department of Morphology, Federal University of Ceará, Fortaleza, Brazil. University Center for the Development of Alto Vale do Itajaí, Rio do Sul, Brazil.

<sup>2</sup> Postgraduate Program in Morphofunctional Sciences, Faculty of Medicine, Department of Morphology, Federal University of Ceará, Fortaleza, Brazil. University Center of Brusque, Brusque, Brazil.

<sup>3</sup> Postgraduate Program in Morphofunctional Sciences, Faculty of Medicine, Department of Morphology, Federal University of Ceará, Fortaleza, Brazil.

## Abstract

*Human anatomy is one of the fundamental disciplines for the training of health professionals, especially in the medical field. Its didactic origin is based on the European school where the body was dissected in amphitheatres and anatomical knowledge was transmitted from the teacher to his students. With the restructuring of medical curricula, and the use of active methodologies, seeking to make the student the center of the learning process, anatomy started to be taught in another way. This study carries out an integrative review in the Scielo, Science Direct and Google Scholar databases, from 2015 to 2020, about the active methodologies used in the teaching of human anatomy for the medical course. The PICo strategy was used to form the guiding question and the results were presented through the Prisma Flow diagram. It was found that there are a number of tools and strategies that can be used aiming at the active teaching of human anatomy, however, a common point observed in most works is the approach of joint use with cadavers and anatomical parts, thus seeking to stimulate the development of the skills and competences of medical students.*

*Keywords:* human anatomy, teaching, active methodologies.

## Introduction

Human anatomy is considered one of the sciences that form the cornerstones of medical education, being of paramount importance for the performance of students' practical skills (Ruzycki et al., 2019). The way of teaching anatomy has undergone changes in the last 20 years, going from a traditional model to a more mixed, multimodal approach (Estai & Bunt, 2016; Rhodes et al., 2018). Its teaching, like any other field, requires constant review and analysis to determine the most appropriate tools for learning (Estai & Bunt, 2016).

Traditionally, the teaching of human anatomy was based on dissections of cadavers and didactic

lectures. Currently, due to curricular changes, new strategies are taking place, “passive” learning opens space for the introduction of new methods to actively involve students (Woodcock et al., 2019).

In view of this scenario, the application of active methodologies within teaching has been increasingly encouraged. According to Bonwill and Eison, (1991) active methodologies are teaching methods in which students are encouraged to actively participate in the learning process, having different levels of learning, depending on the student's involvement (Bonwell & Eison, 1991).

Different active methodologies have already been applied in several areas of teaching, including human anatomy (Entezari & Javdan, 2016). These methodologies vary according to their purpose, and may be focused on developing students' three-dimensional perception skills (Carlson et al., 2019; Fairén González et al., 2017), stimulating competitiveness in a playful way (Burlison & Olimpo, 2016) or even stimulate work in small and / or large groups (Bruno et al., 2016; Martínez & Tuesca, 2014; McBride & Drake, 2016).

There is a scarcity of studies aimed at compiling active teaching methodologies applicable within classroom teaching. Thus, this study was developed in order to fill this gap in the literature with regard to bibliographic reviews addressing this topic within the teaching of anatomy. In this way, access to the search for methodological alternatives to improve the teaching of human anatomy can be facilitated for teachers and students. In addition, many of these methodologies can be applied within remote education, which makes this topic very relevant during the period we are facing, with the Covid-2019 pandemic, since higher education institutions are private classroom teaching. Based on these premises, the objective of this work was to carry out an integrative review of the articles published between 2015-2020 on the active methodologies applied in the teaching of human anatomy in the medical course.

## **Method**

In this study, the active methodology was chosen as a research theme from the perspective of teaching human anatomy. To prepare the guiding question we use the PICO Strategy, which can be used to construct different types of research questions, avoiding unnecessary searches. It is based on an acronym where the letter "P" means population / patient, the letter "I" means intervention / interest, the letter "C" means comparison / context and the letter "o" means outcome (C. M. D. C. Santos et al., 2007). Therefore, the question was defined as: What are the active methodologies used in the teaching of human anatomy in the medical course? What is the relevance of using active methodologies for teaching human anatomy in the medical course?

An integrative review was then carried out with the theme of "Active methodologies applied in the teaching of human anatomy". An integrative review consists of a comprehensive review method that allows the inclusion of several types of study, such as experimental and non-experimental studies in order to synthesize knowledge to understand the topic or phenomenon (Souza et al., 2010).

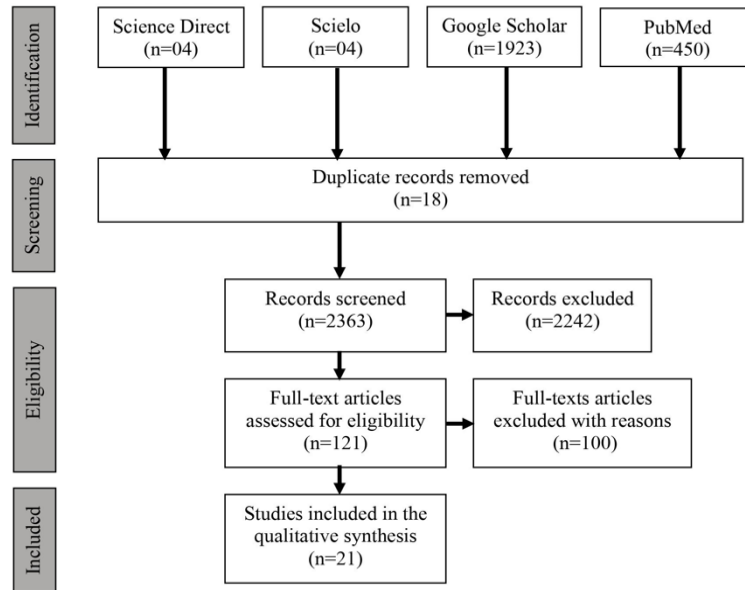
To collect the articles used in the integrative review, a search was conducted in the following databases: Scielo, Science Direct, PubMed and Google Scholar, with the following combinations of words "Active learning" and / or "human anatomy".

The inclusion criteria used were: (i) quantitative and qualitative articles, published in Portuguese,

English or Spanish (ii) articles related to the theme “methodologies in teaching anatomy in the medical course” and (iii) articles published between the years of 2015 and 2020. The exclusion criteria used were: duplicate articles and outside the study theme, theses, dissertations, monographs, abstracts, languages not listed in the inclusion criteria and review articles. Figure 1, called Prisma Flow, presents more detailed information about the selection, inclusion and exclusion of the works researched in the databases.

**Figure 1**

Flow diagram of study selection for the integrative review.



Adapted from Moher et al. (2009). n = number of articles.

After selecting the articles, considering the objective of answering the guiding question of this study, we sought to extract the information from the chosen publications, considering: author and year, objective of the work, main outcomes, conclusions and magazine. Finally, the discussion of the works found with the data collection was exposed.

**Results**

**Table 1**

Summary of studies included in the integrative review.

| <b>Autor e ano</b>                 | <b>Objetivos</b>   | <b>Principais desfechos</b>   | <b>Revista</b>                          |
|------------------------------------|--|---|---|
| Freitas Félix <i>et al.</i> , 2019 | Evaluate the use of clinical cases in the Orthopedic Based Learning Problem (PBL) to facilitate the learning of the anatomy of the locomotor system. | The consolidation of knowledge using the PBL favors the early development of other essential skills, such as reflection on the importance of the discipline and the development of its articulation capacity in an integrated manner with themes effectively used in future | Revista de Medicina e Saúde de Brasília |

|                                   |  | professional practice.  |  |
|-----------------------------------|--|---|--|
| Ransom <i>et al.</i> , 2017       | Evaluate the general satisfaction of students with the use of the Problem Based Learning (PBL) in teaching anatomy.                          | Students valued PBL as a learning tool, specifically due to the benefit of pre-class research, small group discussion and interactions between teachers.  | Medical Science Education.                 |
| Yan <i>et al.</i> , 2018          | To study the effects of the team learning method (TBL) on anatomy in students from the People's Republic of China.                           | The students in the TBL group had higher scores in the evaluations, in addition to obtaining significant improvement in communication skills, generalized execution, cooperative, knowledge extension, mobilization and enthusiasm.   | Advances in Medical Education and Practice |
| Eladl and Jarradi, 2020           | Present a new intervention in practical use based on team learning (PTBL) in anatomy and its impact as a tool to provide immediate feedback. | The study suggests that the PTBL enables students to identify their gaps, in addition to increasing their knowledge through peer discussions. An additional benefit noted was that weaker students could join other students, generating cooperative learning.<br>He observed the students' positive response to the teacher's immediate feedback on anatomy learning, suggesting active and effective learning for teaching anatomy. | European Journal of Anatomy                |
| Veeramani <i>et al.</i> , 2015    | To evaluate the perception of first year medical students about the interactive neuroanatomy session using the inverted classroom method.    | It promoted the active learning process and increased its performance capacity in the tests, when compared to the traditional methodology.  | Anatomy and Cell Biology                   |
| Anantharaman <i>et al.</i> , 2019 | Compare the traditional teaching method with the peer-assisted learning in the teaching of osteology.  | There was a great difference in the score before and after intervention in the group, practically using the peer instruction method, when compared to the traditional teaching group, indicating that the method is effective for teaching.   | Surgical and Radiologic Anatomy            |
| Sacdalan, 2017                    | Using the peer-assisted study  | The results showed an improvement in the scores of students practicing  | Journal of Interdisciplinary               |

|                              | session method in human anatomy students.  | the method.   |                               |
|------------------------------|--|---|-------------------------------|
| Lazarus <i>et al.</i> , 2016 | Evaluate the method of peer-assisted learning using the handoff concept.   | The students stated a positive impact on the application of peer-assisted learning. However, the students affirmed a negative impact on the handoff process, which raised the questioning of knowledge, quality of dissection and accuracy in the transmission of knowledge within the groups formed by the peer-assisted learning. However, it was able to significantly promote learning.                       | Anatomical Sciences Education |
| Manyama <i>et al.</i> , 2016 | To evaluate the opinion of teachers and students of the medical course on traditional teaching and methodologies of peer-assisted learning in dissection. In addition, compare the performance of students before and after applying the proposed methodology. | The students showed improvement in their grades after applying the peer-assisted learning. They observed a greater probability of reading the dissection manual before participating in the peer-assisted learning, when compared to the traditional methodology. The participating teachers affirmed a better atmosphere and greater participation during the class with the peer-assisted learning methodology. | Medical Education             |
| Oakes <i>et al.</i> , 2019   | Use the Jigsaw method (learning, collaborative) as a means for teaching anatomy of the abdominal region.   | Evaluation made through questionnaires (pre and post intervention), where after the intervention there was an improvement in the performance of students regarding the theme. It is also a collaborative method of content related to anatomy, influencing students in a motivational way.  | Anatomical Science Education  |
| Rehorek and Siebert, 2019    | To evaluate an alternative method for teaching musculoskeletal anatomy through the construction of   | It suggests that the use of paper models is a viable and economical teaching tool for teaching anatomy. The active practice of building models motivated students in the search for knowledge.  | HAPS Educator                 |

|                            |   |  |   |
|----------------------------|---|--|---|
|                            | three-dimensional paper models.   |  |   |
| Dixit <i>et al.</i> , 2018 | Evaluate the innovative modeling method for teaching afferent and efferent pathways in neuroanatomy.                  | The activity promoted a positive attitude and good coordination among peers with the increase in communication skills. He found that learning in small groups was better than didactic classes in neuroanatomy.  | Journal of Clinical Neuroscience              |
| Guy <i>et al.</i> , 2017   | Check the use of concept maps by students, to improve knowledge retention.  | Concept maps acted as active learning tasks at a deep level, as students agreed that maps help their thinking skills, allowing them to identify deficiencies in their learning, as well as helping to understand how anatomy can be related to a real life situation . | Advances in Physiology Education              |
| Matos <i>et al.</i> , 2019 | Describe the design, development and evaluation of the educational game called LabMorfoQuiz.                          | Participants reported feeling challenged and satisfied, in addition to indicating that they would recommend the game to their colleagues. However, it was identified that the items related to social interaction, had a lower evaluation.                             | Revista Novas Tecnologias na Educação         |
| Tat <i>et al.</i> , 2018.  | To evaluate the possible association between the use of games in teaching anatomy and the grades of medical students. | Students who used the games began to better identify the structures, when compared to those who did not participate in the games. The students stated that the idea of having fun while attending class was positive, feeling more motivated to study.                 | Clinical Anatomy                              |
| Roy <i>et al.</i> , 2017   | Observe the effectiveness of using quiz to improve the academic performance of medical students.                      | The students showed a positive response to the application of the quiz, motivating them to study and improving their interaction with teachers. In addition to providing group integration.  | International Journal of Anatomy and Research |
| Kolla <i>et al.</i> , 2020 | Evaluate the use of virtual reality in teaching anatomy compared to traditional teaching methods.                     | The subjects of this study reported that virtual reality facilitated the learning of names and locations of structures and anatomical relationships in 3D. There was a great preference for the  | Medical Science Educator                      |

|  |   |  |  |
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|  |   | use of this methodology, instead of lectures and cadaveric dissection.   |  |
| Ferrer-Torregrosa <i>et al.</i> , 2016 | Evaluate the use of augmented reality (AR), videos and notes in teaching anatomy from the inverted classroom methodology.                           | The use of AR showed a better result in the applied tests, followed by videos and notes. The students opted for AR as the best method to maintain focus during the study, also showing an improvement in the three-dimensional understanding of the structures. The students also stated that the use of AR facilitated their ability to understand the subject without requiring the presence of the teacher. | Medical Education                            |
| Santos <i>et al.</i> , 2020            | Understand how computer-aided learning (ASC) can influence the performance of medical students in the discipline of anatomy.                        | The students' performance was better in the groups that used ASC, when compared to the groups that did not use this methodology, both in the teaching of musculoskeletal and cardiovascular anatomy.   | Anatomical Sciences Education                |
| Fernandez-Alemán <i>et al.</i> , 2016  | Present the mobile tool (i-SIDRA) that could be used by medical students to obtain feedback on tests.   | Students who used i-SIDRA performed better in the final exams. They also positively evaluated the use of this resource, demonstrating their satisfaction with the content contained therein and the teaching methodology.  | International Journal of Medical Informatics |
| Soares and Mendes, 2019                | To present the experience report of the use of smartphones, QR code generator and Google Forms in favor of teaching the brain stem in Neuroanatomy. | It was identified the use of the smartphone in favor of the construction of knowledge, favoring communication and teacher-student integration in a collaborative way. It was also possible to verify the weaknesses and remedy them later in the classroom. The disadvantage presented was access to the device, and the internet.   | Revista Docência no Ensino Superior          |

Source: Elaborated by the authors

## Discussion

### ACTIVE METHODOLOGIES USED

#### *Problem-Based Learning (PBL)*

Problem Based Learning (PBL) developed in 1969 at Mc Master University, is a teaching style that



allows students to learn and master knowledge with technical applications. This method requires students mediated by the teacher to find essential information and apply it to a certain problem, with guidance from tutors or facilitators (Ransom et al., 2017).

Thus, the method seeks to motivate students to be proactive, so that they become agents for the acquisition of their own knowledge and thus can better understand reality. In addition, it promotes an environment of cooperative discussion by creating an exchange of knowledge between peers, developing a critical sense between the theoretical foundations and the resolution of problems (Neves et al., 2018). When applied to the teaching of human anatomy, it enables the application of knowledge to clinical practice, becoming a beneficial environment for medical education (Freitas Félix et al., 2020).

### ***Team Based Learning (TBL)***

The concept of Team Based Learning (TBL) was introduced as an educational modality by Larry Michaelsen in 1970 at the University of Oklahoma and has been adopted by several medical educators. TBL is an active learning strategy that allows students to apply their knowledge through small group discussions (Yan et al., 2018). The method involves team management, carrying out conceptual preparation and application tasks, feedback and evaluation among peers (Michaelsen et al., 2004).

The TBL method applied to the teaching of Anatomy facilitates the identification of gaps in the teaching and learning process, in addition to enabling immediate feedback from the teacher (Eladl & Jarradi, 2019). It is not only positive in the student's cognitive development, but also in enthusiasm, the ability to learn by initiative, communication skills and teamwork (Yan et al., 2018).

### ***Inverted Classroom - Flipped Classroom***

This pedagogical proposal provides a teaching practice different from that presented in the traditional anatomy model, where the student's role is summarized in: listening, recording and observing, with few opportunities for interaction and questioning. The inverted classroom uses the same time as the traditional classroom for self-study, with recorded lessons, material readings, videos, etc. Thus allowing the time in the classroom to be devoted to discussion and problem solving, creating an environment for active learning, in addition to promoting improved performance in student evaluations (Veeramani et al., 2015).

Studies have shown that the use of this methodology in human anatomy has been able to achieve the teaching objectives and provided students with a better understanding of the content (Veeramani et al., 2015). In addition, it can be used in association with other methodologies, such as virtual reality (Ferrer-Torregrosa et al., 2016). However, it requires good preparation of study materials by the teacher, so that the student can feel directed and prepared for further discussion (Veeramani et al., 2015).

### **Peer instruction**

Learning based on peer instruction proposes a change in teacher-student and student-student interaction, combined with the use of technologies. This learning method has been effectively used in several educational environments, standing out in medical training and also in human anatomy (Anantharaman et al., 2019).



The original method was developed by physicist Eric Mazur, whose main objective is to draw students' attention to the basic concepts of the content, encouraging students to interact with each other throughout the course, making a series of presentations on key points, followed by brief discussions and quick tests that can be used through the computer (Bulut, 2019).

Among the benefits, the prominence of the apprentice in the face of cognitive conflict stands out, where students must strive to convince their colleagues, breaking the monotony of instruction promoted by the traditional method of human anatomy (Anantharaman et al., 2019; Bulut, 2019).

### ***Anatomical modeling***

Traditionally the teaching of human anatomy uses cadavers, however, there are a number of tools such as anatomical models, software, illustrations, among others, that can be used to promote their teaching. Professional anatomical models are often expensive, requiring the teacher to look for cheaper alternatives, such as using clay or assembling models on paper (Rehorek et al., 2019). Although there are several alternatives to teaching anatomy, most authors agree that the use of the corpse is still ideal, allowing the student to have a three-dimensional relationship of structures, texture, and flexibility in handling (McDaniel & Daday, 2017; Rehorek et al., 2019).

### ***Concept maps***

Concept maps consist of the graphic representation of two or more dimensions of a series of concepts, constructed in such a way that the relationships between them are evident. The use of concept maps for active learning, offers students the possibility to make relationships between the information presented, facts and concepts. This interaction between the student and his study material, when carried out with intrinsic interest and motivation, characterizes what is called deep learning (Guy et al., 2017). The theory of concept maps is based on the constructivist proposal, more properly said in Ausubel's theory about meaningful learning (Neves et al., 2018).

In sciences such as anatomy and physiology, concept maps are interesting tools to be worked with students, as they allow the association of basic information of the discipline with clinical knowledge, when worked in association with case studies (Guy et al., 2017).

### ***Gamification***

The use of games as an educational method is a very old concept, being initially seen during classes taught by Plato and Socrates (Bigdeli & Kaufman, 2017). This gamification can occur from games developed within the classroom and quiz applications, either in person or from the use of applications.

The application of gamification within the teaching of anatomy encourages initiative, memorization and understanding of the contents, improving their performance in evaluations. In addition to these benefits, this methodology provides feedback for both students and teachers. Studies have pointed out this active methodology as presenting excellent results for students, who encourage the continuity of these activities, but as a method of complementarity with other teaching methodologies (Matos et al., 2019; Roy et al., 2017; Tat et al., 2018).

### ***Virtual reality***

With the evolution of technology, students have increasingly adapted to their use, such as internet, 3D games, cell phones, among others (Ferrer-Torregrosa et al., 2016). Virtual reality (VR) has received a lot of attention within teaching in the medical field, being very useful for understanding three-dimensional structures (Kolla et al., 2020).

Its application can be made using VR as a way of viewing images (Kolla et al., 2020). Another way that can be applied is associated with other methodologies such as flipped classroom, presenting video classes associated with the study by this technology (Ferrer-Torregrosa et al., 2016). Its use in the teaching of anatomy has shown a positive result, suggesting an improvement in the spatial understanding of structures and content (Ferrer-Torregrosa et al., 2016; Kolla et al., 2020).

### ***Technologies and E-learning***

E-learning is a methodology that has been applied in distance learning, being increasingly encouraged in person. This teaching methodology can be applied within the classroom, using cell phones, tablets, smartphones, Google forms, QR codes, among others (Soares & Mendes, 2019). In addition, digital platforms can be used on which students can access outside the classroom, encouraging the process of continuing education (Fernández-Alemán et al., 2016; Santos et al., 2020).

Soares and Mendes (2019) demonstrated that using the smartphone inside the classroom stimulates the construction of knowledge, improves the teacher-student relationship, making the class more attractive and with a better feedback system (Soares & Mendes, 2019). The use of these tools for active methodologies has been shown to improve the performance of students in classroom activities in addition to being able to also provide feedback to teachers and students (Fernández-Alemán et al., 2016; Santos et al., 2020). These methodologies still have their limitations, related to the need for and the student to have a smartphone and access to the internet, however they still have positive points that encourage their use.

## **Conclusion**

In this research, we sought to synthesize, through an integrative literature review, information related to methodologies active in the teaching of human anatomy. Through the reviewed research, it suggests that in medical education, especially the teaching of anatomy has undergone curricular changes that led to the introduction of new pedagogical strategies that actively involved its students, encouraging the process of continuing education and improving the student-teacher relationship.

It can be observed that it may be possible to apply active methodologies for teaching anatomy and that they seem to favor cognitive development, performance in evaluative activities, engagement in classes, motivation, interdisciplinarity, cooperation and communication skills of the students. In addition, these methodologies do not present risks for their application and their limitations can be handled by the teacher.

However, it is necessary that the teacher, considered in the active methodologies as a facilitating mediator, understands the development and applicability of each technique to achieve the expected learning objective. Another relevant aspect to be considered is that the different methodologies have different

learning purposes and, therefore, they must be analyzed by the teacher before their application in the classroom. Thus, for the application of these methodologies to be successful, the entire educational environment needs to be welcoming, open and creative, making the process centered on the student, so that skills for professional and personal life can be developed, consequently generating significant learning.

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