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Best teaching methods of anatomy courses: A review paper

Shabnam Mohammadi[1*], Alireza Fazel[2]
[1, 2] Department of Anatomy and Cell Biology, Faculty of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran

Abstract
Anatomy is considered as one of the most important subjects of general medical sciences and the knowledge helps a lot diagnosing and treating diseases. This course is difficult for most students and difficult to memorize. So far, various methods have been evaluated in prestigious universities around the world for easier and deeper teaching of anatomy. This paper reviews the best methods of anatomy teaching, including the use of cadaver / prosection, plastination models, the use of cross-sectional images, concept maps, clinical examination, painting, collaborative methods, the use of 3D software, film and mobile, virtual reality, augmented reality, mock and gamification. The study results showed that each method can be useful according to the facilities. For example, in cases where there is a shortage of bodies, prosection or plastination models can be used. For new generation students, using gaming methods and 3D software can be beneficial. Anatomical painting as well as conceptual mapping can be especially effective for postgraduate students.

Keywords: teaching, anatomy, e-learning, review, students

1. Introduction
Anatomy is the basis of medical education. Accurate learning of the anatomy of the human body by medical students is essential for understanding the state of the human body. According to reports in the UK, about 33% of individuals' complaints after surgery have been caused by damage to the surrounding [1-2]. This has attracted the attention of the authorities of the medical education system of this country regarding the more accurate teaching of anatomy. For most students, anatomy is an incomprehensible subject that is difficult to memorize and forget quickly. The teaching of this course should be such that it leads to a better understanding and communication between the learned content and applications in the clinical course of students. The classes should be held in such a way that the student is an active member of learning, and for this purpose, students should be encouraged to learn anatomy in different ways [1-2]. The use of different methods for easier teaching and faster recall of content has long been of interest to professors. Regarding anatomy teaching, various methods have been evaluated in prestigious universities around the world. In this paper, we have attempted to collect and present effective methods from the perspective of researchers and professors.

2. Research Method
This study was a review of various papers collected from various databases, such as Google Scholar, Magiran and SID. The national and international papers were reviewed. The content was categorized, noted and presented in the form of a paper.

3. Results
3.1 Cadaver Dissection/ Prosection
Cadaver dissection is known as the gold standard for anatomy teaching. Anatomy is the observation and touch of vascular tissues, nerves, ligaments and the surrounding by the student. The body is not only effective on anatomical teaching and understanding of the structure of the human body, but also helps learning clinical examinations and surgical procedures. It is also useful for preparing students to study pathology and diseases. Surgery by a surgeon is impossible without working on a real body [3]. A study reported that both teaching and cadaver mannequins are useful in teaching chip piping teaching and can lead to an increase in scores after anesthesia assistants teaching, and cadaver such as teaching mannequins can be used in chip plumbing teaching in academic centers [4]. The use of cadavers also increased anatomy knowledge and surgical skill of residents from 50% to about 84% [5].
Collin (2008) found prosections useful for anatomy teaching [6]. Prosection is part of a cadaver such as limbs. Some organs, such as the heart and arteries, are deep in the chest and abdomen, and layer dissection and region are impossible, and the system-based dissection is better. Therefore, in these cases, prosection is used more than dissection [7]. In addition, prosection requires less time and cadavers [8].

3.2 Plastination
Plastination is a unique way to store anatomical samples for anatomical teaching and research. Plastination samples are used for anatomy, neuroanatomy, pathology and radiology teaching. The scientific value of using plasticized bodies and organs in educational settings such as medical and paramedical anatomy classes is undeniable, because students can easily touch and work with samples prepared in this way. These samples can also be examined from all angles or compared with other samples. For example, organs can be displayed together under normal and pathological conditions to make it easier to understand the disease process. Plastination samples are very effective tools for body anatomy studies. For example, in types that require better understanding of MRI sections, plastination sections of the organs will be very useful [9-10]. Latorre reported that students were satisfied with the teaching of anatomy by

plastination models and found them useful for anatomy teaching [11].

3.3 CT Scan and MRI

In a study, Teichgraber *et al*. used abdominal and pelvic ultrasonography to improve anatomy teaching of medical students [12]. Ghorbani proved that teaching of sectional images, while helping improve the student's ability to detect three-dimensional structures further helped the stability of anatomical information in the mind [13]. MR and non-invasive imaging were introduced, which are of great value for evaluating anatomy and changes in veins at different ages and subsequent measures [14]. The study results of Paech *et al*. showed that the score of students who were trained by CT scans and radiology images was higher than that with radiology or dissect images alone [15].

3.4 Concept map

A conceptual map is a tool that connects a set of concepts logically and leads to in-depth learning. In this tool, the concepts become more specific from top to bottom, in other words, the general concepts are at the top of the map and the minor concepts are at the bottom of the map. The concept map is a regular presentation of the keywords of the lesson content that the student can identify and place in a hierarchical structure [16-17].

Rendas *et al*. reported that the use of the concept map significantly improves learning. They stated that problem-solving and conceptual mapping learning is a complementary tool [18]. Similarly, Boxtel *et al*. used concept mapping as a group activity to increase learning [19]. Gonza´lez *et al*. reported that physiology students who had been trained with a conceptual map performed better than the traditional method group [20]. The critical thinking scores were also higher in one group of nursing students trained by conceptual mapping than in the other group [21].

3.5 Clinical examination

Boon *et al*. showed that the use of 4 components of physical examination (observation, touch, percussion and hearing) was useful for teaching superficial anatomy to students, and this teaching method helped understand the basics of anatomy [22-23]. Camm *et al*. in a study on the cardiac hearing centers reported that teaching hearing centers was not only helpful in improving the quality of hearing sounds, but also in diagnosing non-medical sounds of the heart [24]. A report by Kumar *et al*. on children's residents shows that 73% of residents were able to distinguish abnormal sounds from natural ones [25]. In addition, teaching superficial anatomy to students before clinical examinations increased students' ability and efficiency [26].

3.6 Painting

Painting is one of the low-cost methods of teaching that requires careful observation and recording on a paper. Painting has helped artists look closely and reflect on their views [27]. Nevertheless, painting has received less attention as a tool to help spread and stabilize complex concepts in teaching. Jariyapong *et al*. reported that the anatomical knowledge of students who used painting to learn anatomy was much deeper than that of others [28]. Professor Abraham considers Leonardo's paintings as accurate as the scientific work of a modern artist. He drew what he saw [29].

3.7 Cooperation

The cooperative learning method is one of the active teaching methods that has a positive effect on learning and has been considered useful by Pinto-Souza *et al*. (2019) for teaching the human body anatomy [30]. Using this method, students' motivation and active participation increase. The cooperative learning method leads to the student social growth. This type of learning is derived from a sense of be together and the human cooperation. The cooperative learning method is based on the ability to work together, and is a way for students to learn to work together to achieve a joint objective and coordinate their activities effectively.

3.8 3D software

One of the relatively new teaching methods is the use of e-learning. E-learning is a wide range of software applications and information technology-based learning methods, including computers, CDs, networks, the Internet, the Intranet, and etc., that can be taught to anyone at any time, for life.

Khoshvaghti *et al*., in their study entitled "Study of the Effect of an Innovative 3D Model on Learning Tympanum Anatomy", concluded that computer 3D images are effective on learning tympanum anatomy [31]. Van Nuland recommended using Netter's 3D Interactive Anatomy software to teach anatomy. The study results of Mitrousias *et al*. also showed that teaching by a three-dimensional method was better than prosection method for first-year students, but no difference was observed in satisfaction between the two methods [33].

3.9 Mobile-learning

One of the methods of e-learning is teaching using mobile, which has been developed significantly today and widely used as a new method of teaching in the world's major universities [31]. The younger generation, and especially students, have a strong desire to hear or view multimedia files using this device. Since almost all students today have a cell phone, the role of this device in promoting teaching and learning anatomy can be examined. Mobile can play an effective role in promoting teaching and learning anatomy lessons due to its pervasiveness, desirableness, ability to be with a person, attractiveness, and reproducibility [34]. Zare Bidaki *et al*. consider mobile content learning to be very popular among students, and Papzan and Sulaimany report this teaching method as more effective than lecturing [35-36].

3.10 Film and DVD

Roozbehi *et al*. proposed the positive effect of training videos and computer CDs as teaching aids for teaching anatomy to students. They stated that more information are transmitted in this way and are more attractive [37]. Aclands DVD and 3D anatomical software such as Primal Picture are also effective on teaching anatomy [38].

3.11 Virtual reality

Regarding the advance of technology and the modernity of the virtual reality setting, individuals can continue the learning process alone and do not need to attend training classes at a specific time and in a specific place. Virtual Reality is the human effort to draw the border between real space and virtual space. In other words, virtual reality technology is the experience of being fully immersed in a

virtual and digital setting and completely ignoring the physical world. In this technology, using VR glasses, users can be in a virtual setting and benefit from the ability to change the setting around them. Moro *et al*. compared the three methods of virtual reality, augmented reality, and tablet-based applications. The results showed that all three methods, especially virtual reality, were effective on teaching skull anatomy to medical students, although virtual reality caused headaches, dizziness and blurred vision in some students [39].

3.12 Augmented reality

Augmented Reality is a live, direct, or indirect physical view that adds elements to individuals' real world. The augmented reality is somewhat similar to virtual reality, which is completely simulated by a simulator. In fact, the difference between virtual reality and augmented reality is that in virtual reality, all the elements understood by the user are made by the computer. But in augmented reality, part of the information that the user understands exists in the real world, and part is made by the computer. In a study, augmented reality helped to improve the learning of neuroanatomy [40]. Augmented reality has been introduced as a magic mirror and has been shown to be effective on teaching anatomy in studies [41].

3.13 MOOC

One example of a new generation of e-learning that has emerged and developed in recent decades is Massive Open Online Course (MOOC). This content is designed for a number of students, and individuals can access training materials, group discussion tools, and online assessment through the Internet. Using this method, it is possible to communicate by the interactive network [42]. Hossain *et al*. reported that MOOC was effective on teaching spinal cord injury to physiotherapy students [43]. De Castaneda *et al*. pointed to the effect of MOOC as an innovative tool on teaching infection prevention and control [44].

3.14 Gamification

Gamification is the use of natural motivators to move the audience. Work games include trends that change students' enthusiasm and involvement in learning and increase the efficiency of teaching and learning. In teaching, gamification allows using interesting and innovative methods inside and outside the workplace instead of bored and tedious classes. The advantage of games in teaching is that they are very fun, simple, understandable and with no time, space or individual limitations. Studies have shown that the use of game concepts for the design of teaching has a positive effect on individuals' participation in various activities, and the use of virtual advantages makes individuals more cooperative. The use of gamification in teaching facilitates social interactions and increases problem-solving ability. Felszeghy *et al*. designed Kahoot game software to teach histology to first-year students, which increased students' motivation and interest [45].

4. Conclusion

The study results showed that each method can be useful according to the facilities. For example, in cases where there is a shortage of bodies, prosection or plastination models can be used. For new generation students, using gaming methods and 3D software can be beneficial. Anatomical painting as well as conceptual mapping can be especially effective for postgraduate students.

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