

## The Possible Innovation in Teaching and Learning Anatomy

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### Abstrak

Cara dan alat belajar mengajar mengalami kemajuan pesat pasca pandemi COVID-19. Kemajuan ini meliputi proses belajar mengajar anatomi. Beberapa inovasi yang dikembangkan akhir-akhir ini adalah dengan menggunakan pembelajaran berbasis web, kelas virtual, realitas virtual, realitas tertambah, realitas campuran untuk diseksi (studio anatomi), realitas alternatif, pencetakan 3D, simulasi ketelitian tinggi, antarmuka manusia-komputer secara imersi/teknologi haptic, tutorial dari media sosial, kecerdasan buatan/robot humanoid, dan stereoskopi 3D. Teknologi-teknologi tersebut mempunyai kelebihan dan kekurangan dibandingkan dengan pembelajaran anatomi dengan menggunakan mayat. Kelebihannya adalah proses belajar mengajar dapat dilakukan secara virtual tanpa ada batasan tempat dan waktu. Ini sangat berguna di masa pandemi COVID-19. Namun, teknologi dan peralatannya memerlukan banyak pemeliharaan dan pembaruan sehingga memerlukan pendanaan dan upaya. Terkadang, mungkin terjadi ketimpangan dalam mengakses teknologi karena masalah keuangan. Diseksi kadaver memungkinkan siswa merasakan konsistensi tubuh manusia secara real-time, termasuk ukuran dan perasaan untuk pengalaman keterampilan bedah awal. Teknologi yang lebih baru dapat digunakan sebagai tambahan selama proses tersebut. Kesimpulannya, kemungkinan penerapan inovasi dalam pembelajaran anatomi sangat besar. Satu metode mungkin saling melengkapi untuk pembelajaran dan pengajaran komprehensif yang lebih baik.

**Kata Kunci**— anatomi, pembelajaran, pengajaran, teknologi

### Abstract

The ways and tools of teaching and learning are improving greatly after the COVID-19 pandemic. This progress includes the anatomy teaching and learning process. Some innovations that have been developed lately are by using web-based learning, virtual classroom, virtual reality, augmented reality, mixed reality for dissection (anatomy studio), alternate reality, 3D printing, high-fidelity simulation, human-computer interface in immersion/haptic technology, tutorial from social media, artificial intelligence/humanoid robots, and 3D stereoscopy. Those technologies have their strength and weakness compared with learning anatomy by cadavers. The strength is the process of learning and teaching can be done virtually without any border of places and time. It is very useful during the COVID-19 pandemic. However, the technologies and the tools need a lot of maintenance and updates which need some funding and effort. Sometimes, there might be inequality in accessing the technologies due to financial problems. Cadaveric dissection enables students to feel the real-time consistency of the human body, including the size and feeling for the early surgical skill experiences. Newer technology can be used as an add-on during the process. In conclusion, the possibility of implementing innovation in teaching and learning anatomy is very vast. One method might complement each other for better comprehensive learning and teaching.

**Keywords:** anatomy, learning, teaching, technology

## 1. Introduction

The COVID-19 pandemic has changed the ways of delivering study materials in medical teaching, including anatomy. Anatomy comprehensive learning needs a lot of practical sessions to enrich the knowledge and experiences of the students. Therefore, teachers should think about another way of delivering the practical session materials into the online classroom. The practical session material in anatomy comprises cadaveric dissection, bones, and specimens of organs. Various advanced technology techniques are used nowadays to make the lesson more interesting [1].

Based on the 2007 government review of Australian medical education, it was found that the medical students felt the sense of inadequacy. This negative feeling arose because the students were concerned about the sufficient anatomy knowledge. The knowledge is taught differently in the past [2].

Modern medical education system should adapt with the rapid expansions in medical science knowledge development. The medical students should be prepared how to be responsive to the medical needs of the society. The programs should be designed to teach the graduates how to practice safely and effectively. Therefore, clinical practice is the fundamental focus of education, including anatomy. Based on the rapid changes in the health system, medical, the medical students should be taught how to be adaptive and flexible [2].

Some innovations that have been developed lately are by using web-based learning, virtual classroom, virtual reality, augmented reality, mixed reality for dissection (anatomy studio), alternate reality, 3D printing, high-fidelity simulation, human-computer interface in immersion/haptic technology, tutorial from social media, artificial intelligence/humanoid robots, and 3D stereoscopy. Those technologies have their strength and weakness compared with learning anatomy by cadavers. The strength is the process of learning and teaching can be done virtually without any border of places and time. It is very useful during the COVID-19 pandemic. However, the technologies and the tools need a lot of maintenance and updates which need some funding and effort. Sometimes, there might be inequality in accessing the technologies due to financial problems. Cadaveric dissection enables students to feel the real-time consistency of the human body, including the size and feeling for the early surgical skill experiences. Newer technology can be used as an add-on during the process [1]. This paper aims to describe the possible innovation in teaching and learning anatomy.

## 2. Method

This paper is a narrative literature review. Literatures were searched from PubMed, Google Scholar, and Science Direct. Publication date is within 10 years. Unavailable full text journals were excluded. Literatures were read twice to reduce bias. Keywords used were anatomy, learning, teaching, technology. The narrative literature review category was considered as a weakness of this paper.

## 3. Result and Discussion

The previous anatomy teaching which uses the blackboard method and overhead has evolved into virtual dissector, 3D models, and online remote learning during the COVID-19 pandemic. These new methods are important for laying a foundation for the next generation doctors in the future. Understanding the complexities of the human anatomy is very critical for the preparation of being a good doctor [1].

The role of the teachers to facilitate the learning process with various technologies. The technologies are not new modalities. The introduction of these contemporary educational technologies is not entirely new; but in the current environment, their significance has expanded dramatically. As a result, anatomy teachers need to stay current with emerging technology in medical education. The way that students learn has also changed significantly over time. The students are quite computer aware and comfortable using a variety of devices to learn anatomy. They are currently updating their dissection skills by watching YouTube videos, utilizing different learning tools, and going to online workshops. New additions to help students understand anatomy include an anatomy studio, virtual dissectors, simulation labs, a radiography machine etc. [1].

Below are some innovative technologies for learning anatomy [3]:

#### **a. Endoscopic anatomy**

The most recent development in anatomy education is endoscopic anatomy, which offers students a completely different perspective on the human body. The method of body preservation made popular by the Egyptians has advanced to the point where a person can be preserved for centuries in a cryogenic chamber. I'm hoping a technique will one day allow us to reawaken the dead. Obtaining a body was a difficult undertaking both then and now. To address this issue, the majority of nations implement body donation programs. Religious groups in India encourage their members to donate their bodies for the benefit of medical education and research. The practice of donating one's body voluntarily is steadily gaining acceptance in society. The simple chalk and board method of teaching anatomy gave way to the use of 3D models, computerized dissection tables, PowerPoint presentations, and role plays today. A teacher today needs to continually update their knowledge of medicine by taking advanced courses. Webinars have become our new standard. They provide a useful and secure setting for meeting and exchanging opinions on current issues and novel approaches to anatomy [3].

Modern educators mentor and support the pupils in addition to teaching. Students have changed as well, no longer relying just on books to understand anatomy. To keep their skills up to date, they use YouTube, numerous applications, and hands-on workshops. The C-arm, ultrasound machine, and simulation labs are recent additions to learning anatomy. Endoscopic anatomy is the newest developing trend that teaches students more than just anatomical positions and offers a completely different way to view the body. The new competency-based medical education (CBME) curriculum is gaining popularity and has replaced the formal teaching of medical ethics in anatomy [3].

#### **b. Virtual reality**

Virtual reality/augmented reality/mixed realities are used for viewing the human body virtually. These technologies are growing well lately. The advantage of the methods is encouraging the visual learners to learn more and more in interesting ways. However, students are lacking of human interaction.

#### **c. Digital readers/tablets/ Mobile technology**

More and more, lighter digital textbooks that can be accessed on a tablet or smartphone are taking the place of larger, heavier hard-copy textbooks. Instead of outlawing the use of mobile devices in the classroom, some schools are integrating them into the teaching and learning process through educational apps. Positives: Because digital content is constantly updated, there is no longer a need to replace textbook copies every few years. These educational software programs provide for customization.

#### **d. 3D Printing**

Another more recent method for improving student learning is 3D printing (3DP), which includes scanning and printing anatomical structures from dissected specimens. The use of building organs and models that students can explore in order to interact and learn together is outstanding. Clinical anatomy training can make use of 3DP, particularly those that are challenging to visualize and difficult to see on cadavers (such as the brain's ventricles, sinus cavities, and middle ear bones) [4]. Although, in terms of the metrics examined, 3DP is noticeably superior to two-dimensional photographs. However, no study made a comparison between 3DP and student-performed corpse dissection. Results from the 3DP application in anatomy teaching were encouraging. However, the paucity of research reduces the efficacy of cadaver dissection. Therefore, 3DP might be useful as supplement for understanding the human anatomy beside cadaver dissection [1].

#### **e. Web-based learning**

Based on the anatomy education paradigm shift, the component of learning anatomy involves online web-based remote learning. Therefore, portable network devices become critical component in the learning process. An automated learning system is available abundantly for the source of self-directed learning. Online lecture schedule is available for learning sources. For example: zoom meetings, Microsoft teams, or google classroom. Courses are predominantly delivered online via zoom meetings, google classroom, Microsoft teams, etc. These new technologies might enhance the teaching and learning experiences. It

creates a better and more interesting integration between problem solving and learning activities. However, the online information should be screened to prevent inaccurate and missing information. [1]

#### f. Computer-based educational programs and technology

To ease the shift from the mostly didactic form of delivery to the primarily virtual one, computer-based educational programs are already in use. For instance, Elsevier's Complete 3D Anatomy instructional package was successfully used to teach functional anatomy during the epidemic. We may combine the dynamic 3D representations and creations with the voice recording tools to produce videos. These video lectures can be shared with a group of students directly through the program platform or connected to the learning management system (LMS). As a result of the visual, auditory, reading/writing, and kinesthetic (VARK) hypothesis, it also provides the kinesthetic benefit of learning [5], [6].

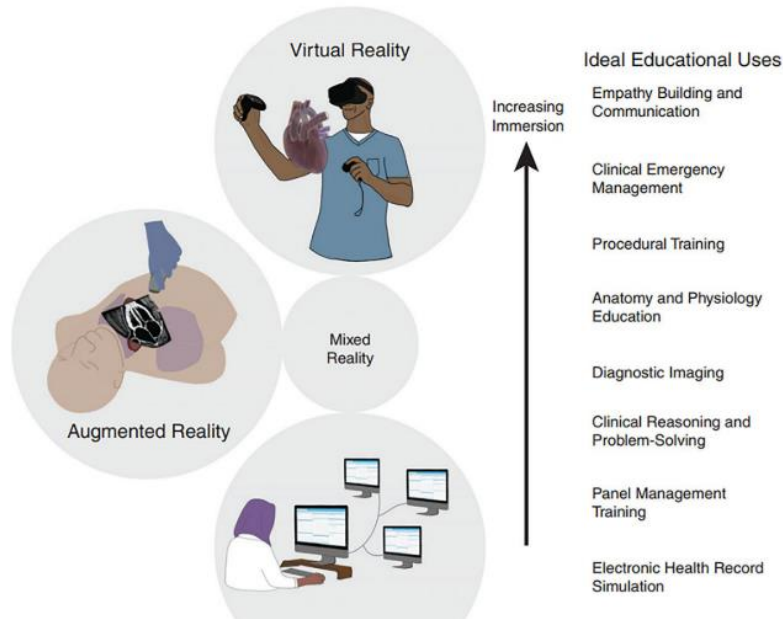


Figure 1. Representation of augmented reality and virtual reality [1]

#### g. Virtual classroom

The Learning Management System (LMS) or Virtual Learning Environment (VLE) is special systems to track the students' progress during the course. These systems can be used as media for communication between lecturers/teachers and students. The systems are also known as virtual classroom because lecture can be sent by broadcasts to the students. Anatomy is not taught by face to face method only, but it can also deliver by using information technologies. Learning habit might change due to changes of learning method. Modern teaching methods include using smart boards to create diagrams, linking videos (like ScholarRx and Osmosis films through an LMS), and using 3D visuals to engage students in the learning process. Modern anatomy lectures are more entertaining and not just a passive way to learn. Current online resources include the class schedule, teacher presentations, and test results. The majority of course delivery occurs online using an LMS or a Virtual Learning Environment (VLE) [7].

The LMS may be used to track students' actions, development, and compliance with course requirements. Additionally, it can help students and teachers communicate with one another. Many medical schools now offer lecture broadcasts to their students, enabling them to participate in the "virtual classroom" from anywhere at any time. These informational tools allow anatomy to "go beyond" lecture halls and dissection rooms [8].

#### h. Anatomy Studio

Anatomy Studio is a collaborative Mixed Reality tool for virtual dissection. It is a combination of visualization and contour drawing on 2D images.

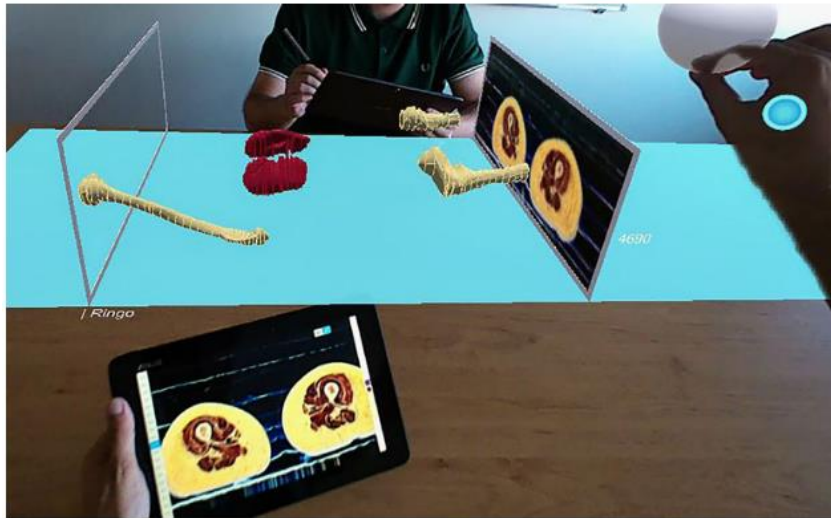


Figure 2. Anatomy Studio [1]

#### **i. Gamification**

##### **Quiz/crossword puzzles/snowball/fishbowl technique/ role plays for AETCOM modules**

In the classroom, gaming can be utilized to blend the fun elements of play with conceptual learning. The opportunity to receive fast feedback is one advantage, along with improved student involvement. The fact that not all games are successful at teaching every subject is a drawback, necessitating the creation of efficient game-based learning packages.

#### **j. Cloud Technology Flipped classroom and self-directed learning**

Digital textbooks, courses, videos, and assignments are stored and shared using the cloud. With the use of this technology, it is possible to use the 'flipped classrooms', a novel instructional strategy. In this method, students see a lecture in advance of class and engage in the discussion afterward. It is possible to engage in group projects and analytical exercises in a classroom context. Pros: It gives students immediate access to the teacher through live chat features and easy access to information from any internet-connected device.

#### **k. Magic Mirror**

A user interface method called "The Magic Mirror" imitates the appearance of a regular mirror while also providing nonphysical visual input in addition to the usual optical effect. A camera is used to capture the user's image, which is then displayed on a screen that resembles a mirror for the user. Advantages: It displays medical information overlaid on the user's body and provides additional 2D and 3D information based on their need. The concept of medical education and rehabilitation is expanded by this approach.

#### **l. Artificial Intelligence (AI)**

AI is utilized in the educational sector to automate feedback and grading. It offers chances for individualized learning. It offers deeper perceptions about a student's learning trends. Benefits: Less human resources are needed. by assessing assignments and providing feedback on their behalf, saves teachers' time.

#### **m. Science**

Advanced manikins are employed in simulated patient situations in this instructional technology. It is also referred to as a high-fidelity simulator or a human patient simulator. Benefits: Using this method, full-body manikins can be controlled by computers. These are set up to react realistically to the actions of the students. The manikins have speech, breathing, and sleep/wake cycles. These features are utilized to communicate structures, functions, symptoms, and medical knowledge more effectively.

## 5. Conclusion

The new technology should be seen as new method in learning anatomy. Therefore, adaptation and investment in new technology are needed. Many learning techniques and tools are accessible. The implementation of evidence-based teaching will be helpful in reaching the goals of curriculum-based medical education. The more active and collaborative method are preferable. The possible innovation in teaching and learning anatomy are web-based learning, virtual classroom, virtual reality, augmented reality, mixed reality for dissection (anatomy studio), alternate reality, 3D printing, high-fidelity simulation, human-computer interface in immersion/haptic technology, tutorial from social media, artificial intelligence/humanoid robots, and 3D stereoscopy. The contribution of this paper is providing some insights about the possible innovation in teaching and learning anatomy, especially in the era of advanced technology.

## Reference

- [1] A. Patra, A. Asghar, P. Chaudhary, and K. S. Ravi, "Integration of innovative educational technologies in anatomy teaching: new normal in anatomy education," *Surg. Radiol. Anat.*, no. January, pp. 1–10, 2022, doi: 10.1007/s00276-021-02868-6.
- [2] P. G. Mcmenamin, N. Eizenberg, Q. Fogg, and M. Lazarus, "A broad perspective on anatomy education: celebrating teaching diversity and innovations," *Med. J. Aust.*, no. September 2017, p. 950, 2016, doi: 10.5694/mja15.00796.
- [3] A. Sharma and A. Kumar, "Evolving trends in anatomy- A global perspective Evolving trends in anatomy- A global perspective," *Indian J. Clin. Anat. Physiol.*, vol. 8, no. 3, pp. 159–161, 2021, doi: 10.18231/j.ijcap.2021.037.
- [4] S. Shokoohi, A. H. Emami, and A. Mohammadi, "Medical Education Online," *Med. Educ. Online*, vol. 19, pp. 4–6, 2014.
- [5] A. Bhagat, R. Vyas, and T. Singh, "Students awareness of learning styles and their perceptions to a mixed method approach for learning," *Int. J. Appl. Basic Med. Res.*, vol. 5, no. 4, pp. 58–65, 2015, doi: 10.4103/2229-516x.162281.
- [6] H. R. Mozaffari, M. Janatolmakan, R. Sharifi, F. Ghandinejad, B. Andayeshgar, and A. Khatony, "The relationship between the vark learning styles and academic achievement in dental students," *Adv. Med. Educ. Pract.*, vol. 11, pp. 15–19, 2020, doi: 10.2147/AMEP.S235002.
- [7] V. Mavrych, "Modern Trends in Clinical Anatomy Teaching," *MOJ Anat. Physiol.*, vol. 2, no. 1, pp. 20–21, 2016, doi: 10.15406/mojap.2016.02.00035.
- [8] J. Owolabi and A. Bekele, "Implementation of innovative educational technologies in teaching of anatomy and basic medical sciences during the covid-19 pandemic in a developing country: The covid-19 silver lining?," *Advances in Medical Education and Practice*, vol. 12, pp. 619–625, 2021, doi: 10.2147/AMEP.S295239.