

Virtual Reality: A New Approach for Learning Anatomy

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Abstract

Virtual systems have revolutionized the way anatomy is taught in medical and health science schools. These innovative tools provide students with a more interactive and engaging learning experience, allowing them to explore the human body in ways that were previously impossible. By using virtual systems, students can visualize complex anatomical structures and understand their functions more easily. In this research a virtual reality web application using blender as a primary tool was designed. This study suggests that incorporating virtual reality technology into medical education can be an effective way to bridge the gap between theoretical knowledge and practical application. By providing students with a more immersive and interactive learning experience, they are better equipped to apply their knowledge in real-world scenarios. This research work has provided students with a virtual reality dissection web application that gives access to life-size digital cadavers of both male and female corpses that can be rotated, magnified, labeled, and dissected. Students can dissect, reconstruct, magnify, and transect regions and structures to understand anatomical shape and connections. They can also isolate structures in three dimensions.

Keywords: Virtual reality, anatomy, immersive, web application, blender.

Introduction

Anatomy is a fundamental subject for medical students, as it provides them with a comprehensive understanding of the human body's structure and function. It helps them to identify the different organs, tissues, and systems that make up the body and how they work together to maintain homeostasis (Darras *et al.*, 2019).

Anatomy is key to understanding the functions and relationships between different parts of the body. With a solid understanding of anatomy, medical professionals can diagnose the patient's condition, plan the most effective course of treatment, and identify any potential complications.

Without a thorough understanding of anatomy, it is impossible to diagnose and treat medical conditions accurately. Anatomy provides the foundation for understanding the structure and function of the human body, which is essential for identifying abnormalities and diseases. It also helps healthcare professionals to communicate effectively with each other about patient care. Anatomy is the foundation upon which medical science is built. Without a thorough understanding of the human body's structure, it would be impossible to diagnose and treat diseases or injuries effectively.

The importance of teaching anatomy cannot be overstated. It serves as the framework for medical practice, improving diagnostic abilities, developing new treatments, and communicating effectively with patients. Medical professionals must have a thorough understanding of the body's structures and functions to make informed decisions and provide efficacious care.

The best techniques for teaching anatomy are a major topic of discussion when it comes to the inclusion of anatomy instruction in medical curricula (Kerby *et al.*, 2011)

Statement of Problem

From a historical perspective, learning human gross anatomy by dissecting cadavers has been the most effective teaching method. However, as class sizes have grown and interest in anatomical exercises on cadavers among students, postgraduates, and specialists has exponentially increased, the number of bodies available is still insufficient to meet demand (Boscolo-Berto *et al.*, 2021).

In addition to the low availability of cadavers, Prolonged exposure to formaldehyde (which is a colorless, flammable, strong-smelling chemical that is used in building materials and to produce many household products as well as preservatives in mortuaries and medical laboratories) has been linked to an increased risk of cancer (Dan *et al.*, 2020).

Different methods of Teaching Anatomy

The conventional approach and the approach that is most frequently used is the chalk-and-board approach. Important phrases and words are written down on the chalkboard during lectures, and any required diagrams are also drawn there with chalk. The didactic lecture is as ancient as dissection in anatomy education and it is tailored to the learning goals of the students. It is described as a teacher giving a class of students a presentation of theoretical information. The conventional lecture method of instruction requires that students be present in a lecture hall or classroom at a specific time and place (Youssef, 2021).

Another method is Cadaver dissection method which has been used as the main method of teaching human anatomy for the last five centuries (Karau *et al.*, 2014). Despite the advancements in technology and the availability of virtual dissection software, cadaver dissection remains an essential component of medical education. It provides students with a hands-on experience that cannot be replicated through simulations or textbooks.

In the absence of cadaver dissection, prosected specimens (the use of pre-dissected cadaver specimens) have been extensively used to teach anatomy to medical undergraduate students. Unexpectedly, prior anatomical information affected short-term memory recall after prosection (Lackey-Cornelison *et al.*, 2020).

Plastined specimens are a great supplement to dissection because they are simple for students to use to gain a better topographical understanding of anatomical regions. Students can gain a better understanding of anatomical structures in connection to clinical diagnosis by using plasticated specimens to compare serially sectioned specimens to their corresponding MRI and CT images (Sora *et al.*, 2019).

Virtual dissection is an interactive computer simulation that models the internal anatomy of animals and humans without interacting with real organisms or tissues (these are not static photographs, movies, or animations that do not enable the viewer to participate). Students now have access to ground-breaking anatomical learning possibilities because of virtual dissection, also referred to as digital dissection. Virtual dissection has some advantages over cadaveric dissections. The virtual dissection is operated by touch or styluses and provides life-size digital cadavers of male and female bodies, which can be rotated, magnified, labeled, and dissected with virtual scalpels. Students can isolate structures in three-dimensional form, dissect, reconstruct, magnify, and transect regions and structures to appreciate anatomical form and relationships (Karkera, 2021).

Other methods of Anatomy teaching include; 3D Atlas, 3D painting, Ultra Sound imaging Plastic models, and Simulation.

There are various methods of teaching anatomy, each with its own advantages and disadvantages. Educators can choose the method that best suits their teaching style, resources, and students' needs. A combination of different methods can also be used to enhance the learning experience. Regardless of the method used, the goal is to provide students with a thorough understanding of the structure and function of the body, preparing them for careers in the medical field.

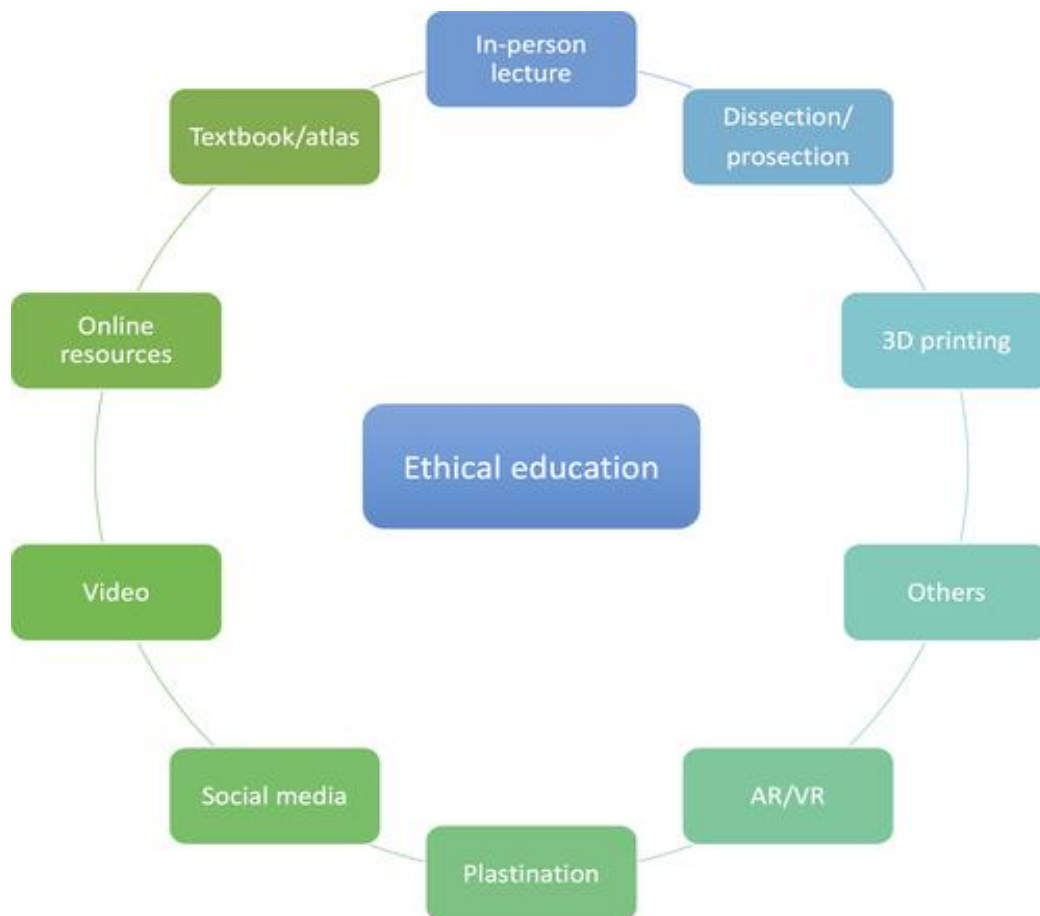


Fig 1: Different methods of teaching Anatomy

Methods

The virtual anatomy virtual dissection application which is presented in this paper allows for a more engaging and immersive learning experience, which could aid in retention of information and understanding of complex anatomical structures. The software development approach adopted for the system presented relies on the use of internet-enabled mobile phone features like touch screens to enable dissection. The web application focuses on the dissection of the Upper Extremity, Lower Extremity, Thorax and Abdomen, Head and Neck, Pelvis and Perineum and Back region.

Modelling Tools

Three tools were used for modelling of the Cadavers:

- **Blender:** All virtual cadavers were modelled using blender. With its user-friendly interface and powerful features, Blender has become a popular choice for creating everything from animated films to video game assets. Its compatibility with multiple operating systems also makes it easy to collaborate with others regardless of their preferred platform. Overall, Blender's accessibility and flexibility make it an excellent choice for anyone looking to get started with 3D creation or expand their existing skillset.
- **Vectary:** Vectary is an innovative platform that has revolutionized the way designers create and share 3D models. With its intuitive interface and powerful features, it has become the go-to tool for designers of all levels. Whether you are a beginner or an experienced professional, Vectary makes it easy to create stunning 3D models that can be shared with others online.
- **Vector Magic:** By using Vector Magic, the design background was removed with precision and converted into a vector format. This allowed for a more flexible and scalable design that could be easily imported into Blender for further manipulation. With the vectorized design, it was possible to round up the edges and refine the details of the image, resulting in a more polished final product. The use of Vector Magic not only saved time but also ensured that the design maintained its quality throughout the entire process.

System Database and User Interface

The user interface was designed using hypertext markup language (HTML), javascript, jquery, cascading style sheet (CSS) and bootstrap. The database was designed using PHP and SQL.

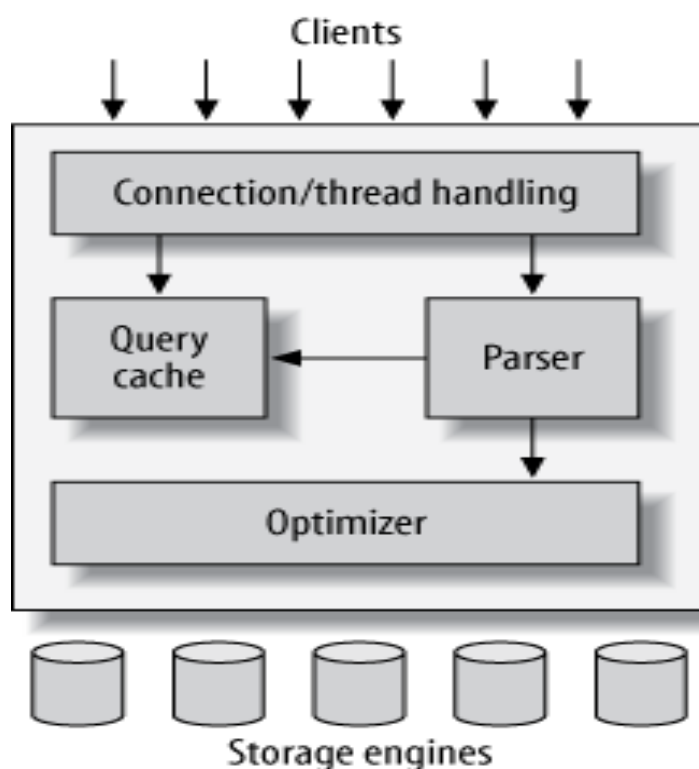


Fig 2: A systemic view of the MySQL server architecture (Source: High Performance MySQL)

Results

The ultimate goal of this research was to create an innovative and interactive way for students to learn about human anatomy. By combining technology with traditional teaching methods, this research aimed to enhance the learning experience and make it more engaging for students. The user interface/layout was designed to be intuitive and user-friendly, allowing students to easily navigate through the virtual cadaver and access information on different parts of the body.

The 3D model created was a crucial component of this project, as it allows to accurately represent the human body in a digital format. By dissecting and assembling the virtual cadaver, students could gain a deeper understanding of how different organs and systems work together.

The MySQL database was used to store data on human anatomy, including information on different organs, muscles, bones, and other structures. This data could be accessed through the web application, providing students with a comprehensive resource for studying anatomy.

The segments were imported into Amira, and a surface model/polygon model was created, which was then smoothed in Mudbox. The smoothed polygon models were automatically retopologized into quadrilaterals in 3D Coat software, and a UV map was added. The textures of go structures were rendered realistically in Mudbox using photos of real tissue,

and then height maps, gloss maps, and specular maps were created to add more detail and realistic lighting to each structure.

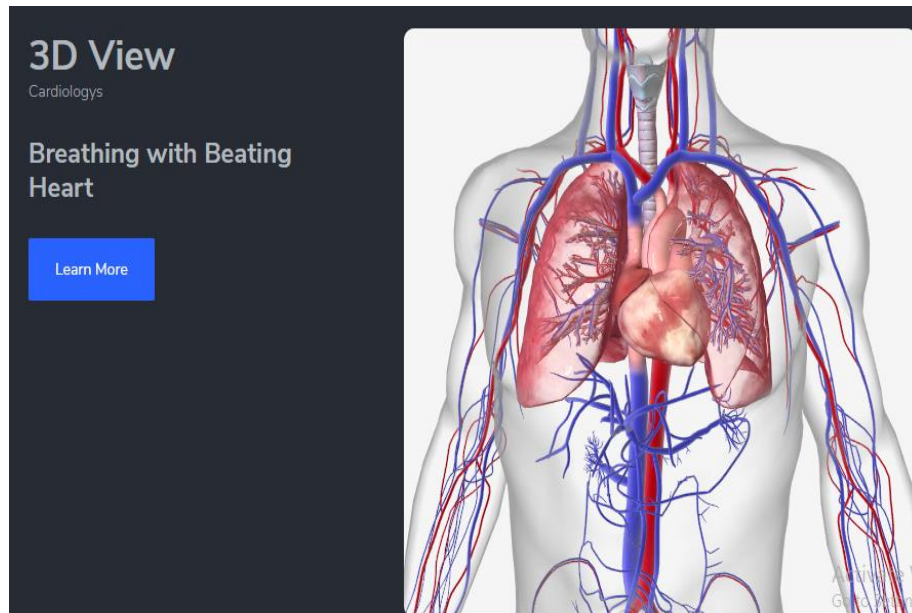


Fig 3: A modeled skeleton showing the vein and arteries with a beating heart (source: from the VR web application)

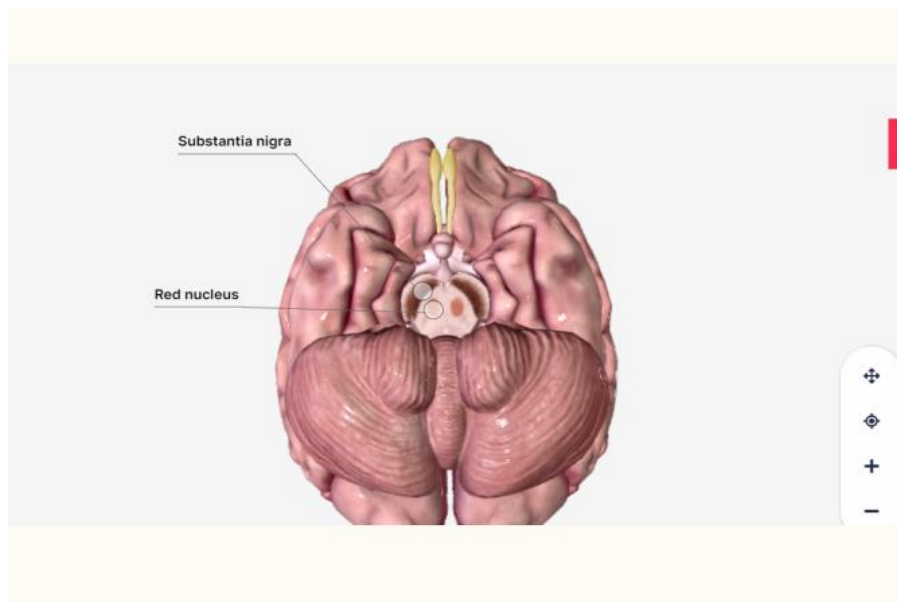


Fig 4: A cross section of the brain (source: from the VR web application)

Conclusion

Each method of education has its own advantages and disadvantages. Didactic lectures are useful for providing a broad overview of the subject matter, but they may not be as effective in helping students develop practical skills. Practical sessions based on models can help students gain hands-on experience, but they may not provide the same level of detail as

cadaveric dissection. Cadaveric dissection is considered the gold standard for anatomical education because it provides a realistic representation of human anatomy, but it can be expensive and time-consuming. Computer-based learning is becoming increasingly popular because it allows students to interact with 3D models and simulations.

The visualization of student learning materials made possible by this application helps to increase student interest in the topics of anatomy material learning. Students are more likely to want to use mobile applications with virtual reality technology as a supplement to learning and comprehending human anatomy.

The recommendation for a VR system on teaching anatomy should have certain features to create a comprehensive and engaging experience. The VR system should be interactive, providing options to explore the human body's various systems in diverse angles and layers. The system should also have a realistic representation of the human body, complete with its textures, colors, and shadowing, to provide students with a more lifelike and engaging experience. Adding sound effects can also enhance the learning experience and all of this has been provided with this new virtual reality design.

This research work has provided students with a virtual reality dissection web application that gives access to life-size digital cadavers of both male and female corpses that can be rotated, magnified, labeled, and dissected. Students can dissect, reconstruct, magnify, and transect regions and structures to understand anatomical shape and connections. They can also isolate structures in three dimensions.

Recommendation

A Virtual reality system with interactive features, a user-friendly interface, multiplayer support, high-end hardware specifications, and regular updates is recommended for teaching anatomy. By investing in this technology, tertiary institutions can provide their students with an immersive and engaging learning experience that enhances their understanding of the human body's structures and functions.

Conflict of Interest

The authors declares that there is no conflict of interest regarding the publication of this paper.

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