Anatomage

Conceptualize the Most Difficult Anatomy Concepts with 3D Visualization

Table of Contents

Introduction 2

What are 3D Digital Modeling and Simulation of Human Bodies? 2

Challenges in Teaching Gross Anatomy 4

1. Cardio Vascular System 4
2. Nervous System Pathways 5
3. Kinesiology 6

Conclusion 7

Visualize Life with the Anatomage Table 8

Academic Advantages of Anatomage Table 8's 3D Visualization & Simulation 9

"I profess to learn and to teach anatomy not from books but from dissections, not from the tenets of Philosophers but from the fabric of Nature."

—William Harvey

Providing essential knowledge to many medical areas, anatomy beyond a doubt helps students gain significant insights into anatomical variation, its structures, and roles in keeping our bodies alive. As one of the most significant components in gross anatomy is cadaveric dissection, anatomy educators and trainers pay special attention to ensure the accuracy and efficiency of the dissection materials including cadaveric specimens and anatomy models.

In the early 20th century, cadaveric dissection was often used as the main tool for human anatomy discovery & education. Given physical cadavers' limits, digital cadavers were developed allowing students and trainers to manipulate human bodies without the pressure of making an irreversible mistake.

Recently, an emerging issue around the lack of human specimens and cadavers has raised concerns about the accessibility of learning materials for teaching anatomy. This concern also pushes for a quest to look for technologies that help students to visualize, interact and study human bodies accurately.

What are 3D Digital Modeling and Simulation of Human Bodies?

Before, 3D anatomy modeling and simulation were utilized as an instrument to supplement lab activities in addition to cadaveric dissection. Gradually, as the technology continues to be innovated, their applications also become more versatile allowing them to resolve visualization challenges that physical cadavers can't.

One of 3D modeling's greatest benefits is its ability to provide accurate anatomy that is often taken from real human corpses. Digital reconstruction allows anatomy to be visualized in its original state, unlike human specimens where the tissue on the surface can be damaged and tarnished by chemicals or natural causes.

The terms "modeling" and "simulation" are often used simultaneously but they describe different processes. 3D modeling is a process in which raw data from human specimens or imaging files (MRI/CT) is extracted then reconstructed into 3D modeling of the organs, while the simulation refers to how the modeling process is executed. When it comes to anatomy visualization, simulation tools replicate a certain set of actions or behaviors that a human body produces.

For example, a heart's anatomy can be digitally modeled to examine the internal structures while its cardiac motions can be simulated to inspect electrical conduction.

Challenges in Teaching Gross Anatomy

Visualization is an important process in anatomy learning. Realizing each concept of anatomy can be digested differently, we asked a group of medical educators to list three anatomy concepts that students have trouble visualizing. Among the answers, the following topics are chosen to dive deeper into investigating the problem and determine any solutions to combat the associated academic challenges.

I. Cardiovascular System

According to a survey that targets 3,000+ teachers, more than 41.66% reported that the cardiovascular system is one of the most challenging concepts that students have trouble with visualization. These findings contradict the perception that the cardiovascular system is easier to learn since it is centered around the heart, one of the most commonly recognized organs in the human body.

Nonetheless, the respondents particularly specified that internal heart details and cardiac conduction are the two cardiological concepts that are hard to understand without visuals. This potentially suggests the difficulty of conceptualizing the heart's interaction and structural connection with blood vessels (arteries, veins). To help students make sense of various cardiac activities, teachers must ensure students' deep knowledge of the heart's structures.

Many teachers acknowledge that the internal anatomy of the heart might be too complicated to comprehend with textual descriptions only. Cardiac structures such as the internal cavity, heart valves, and heart walls may require spatial visualization to picture their tasks during the cardiac cycle. In addition, details around the electrical conduction are believed to be best processed with 3D visualization.

3D Modeling / Simulation Approach:

To improve students' ability to visualize the cardiovascular system, the adoption of 3D heart models is encouraged. In a 3D space, students can appreciate the depth, perspective, and spatial relations between the anatomical structures. Even so, 3D anatomy models aren't sufficient in illustrating the complex cardiac conduction. Plastic 3D models can't allow the inner workings of the valves, arteries, and veins to be inspected accurately during the cardiac cycle. To conceptualize the electrical conduction of a heart, medical students are usually taught using 3D simulation tools.

It's essential to visualize the normal cardiac electrical system to conceptualize how the heart works properly. This serves as a strong foundation to investigate and study abnormal cardiac rhythm conditions – like heart arrhythmias.

For instance, a report published by **Yenepoya Medical College surveying 145 medical students** demonstrates that the simulation-based teaching of cardiovascular operation successfully enhances medical learning and applications.

The college set up a learning environment consisting of four stations:

1. The first station included the Anatomage Table
2. The second station had an ultrasound simulator that allowed students to visualize cardiac hemodynamic
3. The third station had a human patient simulator in which students could learn about the electrical conduction system of the heart through detecting the abnormalities of cardiac rhythm in ECG
4. The last station also included a patient simulator that allowed students to perform a clinical examination of the cardiovascular system.

After completing the learning module involving interacting with these four stations, 84.30% of the students strongly agreed that the use of the Anatomage Table (specifically its 3D visualization capabilities) improved their understanding of cardiovascular anatomy. As a result, students could perform layer-by-layer dissection and photo-realistically visualize the spatial relations of internal anatomy structures in various 3D planes on the Table.

II. Nervous System Pathways

Widely regarded as the most complicated system in the human body, learning the nervous system involves knowledge of functional anatomy concepts. Given its critical roles in helping all body parts communicate and process almost all internal and external activities, the nervous system is undoubtedly an essential learning topic for medical students. Its extensive network and functions also make it the most demanding concept to learn.

Our Anatomage survey indicates that 27.00% of educators listed the nervous system as one of the most challenging anatomy concepts while 63.00% listed neural pathways and homeostasis as the most challenging functional anatomy concept. Additionally, the quantity of anatomy terminology can be one of the factors complicating students' learning process. According to a survey published by HAPS Educator (2018), the central and peripheral nervous systems contain at least 150+ terms in each category. The survey found that the central, peripheral, and autonomic nervous systems consist of many terms and details that might be hard to remember for undergraduate students.

When asked to identify some anatomy concepts that would benefit from 3D simulation technologies, 36.00% selected the nervous system and its conduction.

Potential reasons behind students' struggles with learning the nervous system might include:

- Lack of motivation
- Lack of relevant anatomy knowledge
- The inadequacy of instructional materials and learning boredom
- The absence of competent tools to visualize and learn the materials

3D Simulation Approach:

Efficiently learning the nervous system requires an integrative approach to activities which can be facilitated through traditional methods, virtual dissection, 3D anatomy, and functional anatomy simulation platforms.

Interelattedly, understanding functional anatomical notions of both the central and peripheral nervous systems involves more than just visualization. For example, to intellectually examine the central nervous system functions, students can rely on a 3D simulation tool to assist users in identifying which spinal nerve corresponds to each dermatome. Also, because the nerve system of the cerebral cortex might be challenging to visualize through the naked eye, some 3D simulation tools can help magnify nervous structures for better observation.

Furthermore, selected 3D visualization and simulation platforms provide annotated nervous structures that can assist in memorizing the structures better.

More importantly, 3D simulation presents insightful clinical applications to medical students. For example, determining the pain stemming from specific nerves or cortex regions requires an in-depth inspection of the comprehensive sensory and motor distribution of spinal nerves and 3D simulation enables such visualization.

III. Kinesiology

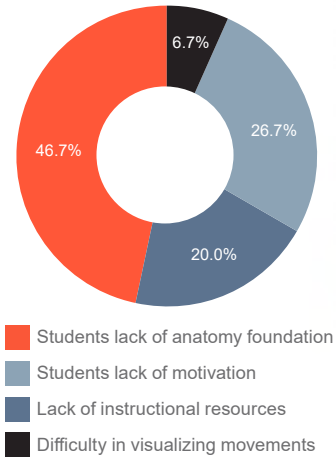
Compared to other medical sciences, kinesiology is often considered a “less challenging” discipline. Even so, 27.00% of the surveyed educators responded that muscle movement is one of the functional anatomy concepts that students have trouble with visualizing.

Interestingly, a separate survey by HAPS reveals that 46.70% of the surveyed educators believe that students’ lack of anatomy foundation prevents them from successfully learning Kinesiology. The difficulty of visualizing anatomical movements is also reported by 6.70% of the respondents.

This data correlates with findings in a study published by Youngstown State University - which acknowledges that the difficulty of learning kinesiology lies in the lack of basis for understanding how the body system works.

Specifically, the study concluded that one of the barriers preventing students from successfully learning kinesiology is the vast amount of information pertaining to muscles and their function. To truly understand the basis of kinesiology - in addition to identifying muscles - students must also recognize the impact (and functions) of muscles on anatomical movements.

What are some challenges you’re facing in your kinesiology teaching?



3D Simulation Approach:

With the subject heavily emphasizing anatomical movements, it’s crucial to integrate technology into the learning activities that allow students to accurately visualize how joints, bones, and muscles work together to generate motions.

For instance, a research study conducted at Université Claude Bernard Lyon, Villeurbanne survey introduced an integrative approach to teaching kinesiology with both 2D and 3D animation. The goal of this approach was to test the effectiveness of 3D animation in teaching kinesiology to first-year undergraduate students. To experiment with this approach, one of the two groups of students was given lectures in which the PowerPoint slides were embedded with 3D animation, while another group was given lectures with 2D drawings only.

According to the findings, 3D digital animation was reported to be more effective as instructional materials in allowing students to deeply understand spatial relationships between anatomical structures. 3D simulation can assist in visually interpreting the mechanism behind anatomical movements. Specifically, it allows for visualization of how the movements are generated by joints, muscles, and bones.

The simulation of the movements can also help differentiate the antagonistic pairs, as well as different types of anatomical movements:

- flexion/extension
- abduction/adduction
- internal/external rotation
- protraction/retraction
- elevation/depression directions

Conclusion

A crucial part of learning gross anatomy, 3D modeling and simulation enable both educators and students to engage with the anatomy materials in the most possible interactive manner. In addition to providing in-depth visualization of the human anatomy, it also offers visual insights into functional anatomy - which can't be done with physical cadavers.

Most importantly, 3D modeling and simulation technology simplifies the most complicated learning concepts by turning them into reality, allowing trainers to gain real-world clinical knowledge.

Visualize Life With Anatomage Table: Concepts to Reality

The goal of science is to allow us to discover, study and understand life to preserve, maintain, and further it.

And to understand life, we rely on the information that the human body offers us - from its structures, systems, and functions. Learning anatomy helps us to absorb these details academically.

Yet, the human body contains tremendous information that can't be digested efficiently using one medium. Whether it's books, cadaveric dissections, virtual anatomy, or physiology simulation, many approaches aim for one goal: turning learning concepts into reality.

Fostering this idea, Anatomage Table is developed to transform anatomy concepts into reality by helping users visualize "life" better.

From when life begins to when the heart beats, the body moves, functions, and suffers disease, the Anatomage Table captures the essence of life and translates it into technology that enables users to visualize, study and understand life better.

Recently, **Table 8** - the Anatomage Table's latest software - was released that makes it possible for users to interact with functional anatomy.

Academic advantages of Anatomage Table 8's 3D visualization & simulation:

Spatial Relationship

- Enables a better visualization of spatial relations between anatomical structures
- Improves spatial learning ability for students
- Assists in understanding and reading of MRI, CT and other imaging scans

Functional Anatomy Conceptualization

- Allows for visually conceptualizing challenging functional anatomy concepts that can't be obtained through cadaveric dissections
- Enhances the understanding of pathophysiological responses in a human body
- Provides accurate and realistic scientific insights into how the living human body acts, functions and responds

Clinical Applications

- Assists in inspecting pathological responses from real human bodies
- Enables access to clinical cases that contains common and rare diseases
- Allows for interaction and manipulation with MRI/CT scans

Interactive Learning

- Promotes an interactive learning space where 3D visualization and simulation is accessible
- Encourages students to collaborate with each other to explore the wonders of the human body
- Allows students to interact with living human bodies

Accurate Perception

- Makes it possible for students to visualize accurate human anatomy content
- Facilitates interacting with functional anatomy
- Allows for a highly insightful and accurate perspective into how anatomical systems work with each other

Cost Efficiency

- Enables institutions to reduce costs from cadaver maintenance
- Offers annual software upgrades that contain the most applicable anatomy content and simulation tools
- Helps institutions establish technological leadership within their community, improving student application rates

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About Anatomage

As a market leader in medical virtualization technology, Anatomage enables an ecosystem of 3D anatomy hardware and software, allowing users to visualize anatomy at the highest level of accuracy. Established in both education and healthcare industries, Anatomage is transforming standard anatomy learning, medical diagnosis and treatment planning through its highly innovative products.

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