

Navigating Veterinary and Human Anatomy Teaching

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Abstract

Beside the normal tools for studying comparative anatomy all over the world (Museum facilities, anatomy models, anatomical charts, Closed-circuit Television and virtual 3-D models), this article focuses on two new tools for teaching human and veterinary anatomy namely: the 3-D plastic printed models and using of AI and deep learning.

Keywords: veterinary anatomy teaching, 3-D plastic models, artificial intelligence (AI).

A paper was published in J. Vet. Anat. On "Teaching Veterinary Anatomy and Histology During Covid-19 Pandemic, Challenges and Solutions" (Saber, 2021). This paper focused on how it was managed, in Egypt, the official suspension of the study in the Universities since 14 March 2020. The challenges were: how to manage the lectures, how to prepare the practical lessons, and how to make the exams specially the practical ones.

The paper mentioned the different tools available including the anatomy

museums to teach anatomy avoiding the crowding of the students.

The normal tools for studying comparative anatomy all over the world are:

- Museum facilities which are a major source of learning anatomy for the students, as it displays dry specimens (bones, skeletons, anatomical models, anatomy charts, air-dried specimens, plastinated organs and sheets, plasticine plates, corrosion casts), wet specimens (formalin preserved organs and animals and cross sections, plastinated organs with different ways) as well as CDs and different anatomical images).
- Anatomy modules (bringing the various teaching materials together to enhance self-directed integrated learning).
- Lighted colored anatomical charts fixed on the walls in the halls, corridors of the museums and anatomy department areas.
- Some faculties installed Closed-circuit Television (CCTV) in the dissecting rooms to overcome the crowding and large number of the students around each table.

- Some faculties have Virtual 3-D model to teach cow anatomy. The 3-D model shows the skeleton, heart, lungs, four-chamber stomach, spiral colon, liver, gall bladder, kidneys, uterus and ovaries, as well as the major blood vessels. (University of Illinois, USA).
- Other faculties (Royal “Dick” School of Veterinary Studies) developed an equine simulator which contains large intestines and other organs made of latex. These can be inflated to photographs.

Two new tools for teaching veterinary anatomy in Egypt will be focused on in this essay namely: the 3-D plastic printed models and the using of the Artificial Intelligence (AI) and deep learning.

(1) The 3D printing Models

3D printing is the construction of a three-dimensional object from a CAD (Computer Aided Design) model or a digital 3D model. It can be done in a variety of processes in which material is deposited, joined or solidified under computer control, with the material being added together (such as plastics, liquids or powder grains being fused), typically layer by layer. (Wikipedia).

Beside the virtual reality (VR), Augmented reality (AR) and 3D modeling software as well as adaptive learning

systems which have emerged and enhanced the knowledge delivery to students as accurate, adaptive and real in many a cases, another 3D modeling method should be added i.e. 3D printed models.

This method of producing plastic comparative anatomical organs was introduced in some faculties (Figs. 1- 5)

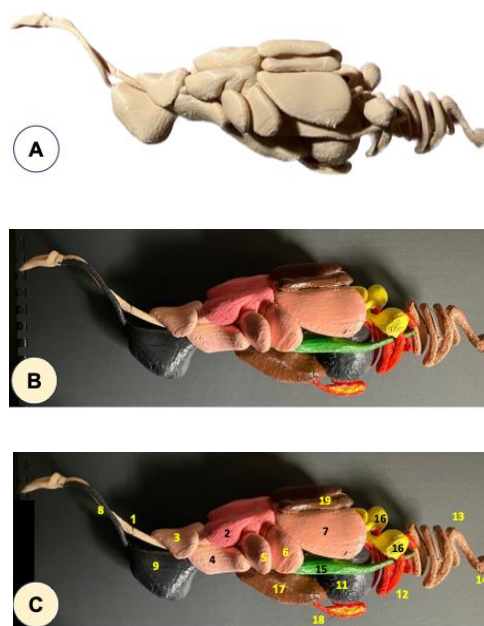


Fig. (1, a, b, c): 3-D Plastic Model of fowl's viscera, prepared and coloured by the author, kept in the Anatomy Museum of Faculty of Veterinary Medicine, University of Sadat City, Egypt

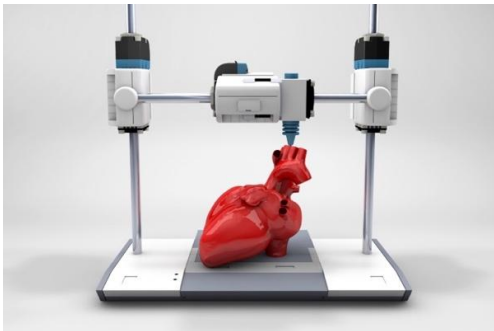


Fig. (2):3-D printer (Left), printing a heart model(right)



Fig. (3): some 3D plastic models (eye and heart) produced for comparative veterinary anatomy teaching



Fig. (4): some 3D plastic models (stifle joint, pelvic bone and muscles and hip joint and muscles) produced for comparative veterinary anatomy teaching



Fig. (5): some 3D plastic replicate human ear.

Using a 3D printer in teaching veterinary anatomy can be beneficial and innovative in several ways. Here are some potential benefits and technologies:

1. 3D anatomical models: Accurate 3D models of animals can be created, allowing students to study anatomical structures in greater depth. These

models can be modified to illustrate various anatomical aspects.

2. Hands-on training: A 3D printer can be used to create anatomical models that students can use for practical exercises, such as simulated surgery or studying internal structures.

3. Enhanced understanding: 3D models can help enhance students' understanding of the spatial relationships between different anatomical structures, leading to a deeper understanding of veterinary anatomy.

4. Personalized education: Custom models can be created to meet individual student needs or to represent unusual anatomical cases.

5. Cost savings: Using a 3D printer can be a more cost-effective alternative to using animal cadavers or traditional anatomical formalin-preserved or plastinated models.

6. Modernized educational curricula: Using a 3D printer can help modernize veterinary anatomy curricula to become more interactive and sophisticated.

7. Scientific research: 3D printing can be used in scientific research to create accurate anatomical models to study animal anatomy in new ways.

8. Interdisciplinary collaboration: The use of 3D printing can lead to greater collaboration between veterinary anatomists, engineers, and artists, leading to a more holistic approach to education and research.

(2) AI in Teaching Veterinary Anatomy

Recently, artificial intelligence (AI) platforms and systems integrations have exploded into being. It is too early to tell what influences AI may have on the educators teach and the way students learn, with its potential to influence the scaling, speed, and consistency of working, it seems highly likely that the use of AI in anatomy education will increase (Lazarus et al., 2022).

Artificial Intelligence (AI) is making a big impact on teaching veterinary (and human) anatomy by providing interactive immersive, and personalized learning experiences. Some key ways AI is being used include:

1) 3D Visualization & Virtual Dissection

a. AI-powered platforms like **Visible Body** and **Anatome** allow students to explore animal anatomy in 3D rotate structures, and “dissect” virtually without using real specimens.

b. Virtual reality (VR) and augmented reality (AR) enhance understanding by allowing hands-on interactions with digital models.

2) AI Tutors & Adaptive Learning

a. AI-driven system analyze students' progress and adapt lessons to focus on weak areas.

b. Chatbots and AI tutors provide instant feedback and answer questions on anatomy topics.

3) *Automated Image Analysis & Diagnostics*

AI assists in recognizing anatomical structures in radiographs, CT scans, and MRIs, helping students and professionals learn how to interpret medical imaging.

4) *Simulating-Based Learning*

a. AI-powered simulation allow students to practice procedures like ultrasounds, injections, or surgeries in a risk-free virtual environment.

b. Some AI models simulate physiological responses, giving a more realistic experience.

5) *Enhanced Research & Knowledge Access*

a. AI can summarize complex anatomical research making it easier for students to grasp difficult concepts.

b. AI-powered search engines (like Semantic Scholar) help students find relevant anatomy resources faster.

Some AI-powered tools teaching and learning veterinary (and human anatomy):

Examples of some AI-powered tools for teaching and learning veterinary anatomy will be pointed out in the following:

1) 3D Visualization & Virtual Dissectional

a. Visible Body (Fig.6): Offers 3D interactive anatomy models for animals and human.



Fig. (6): Visible Body and Virtual Dissectional tools for learning anatomy

b. Anatomage Table (Fig. 7): A virtual dissection table with detailed 3D animal anatomy.

- Anatomage offers a life-size digital representation of the human and the animal body, allowing the visualization, manipulation, and virtual dissection of complex anatomical structures, using detailed 3D (three-dimensional) models.



Fig (7): Anatomage virtual dissection table for human and veterinary anatomy

c. Zygote Body (fig. 8): Provides interactive 3D models of anatomical structures, mainly for human anatomy.



Fig (8): Zygote Body interactive 3D models for human anatomy

2) AI-Powered Learning Platforms

a. Elsevier's Complete Anatomy (Fig. 9): AI driven adaptive learning with detailed anatomical models.



Fig (9): Elsevier's Complete Anatomy platform for human anatomy

b. Bio-Digital Human (and Veterinary) (Fig. 10): Interactive 3D anatomy platform with AI-powered insights.



Fig (10): Bio-Digital human and veterinary anatomy 3D platform.

3) AI-Assisted Image Analysis & Diagnostics

a. Asteris Keystone (Fig. 11): AI-assisted veterinary imaging and radiology platform.

- Designed specifically for veterinary radiologists, this advanced technology provides detailed views of anatomical structures from multiple planes, facilitating accurate interpretations and informed decision-making in your clinical practice.

tations and informed decision-making in your clinical practice.

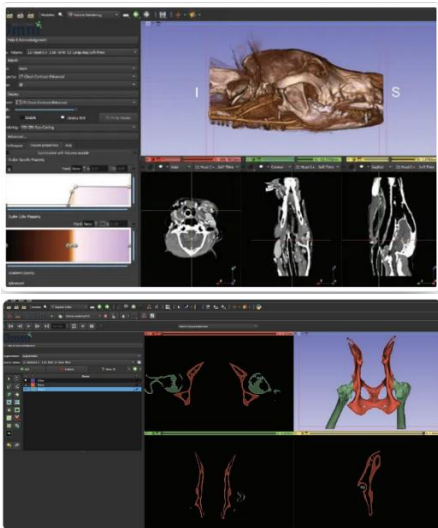


Fig (11): Asteris Keystone veterinary imaging and radiology platform.

b. VetCT (Fig. 12): Uses AI to assist in interpreting CT and MRI scans for veterinary students and professionals.

- Established in 2009 in Cambridge, UK, VET.CT provides vet-to-specialist clinical support services through tele-radiology, specialist consultancy services, and novel educational strategies for veterinary medicine.





Fig (12): Vet.CT provides vet-to-specialist clinical support services through teleradiology, and other veterinary consultancy services.

4) Index AI imaging- AI-powered diagnostics and imaging analysis for veterinary education.

5) Simulation-Based Learning

a. Symbionix Vet VR (Fig.13): AI and VR-based veterinary surgery simulations.



Fig (13): Symbionix Vet VR, veterinary surgery simulator.

b. Vet VR (Fig.14): A Vet VR learning tool for veterinary anatomy and procedures.

• Learning veterinary anatomy, especially the complex musculo-skeletal and neurovascular systems, can be a daunting task. Traditional methods using textbooks, 2D images, or static models often fall short in conveying the depth and intricacies of animal anatomy. VET VR Anatomy addresses this challenge by offering an immersive 3D experience that makes understanding anatomy easier and more efficient.

• By using VET VR, veterinary students and professionals save valuable time and energy, focusing on truly understanding anatomy rather than wrestling with outdated, static learning methods. VET VR brings anatomy to life, offering a modern, efficient solution to a traditionally difficult area of veterinary education.



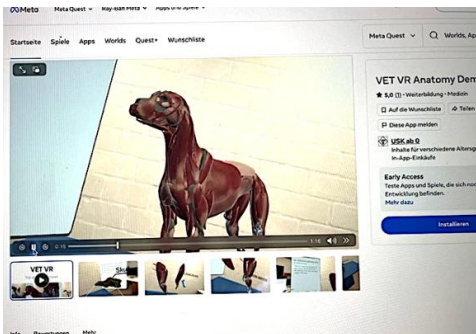
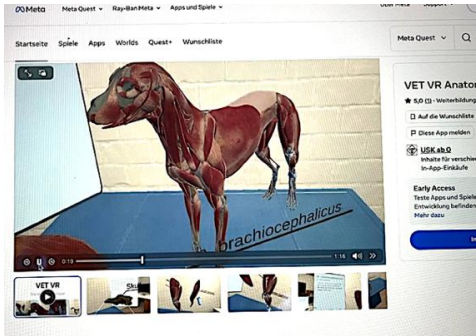


Fig (14): A Vet VR learning tool for veterinary anatomy and procedures.

6) AI Chatbots & Tutors

a. ChatGPT (Customized for Vet Med)- can assist with veterinary anatomy Q&A and case studies.

b. Quizlet AI Tutor (Fig. 15): Uses AI to creat custom anatomy flashcards. And quizzes.

- Quizlet has over 700 million flashcard sets created by students and teachers. Search to find relevant content for your class or if you would rather make your own, Quizlet makes set creation fast with Magic Notes or our predictive word and suggested images features.

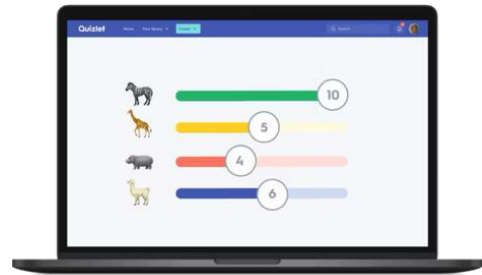


Fig (15): Quizlet AI Tutor for creating anatomy flashcards. And quizzes.

c. Anki with AI Plugins (Fig. 16): AI-enhanced spaced repetition learning for veterinary anatomy terms.

How to make flashcards with jungle Anki AI?

- jungle's advanced AI algorithms analyze your content and automatically create concise, effective anki flashcards, saving you hours of manual work.

- *import your study content*

upload your textbooks, lecture notes, or any study material you want to convert into anki flashcards. Jungle processes various file formats to extract key information.

- *review and export to anki*
quickly review the generated flashcards, make any necessary edits, and export them directly to your anki deck for seamless integration into your study routine.

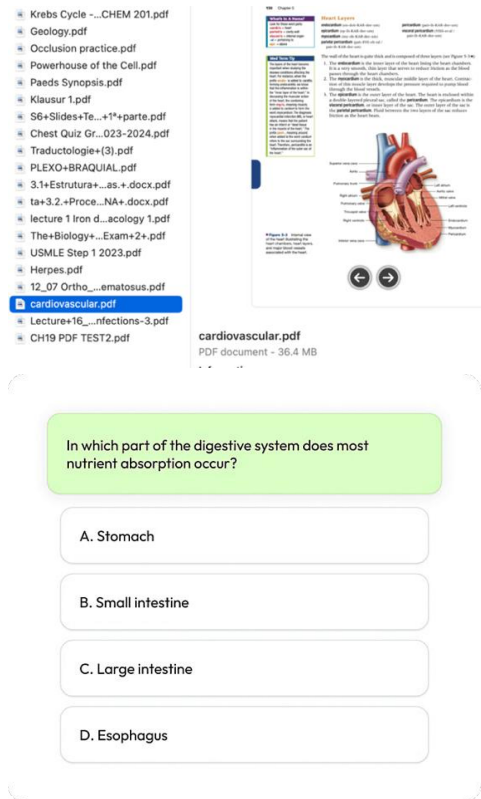


Fig (16): Anki with AI Plugins, converts textbooks and lectures notes to flash-cards

Free AI Tools for Veterinary Anatomy

1) AI Vet Coach

- AI Vet Coach is a specialized virtual assistant designed to support and enhance the learning experience of students interested in veterinary science.
- Its primary function is to engage users in educational activities through interactive games, quizzes, and scenario-based exercises.

- AI Vet Coach offers a unique blend of entertainment and education, aiming to make the study of veterinary science more engaging and accessible.
- Examples of its use include aiding in the study of animal anatomy through crossword puzzles, where terms and definitions are used as clues. Another scenario involves decision-making games that simulate real-world veterinary cases, allowing users to apply their knowledge in a virtual environment.

Core Functions of AI Vet Coach

1) **Crossword Puzzles (Fig. 17)**

Example: A crossword puzzle focusing on the terminology related to the cardiovascular system of dogs. Users are prompted with definitions, and they must fill in the correct term.

Scenario: Used in a classroom setting, a veterinary instructor assigns the cross-word as homework to reinforce students' understanding of key concepts covered in lectures.

2) **Matching Games (Fig. 18)**

Example: A game where users match common symptoms with the diseases they are associated with. This can include matching 'polydipsia' with 'diabetes mellitus'.

e.g.: Match the anatomical terms on the left with the correct descriptions/locations on the right.

	1	2	3	4	5	6	7
1		A					
2							
3							
4							
5							
6							
7							

Across

- The science of diagnosing and treating diseases in animals (11)
- A common parasite found in dog intestines (8)
- A sterile field is crucial during this procedure (9)

Down

- The process of determining the cause of a disease (10)
- Common imaging tool in veterinary radiology (3)
- A species commonly treated in small animal practice (3)
- Abbreviation for feline infectious peritonitis (3)

Fig (17): Example of a Crossword Puzzle

You'll be filling in words horizontally (Across) and vertically (Down).

e.g.: Grid Layout (7x7 Sample Puzzle)

Column 1: Anatomical Term	Column 2: Description/Location
1. Stifle	A. The upper lips of a dog, especially pronounced in breeds like Bloodhounds.
2. Withers	B. The area at the base of the neck, between the shoulder blades.
3. Dewclaw	C. The equivalent of the human wrist; part of the forelimb.
4. Pastern	D. The joint on the hind leg corresponding to the human knee.
5. Flews	E. A vestigial digit found on the inside of the leg above the paw.
6. Hock	F. The part of the hind leg that corresponds to the human ankle.
7. Carpus	G. The area of the forelimb between the wrist and the toes.

Fig (18): Example of Matching Games in animal anatomy

3) Anatomy Quizzes (Fig. 19)

Example: Quizzes that challenge users to identify parts of animal anatomy on diagrams or photos, such as identifying the parts of the equine hoof.

Scenario: During a study group session, veterinary students use this feature to test each other's knowledge on equine anatomy.

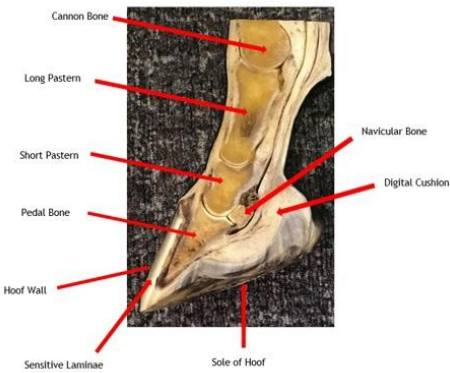


Fig (19): Example of veterinary anatomy quizze

4) Scenario-Based Decision-Making Games

Example: A game that presents a case of a cat with chronic kidney disease, asking the user to choose the best management approach based on the information provided.

Scenario: In a continuing education workshop, practicing veterinarians use this function to discuss and explore different management strategies for chronic conditions.

5) **Case Studies**

Example: Interactive case studies where users walk through the diagnosis and treatment process for various animal cases, such as a dog with heartworm disease.

Scenario: Veterinary medicine students collaborate on these case studies to apply their clinical reasoning skills in a safe, educational environment.

6) **Role-Plays and Mock Interviews**

Example: Role-playing exercises that simulate client-veterinarian interactions, with a focus on improving communication skills.

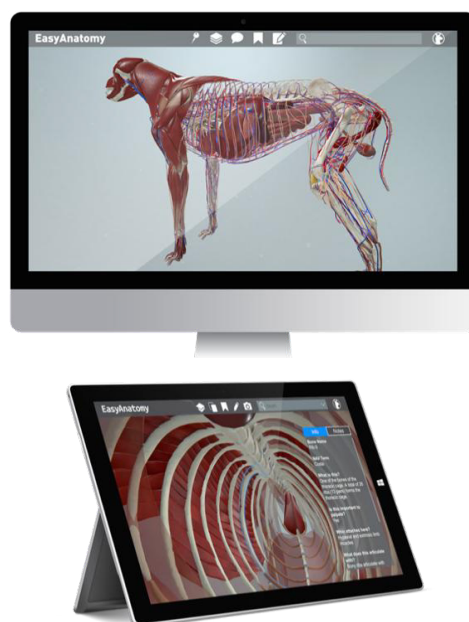
Scenario: Used in veterinary communication courses to help students practice delivering difficult news to pet owners, such as a terminal diagnosis.

2) **EasyAnatomy (fig. 20)**

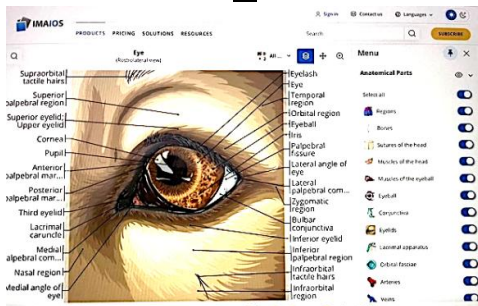
- **Dissection without a cadaver**
Virtual dissection lets the student explore and dissect outside the lab. Peel away layers, hide components, isolate regions, and visualize the spatial relationship between anatomical structures.
- **Designed for:** Pre-Vet Students, Pre-Clinical Students, and Clinical Students

1) **vet-Anatomy by IMAIO (Fig. 21)**

vet-Anatomy is a high-quality atlas of veterinary anatomy based on medical imaging, created under the supervision of Dr. Susanne AEB Boroffka, dipl. ECVDI, PhD and Antoine Micheau, MD. It's based on the same framework as the popular award-winning e-Anatomy, but dedicated to animals.



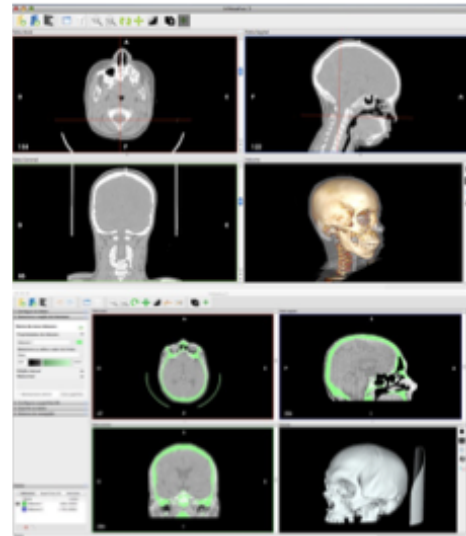
(fig. 20): EasyAnatomy tool for learning veterinary anatomy



(fig. 21): vet-Anatomy is a high-quality atlas of veterinary anatomy based on medical imaging

2) InVesalius (Fig.22)

- **InVesalius** is a free medical software used to generate virtual reconstructions of structures in the human body. Based on two-dimensional images, acquired using computed tomography or magnetic resonance imaging equipment, the software generates virtual three-dimensional models correspondent to anatomical parts of the human body.
- Available for the Microsoft Windows, GNU/ Linux and Apple Mac OS X platforms.
- InVesalius was developed at **CTI** (Renato Archer Information Technology Center), a research



(fig. 22): InVesalius is a free medical software used to generate virtual reconstructions of structures in the human body.

3) WikiVet (Fig.23)

- **WikiVet** is a wiki of veterinary content based on the Media-Wiki platform. The web-site is a collaborative initiative between various veterinary schools, and its content covers the entire veterinary curriculum. WikiVet is a part of the WikiVet Educational Foundation (UK registered charity number 1160546).
- Full access to WikiVet requires a free registration, which is available to veterinarians, veterinary students and veterinary technicians. Except for content relating specifically to the veterinary curriculum, articles are authored by students or veterinarians, and

subsequently peer reviewed by subject specialists.

- WikiVet is desinged to be used in one of three main ways, either for **reference**, **revision** or for **learning**.



Fig. (23): Logo of WikiVet

Furthermore, there are two more sites also generated to ease the study and learning of human and veterinary anatomy. Namely, HoloAnatomy and Visible Body Lesson Plan.

a. HoloAnatomy: A virtual view of the human body (fig.24)



Fig. (24): HoloAnatomy software:Studies have shown that the HoloAnatomy® Software is not only effective and time-saving, but preferable over cadaveric dissection in some aspects.

For human anatomy educators, one of the biggest challenges is helping students truly understand the body’s intricate structures and spatial relationships. Textbooks and cadavers provide critical foundations, but they have limitations-flat images lack depth, and dissec-tion can’t always reveal intricate structures. That’s where immer-sive technology can bridge the gap.

Since 2014, HoloAnatomy® has helped educators transform medical learning through collaborative immer-sion. Now, with the Holo-Anatomy 2.0 Preview, AlensiaXR is introducing a modernized platform that gives

instructors even more flexibility and innovative tools to engage students and deepen understanding.

b. Visible Body Lesson Plan(Fig.25)

In this blog post, we'll walk through a lesson plan that asks students to compare and contrast different animals using the four animal models in VB Suite: the earthworm, sea star, frog, and pig.

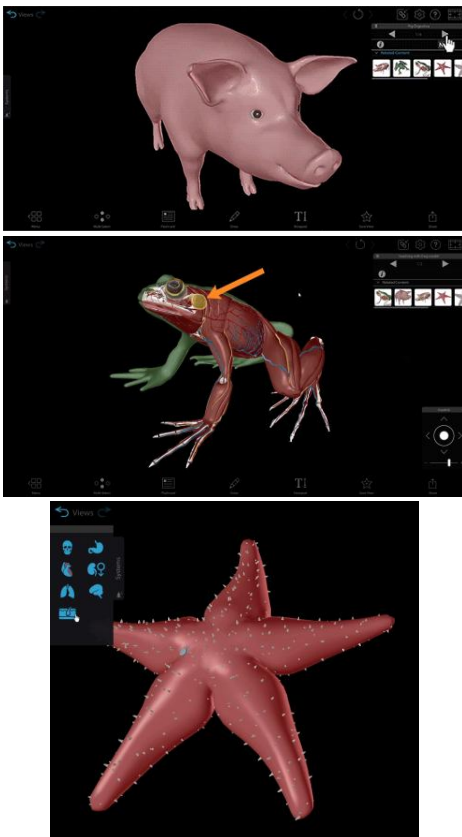


Fig. (25): Comparing Animal Anatomy: A Visible Body Lesson Plan in pig, frog and sea star.

Conclusion

The implementation of AI in teaching and learning veterinary anatomy as well as human anatomy has advantages: accessibility, standardization, and motivation of students but there are also issues: the cost, the ethical issue, and requirements for IT skills (Sahu, 2025).

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