Establishing Optimal Tools for an Anatomy Laboratory based on the Six-Point Mastery Learning Model

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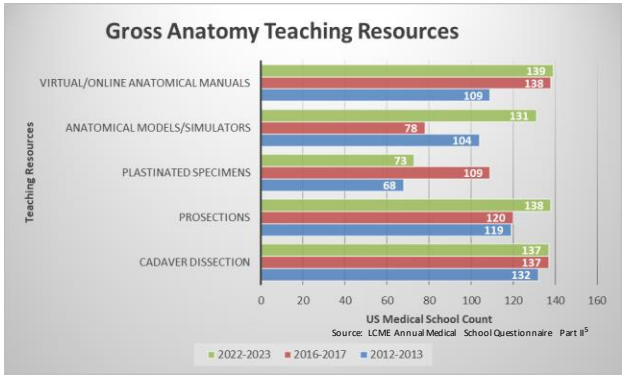

According to a survey of US medical schools, most schools (60%) reported a major change to their anatomy courses within the past five years, including a decrease in total course time (20%), integration of anatomy into other courses (19%), and implementation of a "flipped classroom" (15%) teaching style[1]. These changes were driven by the need to adopt innovative, competency-based, and student-centered curricula that can prepare medical students for the complex and dynamic health care system[2]. However, these changes also have some drawbacks, such as reduced exposure to cadaveric dissection, decreased emphasis on clinical and radiological anatomy, and increased cognitive load for students[1].

A major challenge of learning anatomy is the reduced contact hours that students have with the subject. Due to the compression of the preclinical curriculum, the time allocated for anatomy has been significantly reduced in many medical schools. For example, a study found that the average time spent on anatomy education in US medical schools decreased from 149 to 110 hours between 2002 and 2014. This reduction has implications for the depth and breadth of anatomical knowledge that students can acquire, as well as their ability to retain and recall information[3]. Furthermore, the reduced contact hours may also affect the students' motivation and interest in learning anatomy, as they may perceive it as less important or relevant than other subjects.

Roseman University of Health Sciences (RU) is establishing a new College of Medicine in Southern Nevada with the goal of transforming Medical Education and Healthcare delivery. To this end, facilities and resources for an integrated anatomy education need to be established, considering best practices for anatomy education. At Roseman University the six-point learning mastery model is at the center of the process of delivering the study materials.

1) Block Curriculum: Students focus on one organ system at a time, integrating clinical and basic sciences seamlessly. For instance, for the cardiopulmonary block, students will be learning the anatomy of the heart, while grappling with its hemodynamics and function. Creating an engaging lab will allow them to visualize the structures and consolidate learning contents.

2) Classroom as teacher: The lab design and layout (Fig. 4) will ensure that students are near the teacher and study tools, be it the SECTRA tables or hands-on anatomical models.

3) Active and Collaborative learning: Lab layout will allow for group activities to keep students engaged with both virtual and hands-on anatomy tools[3].

4) Early Experiential Learning: Students will be provided the opportunity to see, feel and understand anatomy in a clinical context by integrating early clinical experiences with simulation, radiology, and ultrasound.

5) Assessment Learning: The virtual anatomy tools were selected for their ability to be used as formative assessment tools that allow students to test each other on their knowledge and provide formative feedback in real-time[4].

6) Competency-Based Education: Students can progress through the curriculum as they demonstrate mastery of three-dimensional relationships of organs.

The anatomy laboratory is designed to accommodate students with visual, hearing, visual-spatial processing and mobility disabilities, providing access to anatomy education without hindrance or limitations, e.g., table heights and adjustability, access to SECTRA tables and reasonable adaptations.

This combination of educational resources, i.e., plastinated human organs, anatomical models, simulators and virtual anatomy tools (Table 1), within our block curriculum will allow for an innovative and inclusive competency-based anatomy education.

References

1) Shin, M., Prasad, A., Sabo, G. et al. Anatomy education in US Medical Schools: before, during, and beyond COVID-19. BMC Med Educ 22, 103 (2022). https://doi.org/10.1186/s12909-022-03177-1

2) Singh, K., Bharatha, A., Sa, B. et al. Teaching anatomy using an active and engaging learning strategy. BMC Med Educ 19, 149 (2019). https://doi.org/10.1186/s12909-019-1590-2

3) Lorke DE, Rock JA, Hernandez R Jr, Graham D, Keough N, van Tonder DI. Creation of 21st century anatomy facilities: designing facilities for integrated preclinical education in the Middle East. BMC Med Educ. 2023 May 26;23(1):388. doi: 10.1186/s12909-023-04361-7. PMID: 37237263; PMCID: PMC10215063.

4) Jastrow H, Vollrath L. Teaching and learning gross anatomy using modern electronic media based on the visible human project. Clin Anat. 2003 Jan;16(1):44-54. doi: 10.1002/ca.10062. PMID: 12486739.

5) LCME Annual Medical School Questionnaire Part II, 2012-2013, 2016-2017, and 2022-2023

Figure 1. SOMSO Model of muscles of the arm with shoulder girdle

Figure 2. SECTRA Table: large, immersive and interactive touch device, allowing for virtual dissection, that provides optimal touch interaction and visualization of 3D relationships of human organs

Method	Description	Advantages	Disadvantages
Cadaver Dissection	The process of dissecting human bodies to study their structure and function.	○ Realistic, hands-on experience that mimics clinical practice. ○ Enhanced 3D understanding of spatial relationships of organs. ○ Development of collateral skills, such as teamwork, communication, professionalism, and empathy. ○ Exposure to variability and individual differences among human bodies.	○ Ethical and emotional challenges of working with human remains. ○ Extensive storage requirements and high cost involved. ○ Potential health and safety risks of exposure to chemicals and pathogens.
Prosections	Preserved specimens that have been dissected by experts and are used for demonstration and observation.	○ Reduced workload and time for students and instructors. ○ Superior quality and accuracy of dissection. ○ Enhanced visibility and clarity of anatomical structures.	○ Loss of hands-on experience and active learning. ○ Reduced sense of ownership and responsibility. ○ Lack of variability and individuality among specimens. ○ Potential deterioration and damage of specimens over time.
Plastinated Specimens (Fig. 3)	Human body donations that have been treated with a polymer to preserve their structure and appearance.	○ Long-lasting and durable preservation of specimens. ○ Elimination of health and safety hazards of chemicals and pathogens. ○ Maintenance of natural color and texture of tissues. ○ Flexibility and portability of specimens for teaching and learning.	○ High cost and complexity of plastination process. ○ Limited availability and supply of specimens. ○ Lack of ability to reflect or remove parts of the plastinate impair understanding of three-dimensional relationships.
Printed Anatomical Models (Fig. 1)	Artificial representations of human anatomy, such as plastic models, mannequins, or sculptures.	○ Low cost and easy availability of models. ○ Simplicity and convenience of use and storage. ○ Ability to illustrate and manipulate specific anatomical structures ○ Suitability for repeated practice and testing.	○ Lack of realism and authenticity of models. ○ Inaccuracy and inconsistency of models with human anatomy. ○ Limitation and oversimplification of models in representing complex anatomy. ○ Reduced engagement and motivation of students with models.
Simulators (Fig. 2)	Computer-based or mechanical devices, e.g., SECTRA table educational portal, that simulate human anatomy and physiology, such as virtual reality, haptic devices, or robotic models.	○ High level of realism and interactivity of simulators. ○ Ability to provide feedback and assessment of performance. ○ Potential to enhance clinical skills and confidence of students. ○ Customized scenarios and cases.	○ High cost and technical complexity of simulators. ○ Need for specialized training and support for using simulators. ○ Dependence and reliance on technology and software. ○ Ethical and social implications of replacing human interaction with simulation.
Virtual Anatomy Tools	Software applications that allow users to view and explore digital models of human anatomy.	○ Accessibility and convenience of learning from anywhere and anytime. ○ Flexibility and adaptability of learning to different levels and styles. ○ Ability to manipulate and visualize anatomy in multiple dimensions and perspectives. ○ Integration and collaboration of learning with other resources and platforms.	○ Loss of tactile and kinesthetic experience of anatomy. ○ Difficulty of translating and applying virtual anatomy to real life situations. ○ Variation and quality of virtual anatomy models and content. ○ Distraction and overload of information and features.

Table 1: Comparison of anatomy teaching resources

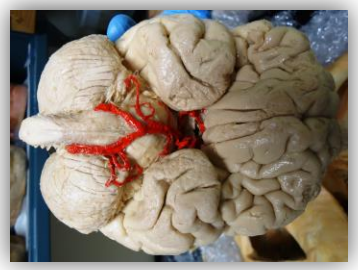

Figure 3. Plastinated human brain, showing its vasculature

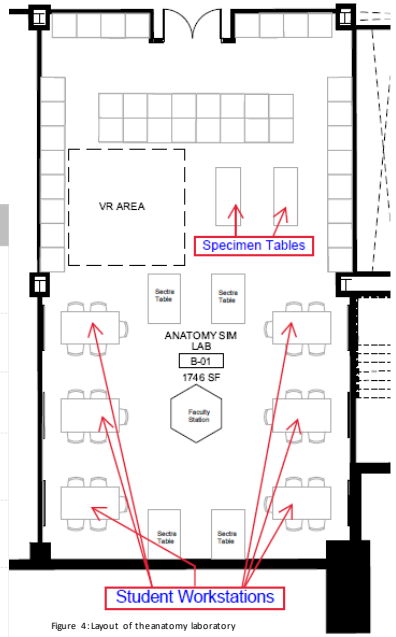

Figure 4: Layout of the anatomy laboratory

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