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Review Article

Progress in the Construction and Management of Smart Anatomy Laboratories

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Abstract

Background: Smart anatomy is an emerging interdisciplinary field that utilizes digital technology, information technology, artificial intelligence (AI), and other modern technological means to study, display, and apply human anatomy. The emergence of smart anatomy as a discipline is not accidental; it is a response to the actual needs of modern, information - based anatomy teaching and the development of modern medical science. It is equipped with digital and information technology and is an inevitable product of the AI era. *Objective*: The use of smart anatomy laboratories for anatomy teaching is conducive to opening up new fields of research in anatomy education, changing the traditional expression and teaching modes of human anatomy, re - evaluating the relationship between anatomy and other disciplines, and utilizing more extensive and detailed anatomical atlases for teaching. This approach aims to completely transform the traditional, cumbersome laboratory settings. *Results*: Currently, there are no reports on the use of smart anatomy laboratories for anatomy teaching research. Existing reports on smart anatomy teaching only cover certain aspects, such as creating smart classrooms for human anatomy using "Rain Classroom." *Conclusion*: This paper introduces the resource allocation, application scope, and management of newly - established smart anatomy laboratories. It also analyzes the characteristics and advantages of using smart anatomy laboratories for anatomy teaching, providing new insights and references for the development and teaching research of smart anatomy.

Keywords

Intelligence, AI Technology, Anatomy, Laboratory, Construction, Management

1. Introduction

Establishment, Equipment Configuration, and Teaching Resource Allocation of Smart Anatomy Laboratories. At present, based on the different hardware and software conditions of each institution, the following standards for the establishment of smart anatomy laboratories and basic equipment configuration are proposed for reference. The area of each laboratory is generally 90 - 120 m^2, depending on the number of students [1]. A smaller area is not conducive to the installation of various instruments and equipment or the display of specimens and models, while a larger area is not conducive to classroom control [2]. Each laboratory is equipped with 8 - 10 dissection tables with fully - automated internal and external ventilation systems for freezing and refrigeration, 4 - 8 digital human anatomy systems (each digital human anatomy system is equipped with teaching resources including systemic anatomy, regional anatomy, sectional anatomy, clinical cases, 3D human specimens, anatomy micro - courses, and self - study resources), 1 specimen - teaching system, and 8 - 10 surgical

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shadowless lamps. Each laboratory is also equipped with a laboratory and equipment control system. Additionally, bottled specimens, teaching specimens, and models for various systems are provided according to the actual needs of teaching.

2. Scope of Application of Smart Anatomy Laboratories

2.1. Scope of Application for the Discipline of Anatomy

Based on the existing hardware and software resources of smart anatomy laboratories, the smart anatomy teaching model can be used for the instruction of disciplines such as systemic anatomy, regional anatomy, sectional imaging anatomy, kinesiology, and clinical applied anatomy.

2.2. Scope of Application for Student Levels

Depending on the depth of the teaching resources available, the smart anatomy teaching model can be implemented for anatomy education among undergraduate, master's, and doctoral students.

2.3. Scope of Application for Student Majors

Given the breadth of the teaching resources available, the smart anatomy teaching model can be applied to the anatomy education of students in various majors, including clinical medicine, basic medicine, nursing, preventive medicine, laboratory medicine, stomatology, pharmacy, magnetic medicine, intelligent medicine, hospital management, biomedical science, sports, human anatomy art, and sculpture.

It is evident that, with its rich array of teaching resources, the smart anatomy laboratory is capable of conducting smart anatomy teaching across various related disciplines of anatomy. It can also cater to students at different academic levels and from multiple related majors. Therefore, the construction and investment in smart anatomy laboratories offer a high cost - effectiveness ratio and represent a new attempt and practical exploration in line with the modern trends in anatomy teaching.

3. Management of Smart Anatomy Laboratories

3.1. Pre - class Management of Smart Anatomy Laboratories

Turn on the instruments and equipment 0.5 hours in advance, and prepare the laboratory conditions (laboratory environment temperature control system and ventilation system), laboratory bench conditions, teaching courseware, specimens and models, projection - teaching system, digital human and various learning resources, etc., to provide guarantees for the environmental, hardware and software conditions required for the formal application of classroom teaching in smart anatomy laboratories [3, 4].

3.2. Management of Smart Anatomy Laboratories During Class

Adjust the laboratory temperature control and ventilation systems at any time to create a suitable external environment for students' learning. Ensure the activation of the digital human system and various software - based learning resources to create a conducive internal learning environment [5]. Maintain the display of various system specimens and models to provide a practical learning environment for students.

3.3. Post-class Management and Equipment Maintenance of Smart Anatomy Laboratories

After class, in accordance with laboratory management requirements, all instruments and equipment should be turned off, except for the fully - automated freezing and refrigeration dissection tables used for preserving cadavers, which should remain on. This helps protect the equipment, extend its lifespan, and ensure fire safety in the smart anatomy laboratory.

3.4. Routine Management of Smart Anatomy Laboratories

3.4.1. Specimen Storage and Preservation

Maintaining the freshness of specimens is essential for the quality of anatomy laboratory classes. The fully - automated freezing and refrigeration dissection tables equipped in smart anatomy laboratories can be adjusted to a suitable temperature range for specimen preservation and can store specimens in a sealed manner. These tables remain operational at all times, ensuring the long - term quality of specimens and preventing the evaporation of preservatives.

3.4.2. Teaching Resource Updates

In addition to upgrading the digital human software, the content and format of teaching courseware can be updated at any time according to the students' majors to meet their learning needs.

4. Advantages of Smart Anatomy Laboratories

4.1. Significantly Enhances the Efficiency of Teaching and Learning

One - key operation of the class - management system for

starting and ending classes, touch - screen operation on LED screens, functions for writing on the board and editing courseware, the use of specimen - teaching systems, and intelligent management of various teaching resources provide great convenience for teachers' lectures and improve the efficiency of "teaching".

Students can make full use of the cadaver specimens, models, and various electronic learning resources equipped in the smart anatomy laboratory. They can also observe the structures inside cavities through the operating - room - type lights, which greatly facilitates their learning and enhances the efficiency of "learning".

4.2. Facilitates Management Before, During, and After Class, as Well as Routine Laboratory Management

Despite the wide variety of instruments and equipment in smart anatomy laboratories, the adoption of intelligent - management models makes it extremely convenient to manage the laboratory before, during, and after class, as well as in daily operations.

Before class, technicians can remotely turn on the laboratory, and teachers can start the computer host and LED screen with a one - key class - start system. During class, both teachers and students can access the required learning resources as needed. After class, teachers can shut down the computer host and LED screen with a one - key class - end system, and both teachers and students can turn off the equipment using the central control screen in each laboratory.

4.3. Strengthens the Connection with Clinical Disciplines

Anatomy is the foundation of all clinical disciplines. Among the numerous learning resources in smart anatomy laboratories, in addition to introducing the normal structures of various human systems, there are also clinical cases based on anatomical knowledge. These resources analyze the clinical significance of these structures from multiple perspectives. This not only increases students' interest in learning anatomy but also lays a necessary anatomical foundation for future studies in clinical disciplines and provides students with an early understanding of various clinical fields.

4.4. Fosters Inspiration for Research Ideas and Innovative Thinking

When presenting the normal structures of various human systems, questions related to current medical issues are raised based on the morphological characteristics of each system. This provides ideas for medical research and is conducive to the cultivation of students' innovative thinking, which can offer certain insights for students' long - term career planning [6, 7].

4.5. Facilitates the Implementation of Ideological and Political Education in Courses

Smart anatomy laboratories facilitate the seamless integration of ideological and political education content into teaching materials. This content can be incorporated into any stage of teaching without disrupting the continuity of the material. Important ideological and political education content can be vividly displayed, demonstrated, and disseminated through various laboratory media. This approach leaves a deep impression on students, is easily accepted, and further stimulates their interest in learning anatomy.

5. Deep Reflections on the Construction and Application of Smart Anatomy Laboratories

Although the traditional anatomy teaching model will still exist in many aspects in the future and remain in the teaching process of anatomy, and the coexistence of different forms of anatomy teaching methods may continue for a long time, it cannot be denied that the establishment of smart anatomy laboratories will fully usher in a new era of smart anatomy teaching to meet the actual needs of the rapidly developing modern medical system and to maintain the status of anatomy as a cornerstone discipline in modern medicine [8, 9]. The creation and implementation of smart anatomy laboratories should not only focus on their appearance and form but, more importantly, on their connotation and essence, carefully appreciating their profound mysteries and the rigorous structure of their extensive system [10-14]. The establishment and development of smart anatomy as a discipline is not something that can be achieved overnight. It requires the collective wisdom and forward-looking actions of experts from multiple related disciplines and fields to be realized and to provide the driving force and strategies for its development and continuous progress. Existing deficiencies and shortcomings in smart anatomy laboratories should be further improved, and incomplete project content should continue to be completed [15-18]. Perfection should be pursued in every aspect and at every stage, striving for continuous improvement. The teaching and learning of anatomy should be closely integrated with the establishment of smart anatomy laboratories, becoming one entity. Throughout the teaching and learning process, an immersive academic atmosphere should be deeply felt, highlighting the unique advantages of smart anatomy teaching. With smart anatomy laboratories as support, the implementation of smart anatomy teaching becomes a natural progression. As times develop, smart anatomy will make new progress in various fields, and the establishment and application of smart anatomy laboratories can timely incorporate the latest research advancements of smart anatomy into the teaching content of anatomy [19-23]. If the smart anatomy

laboratory is merely relied upon while still using traditional anatomy teaching models, even if new research advancements are made in smart anatomy, it will be difficult to integrate them into actual anatomy teaching in a timely manner. It is evident that the establishment of smart anatomy laboratories, the availability of anatomy teachers and technicians with smart anatomy teaching ideas and professional qualities, are necessary guarantees for the implementation of smart anatomy teaching [24, 25]. The establishment of a more intelligent AI - assisted anatomy teaching platform is an important issue that needs to be urgently addressed [26, 27]. In this way, institutions that have not yet invested a large amount of funds in building smart anatomy teaching laboratories can rely on AI - assisted anatomy teaching platforms to explore smart anatomy teaching and achieve an advanced smart anatomy teaching model that is in line with the development of the times. Although the author has proposed the implementation and existing advantages of smart anatomy teaching, there is still a long way to go to achieve truly meaningful smart anatomy teaching. How to make the research and application of smart anatomy teaching more extensive and in-depth through the joint efforts of all, and to continuously adjust, improve, perfect, and popularize it with the development of the times, is the goal and direction of the development and progress of smart anatomy teaching.

Abbreviations

LED Light-emitting diode

Author Contributions

Zuqiang Hang is the sole author. The author read and approved the final manuscript.

Conflicts of Interest

The author declares no conflicts of interest.

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