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A REVIEW ON VARIOUS PEDAGOGICAL STRATEGIES IN ANATOMY EDUCATION WITH TECHNOLOGY INTEGRATION: A TRANSFORMING EDUCATION

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Abstract: *The science of Anatomy is a prerequisite for medical undergraduates and forms the basis of many medical and surgical specialties. It is common for students to struggle with studying and understanding course. The ways that anatomy is taught and learned must adapt newer methodology in medical education. Numerous pedagogical strategies have been developed and implemented to improve the teaching and learning process in the subject of anatomy. In recent year Artificial intelligence (AI) has become more and more popular by transforming anatomy education through programmed based learning which enables the improving decision making and efficiency. Several advantages of using AI in education include deep learning, storing vast amounts of electronic data, teaching remotely, rapid respondent input, and creative evaluation techniques. However, it may affect the loss of human occupations, decision making, privacy and security. The article intends to discuss an overview of various pedagogical strategies in anatomy teaching and learning methods.*

Keywords: *Anatomy education, Digital technology, Artificial intelligence, Virtual reality.*

1. INTRODUCTION:

Anatomy is often regards as the polestar of all medical education. It is the basic fundamental science to build up a strong foundation of future health professional. So medical students are must acquire the knowledge of basic understanding of anatomy for the future. Now a days to enhance the effectiveness of teaching and learning of anatomy various pedagogical strategies are adopted. The methodologies used for teaching and learning anatomy have to change with the ongoing evolution of medical education, from being “teacher centered” to “student centered”.[1] Primarily teaching of Anatomy is undertaken by using textbooks, diagram, figures, practical and dissection. Although these methods have proven to be effective, but to uphold the standard of anatomical education, increase interest and creative learning various integrating virtual resources, including 3D models, online simulations, and virtual anatomy atlases are implemented by various medical professionals and institutions. In recent year Artificial intelligence (AI) has become more and more popular by transforming anatomy education through programmed based learning which enables the improving decision making and efficiency. AI is the capacity of a programmed based machine or computer to carry out operations that normally require human intelligence. AI systems frequently analyze data, spot trends, and generate predictions using methods like machine learning and language processing. It is an advanced technology that has the potential to influence many fields, including medical education. Educating students and medical professionals about artificial intelligence is essential for creating and utilizing AI-based tools in medical education. Numerous benefits of artificial intelligence in education have been documented, including the ability to store large amounts of electronic data, educate remotely, and provide quick user response. Artificial tools can alter learning and teaching anatomy, verify, offer deep learning, and create a three-dimensional virtual reality, but they might not be able to completely replace human communications. This literature review intends to discuss the present status of different pedagogical methods along with technologies in teaching learning methods of Anatomy.

2. METHODOLOGY:

This literature review used multiple reliable sources, various articles, and research database. The search parameters encompassed terms such as "pedagogical strategies of Anatomy", "conventional approaches to teaching anatomy", "active learning methodologies in anatomy", "role of AI in anatomy education", and "impact of artificial intelligence in teaching". All the data were collected synthesized and summarized.

3. LITERATURE REVIEW:

In anatomy medical education, teaching and learning methods have changed to take advantage of new technology and a variety of learning preferences. Although the conventional approach of anatomical study by lecture and cadaveric dissection remains important, however, technological developments have improved the educational experience.

A. Conventional approaches to teaching anatomy

a. Lectures based teaching:

In anatomy lectures, a lecturer presents academic material to a group of students in accordance with the learning objectives. Students must be present in a designated area, such as a lecture hall or classroom, at a specified time in order to use the traditional teaching lectures technique. The aim of teaching is to explaining a topic through presentation and discussion. Recently, various active learning strategies enhanced the learning like case-based learning, team-based learning, and the flipped classroom increase student commitment and collaboration. [2]

b. Demonstration of models:

Plastic models of bone and organs are commonly used for demonstration. However, vital particular features are frequently absent. Plastic models work well for some simple teaching tasks, but they are not the best choice for teaching detailed anatomy, which is necessary for the majority of anatomy medical courses.

c. Dissection of cadaver:

Cadaveric dissection has long been regarded as the gold standard technique for studying anatomy.[3] Cadaveric dissection provides students with a realistic learning environment that enables them to understand the organization of the human body and feel the texture of the tissue. [4] Medical students benefit greatly from cadaver dissection by learning how various anatomical structures relate to one another, recognizing anatomical variances, and contributes significantly to a future professional work. This training contributes to an increase in surgical efficacy and self-confidence of students.

d. Histological study:

The study of the microscopic structure of cells, tissues, and organs is called histological anatomy, sometimes referred to as microscopic anatomy or microanatomy. It investigates the structure and makeup of tissues at the cellular and subcellular levels using microscopes and other specialized methods. It provides further insight into the organization and structure of tissues. Understanding the intercellular matrix, tissue layout, and cellular makeup is essential for comprehending the connection between structure and function.

B. Integrating active learning methodologies for teaching anatomy

Students are actively engaged and their comprehension of anatomical ideas is improved when active learning approaches are combined with conventional teaching methods. These approaches encourage the growth of critical thinking, problem-solving, and the application of theoretical ideas in practical contexts. [5]

a. Problem based learning (PLB):

PBL is a teaching strategy that gives students real-world case scenarios to help them learn actively. Within the classroom, in small groups, students collaborate to resolve clinical issues. This method is a great choice for medical education since it improves anatomical knowledge, develops critical thinking, problem-solving, and teamwork abilities, and encourages self-directed learning. [6]

b. Case‑based learning (CBL):

CBL is an educational approach used in anatomy that uses real-world circumstances, usually connected to medical or clinical settings. In order to apply their understanding of anatomy to real-world situations, the students analyse and discuss cases pertaining to anatomical structures. As students struggle through challenging problems and come up with solutions, this method promotes active learning, problem-solving, and critical thinking. [7]

c. Early clinical exposure (ECE):

Medical students are exposed to patients and clinical environments as early as their first year of medical school using a teaching-learning strategy known as early clinical exposure (ECE). By giving fundamental science concepts a real-world context and encouraging the growth of clinical skills and professional attitudes, this method seeks to increase student engagement, motivation, and learning outcomes. [8]

d. Self-directed learning (SDL):

With self-directed learning (SDL) in anatomy, medical students take charge of determining their own learning needs, establishing objectives, and selecting their own learning methods. This method helps students to become lifelong learners, have a deeper comprehension of anatomical principles, and take an active role in their own education. [9]

e. Integrated teaching (IT):

In order to enhance learning outcomes and get students ready to engage in clinical practice, integrated education in anatomy seeks to link anatomical knowledge with other related fields like physiology, pathology, and clinical sciences. With this method, an in-depth knowledge of the human body will be achieved, moving away from isolated anatomy lectures.[10]

C. Integrating of innovative technology for teaching anatomy

Technology integration in anatomy education improves learning by providing interactive simulations, and individualized learning experiences. Applications for virtual reality (VR), augmented reality (AR), and virtual dissection provide realistic 3D representations of the body, enhances the knowledge of anatomy. AI is being integrated into anatomy teaching in several ways, including personalized learning through adaptive platforms, interactive 3D simulations, and AI-powered chatbots for answering questions and providing feedback. These applications aim to enhance engagement, personalize learning experiences, and provide individualized guidance to students. [11]

a. Interactive Simulations:

Interactive simulations are virtual environments that resemble real-world scenarios and allow users to interact with and explore them in a dynamic and interactive manner. They are frequently employed in training and education to offer possibilities for experiential learning, allowing users to put information into practice, get feedback, and improve skills in a safe environment. 3D simulations, augmented reality (AR), and virtual reality (VR) experiences can provide hands-on, interactive learning about anatomical structures and their relationships, helping students visualize complex concepts.

b. 3D printing:

Using 3D printing technology makes it easier to create lifelike anatomical models, which improves students' comprehension of complex anatomical structures by use of illustrations. These realistic representations can be altered to meet certain learning goals.

c. Anatomy apps and online resources:

Numerous educational applications and online resources have been developed as a result of the increased use of smartphones and tablets. These developments in technology raise the degree of participation and make the educational process more accessible. These materials are available 24/7 and include interactive tests, 3D models, multimedia content, and atlases, allowing students to independently improve their comprehension. These include apps like Anatomy Learning - 3D Anatomy, BioDigital Human, and E-Anatomy, as well as websites like TeachMeAnatomy and IMAIOS.

d. Artificial Intelligence (AI) in Anatomy teaching and learning:

AI has the potential to completely transform anatomy teaching by offering personalizing learning experiences, delivering real-time feedback, virtual dissections, which would eliminate the need for cadavers. AI-powered tools can enhance learning by providing automated assessments, objective grading, and personalized feedback. AI can also be used to generate detailed and accurate anatomical illustrations from text prompts, making it a valuable tool for medical education and illustration.

AI can provide personalized information and feedback by adjusting to different learning styles and paces. To strengthen learning, AI-powered tutors can provide engaging lectures, activities, and tests. AI is capable of automating grading and giving immediate feedback on student performance and responses. AI is able to evaluate student work and pinpoint areas in which they require further assistance. [12] Virtual dissections and interactive 3D models of the human body can be produced by AI, giving students a fun and safe opportunity to investigate and work with anatomical components. AI can be used to create clinical scenarios that allow students to apply their anatomy knowledge in a practical context. AI chatbots can be used to explain and respond to inquiries about anatomy, enhancing conventional teaching techniques.

Examples of AI tools in anatomy education:

Technologies related to artificial intelligence (AI) have the potential to play a bigger role in anatomical science teaching. Additionally, generative pre-trained transformers (GPTs) have been introduced by OpenAI.

a. ChatGPT:

It is a large language model (LLM) that can be used to answer anatomy questions, generate clinical scenarios, create quizzes and attracted interest in the field of education, particularly in the teaching and learning of anatomy. ChatGPT could aid students in comprehending fundamental anatomical ideas like as names, locations, and functions of body structures. By interacting, students may improve their memory, learn more, and receive quick feedback.

b. AnatomyGPT:

AnatomyGPT is an AI application specifically designed for teaching the anatomical sciences that can produce anatomical illustrations and provide answers. The performance of AnatomyGPT and ChatGPT are same by evaluating the responses of both applications to prompts of the National Board of Medical Examiners (NBME) sample items with respect to accuracy, rationales, and citations. [13]

c. Google Bard (Gemini):

It is a large language model (LLMS) by Google, can be a valuable tool in anatomy education, offering features like personalized learning plans, study guidance, and the ability to answer questions and summarize information.

4. CONCLUSION:

Anatomy medical education systems have evolved to accommodate various learning styles and technological improvements. Although the conventional technique of cadaveric dissection remains an essential element, it is now enhanced by technological developments, visual aids, interactive approaches, and the incorporation of clinical knowledge, all of which work together to improve the educational process. Incorporating technology and active learning tactics into anatomy instruction through interactive tools enhances students' engagement and comprehension.

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