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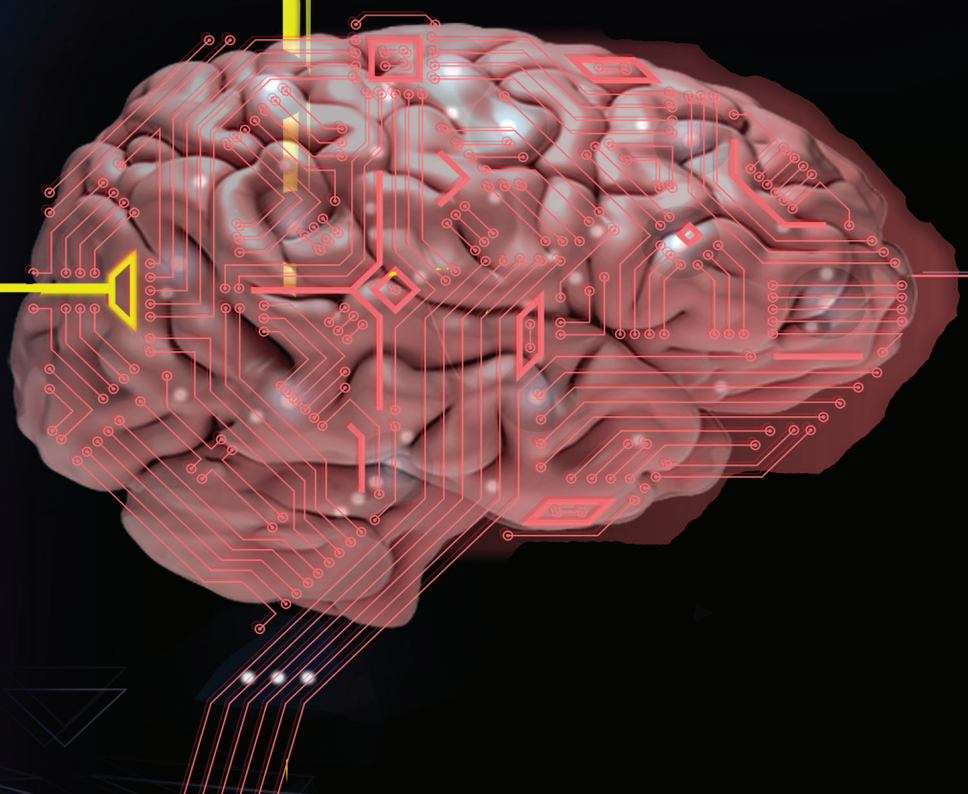

A PATH FOR MEDICAL SCIENCE EDUCATION

DESIGN BY ALIREZA BAGHERIRESAEI

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Historical Understandings of Edcational Technology

[1]Since Sydney Pressey introduSince Sydney Pressey introduced testing machines in 1920 and Skinners' teaching machine in 1958, the concept of Educational Technology (ET) has undergone various conceptual shifts. Initially, the field primarily focused on utilizing devices and audiovisual media to enhance educational activities. However, as the discipline progressed, the emphasis on machines and products was challenged, leading to a broader perspective that includes a process-oriented view. This expanded view recognizes ET as technological processes and open systems that encompass the entirety of meaningful activities and the application of principles and theories to achieve desired learning outcomes through continuous feedback loops. By embracing this systems view of instruction, the concept of ET evolves towards the creation and management of technological processes. This holistic perspective also involves a shift in the understanding of learning, moving from a sensory and authoritative viewpoint to one that values individuals' specific experiences and tacit knowledge in defining educational technology.

In the context of medical education, the traditional understanding of ET has revolved around technology as a product or device, with practices focusing on the mere utilization of technology. Engel defined ET as both "technology in education and technology of education," considering it a technical device for information dissemination and experiential support. This view has persisted in recent practices within medical education. Gunderman et al. described ET in radiologic education as the utilization of information processing and communication technology to bolster educational practices. Similarly, Kamin et al. defined educational technology in medical schools as encompassing electronic and other forms of technology employed to support teaching and learning, including computer-based programs, instructional websites, video/audio production, and online course management.

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1 Amirmahdi Safarian

While the concept of ET has evolved towards a systemic approach to technological processes, the application of educational technology in medical education has remained predominantly focused on the use of devices and computing programs to facilitate instructional delivery. This narrow perspective may constrain the exploration and implementation of ET in medical education, limiting it to the adoption of specific technologies for curriculum purposes rather than fostering a comprehensive learning process comprising meaningful activities and systemic technological management. Bridging this conceptual gap in approaching ET could enable a more holistic approach to learning, empowering both facilitators and learners to shape and define their educational communities. The role of Educational Technology in medical education has been a topic of discussion for several decades, with evolving reflections on its utilization to address pedagogical challenges, enhance curriculum efficiency, and improve educational effectiveness. In response to challenges posed by information overload, the need for lifelong learning, and reduced teaching opportunities in ambulatory settings, educators have explored the potential of computers and information technology in medical education. These tools have been recognized for their value in medical knowledge search, creation of electronic resources, multimedia content indexing, and interactive simulations, including assessments. challenges for students and faculty in understanding their strengths and limitations. E-learning has emerged as a prominent educational technology practice in medical education, encompassing online synchronous and asynchronous communication, learning management systems, and web-based multimedia resources for online lectures, virtual patient scenarios, self-assessments, and feedback mechanisms. Studies have shown that students exhibit positive attitudes towards e-learning, with comparable effects on knowledge and skill acquisition as traditional teaching methods. Notably, instructional design features play a crucial role in determining the effectiveness of e-learning, emphasizing the importance of pedagogical strategies over the delivery medium itself. Cook, Levinson, and Garside found no significant differences in time and learning efficiency between e-learning and non-computer-based instruction in a meta-analysis, underscoring the potential of e-learning to enhance medical education practices.

Simulation technology has emerged as a valuable tool in medical education, addressing challenges such as limited patient availability, infrequent critical disease processes, and the need for flexible faculty time. This technology encompasses various modalities, including computer-based virtual reality simulators, computerized mannequins, interactive simulations, and task trainers. Simple methods like standardized patients or static mannequins without computerized capabilities do not fall under the category of technology-enhanced simulation. While reports on the effectiveness of simulation technology date back to the late 1960s, the bulk of published work on this topic has emerged since 2008.

The focus of simulation technology has primarily been on undergraduate and graduate medical education, with applications expanding significantly in the past decade. Common uses of technology-enhanced simulation include training in technical skills such as laparoscopic procedures, anesthesia and surgical skills, team and leadership skills, clinical reasoning, emergency resuscitation, and management.

Despite its widespread use for training and assessment purposes, simulation technology in medical education is yet to be fully utilized for quality improvement and research. While meta-analyses indicate that simulation technology enhances learning outcomes compared to no training, evidence supporting its impact on patient outcomes remains limited. Following the enactment of the Affordable Care Act, health information technology (HIT) like electronic health records (EHR) has played a crucial role in patient care. HIT, including EHR, is increasingly recognized as an emerging educational technology in medical education for knowledge acquisition, decision support, and quality improvement. These technologies provide large volumes of data that require prioritization and organization for application in clinical problem-solving, posing ongoing challenges for students and faculty in understanding their strengths and limitations.

Educational technology in medical education extends beyond the discussed topics, representing a broader landscape of experiences and messages within the field. As new educational technologies continue to emerge, shaping the pedagogical landscape of medical education, it is essential to anticipate and reflect on the ways in which these technologies will enhance the educational experience. Embracing a broader concept of educational technology in medical education is essential in adapting to the evolving healthcare landscape, marked by a focus on transparently reported outcomes and process measurements for improving patient care and safety. This shift necessitates a systemic and process-oriented approach to educational technology, facilitating learning and performance improvement in patient care through the integrated creation, utilization, and management of technological processes and resources. By incorporating continuous feedback mechanisms, educational technology can enhance the development of both tacit and explicit knowledge, ultimately impacting patient care positively. The integration of simulation technology with competence dashboards for deliberate practice represents the future of medical education. This approach focuses on creating technological processes that enable deliberate practice, knowledge transfer, and improved patient outcomes. By monitoring, assessing, and remediating individual simulation experiences, learners can tailor their learning experiences and seek personalized coaching. This integration not only benefits undergraduate and graduate medical education but also offers opportunities for practicing physicians to learn new

procedures and protocols, enhancing their knowledge and skills. In particular, simulation technology is valuable for interprofessional training in healthcare systems, addressing the complexities of care delivery and the performance of multiple healthcare providers.

While technology-enhanced simulation presents significant benefits, cost remains a notable obstacle. Efficient and cost-effective utilization of simulation facilities is crucial, necessitating multi-institutional collaborative structures to maximize resources and avoid redundancy in simulation center capabilities within the same region. Collaboration among healthcare institutions can optimize the use of simulation technology, benefiting the entire healthcare system. In light of the significant technological advancements, physicians must cultivate technological leadership to drive and enhance Health Information Technology (HIT) systems. A critical priority is to educate medical students and physicians on Electronic Health Records (EHRs), focusing on their functionality to empower them to lead the development, utilization, and governance of HIT systems. It is essential not only to understand how to access and input patient data but also to prioritize and validate health information for informed decision-making. Despite optimistic expectations surrounding EHRs, current systems often lack user-friendliness and efficiency. The fragmented nature of EHR features, influenced by various vendors, leads to interoperability challenges that hinder seamless patient care. Furthermore, the complex structure of these systems results in inconsistencies in the quality of health information input and retrieval by users. Physicians must grasp these existing system flaws within the framework of ideal systems that efficiently cater to patient care needs. Educational initiatives can enhance physicians' comprehension of the HIT landscape, emphasizing the need for long-term technological leadership. Physicians should not merely adhere to existing technological processes but actively engage in shaping innovative processes within HIT systems to enhance decision-making for patient care. Establishing technological frameworks for learning and performance enhancement represents an educational technology practice that has been underemphasized in medical education but will be crucial moving forward.

The effect of Increasing the capacity of classrooms In the Field of Medicine on students' learning

The expansion of the medical field has garnered significant attention in recent years. Following the announcement of "increasing medical capacity at a general level" for implementation in January 1400, this capacity boost was put into effect in the entrance exam of 1401, resulting in the recruitment of 9600 students that year.

The plan is to incrementally increase the medical field's capacity by 20% annually starting from 1401 for a minimum of four years. A substantial portion of this capacity growth is linked to places with commitments, where students commit to studying for free in national universities for 1.5 times their educational period, particularly in underserved regions lacking an adequate number of healthcare professionals.

However, a notable concern arises from the significant increase in class sizes without corresponding adjustments in university infrastructure, class numbers, or faculty members. This raises challenges regarding the quality of education and the depth of learning within these larger classes. For instance, in basic science courses like anatomy, hands-on learning in the dissecting room is crucial for observing organs, veins, and nerves with precision. Discrepancies arise when class sizes double, impacting the effectiveness of learning experiences. Moreover, the preservation and maintenance of anatomical specimens become more challenging with a larger student population. In institutions with renowned and larger universities experiencing the most substantial capacity increases, questions emerge about whether professors have adequate time and resources to effectively manage and engage with a larger student body across various learning activities. This example highlights the broader issue of maintaining educational standards and individualized attention in practical training scenarios, such as clinical rotations, where a high student-to-patient ratio can hinder the quality of hands-on learning experiences.

Furthermore, the psychological dynamics in larger classes may deter some students from actively participating or seeking clarification, impacting their learning outcomes. Ensuring that professors have the capacity to address individual student queries and concerns becomes increasingly crucial in such settings. Addressing the need for proper infrastructure and planning is essential to support the growing number of students in medical education adequately. It is imperative to prioritize equitable access to quality medical education and facilities in underserved areas to ensure comprehensive healthcare provision and uphold the ethical duty of healthcare professionals. In conclusion, expanding medical education capacity necessitates a holistic approach that encompasses infrastructure development, faculty support, and student well-being to uphold educational quality and ensure graduates are equipped to meet the healthcare needs of society.

1 **Fatemeh Haresabadi**

The current disadvantages of the medical field

The field of medicine is renowned for its demanding and crucial nature, requiring individuals to prioritize the health and recovery of patients. While the medical profession offers numerous benefits, it also presents challenges and drawbacks. Some of the disadvantages of a career in medicine are the extensive duration of study, high financial costs, job-related stress, continuous presence at work, and heavy responsibilities. Here are examples illustrating the challenges faced by professionals in the medical field: Impact of workload on physicians' performance: Medical professionals often contend with heavy workloads characterized by long hours, time constraints, patient care demands, and a work environment that lacks opportunities for adequate rest. The burden of workload can diminish one's motivation to meet the expectations of others, leading to feelings of exhaustion and fatigue. Fatigue among medical staff can result in errors that impact patient care, as tired individuals are more prone to questioning their decisions and double-checking tasks, which can slow down their work.

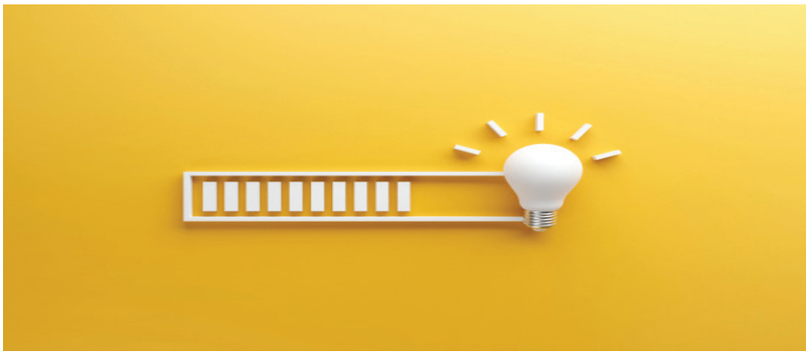
Burnout in the medical profession: Modern physicians have access to advanced diagnostic and treatment options, yet they face increasing external pressures that limit their professional autonomy. These factors contribute to chronic stress, with a significant proportion of physicians experiencing symptoms of burnout. Burnout is characterized by three dimensions: emotional exhaustion, depersonalization or cynicism, and reduced personal accomplishment. Studies indicate that burnout affects a substantial number of physicians at various stages of their careers, with prevalence rates ranging from 30% to 68% across medical specialties. The roots of burnout are often traced back to medical school, continuing through residency and into the daily lives of practicing physicians. Certain specialties, such as trauma surgery, urology, otolaryngology, emergency medicine, vascular surgery, and general surgery, as well as young professionals with children, are more susceptible to burnout. Factors like long working hours, frequent on-call duties, and high stress levels are associated with burnout, leading to negative outcomes for both physicians and patients. Addressing work-related stress, burnout, and depression among medical professionals is crucial, necessitating the development of stress management skills and destigmatization of mental health issues. Screening for mental health, conducting stress management workshops, and implementing strategies for resilience are essential at both individual and institutional levels to support the well-being of healthcare providers. Burnout can manifest in various health issues, including substance use, sleep disorders, depression, sedentary behavior, obesity, and musculoskeletal pain. Recognizing the signs of burnout and taking proactive steps to address it can prevent its escalation to severe levels or mental health crises among medical profe • Psychological challenges: A comprehensive national survey conducted in Canada involving

1 **Fatemeh Dehghani**

with their medical work. A study encompassing 524 medical professionals in the United Kingdom, including hospital consultants, general practitioners, and senior hospital managers, revealed that approximately 27% of participants scored within the clinical range for depression. Similarly, research involving 50,000 practicing physicians and medical students in Australia indicated a higher incidence of severe psychological distress and a twofold increase in suicidal ideation among physicians compared to the general population. These findings underscore the correlation between psychological struggles, burnout, and adverse patient outcomes within the medical community. Discrepancies in study results can be attributed to variations in assessment tools used to evaluate psychological well-being. Barriers to seeking mental health support among medical professionals include stigma, concerns about confidentiality, lack of awareness, and fear of unwanted interventions.

Evaluation of Physician Sleep and Well-Being Impact on Medical Errors: In a profession where long and irregular work hours are the norm, sleep deprivation poses a significant occupational hazard for physicians. Extensive research confirms the detrimental effects of inadequate sleep on health and cognitive performance. Sleep deficits disrupt neural connectivity and processing in key brain regions, leading to emotional dysregulation and impaired empathy. Insufficient sleep also impairs attention span and cognitive function, affecting critical tasks in patient care such as assessment and treatment planning. The heightened emotional demands of medical practice coupled with sleep deprivation increase the risk of burnout among physicians. Strategies to mitigate sleep-related impairments may include regulating work hours, promoting rest breaks during shifts, incorporating melatonin supplements, and fostering a culture that prioritizes adequate sleep in the medical profession. Further research and interventions are necessary to address the impact of sleep deprivation on physicians and patient care outcomes. Understanding and addressing these challenges in the medical field are essential for individuals considering a career in healthcare ssionals.

New medical education methods



Medical schools and residency programs are currently undergoing a transformation in their educational approach. The ever-growing volume of medical information and research poses a challenge for medical education to keep pace with current curriculum demands. As patient safety and quality take precedence over traditional bedside teaching, educators are adapting by restructuring curricula, introducing small-group sessions, and promoting self-directed learning and independent research. Despite these efforts, a gap persists between classroom learning and real-world clinical practice, leaving many students feeling inadequately prepared in essential skills such as history taking, physical examination, diagnosis, and patient management.

To address this educational disparity, medical simulation has emerged as a promising solution. This article explores the efficacy of simulation in medical education through a comprehensive review of relevant literature. A search of MEDLINE was conducted, focusing on original articles and reviews related to simulation in education using keywords like simulation, mannequin simulator, partial task simulator, graduate medical education, undergraduate medical education, and continuing medical education. One hundred thirteen articles were included in this review, covering various aspects of medical education.

Simulation-based training has shown notable benefits in specific areas of medical education research. For instance, residents trained on laparoscopic surgery simulators exhibited improved procedural performance in actual operating room settings. Another study highlighted that residents trained on simulators displayed better adherence to advanced cardiac life support protocols compared to those receiving standard training for cardiac arrest cases. In addition to enhancing procedural skills, simulation has proven effective in boosting medical knowledge, procedural comfort, and performance improvements in simulated scenarios. Furthermore, simulation serves as a valuable tool for assessing learners and teaching critical skills like teamwork and communication.

While direct improvements in clinical outcomes from simulation training are limited, numerous studies have validated the effectiveness of simulation in teaching basic science, clinical knowledge, procedural skills, teamwork, communication, and assessment at both undergraduate and graduate medical education levels. As the integration of simulation in medical education continues to expand, further research is essential to ascertain whether simulation training translates into improved patient outcomes. The utility of simulation in medical education: what is the evidence?

1 **Fatemeh Zarei**

Medical education through the Internet and Asynchronous

1The COVID-19 pandemic has catalyzed a reassessment of teaching and learning methodologies in medical education, with online learning poised to remain a pivotal element of healthcare education post-pandemic. Medical educators must adapt to this paradigm shift by enhancing their technological proficiencies to meet evolving learning needs. Institutions should prioritize fortifying their technical infrastructure, offering continuous professional development opportunities for faculty, and ensuring equitable access to digital resources for disadvantaged students. The role of online education in evaluating learning outcomes through diverse approaches is crucial for academic success for both educators and learners. It is imperative to evaluate the efficacy of various online teaching methods, considering their benefits, feasibility, limitations, and potential for refinement. If proven effective for educators, students, and institutions, these approaches should be integrated into long-term educational strategies beyond the current pandemic period.

Medical education must evolve and adjust continuously, as the field of medicine is perpetually shaped by societal, scientific, and service-related contexts. The COVID-19 crisis has necessitated a reevaluation of traditional medical education delivery methods. Medical educators should view this as an opportunity for transformative introspection that can propel the field of medicine forward and enhance its societal impact. This crisis offers a unique chance for the medical education sector to move away from conventional practices and adopt more effective standards and practices that enhance responsiveness and accountability to society. Collective efforts should be directed towards avoiding a return to outdated practices solely due to familiarity and instead leveraging the pandemic's potential to drive growth and reform in the field. It is crucial to explicitly justify the preservation of contemporary medical education aspects that are deemed valuable, with careful consideration for their retention. This critical examination will leverage the current situation as a "teachable moment," presenting a unique opportunity for innovation in preparing the next generation of physicians. The convergence of a global health crisis with modern scientific medicine on this scale underscores the potential for innovation in enhancing medical education within the current COVID-19 environment.

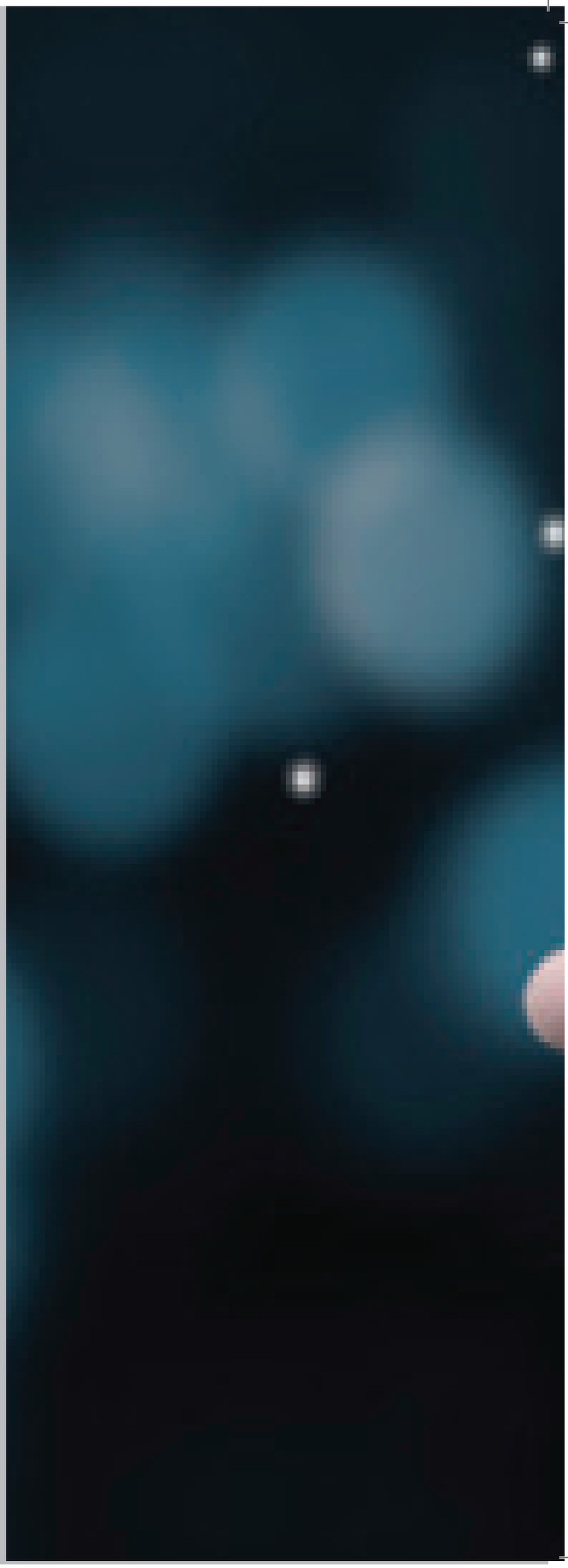
Research focusing on the impact of the COVID-19 pandemic on anatomy education has predominantly centered on students, but the insights and recommendations of anatomy educators are equally significant. Current research findings indicate a positive outlook towards distance theoretical anatomy education and blended face-to-face practical anatomy education methods for the post-pandemic era.

Asynchronous interprofessional education modules represent a method of online teaching that may effectively prepare students for future interprofessional learning in synchronous settings. While asynchronous modules can introduce interprofessional objectives such as conflict resolution and role

1 **Ali Eshaghi**

asynchronous environment. Future studies can explore the optimal sequence for completing asynchronous modules to foster the development of interprofessional competencies in health professions learners.

Among asynchronous methods, the Learning Management System (LMS) is a notable approach to online education. Google Classroom, serving as an LMS since 2014, offers a user-friendly platform. A study testing its efficacy in teaching a biochemistry module to first-year MBBS students in an Indian medical school revealed positive outcomes. Students reported improved access to learning materials and supplementary resources, appreciated immediate feedback, and valued the flexibility of learning outside the traditional classroom environment. Students also expressed a preference for accessing the LMS via mobile phones over laptops. Leveraging free-to-use LMS platforms like Google Classroom can promote broader access to e-learning, particularly in resource-constrained low and middle-income countries.



The role of new technologies in medical education: validity of educational programs

One of the important topics that has received significant attention in the scientific community of medical education in the country is Accreditation. The actions taken in recent years to establish accreditation structures will undoubtedly ensure the improvement of the quality of specialized medical education in the not-so-distant future. In this structure, two fundamental axes have been emphasized by the authorities:

1.Development of educational standards, including educational standards in each specialized field.

2.Evaluation and accreditation of residency programs and specialized medical education units based on these standards. Achieving these two axes at the level of medical universities will lead to the creation of an educational reform, and steps will be taken to address any shortcomings and deficiencies before summative evaluation of educational units for accreditation purposes.

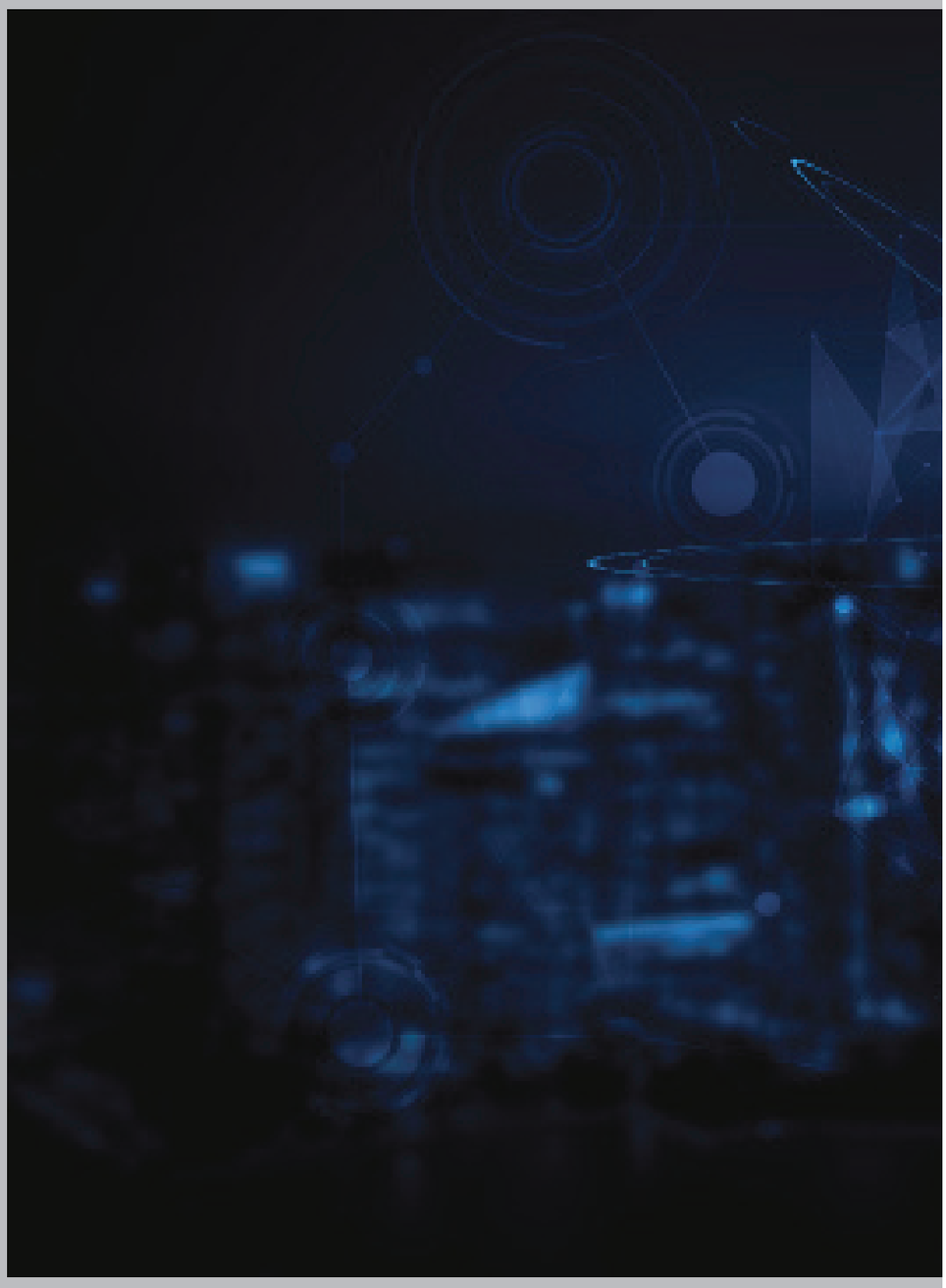
In a research study involving a mixed-method approach through questionnaires, the viewpoints and opinions of several professors, administrators, and students regarding the impact of accreditation on improving the process of specialized medical education and evaluating residency programs as a way to enhance the quality of residency programs were examined. The results of this research within the statistical community showed that with 95% confidence, the impact of accreditation in improving the process of specialized medical education and evaluating residency

programs as a means to enhance the quality of specialized medical education is confirmed. This result reflects the statistical community's belief in the research questions. Therefore, it is recommended that relevant authorities, while considering the opinions of professors regarding the achievement of accreditation goals in educational, research, and service areas, familiarize educational groups with these structures and educational standards in various fields, address declared deficiencies, and with an understanding of the strengths and weaknesses of accreditation, pay considerable attention to self-assessment mechanisms in universities. By properly implementing the stages of establishing accreditation structures and supporting them, they can play an effective role in improving the quality of specialized medical education.

Educational technology, as one of the most effective tools for improving the educational system, plays a crucial role in facilitating learning. This systematic approach aims to design, implement, and evaluate the teaching-learning process for deeper, more effective, and longer-lasting learning using specific goals, new psychological and communication methods, as well as human and non-human resources. An effective and fruitful educational system that leads to real learning improvement cannot be achieved unless its faculty members acquire competence. To achieve this goal, they must not only obtain or maintain academic qualifications, especially in their teaching field but also be familiar with the latest communication and teaching methods and be equipped with teaching and professional skills.

1 Alireza Elyasi

Given the increasing trend of education towards new technologies and the Ministry of Health's inclination towards upgrading educational technology and virtual learning, there is a need for specialists in educational technology. Therefore, Shiraz Educational Technology Unit, with its focus on academic excellence and educational advancement, in collaboration with Shiraz Educational Development Center along with the Center for Excellence in Electronic Education, has established a Master's program in Educational Technology. Educational technology and electronic learning create conditions where many educational goals such as independent learning, self-directed learning, learning regardless of time and place, collaborative learning, and immediate feedback provision and learning assessment become more accessible.



Electronic medical education has become very common in developed countries and is rapidly evolving because it has educational value and is expanding to a large audience through educational programs. Given the current reality that faculty members must learn more about new teaching tools, for most of their students, these new educational tools such as computers and other related applications are not really considered technology, as they are not only very familiar with technology but also able to use it. Therefore, while faculties are striving to learn these new information transfer methods, students' expectations are increasing every day, so mastery of educational technology seems to be an overlooked competency in faculties that requires a special program for upgrading and improving the quality of universities.

The role of new technologies in medical education: Designing educational service system

1Advanced learning with technology involves the systematic and targeted use of various technologies to facilitate, enhance, and expand the learning process. It encompasses a set of approaches, tools, environments, and instructional methods in which technology is used as a tool to support learning.

The use of technology for support, supplementation, or enhancement of the learning process. This type of learning can provide students with more personalized learning experiences, allow them access to more content, and provide more opportunities for engagement. Today, theories of technology-enhanced learning have progressed from behaviorist theories towards cognitive and social learning theories that are reinforced by innovative technologies. Some of the key theories that form the basis of technology-enhanced learning include:

1. Constructivism theory emphasizes the importance of the learner in creating knowledge and constructing their own understanding of the world around them. It emphasizes participation, teamwork, reflection, and feedback in the learning process.

2. Cognitive load theory states that the amount of mental effort required to understand a learning activity affects an individual's ability to learn deeply. Cognitive load that is excessive can lead to a decrease in cognitive performance because when cognitive load is too high, focusing on the learning activity becomes difficult. This makes information processing and memorization more challenging and concept learning more difficult.

3. Multimedia learning theory suggests that multimedia tools can enhance learning and motivation in students by providing engaging and interactive learning activities and immediate feedback.

4. Connectivism theory emphasizes the importance of learning networks and participation in the learning process. Knowledge is socially constructed and constantly evolving, and in learning, the focus should be on creating and linking ideas rather than memorizing facts. It also emphasizes the importance of participation and using technology for accessing, storing, and sharing knowledge.

These theories highlight the significance of leveraging technology to improve the learning process and engage students in a more effective and personalized way.

- *E-learning is defined as the use of electronic systems in education with the goal of saving time, cost, and facilitating learning more efficiently.*
- *Distance learning is a type of educational process in which the learner and instructor are remote from each other and do not have physical presence. Nowadays, technology plays a significant role in this type of learning.*

1 **Ilia Ghotbtahriri**

- *Learning Management System (LMS) is a type of content management software. This software automates all learning management tasks and provides an integrated set of features and options online to individuals.*

- *Learning Management Systems consist of processes that help instructors design and implement virtual learning units according to their needs, manage virtual classes and course content, and allow learners to interact with peers and answer instructors' questions.*

- *In networked learning, students and instructors do not have access to the internet. Instead, institutions create a local educational network where educational resources, exams, and lab work are provided locally, and internet access is simulated if needed.*

- *MOOC stands for Massive Open Online Course. MOOC is a type of online course aimed at open access through the web and participation on a large scale. The Oxford Dictionary defines MOOC as a free educational course offered over the internet to a large number of people.*

- *In MOOC courses, learning takes place in an informal environment or under informal conditions, and participants are not restricted by physical class limitations. The only requirement for participation in these courses is internet access. In these courses, voluntary and social learning occurs, and participants are not required to register with the hosting institution.*

- *In MOOC courses, there is a possibility for learners to deviate from the main topic because complete control over learners' performance is not possible, and learners may seek other distractions while using a MOOC.*

- *Research has shown that medical education will be effective when students can adapt to the increasing complexity of medical knowledge and clinical environments and can make vital decisions in new clinical situations. Many of these abilities occur when students enter clinical environments. However, in many cases, exposure to new and complex situations and limited opportunities for practice and repetition occur.*

- *Currently, various simulation technologies have been developed in medical education. These technologies provide new ways to improve medical errors and enhance the quality of education. Moreover, numerous studies have been conducted on the effectiveness of simulation-based education, showing that simulation-based education is an effective method for familiarizing medical students with clinical environments.*

- *Mobile-based simulation learning environments are one of the growing technologies that enhance active and interactive learning, leading to increased motivation, learning, and performance in medical students.*

• *Artificial Intelligence (AI) is defined as a technology related to the construction and development of systems and computers capable of human-like thinking and decision-making. In fact, the main goal of AI is to create systems that can interact with the environment and perform tasks similar to human intelligence. Unlike humans, AI can process large amounts of data in various ways. The goal of AI is to perform tasks such as pattern recognition, decision-making, and judgment like humans.*

Systems Providing Medical Education Services:

1.IBM Watson for Oncology: This system is used to develop a system that helps physicians in diagnosing and treating cancer. This system utilizes clinical data and medical articles to provide treatment recommendations.

2.Osso VR: A virtual reality educational platform that allows medical students to practice surgical skills in a virtual environment.

3.Visual Dx: This system uses artificial intelligence to diagnose diseases based on skin images and symptoms.

4.AI-powered Physician-Patient Dialogue Training Systems: Companies like Kognito have developed interactive AI-based training systems for medical students to develop skills related to patient communication and clinical skills.

5.Google DeepMind AlphaFold: This project uses biochemical data to predict protein structures. These predictions can be useful in medical research, drug development, and pharmaceutical student studies.

The most used technologies in various medical education fields include virtual patient simulators, 3D software, augmented reality tools, video conferencing platforms, podcasts, e-books, interactive mobile applications, AI-based diagnostic tools, and virtual anatomy labs with the aim of enhancing learning experiences and improving overall competencies of medical students.

Online medical resources provide a wealth of information and educational materials that can complement traditional textbooks and lectures. Some examples of these resources are:

1.MedEd portal: A reputable journal in the field of health education and learning.

2.Jref: A reference for reputable scientific journals in Persian and English languages.

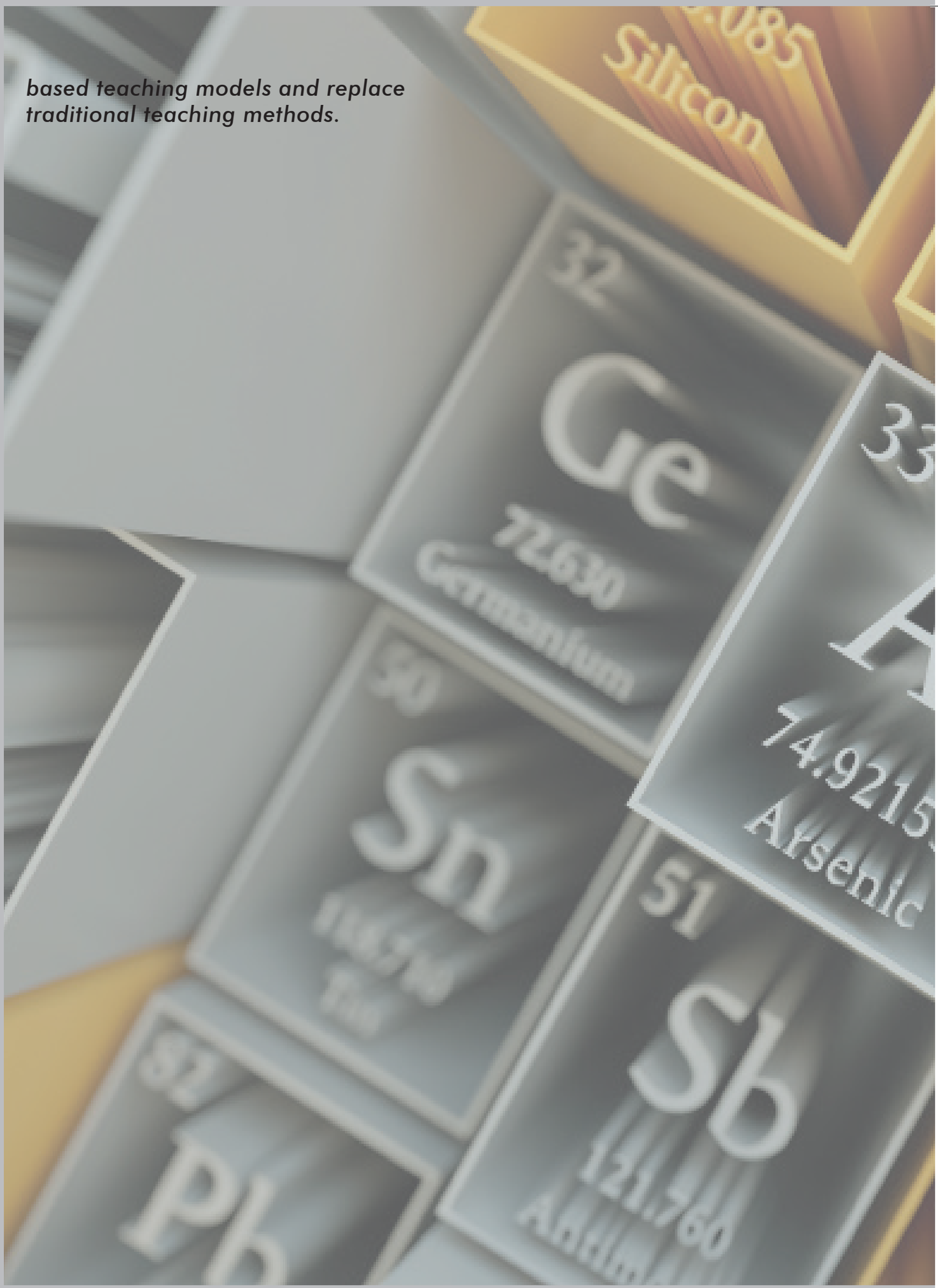
3.SID: The database of the Scientific Information Center of the Iranian Academic Jihad.

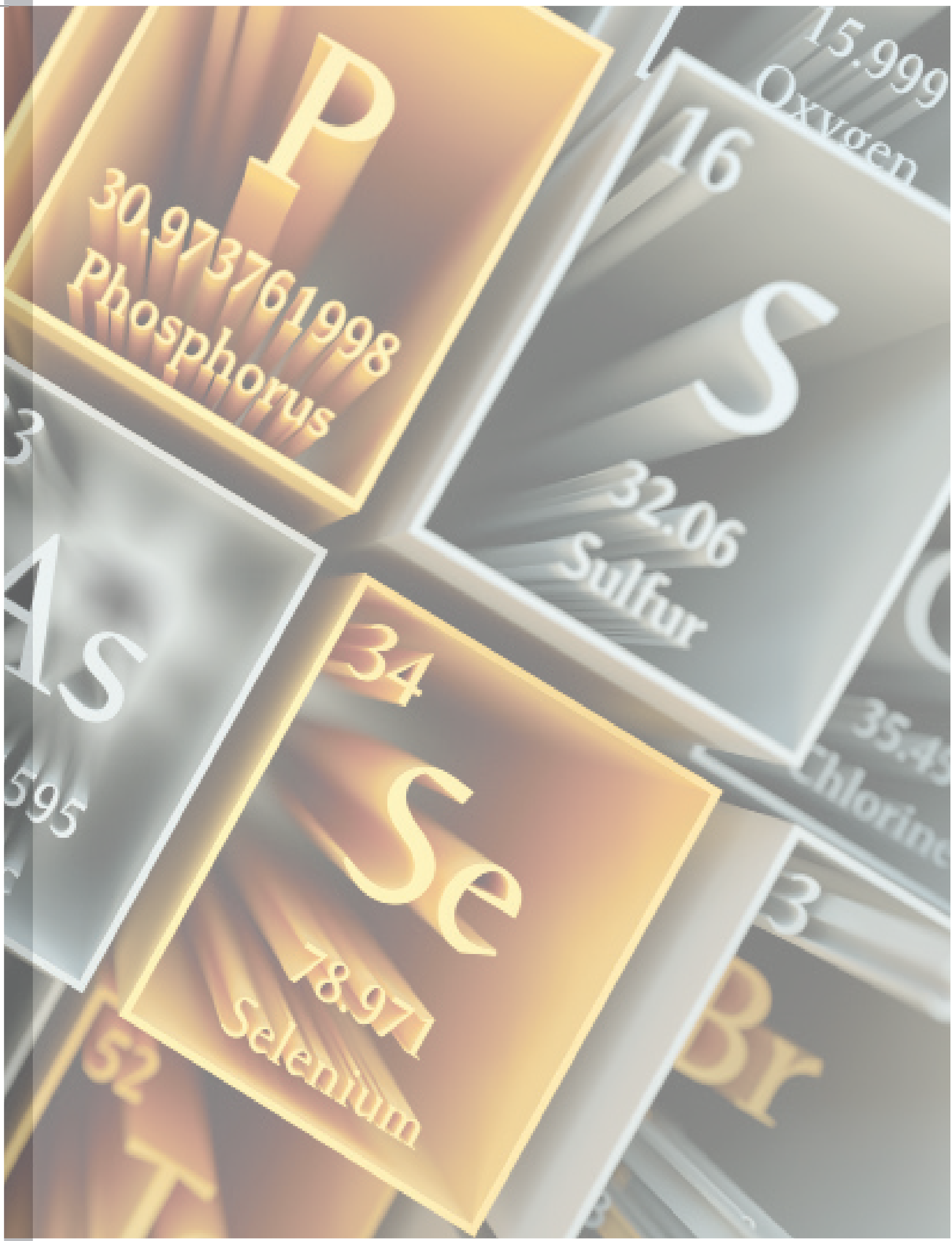
4.Tehran University of Medical Sciences Library

Nowadays, the use of technology is not merely considered as an educational aid but has become an integral part of life in all educational activities, bringing about structural and substantive changes in teaching-

learning activities and being recognized as a standard and topic for accreditation. Therefore, it is necessary for educators to embrace effective technology-

based teaching models and replace traditional teaching methods.

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A brief overview of technology-based learning and education methods in medical science

1Neuroscientists have identified distinct molecular signaling pathways within and between neurons that contribute to the learning process. Initially, the learning experience is encoded as a temporary representation in working memory, which has limited capacity and duration. Over time, this information transitions into a more enduring and stable form of memory with increased capacity, stored for future retrieval. Learning triggers both functional and structural changes in the interconnected networks of cells (synapses) across the central nervous system. Recent studies suggest that these changes involve various posttranslational modifications of proteins near synaptic junctions, enhancing subsequent signals evoked by a nerve impulse at the postsynaptic neuron. These experimental results establish a clear link between spaced repetition of information and the lasting neural adaptations associated with learning.

Advancements in technology have transformed various aspects of life, including education and learning. The field of medical sciences has not been immune to these changes, with technology not only facilitating educational progress but also inspiring students in the medical domain to engage in learning more effectively. In the realm of medicine, diverse technologies are utilized for learning and studying, such as Mobile Devices, Digital Games, Simulation, and Wearable Technologies.

One example of Computer-assisted Learning is the adoption of "flipped classrooms," where students view online lectures beforehand and engage in interactive sessions with instructors during class time. Additionally, medical apps play a significant role in self-directed learning. While anatomy-focused apps are commonly used by students, there are also apps tailored for studying physiology, medical problem-solving, diagnosis, and treatment. iMedicalApps.com offers recommendations for top apps beneficial for students.

A survey conducted at Mashhad University of Medical Sciences, involving 70 medical students, highlighted that educational aids perceived as most effective for learning anatomy from the students' viewpoint were mobile apps (42.1%), while flashcards were considered the least effective (1%). Students frequently utilized software like Netter's Atlas of Anatomy and 3D-essential anatomy software. Educational images, posters, anatomy instructional videos, plastic models, clinical scenarios, and books were also popular resources among students. The study outcomes emphasize the high interest medical students have in educational apps for studying anatomy. Simulation in medical education aims to replicate real-life scenarios involving patients, anatomical structures, or clinical procedures, providing a realistic environment for learning and practice. This can involve the use of 3-D representations of body parts and regions as well as Virtual Reality (VR) technology, which can be utilized in classrooms or for self-directed learning.

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In a study conducted at a university medical school in the Midwestern U.S., students were required to review approximately 15 hours of online readings and videos each week during guided independent learning. Classroom activities primarily focused on small-group discussions and case-based learning centered around patients' chief complaints and concerns. The study highlighted four main types of technologies used for learning: video resources, self-assessment tools, management tools, and social media. One significant advantage mentioned in the study regarding the use of video resources was that students could learn at their own pace. Medical students primarily utilized these resources for knowledge consolidation, including information retention, summarization, and making connections. Self-assessment tools such as question banks and flashcard software like Anki, UWorld, and Firecracker were predominantly used by students for knowledge retention and self-reflection, particularly in remembering drug and disease names and enhancing long-term retention. In terms of management tools, note-taking applications like Microsoft OneNote, Notability, Good Notes, PDF Expert, Cram Fighter, and Focus Booster were popular choices for students to organize various learning resources, including diagrams, photos, and screenshots, enabling them to color code, draw, and establish connections between different materials. Among social media platforms, students primarily utilized group chats, with Instagram, Reddit, and Snapchat being less frequently used. Social media group chats facilitated resource sharing, posting reminders, asking and answering questions, and providing social and emotional support among students.

The adoption of digital textbooks offers a cost-effective way to enhance the quality of medical education and provide students with essential study materials in today's technological landscape. Institutions now have the option to utilize digital textbooks as a powerful educational tool in medical training, offering accessibility across various devices such as laptops, tablets, and smartphones. These electronic resources provide interactivity, multimedia features, and receive updates more promptly compared to traditional printed editions. Additionally, platforms like Peachy Essay offer online essay assistance for students working on assignments, further enhancing the educational experience. Digital textbooks are notably cost-effective, as they are available through subscription services spanning one year or longer, unlike traditional printed books. This approach fosters equal access to learning resources for all students, regardless of their location. Additionally, with cloud storage integration, learners can access their digital textbooks from any device with internet connectivity.

As technology continues to evolve, an increasing number of web-based resources are being utilized by medical students, with many turning to expanded-retrieval platforms. These platforms are typically used for content review, gradually extending the intervals between testing on subject matter.

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Education of future doctors: virtual? Traditional? Blended?

The primary objective of medical education is to impart essential medical knowledge to physicians, enabling them to apply their learning effectively. Despite the critical nature of medical education and the necessity for ongoing enhancements in this domain, traditional methods face constraints. In the contemporary era, the evolution of information and communication technology has revolutionized various aspects of human life, including education. This transformation has redefined the conventional notion of education, making it accessible beyond physical educational institutions and offering flexibility in terms of time and location.

An eminent challenge in medical education pertains to the abundance of course materials juxtaposed with the limited time available for course delivery. Additionally, constraints such as inadequate infrastructure and a shortage of faculty members in universities pose obstacles, including the provision of suitable classrooms and a lecturer-centric approach to teaching. Research has indicated that traditional methods fall short in effectively conveying clinical material to students. Consequently, the integration of electronic and virtual education has emerged as a preferred choice within medical education systems.

Electronic (virtual) education has demonstrated a pivotal role in enhancing students' skills and knowledge, catering to the needs of medical students. This mode of education leverages technology and the internet, employing multimedia resources to facilitate learning. Compared to traditional methods, virtual education offers superior learning outcomes for students. However, it also presents challenges that necessitate substantial theoretical and practical research, emphasizing the importance of technology utilization and learning enhancement.

The successful implementation of technology in education requires a comprehensive approach to educational design, encompassing various dimensions such as educational environments, content, methods, activities, and evaluation. Definitions of technology-integrated curricula often emphasize the fusion of technologies, including web-based tools, with educational frameworks. Effective distance learning hinges on aligning content and learning activities with learners' needs, fostering engagement through diverse forms of interaction like discussions, debates, and reflective exercises. To address the challenges associated with electronic classes, educators can incorporate inclusive activities that promote independent and group work, thereby enhancing the quality of learning experiences. Strategies proposed by experts like Raffeld, Hayestra, and Philip Zack advocate for creating interactive learning environments that stimulate critical thinking and collaborative learning processes. By emphasizing inclusive and engaging activities, educators can optimize the effectiveness of distance learning initiatives.

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Grayson Anderson and Erger introduced the learning community model in electronic education, emphasizing the integration of social and cognitive factors in the learning process. In online education, the electronic teacher assumes three essential roles: designing and organizing learning experiences, facilitating learning activities and fostering discourse, and providing direct instruction. Various learning activities utilized in e-learning include reviewing questions, conducting research reports, analyzing case studies, engaging in visual studies, completing exams, participating in simulations, and engaging in discussions. Discussions in online learning occur through both simultaneous and asynchronous methods. Simultaneous learning technologies encompass text-based chat rooms, audio conferences, and video conferences. Asynchronous learning technologies involve platforms such as electronic lists and computer conferences, including news boards for notifications, discussion environments for posting and organizing messages, and grading learners' participation through ongoing discussions on notice boards.

Clinical education holds paramount importance in the realm of health education, with virtual medical education making significant strides in surgical and clinical fields. While virtual education plays a crucial role, blended learning approaches have gained prominence in certain educational institutions worldwide. Research indicates that solely relying on virtual education in clinical fields may not suffice, emphasizing the effectiveness of blended education over traditional or virtual methods alone. The success of education lies in the interdependence of teaching and learning processes. Effective student outcomes are influenced by factors such as cognitive abilities and metacognitive skills like creativity, critical thinking, self-direction, reasoning, and problem-solving. The presence of capable students who possess these skills is essential for optimal learning outcomes. Educators and students alike should possess information and computer literacy, alongside a conducive personality structure that fosters effective interactions and learning experiences.

Instructor qualifications play a pivotal role in the effectiveness of education, with expertise in the field and ethical conduct being crucial aspects. Technical aspects, including the accessibility and quality of course content, are vital for ensuring effective education. Pedagogical considerations such as group collaboration, student progress monitoring, and virtual feedback systems are integral components of a successful blended learning environment. Creating a supportive and communicative atmosphere enhances the learning experience for both learners and instructors, fostering engagement and interest in the educational process.

Research comparing traditional and blended education groups indicates higher satisfaction and quality of education in the blended learning group. Factors such as academic ability, professor's dynamism and interest, student motivation, human relationships, curriculum planning, ethical considerations,

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