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Review Article

Tips plus a national experience for developing a smart university in medical sciences education

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Abstract
The increase in technological developments in recent years and its effects on university systems have compelled countries to rethink higher education structures. Due to these developments, universities of medical sciences are now faced with complex conditions that render the traditional models of higher education ineffective. In this article, the authors present twelve tips based on their experience in creating and developing a smart university (SmU) in the medical sciences. To demonstrate the applicability of these tips, they provide a national example at the end. Shifting from a traditional university to an SmU depends on developing hardware infrastructure, advanced software, and innovative technical applications and platforms. It also requires inter-professional collaboration and the formation of smart learning communities, leadership, and interaction of potential physical, human, financial, intellectual, informational, and technological resources. Additionally, it requires the planning of strategies that guarantee this transformation. Moreover, maintaining such a university requires incorporating social accountability into smart education (SmE) processes and promoting an organizational culture that supports smartization and integrating technology into higher education.

Introduction

The use of technology in the health higher education system is advancing at an unprecedented pace and has transformed this field; the COVID-19 pandemic and its effects on medical education have multiplied the rate at which this transformation is occurring.[1] Technology has become an integral component of higher education, and universities cannot perform any of their fundamental functions without it.[2]

The articles presented at annual international conferences,[3-6] on smart education (SmE) and e-learning demonstrate unequivocally that the concepts of smart university (SmU), SmCs, and Smart Pedagogy will be actively deployed and utilized by the world's leading academic institutions and educational organizations. As Einstein said, "We cannot solve our problems with the same thinking we used when we created them." We must develop new conceptual models and identify unique features, systems, and technologies for the next level of university evolution. After the first decade of the 21st century, few educational and research activities are conceivable without Internet and computer communication due to the development of ICT. In the past, education was only feasible through teachers and trainers, and books were considered the primary source of instruction. However, today, education utilizes new tools and communication environments. The Internet, multimedia, and communication technologies have provided developers, planners, managers, and agents with new tools and methods. Higher education and smart universities are the latest achievements of ICT that may offer favorable solutions to overcome the complications and limitations of traditional methods. In other words, continuous development in the field of communication technologies has led to more efficient and cost-effective learning methods than traditional approaches to learning.[7]

According to Tikhomirov and Dneprovskaya,[8] an SmU is a concept that includes a comprehensive modernization of all educational processes. It represents the creative integration of smart technologies and systems, smart objects, smart environments, smart software and hardware systems, smart curricula, SmCs with cutting-edge technologies and technical platforms, smart pedagogy based on contemporary teaching-learning strategies, and various branches of computer science and computer

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engineering.[9,10] By their nature, smart universities leverage existing technologies to enhance their performance and the quality of their faculty, teaching-learning processes, and graduates.[11,12] In general, shifting from a traditional university to an SmU is a complex process not solely caused by the advancement of technology and its side effects. Instead, creating an SmU requires actions and creative integration, presented in this guide as twelve tips and a national experience (Figure 1). As a consequence of implementing these tips in any environment with local considerations, an SmU of medical sciences can be developed.

Tip 1: Determine the road ahead (specify the landscape)

Today, developed and top universities are attempting to provide all their services and educational missions on the Internet and globally. In addition, these universities are trying to modernize and expand key aspects of their educational and research services by employing cutting-edge ICT tools. Consequently, using these technologies has considerably improved the quality of learning and related services in educational systems, notably higher education.[14] In recent years, the ideas of SmE, SmU, smart classroom (SmC), smart learning environments (SLE), and other related topics have become the main themes of different pioneering international and national events and projects. The SmU is one area that brings ICT into higher education with a comprehensive and holistic model and predetermined goals and missions. Health higher education continuously evolves, and nations create, modify, and expand their health education systems following their needs and objectives. Therefore, SmU of Medical Sciences is beginning a new era for the health higher education system. There has been a paradigm shift from traditional to SmE. SMART stands for Self-directed, Motivated, Adaptable, Resource-enriched, and

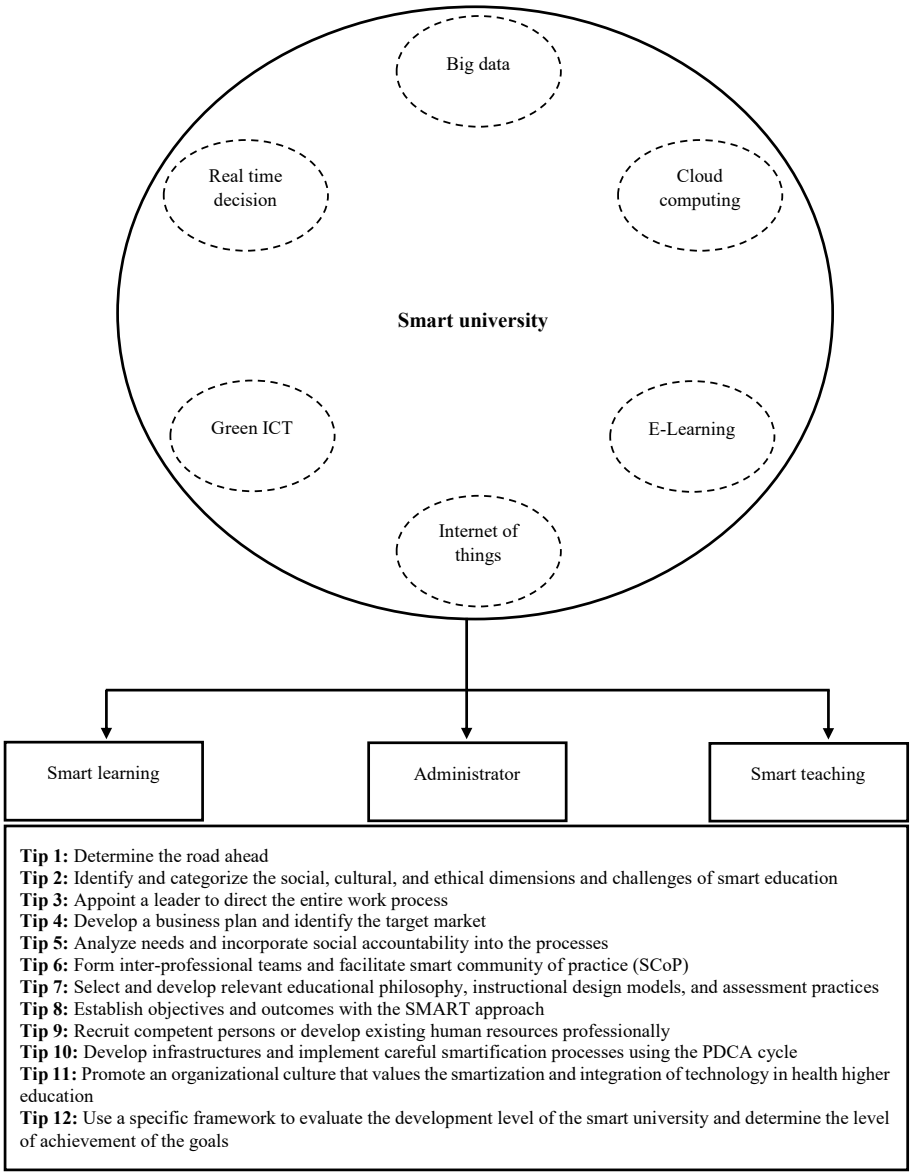

Figure 1. Elements of Smart University,[13] and all twelve tips for developing a smart university in medical sciences education

Technology-embedded education.[15] These ideas can represent the fundamental principles that regulate smart universities. Based on these values, the SmU's developers should thoroughly consider its mission's nature, reach an agreement, and clarify this objective. In other words, agents, policymakers, and planners should define an ambitious vision and a clear path considering the time frame for a successful future.

Tip 2: Identify and categorize the social, cultural, and ethical dimensions and challenges of smart education

With the introduction of the Internet and the ongoing development of technology, the scope of education has constantly expanded. Technology now allows people to access knowledge and information from remote locations. The advent of the Internet and the development of technologies have permitted the advancement of higher education by leaps and bounds. However, implementing smart technologies in higher education faces obstacles that must be addressed. In other words, implementing smart higher education and developing a SmU is not easy.[16] SmE challenges can be categorized differently depending on a country's development level. Concerning the socio-economic challenges of SmE, there are some items such as the lack of access to smartphones and laptops for all targeted people in the society (socio-economic inequity), inadequate infrastructure in the community,[17,18] and inequality in the distribution of technology and digital inequity.[19] Regarding the most significant cultural challenges in the development of SmE, we can also mention the lack of technological readiness among students and professors,[17] and the non-acceptance and non-compliance with technology,[19] by administrators, planners, policymakers, teachers, and students. In addition, regarding the use of new technologies in education, there are significant ethical concerns such as privacy violation and security,[16,20-22] surveillance system (gathering detailed information about the actions and preferences of students and teachers),[23] jeopardizing of and students teachers' autonomy and independence as a result of monitoring systems.[23,24] Before the development of a SmU of medical sciences, it is preferable to identify its challenges in categories such as socio-economic, cultural, and ethical at the micro, meso, and macro levels and provide intelligent solutions to overcome them so that policymakers and planners do not get stuck in the middle of the road.

Tip 3: Appoint a leader or navigator to direct the entire work process

In the higher education system, numerous activities are carried out, such as teaching, facilitating learning, curriculum design and development, technology application, assessment, evaluation, and administration of teams, departments, and programs. Whether leading an existing project team or developing a new program, faculty, or university, these tasks require leadership in some capacity. Effective leaders have adherents, assume accountability, do the right thing, and generate results.[25,26] The evidence shows that effective leadership is necessary for organizational success. Conversely, weak and ineffective leadership or management plays a major role in the failure of organizations.[26,27] It is essential to have information not only about environmental changes but also about the existing resource potential and the capacity to respond to external challenges to increase the competitiveness of an SmU through effective leadership and management. With this information, leaders and managers can compare the potential of an SmU with market requirements, objectively appraise the situation, and make well-informed management decisions, thereby planning the correct course for strategic development.[28] Developing an SmU or transitioning a traditional university into a smart one is complex and difficult.[29] This requires leadership and interaction of potential physical, human, financial, intellectual, informational, and technological resources and planning strategies to ensure this transformation.

Tip 4: Develop a business plan and identify the target market

The evolution of technology affects business models, the way of providing services and producing goods, and governance processes in organizations, including universities.[30] Improving the infrastructure of ICT and the capacity to analyze environmental data will give an organization and its business a competitive advantage.[31] Although the dimensions of technological transformation are numerous, the components that have influenced various businesses and industries and have been considered by researchers and organization managers since 2011 have been referred to as the fourth revolution,[32] like other developments referred to as the Industrial Revolution, the fourth industrial revolution has caused a paradigm shift in the processes of producing products and providing services using transformative technologies. It has shaped new business models.[33] Today, business and academic communities call the fourth revolution the smart industry or industry 4.0.[34] Smart industry is a path that leads to the creation of a competitive advantage for organizations and universities, and it also creates the need for the survival of businesses and industries; therefore, all organizations, including universities, should prepare themselves for such competitive conditions and provide a modern business environment.[35] Planning may vary significantly based on the centralization or decentralization of the higher education system, the extent to which the university that will be developed receives government support regarding budget and finances, and the university's ability to develop income-generating programs. Before creating a smart university of medical sciences (SmUMS), agents and policymakers must devise a business plan under the

direction of a leader or navigator and identify potential customers to whom products and services will be offered. In addition, the initial financing for the development of this university should be established at this stage.

Tip 5: Analyze needs (conduct needs assessment) and incorporate social accountability into the processes

The introduction of the socially accountable approach to medical education approximately four decades ago,[36] has resulted in the establishment of a global network of medical institutions whose approach incorporates community-engaged medical education.[37] The focus is increased on the university's or medical school's social responsibility and the extent to which it equips graduates to meet the requirements of the society they serve. Today, the third generation of universities, referred to as "entrepreneurial and responsive universities," are expected to apply knowledge and awareness in practice so that they can make the application of science in practice and the creation of innovation and entrepreneurship their primary mission and be able to assume social responsibilities more coherently and tenaciously than in the past. On the other hand, recent research indicates universities' inevitable movement and evolution toward a new generation under the title of "smart universities." Universities that use advanced and cutting-edge technologies to bring smartness to various aspects of the university, ranging from strategic changes in university management and knowledge exchange to extensive changes in learning and communication supported by a smart environment and infrastructure. The development of an SmU, like any new program, necessitates a needs assessment, although smart universities have great agility and flexibility in identifying environmental requirements and necessary transformation. Priority should be given to identifying and evaluating the general conditions of the society and the target group when conducting a needs assessment. SmU developers must comprehend students and their learning environment to design a system that meets their requirements. For instance, one of the most distinguishing characteristics of an SmU is its ability to adapt to various types of students/learners, such as regular students and lifelong learners, in-classroom students, online or offline students, and students with special needs (students with various types of disabilities, such as physical, visual, hearing, speech, cognitive, etc).[38] lastly, various approaches to identifying requirements and target groups can be used in consultation with stakeholders to develop a smart medical sciences university.

Tip 6: Form inter-professional teams and facilitate smart community of practice (SCoP)

People with diverse expertise should be brought together in an SmU to maximize performance. In other words, inter-professional teamwork is integral to an SmU's design. As a result of this collaboration, a smart community of practice is formed. These smart communities are focal points for collective leadership and management of data and information, networking, support, and peer learning. According to Adamkó et al,[39] smart learning communities should have the following characteristics: Sensible (sensors sense the environment), connectable (networking devices transmit sensor information to the web), accessible (the information is published on the web, and accessible to the users), ubiquitous (the users can access the information through the web, but most notably on the mobile phone at any time), and sociable (the user can distribute information to others). Coccoli et al,[40] define a "smarter university" as a location where knowledge is shared uniformly among faculty, students, and all other stakeholders. For this reality, technology is no longer sufficient. To transform an SmU into a smarter one, and thus more efficient, more effective, and with more outstanding student and teacher participation, it is necessary to shift the paradigm toward collaboration to achieve the common goal of better learning.[40]

Tip 7: Select and develop relevant educational philosophy, instructional design models, and assessment practices

Educational philosophy, design models, and assessment methods used in traditional educational environments can no longer be suitable for SmE. The evolution of the new concept of the SmU,[41,42] enables a smart learning process that requires the implementation of an adaptive educational model using smart information technologies. This growth in the adaptation and use of digital tools has caused education to gradually progress to satisfy the generation of digital-age students for learning, self-awareness, and communication with the outside world.[43] The "millennial" or "digital" generation makes up most of the current student body. This generation is a group that prefers "personalized" learning with flexibility, utilizing technology and virtual learning environments that provide learning resources when needed.[44,45] Therefore, we must formulate and develop pedagogy, curricula, educational design models, and assessment methods related and appropriate to SmE environments. Even today, a large part of clinical education and assessment can be covered through artificial intelligence, telemedicine, tele-education, clinics, or smart hospitals.

Tip 8: Establish objectives and outcomes with the SMART approach (Smart targeting)

The SMART goal-setting approach is a pragmatic way to achieve goals. SMART defines a clear strategy for achieving any goal. We suggest using the SMART technique to determine the objectives of an SmU. In other words, the goals (Specific, Measurable, Achievable, Realistic, and Timely) should be identified. Studies show that completing small, structured goals using this SMART

approach improves work efficiency.[46,47] In addition, through this method, it is possible to know the extent of achieving the set goals. Overall, engagement and focus on the goals of the SmU can be maintained through this technique.

Tip 9: Recruit competent persons (educational and technical/ support staff and faculty members) or develop existing human resources professionally

The resource potential of an SmU is a combination of human, material and technical, informational, intellectual, innovative, and financial resources, as well as reserves and opportunities, whose rational application will enhance performance and assure the university's long-term sustainability.[28] Meanwhile, the system's performance is influenced by human resources more than anything else because the use of other resources depends on the ability and the way the workforce uses these resources and facilities.[14] Therefore, competent human resources (including educational and technical/ support staff and faculty members) should be hired. Or that a strategic analysis of the university's existing human resources is conducted so that development programs can be added to the agenda if necessary. The significance of competent and developed human resources is that it contributes to the university's national and international development and stability. Finally, the strategic analysis of the potential of resources, including human resources of an SmU for management purposes, should not be ignored.[28]

Tip 10: Develop infrastructures (hardware, software, apps) and implement careful smartification processes using the PDCA cycle

We believe that to achieve its educational goals, SmU, as a smart system, should emphasize not only advanced and cutting-edge software and hardware features, emerging technologies, innovative technical platforms and applications, and pioneering teaching and learning strategies but also the "smart" characteristics of smart systems.[48] Therefore, the designers and developers of SmU should pay more attention to the maturity of smart features of smart universities, which can occur at various levels of smartness or smartness, such as adaptation, sensing, inference, self-learning, anticipation, and self-organization. In addition, opportunities should be provided for researchers, research teams, and practitioners to work on the design, development, testing, and implementation of a variety of innovative smart technologies, software and hardware systems, and smart devices on campus to enable these technologies' integration into the educational processes used. For this purpose, continuous quality improvement (CQI) methods such as the well-known framework (PDCA or PDSA) can be used. The PDCA cycle, also known as the Shewhart cycle, is an iterative design and management method used in organizations to improve processes and products continuously.[49] Studies show that using the cycle (PDCA) can optimize training and learning outcomes.[50] By employing this framework when designing and implementing smartization processes with precision and in a step-by-step manner, the quality of these processes can be continuously enhanced.

Tip 11: Promote an organizational culture that values the smartization and integration of technology in health higher education

Sánchez Bernabeu et al,[51] state that although the SmU pursues and maintains the improving the quality of life of the community under its coverage through the global, intensive, and sustainable use of ICT following the principle of serving citizens, it makes decisions locally and in a manner that is unique to the organization. Today, organizations, including universities, must integrate smart technologies to utilize their capabilities to change their processes and move them toward new organizational models.[16] Therefore, in the digital and modern technology age, the organizational culture of universities and medical schools should demonstrate to faculty, students, and staff the importance of incorporating new technologies in medical education and the smartization of health higher education. This kind of atmosphere and culture encourages all stakeholders, including teachers, students, and educational and technical/ support staff, to participate voluntarily and proactively in these processes to acquire digital capabilities and use new technologies in medical education, engage in relevant development programs, and enhance their knowledge, skills, and attitudes.

Tip 12: Use a specific framework to evaluate the development level of the smart university and determine the level of achievement of the goals

Based on the studies related to digitalization and SmE development trends,[52-54] two main technological and organizational elements can be identified to evaluate the level of development of an SmU. The technological element of the SmU includes new information technologies that are used in SmE and distinguishes this type of education from traditional and simple e-education. These information or digital technologies have features such as interaction, data mining capability, data personalization, etc. The organizational aspect of an SmU is the efficient application of smart technologies. When forming an educational program at a university, it is necessary to consider the unique educational path of each student, which necessitates the use of educational data mining technologies and the ability to integrate various educational programs. In general, the level of development of an SmU can be determined by delineating the components of this framework. Based on another framework, the SmU is viewed as a self-learning

organization or learning organization that operates based on a team of like-minded individuals and has a mechanism that allows for rapid adaptation to varying circumstances. This mechanism includes criteria such as relationship convergence, knowledge transfer and growth, learning capacity, and addressing the external environment's requirements.[55] Consequently, it is also possible to evaluate the SmU's performance and level of development using this framework. Finally, the degree of achievement of the predetermined objectives should be determined based on the evaluation's findings. In addition, the development of the SmU may have led to unexpected outcomes. It is preferable also to state these objectives. In addition, based on the framework and indicators that you evaluate, if necessary, enhance the quality of SmE processes so that the SmU's sustainable development continues.

Smart University of Medical Sciences in Iran is a specialized and pioneer university expanding this experience to international levels (sharing national experiences)

Smart University of Medical Sciences (SmUMS) is the first and only specialized university in e-learning and new technologies in the field of Medical Science in Iran (Figure 2). A university that provides innovative ways of working, learning, and teaching in spaces that creatively integrate advanced hardware and software platforms that utilize big data, sensors, social media, and machine learning. SmUMS, with cutting-edge technology in e-education and artificial intelligence, and taking advantage of competent human resources encourages virtual education, research, knowledge-based technologies, and the development of artificial intelligence in the fields of health, treatment, and medical education. As a synergistic university, SmUMS plays an important role in developing virtual education and artificial intelligence to improve society's welfare and health by collaborating with other domestic and foreign universities and related institutions, as well as by adhering to professional ethics principles. SmUMS was established in 2016 in alliance with the Ministry of Health and Medical Education policies. Since its founding, the university has contributed to the growth of the virtual education approach in the country, by developing software, introducing new teaching strategies, and compiling guidelines and regulations about virtual education. Education is considered a part of the activities of the SmUMS however, its scope of activities is wider than mere education. The creation of the NAVID platform as a national Learning Management

Figure 2. Overview of the website of Smart University of Medical Sciences

System (LMS) is a major accomplishment of the SmU of Medical Sciences and is being used by almost 70 medical universities nationwide. Another major project that was successfully designed and implemented by SmUMS is the first standard national Massive Online Open Course (MOOC) platform, ARMAN, which provide nationwide equal educational opportunities. This platform has a wide range of interactive courses to choose from. Another innovation of this university in the field of research is the launch of a Journal of Visualized Medicine (JoVM). The setting up of the smart monitoring system of the country's medical sciences universities (abbreviated as Sepahda) is another project of this university, which is a comprehensive program for the smartening of the country's medical sciences universities and to evaluate their readiness to move on the path of smartization is designed. Composing the artificial Intelligence in medical Sciences Excellence program document (AIMS), designing and authorizing the National Bioinformatics Network plan (IRNBioAIMS) to create the infrastructure for gathering and exploiting medical data, Designing and authorization of the Iranian Health Metaverse National Project (IRNH-METAVERSE), Establishment of the Incubator center for the smart health technologies, and development of smart clinic are other programs and projects are being implemented by this university. In general, SmUMS oversees all universities and medical institutions in the country as the main trustee for the development of artificial intelligence in the fields of health and medical education as well as virtual education and offers its services to more than 300 000 individuals, including staff, students, professors, and community members.

For further information, please visit our website: https://smums.ac.ir/

Conclusion

Today, digital transformation in universities based on the new "SmU" paradigm has garnered the interest of numerous experts and scientific communities. Since digital natives constitute a more significant part of the student body, change and evolution in the medical education system are inevitable. In addition, as we move forward in the 21st century, we realize that significant advances have been made in providing health services based on state-of-the-art medical education technologies. According to several experts, smartening up universities of medical sciences could be an innovative response to the present challenges. SmU of Medical Sciences is a conceptual framework that entails the comprehensive and continuous modernization of all educational processes following stakeholders' requirements. SmE can provide a new university in which a set of ICT and instructors achieve an entirely new level of quality in educational, commercial, and other processes and outcomes.

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Authors' Contribution

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Supervision: Babak Sabet.
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Competing Interests

The authors declare no competing interest.

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