What Do Future Trends in Medical Education Mean to the Scientific Development of Iran’s Health System?

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Abstract

Background: Medical education system in Iran has an essential role in responding to scientific development targets from both education and research perspectives. Investigating future trends and analyzing how they interact with the medical education system helps increase awareness and give insight into the preferred future.

Methods: The present qualitative study consists of Systematic reviews and interviews that have been analyzed using content analysis. Afterward, the themes and codes were visualized in the form of maps and presented in a focus group discussion of experts to define how medical education trends will impact scientific development.

Results: The future trends of Iran's medical education system were classified into six groups: workplace changes, demographic changes, changes in concepts, the emergence of new players, structural changes in universities, and technology development. The next point is how they will influence science development. Their impact on science development is classified into five main groups or main streams of change of new financial models, open science, redesigning the research management, the role of universities, and capacity building.

Conclusion: Our findings showed that redesigning the structure of medical education is the most important priority to make the system as agile as needed to capture the signs and act. New meanings and concepts should also be considered in restructuring, like power balance, competency-based and personalized education, cost-effectiveness, and openness.

Keywords: Medical education system, Scientific development, Future trends, Environmental scanning, Systematic review, Meta-synthesis, Iran

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Introduction

Scientific development, excellence, and authority have been on the related organization’s agenda in recent years in Iran. The leading cause is the emphasis of the upstream document and development plans on science development

↑What is “already known” in this topic:
Medical education will undergo changes rooted in complicated interactive general or specific trends. Analyzing future trends helps in mapping different images of the future to support stakeholders in their proactive approach to future matters.

—What this article adds:
In this study, the future trends affecting Iran’s medical education are investigated, and also the secondhand effects are also mapped for each main pattern of change. It shows that the most critical aspects of change are structural, and just capturing the concepts from the international academic community will not work; instead, comprehensively translating and justifying the related structural changes are needed at Macro and micro levels.
as a key for national development, so there have been many studies and developed models to respond to this essentiality (1). The health sector is a field of science that has a dual role. One is to respond to the national vision of excellence or authority in health sciences (2), and the second and primary goal is health promotion and health service quality (3). Successing in responding to both types needs to be future-oriented and environment-aware (4).

As much as different economic, social, educational, etc. systems can anticipate future requirements and develop their structures, policies, and regulations, they will benefit the future more with less harm from uncertainties (5). Traditional approaches based on trial and past data-based analysis are ineffective in dealing with upcoming challenges and threats, meeting future needs, and moving toward the vision and aims (5, 6). Just having an action plan is no longer a competitive advantage, though it matters how systems can base their strategies on desired images and vision regardless of inevitable items of the future like uncertainties, driving forces, or wild cards (7, 8). So many countries have devised the foresight process in their systems’ policymaking and planning procedures worldwide, like higher education in England, Romania, Malaysia, and OECD countries (9-12).

One of the primary challenges that all countries will face, especially those with the ministerial structure of higher education policymaking, is to respond proactively to a changing international world and complex politics (8). At the same time, their policies and frameworks tend to be past-oriented and strategic goals are generally short-term oriented (8, 13). Especially for Iran, higher education in Iran was separated into two main categories of medical and non-medical education after the integration of medical education into the structure of the health ministry. So, discussing medical education and its trends includes the future of higher education in general.

Scientific development has been given much attention in Iran’s national documents, and the health sector has a vital role by its nature as the structure is defined as the medical education system. On the other side monitoring, the environmental changes help the systems to be agile and aware enough to be proactive in moving toward the future. This study aims to investigate medical education trends in Iran and how they would affect scientific development in the health sector through a systematic approach as a base of further future-oriented studies in this regard.

Methods
This study is a mixed method and multi-stage study that uses content analysis of the systematic review, meta-synthesis, and interviewing results.

The study started in 2019, but after COVID-19 was updated due to the emergent effects of the pandemic. The brief visualized steps of the study and more details of the steps are presented in Figure 1.

Systematic review and meta-synthesis
The search strategy was “what are the Future trends of...”

Identification
- Searched in Persian and English before October 2018
- Persian databases, Google scholar, PubMed, Scopus, Web of Science, Embase, Science Direct, Eric, and Emerald

Screening
- by title and abstract, full text and critical appraisal using CASP tool

Data extraction
- Search the used databases between November 2018 to July 2021
- Using content analysis

Figure 1. The overview of the study methodology and the steps in each phase
medical education?” which has been developed based on SPIDER (14) and aimed to identify the main changing paths affecting medical education, also shown in Table 1.

The initial systematic and meta-synthesis were done using Sandelowski and Barroso’s guidelines (15). The Persian form of the strategy was searched in related Persian databases and Google Scholar. The English form of the strategy was searched in PubMed, Scopus, Web of Science, Embase, Science Direct, Eric, and Emerald. Due to the nature of the research question, the gray literature needed attention, so the research team identified the sources also presented in Table 2. The Persian databases used in the study were Element, Civilica1, Irando2, google scholar, scientific information database3, and Google local domain.

The steps of the review and the results of each one are presented based on the 2020 updated version of the PRISMA (18) consisting of title screening, full-text screening, critical appraisal, and data extraction for research articles and screening for other related records obtained from gray literature. The peers screened the record to avoid selection bias. The inclusion and exclusion criteria were as follows:

- Inclusion criteria: The research evaluated or mentioned the main trends or patterns of change in finishing education or medical education. Higher education and medical education were both considered in the scope of the review due to their dependency.

- Exclusion criteria: researchers’ approach and design were not future-studies-based or were not future-oriented like the studies that focus on current challenges of medical education.

In the third step of the screening phase, the CASP tool was used for a critical appraisal (19), and peers did the data extraction to ensure consistency. They analyzed the content analysis approach to find the mainstream trends of the future of Iran's medical education. This phase of the study was done between October 2018 to May 2019.

**Updating the systematic review**

Meanwhile, after finalizing the analysis of the data, COVID-19 happened. On one side, it caused an interruption in the study; on the other side, it was a turning point for education, so the research team updated the systematic review using the Garner et al. checklist (20). First, the decision framework is used to assess the feasibility and necessity of updating. The interviewing added another source of data to capture the insight of the experts, too. To update the systematic review, the same PICO was searched in the same databases with a time limit between November 2018 to July 2021. All the phases and steps of the systematic review were repeated for the new records. Finally, three more records were entered in the data extraction and content analysis step.

**Interviewing**

The interviewing was done in-depth using the snowball sampling method. The interview added to capture the experts' comments by considering the pandemic's potential effects. The interview continued till the saturation of the data, and a total of 20 interviews were done, each taking 40 minutes on average. Eight participants were female, and 12 were male, between 35 to 69 years old. The interviewees were medical-education-related policy makers, senior managers of medical education or higher education, vice-Chancellors of Medical Sciences Universities, Futurists active in higher education or medical education future, and the heads of education development centers of medical education universities. The experts were asked to introduce the other related experts as well. The experts were communicated to set the interview time and send the questions before the session. The responsible researcher also explained the objects and the study phases to the experts. The sessions were all virtually by the Microsoft team, via Skype, and by phone. The study was done in the Kerman province of Iran. The interviews were recorded with permission and transcribed by peers to ensure the validity of the data. The interview questions were:

- What are the future trends that affect medical education?
- How do you anticipate how the trends will affect Iran's medical education?

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1. CIVILICA or Knowledge Reference is a private website that indexes and publishes a collection of conference papers and conferences in Iran. Civilica is a member of the National Content Consortium and, in this national consortium, is the only provider of data from specialized conferences and seminars in Iran. Available at https://civilica.com/

2. Irando's core mission is research, science and technology information management, education, research and information collaboration, and science and technology policy support, which is carried out in an organization affiliated with the Ministry of Science, Research, and Technology and under the auspices of the Board of Trustees. Available at https://irando.ac.ir/

3. Scientific Information Database (SID) of Academic Center for Education, Culture, and Research Persian is an Iranian free accessible website for indexing academic journals and access to full text or metadata of Academic Publishing. Available at https://www.sid.ir/
medical education in the future?

**The qualitative analysis**
The data obtained from the updated systematic review and the interviews were analyzed using content analysis by MAXQDA 2018. The findings added to the initial review results, updating the codes and themes.

**Focus group discussion of experts**
The focus group discussion was based on Nyumba guidelines in three main phases research design, data collection, and data analysis (15). The phases and their steps were as follows:

**Research design**
- **Setting the objectives**: The main goal was to investigate the pattern of change and the identified trends in previous phases of the study that would affect the scientific development of the health sector in Iran. The codes and themes of the future of education were presented, and the related relations were discussed in the session.
- **Identifying and recruiting the participants**: The participants were selected homogenous in gender, education, and all Persian speaking. The number of participants was 4, two men and two women. The location of the session was Kerman, Iran.

**Data collection**
- **Pre-session preparation**: The participants were interviewed in the last phase, the preform of the graphs, and the relations before the session.
- **Facilitation during the meeting**: The objectives and the graphs were presented at first, and all the experts had 10 minutes to mention their perspectives. After the discussion started, it was recorded by the research team and analyzed later.

**Data analysis**
The discussions were transcripted by peers and analyzed using content analysis.

**Results**

**Systematic review**
By searching the databases, 4149 records entered the title and abstract screening after omitting the duplicates. Three thousand seven hundred forty records were excluded in this phase, 309 entered the full-text screening, 61 entered the critical appraisal analyzing phase, and finally, 26 records entered the data extraction phase. It is necessary to mention that three were added after updating the review. Twenty-nine records were data extracted, and three sources were entered from gray literature consisting of 20-panel reports, one Ph.D. thesis, and one report from GFIS. The steps of the initial systematic review are presented in Figure 2.

The included studies and their extracted data are presented in Table. The included studies and their extracted data are presented in Table 4, and Appendix 1 shows the results of the review and interview, including selected quotations for themes and codes. The main trends of change in six categories presented in the focus group discussion and revised six main trends of the change were identified. The trends are workplace changes, demographic changes, changes in concepts, the emergence of new players, and structural changes in universities and technology, presented in Figure 3. More information on the trends and their impacts are accessible as follows.

**Workplace changes**
The workplace-related changes of the future regarding medical education are presented in Figure 4. Long-life learning will be an inseparable part of the jobs that need an aligned education system, more agile, mobilized, and...
personalized. New skills and competencies change the concepts of literacy so that the education systems need to be more focused on skills; meanwhile, the demand for just-in-time education increased instead of just-in-case. Cognitive-based new jobs will emerge instead of physical-based ones. The new generation is gradually entering jobs with their differences in characteristics while the paradigms are also changing by redefining the concepts like justice, peace, power, etc.

Demographic changes

Due to the aging trend, there will be an increase in the average age of key players like professors and staff. On the other side, Long-life learning leads to widening the age range of the students as well. Other trends will be changes in the burden of age-related diseases, laws, and regulations, service delivery, and entrance exam. The share of education expenses will decrease, and new financing models will emerge. There will be more education-related mobility in the presence or virtual enhancing the human-resources-related aging challenge. There will be more health-related expectations like providing trained human resources for the elderly, revising the curriculum, and setting related priorities for research. The variation of faculty members’ and students’ age will omit aging stereotypes, so that needs cultural considerations. Even people with higher organizational positions may need to be trained by younger people in a particular skill or training course.

Changes in concepts of higher education

The universities will be more competency and technology-based, moving toward personalized education to meet agile and responsive requirements, covering various educational services. Disabled people will receive more attention, and technology will enhance their access to educational services. New concepts lead to redesigning the structures, so the standards of accreditation and one basic pattern of change expect the universities to set their processes to be cost-effective and community-based. New concepts will emerge, like openness, in data and services, power shift, innovation, long-life learning, and agility.

Emergence of new players

Universities will not be the leading players, and being public will no longer be their competitive advantage. Attention to academic degrees will significantly reduce, and educational services will be need-based. New service providers will emerge and provide customized services in the form of open curriculums or skill-oriented short courses. Other competitors will be academic units affiliated with industries and businesses which have already started in engineering sciences, like those providing learning by doing educational models, and will expand in health.
### Table 4. The included studies and their extracted data

<table>
<thead>
<tr>
<th>Num</th>
<th>Workplace</th>
<th>Demographic changes</th>
<th>Changes in concepts</th>
<th>The emergence of new players</th>
<th>Structural changes in universities</th>
<th>Technology</th>
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</table>
| 1   | Post-university success using trans-disciplinary learning | -                   | • Focusing on research, learning, and community engagement  
• Moving toward education mall  
• Social responsiveness | -                                           | consortium of universities       | -          |
| 2   | -         | -                   | Open education as an emerging concept | -                                           | • Open education helps in being more open and dealing with the related challenges and opportunities and goes beyond MOOCs and OER  
• OE needs attention regarding strategies, vision, and trained human resources and | Technology development as a requirement for open education |
| 3   | Work-ready human resources are needed. | -                   | -                   | More competition globally with online presence, non-university higher education providers (NUHEPs), and other non-traditional private sector providers | -                   | digitalization of curriculum design, delivery, and research |
| 4   | -         | • Insufficient resources to retire human resources  
• Predominance of Millennial Generation Workforce | -                   | Adding games, simulations, and interactive videos to the curriculum to engage students | -                   | -          |
| 5   | -         | -                   | More focus on sustainable development and the role of universities on | Education, research, and outreach will increasingly constitute a core mission for universities. | -                   | -          |
| 6   | -         | -                   | -                   | Virtual patients as multimedia, screen-based interactive patient scenarios  
It helps in moving toward competency-based education and deep learning | -                   | -          |
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| 7   | -         | Globalization       | • Democratization in science  
• Rise of Chindia  
• Multiculturalism in terms of new ways of knowing | -                          | -                          | Web 2 and virtualization |
| 8   | -         | The emergence of a new generation being more exposed to computer-based technology. | -                          | -                          | -                          | -          |
| 9   | It is rapidly changing global demographic dynamics. | Transnational competence (TC) education | -                          | -                          | -                          | -          |
| 10  | -         | Students are increasingly influential. | Students bypass the system by finding ways to meet their learning needs separate from the official education system, such as the rise of massive open online courses (MOOCs), certificate programs, and even the use of YouTube videos | -                          | -                          | -          |
| 11  | -         | More focus on sustainable development and the meaning of competency in new classifications | -                          | -                          | -                          | -          |
| 12  | -         | Changes in the needs of the economy/labor market | -                          | Changes in access, moving from elite provision to mass higher education  
Virtual education mixed with traditional delivery  
New institutional design for higher education institutes  
New models of funding  
More engagement of students | ICT/ virtual delivery |

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<td>13</td>
<td>-</td>
<td>New aware learners, new needs, new expectations</td>
<td>A new level of awareness is needed for staff</td>
<td>-</td>
<td>Changing in institutional imperatives</td>
<td>More use of ICT in the tertiary education</td>
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<td>14</td>
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<td>The ultimate educational content on the internet</td>
<td>Decoupling of learning from credentialing</td>
<td>Learning analytics by analyzing the big data of students to manage their learning environment</td>
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<td>15</td>
<td>-</td>
<td>More share of mature students are also being reinforced by long-life learning</td>
<td>Cost-efficiency of education as a major objective</td>
<td>-</td>
<td>Increased competition among HE organizations for restricted funds</td>
<td>More sophisticated and expensive equipment</td>
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<td>16</td>
<td>-</td>
<td>-</td>
<td>Open education</td>
<td>-</td>
<td>E-learning development, especially in using mobile learning, gamification, social media, and open education</td>
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<td>18</td>
<td>-</td>
<td>More educational mobility</td>
<td>-</td>
<td>Market-based deliverers</td>
<td>Changes in funding models</td>
<td>Innovative service design and delivery</td>
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Table 4. Continued

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### Table 4. Continued

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<td>19</td>
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<td>Globalization in higher education</td>
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<td>Online learning foothold in universities</td>
<td>The growing impact of technology on higher education</td>
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<td>• Extensive development of the Internet by:</td>
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<td>o Increasing channel capacity and data-transfer speed</td>
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<td>o More and more accessibility to the internet</td>
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<td>o More need for digital workflow management</td>
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<td>The increasing role of corporate-academic partnerships</td>
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<td>Technology development</td>
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<td>Online learning is more accessible, less expensive, and appeals to the Net generation’s unique needs and expectations.</td>
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<td>-</td>
<td>Changing demographics and shifting expectations for the learning environment require universities to examine teaching and learning practices</td>
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<td>New-entrant skills requirements</td>
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<td>Changing expectations</td>
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<td>22</td>
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<td>More international students</td>
<td>The knowledge economy paradigm emergence</td>
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<td>Internationalization consisting of international students and universities as international brands</td>
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<td>New expectations of students</td>
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<td>Students mobility</td>
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<td>Overwhelming technology transforming medical education</td>
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<td>Responding to changing community needs Respect for diversity</td>
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<td>New markets and business models</td>
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<td>Development of technology and increasing technological achievements in education</td>
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Cognitive revolution by:
- The interaction of the body, as an interface, with the digital environment and the digital environment adapting to the states of the body and mind, as well
  - Development of Artificial psychological components
  - Neurotechnologies begin to operate directly with the nervous system

Virtualization

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The financing models also will have less cost for students by using emerging financing models like using sponsors and linking to industry.

**Structural changes in universities**

Decentralization will be the dominant stream of future universities. Three main structural changes will focus on outcomes instead of processes, learning instead of teaching, and being just in time instead of just in case. Universities will go beyond the multidisciplinary collaborations, and besides the personalized education dominance, mixed open floating branches of knowledge will also emerge, aligning with the convergence of science. New structures will collaborate with other educational units, industries, and communities with national and international collaboration scopes. New structures need to redesign the rules and regulations supporting new financial models like using cryptocurrencies in transactions and sponsored-based service delivery. New structure designs are justified regarding power balance, competency-based, participatory, future-oriented, and agile.
Technology development

The cryptocurrencies will enter educational transactions, enabling to deal with sanctions-related limits in international scientific collaborations. The technology will provide new educational methods or tools and facilitate knowledge management and remote education, while open sciences, scientific democracy, data visualization, and internationalization will also be sped up. Vaccines and drugs will still be the priority in the health sector. New ethical-related challenges will emerge as technology develops in some fields, like human genetics. The figures of the last five trends have been presented in Appendixes 2-6.

The scientific development

After presenting the results in focus group discussion, their impacts on scientific development have been identified in five main categories.

New financial models

The composition of research funding is changing, and the influence of government providers on research priorities will decrease. Due to the aging and environmental challenges, the government budget for supporting research and science development will decrease. On the other hand, attention to applied research will increase. The social effects of research will be given more attention while it will be one of the essential criteria that provides direction to the pattern of scientific development. The limited budget and a more severe and social-oriented evaluation system increase competition for attracting research grants. So, the need to conduct interdisciplinary studies and research collaborations increases. Financing models will move towards free access to research results, and new financial models will also emerge.

Open Science

Scientific development will be based on free, shared data sources and platform-based. New methods of open librarianship and data sharing will emerge. There will be more public partnerships in science development with new participatory-evaluation models that lead to increasing democracy in research and types of crowdsourcing to answer research questions.

Redesigning the research management

The research management will change processes, evaluation mechanisms, expected outcomes, and informational systems. New technology achievements like blockchain will change research management from research question determining to knowledge transfer in open science. Other fields are artificial intelligence and machine learning, which improve data screening, personalized dashboards for research bodies (individuals and organizations), and prevent plagiarism. Regulations need to be redesigned to respond to social responsiveness of research, new concepts, and expectations, enabling higher education service providers in their science development role.

Role of universities

The universities are known as key players in science development, but in the future, they need to collaborate more with society, media, NGOs, and corporate or firm universities. Science development and benefiting society will still be the primary missions of the universities, which shows they have to focus on education and research but in an updated mechanism that aligns with emerging expectations and structures. Concepts like innovation or entrepreneurship are not new, but universities must redesign the tools they want to act on based on them.

Capacity building

Capacity building will still be one of the essential functions of the science development system but with new requirements for the future. New skills and competencies must be educated and evaluated based on updated and future-oriented structures. Human resources are at the forefront of knowledge production, and investing in it means investing in the future.

Discussion

The trends affecting medical education are categorized into six groups workplace, demographic changes, new concepts, new players, structural changes, and technology development. As Price Waterhouse Coopers (PWC) mentioned in its report on the future of graduate medical education, there will be a need for work-ready human resources emphasizing the changes in the workplace’s requirements (16). The main effects of demographic change are academic mobility and aging, which also change the structures and concepts like long-life-learning or deep learning (19). The other aspects of conceptual changes are knowledge economy (20), respecting diversity in education (22), open education (22), and sustainable development (23). Also, there will be structural changes like competency-based higher education and patient-centered learning (25), new models of learning (23), and funding model variation (25).

The demographic changes mean a lot for medical education, from multigenerational challenges to a lack of resources for retirement (26, 27). With their characteristics, skills, and expectations, Millennial generations have started to come (28, 29) by their worldview of science and how they can contribute to its development, which means new aware learners, new needs, new expectations, and new self-aware students and staff (30) that the systems like medical education should be updated based on. Aging is another demographic-based item of change with less uncertainty, while more share of mature students is also being reinforced by long-life learning (31).

A consortium of universities has been on the agenda of many developing countries like Malaysia by focusing on research, learning, and community engagement with defining new models like education mall (32), but studies showed that despite the future scenarios of higher education, research and education are the main missions for universities with potential alternatives in structures and models (33). In debates on the mission of universities re-

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garding the changing world, two developed modes of learning are proposed. Mode two focuses on teaching students to be ready for an uncertain and changing world, and mode three focuses on learning in and with uncertainty (35). Learning in new modes is changing regarding purposes, objectives, approaches, and places (29), and they also require new modes of skills and competencies. At least there has been mentioned to 12 classifications for competencies as general, from anticipatory thinking to empathy and solidarity, and 19 more from a sustainable development perspective (23). Another aspect of the structure relates to departmental divisions that will diminish, multidisciplinary teams will be replaced (35), and the physical boundaries will fade. Instead, Focus will be on creating a new not-for-profit publishing community in digital and physical spaces (32). Moreover, besides the competition among universities, there will be new higher education models affiliated with firms or NGOs (31).

The third category of change is emerging concepts. Multiculturalism as a trend in higher education (33), covering all functions, at least education and research, prepares a concurrent stream through emerging new concepts. One emerging concept is open education with nine main aspects of quality, strategic business models, access, pedagogy, content, collaboration, recognition, technology, and leadership; that one element of facilitating the OE is the technology, while the main requirements are setting strategies, visioning, and training the staff in scientific development (37). Some concepts intensify the current started trends, like how the norm of diversity as an upcoming one will provide the context for long-life learning. The higher education providers will focus on coaching and mentoring, which is how the power shift begins (35). However, the point here is that enhancing access to educational content does not mean an increased usage rate; users need to have a worldview on what they need to find and how it completes the puzzle of their education path (38).

The next category is technology; as technology progress, new methods of education also emerge, like virtual patients, specifically for medical education, which enables deep learning and moving toward competency-based education (39, 40). Some progress in technology also leads to defining new concepts like learning analytics or structural transitions like decoupling of learning from credentialing (27). Technology development provides a mass of information for educators, but it may cause cognitive dependency, so knowing the path to identify the data is as important as accessing it (38). There will be more focus of universities on branding and marketing and strategies like hiring marketing professionals, increasing digital activities, growing internationalization, and using new methods of service delivery like flipped classrooms or gamification (41). The available big data of educators help in gene testing and comprehensive continuous monitoring (that can be game-based). Gamification can improve academic motivation through competitive motivation, achievement motivation, and making education something of pleasure (38).

What is concluded from all mentioned points is that more involvement of stakeholders is needed to face the upcoming future, as Austin says in her commentary on Simon C. Barrie’s ‘A research-based approach to generic graduate attributes policy (2004) and Ronald Barnett's ‘Learning for an unknown future, “The daily work we do within higher education institutions must be understood within, and connect and respond to, a rapidly changing world and should offer both visions and practical paths to aid our students and the broader society in moving forward with hope, wisdom, integrity, and courage” (34). The common fact in many studies is visioning from the health research system (42), futures studies (36, 43), higher education (33), and medical education (44) perspectives. More Focus on know-why instead of know-how (32) needs the research systems reform. Policy-making level support is required over the HRS beyond the Ministry authority (42). Visioning is essential for Iran’s scientific development through two primary functions education and research (30, 40). Specifically for medical education, service-delivered people and usual patients must be considered in a broader context, so students need to be educated through global competence education approaches (24). From the service deliverers, they should be considered in their context and needs, enabling personalized education or new concepts like Supermarket university (45). Sustainable development and the role of universities in achieving the criteria make it a new concept focused on by higher education providers, especially universities (40, 41). The competition of industry members will continue, so new innovative working models are needed, as are jobs (16).

Conclusion
To achieve the goals and targets of national science development, all fields of study need a future-oriented plan. The health system and its educational and research activities should also be aligned with the national vision. Continuous monitoring of the environment helps capture the insight to move toward the goals. Scanning the future trends of medical education is not a cross-sectional activity and needs a systematic approach. Investigating the future trends in medical education and their impact on scientific development shows that the most crucial point is to reframe the structures, capture the new meanings and concepts, consider the generational differences, and be as flexible as enough to benefit the future and avoid threats.

Limitations of the study
One main limitation of the systematic review was being limited to English and Persian, while some other languages, like Chinese, also have relevant records. The other limitation was access to some types of gray literature like unpublished or processes studies that the researchers may not have reached out to, and last interviewing with other groups of stakeholders like NGOs or community presenters have not been done due to time, human resource, and financial limitations.

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Conflict of Interests

The authors declare that they have no competing interests.

References


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Appendix 1. Selected quotations for themes and codes

<table>
<thead>
<tr>
<th>Themes</th>
<th>Sample Quotations</th>
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<tbody>
<tr>
<td><strong>Workplace</strong></td>
<td>&quot;If the country's medical education system does not see the mid-term future for future jobs, it will be out of date, and the industrial needs, market, businesses, and jobs will be met from somewhere else.&quot;</td>
</tr>
<tr>
<td><strong>Demographic changes</strong></td>
<td>&quot;If used to talk about the difference between generations, it would be a fantasy and far-fetched issue, but now with the arrival of young people as students and even professors, we see the differences, and the same thing will happen with the aging of the workforce. Now this workforce may work in any system. Higher education or industry or pre-university education.&quot;</td>
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<tr>
<td><strong>Changes in concepts</strong></td>
<td>&quot;Future changes, either fundamental or gradual, are based on changing concepts, definitions, and paradigms or on achievements that will change these definitions and concepts. Sustainable development in higher education, equal rights of men and women, attention to ethics, especially about the new achievements of medical genetics, personalized education, and many other concepts will initiate gradual changes and transformations in higher education shortly....&quot;</td>
</tr>
<tr>
<td><strong>The emergence of new players</strong></td>
<td>&quot;The period has passed when the universities are unrivaled due to their government status, and all the outstanding students seek to pass their tough entrance exams. Now the work is important. Learning is important. Security and job security and earnings are important. Do our universities have the ability to respond to these needs? We can see how much the demand for some courses has decreased, especially in postgraduate courses. The emergence of new actors in the world started a long time ago, and in the field of engineering sciences in Iran, it also started a few years ago. We must wait for the emergence of new educational models in medical education, too....&quot;</td>
</tr>
<tr>
<td><strong>Structural changes in universities</strong></td>
<td>&quot;We have seen how Corona acted as a catalyst for the development of distance learning. This pandemic has taught universities that they must be flexible. The focus shifted from administrative and bureaucratic processes to learning. On the other hand, future teaching methods will change with the adoption of new technologies and will move towards deep learning. However, the question is, will we have the necessary funds to provide these technologies, are our laws and infrastructure ready for such changes? Another important point is how much these future changes will become a requirement, and if so, can universities prepare themselves for new accreditation systems?&quot;</td>
</tr>
<tr>
<td><strong>Technology</strong></td>
<td>&quot;No trend will change education as much as the growth of future technology, and if its gifts are properly used, it will help to achieve education goals better. No matter how much you explain anatomy to a student, it cannot help him learn as deeply as the experience of augmented reality. The multi-year corpses period is over, which is promising for medical education at least....&quot;</td>
</tr>
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</table>

Appendix 2. Demographic-related changes in Iran’s medical education system in future

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Appendix 3. Concepts-related changes of Iran's medical education system in future

- Technology-based education
- Competency-based education
- Personalized education

Emergence of new models of universities

Changes in concepts of higher education

- Ethics and supporting IP
- Redesigned standards for accreditation
- Cost-effectiveness concern in defining the processes
- Emergence of concepts that higher education will be redesigned based on

- Social responsiveness
- Sustainable development
- Longlife learning
- Agility

Openness
Power shift
Innovation
Open Science and Open Education
Equity

Appendix 4. How the emergence of new players will affect the future of Iran's medical education

- Emergence of new players

- Expansion of universities affiliated with corporates
- Providers of short-term customized education
- Emergence of new content producers and distributors
- Decreasing the demand for traditional universities

- Development of non-university higher education providers (NUHEPs)
- Emergence of business-based universities
- More demand for learning-by-doing models of educational service providers
- More consortium universities
- Emergence of new business models with less cost for learners
Appendix 5. Structural changes of Iran’s medical education system in future

- Knowledge translation and transfer speed up
- More remote education
- Development of tele-medicine and related education process
- Open sources development
- More visualization
- Increasing ethical challenges
- Crypto-based transactions

Appendix 6. Technological aspects of future changes in Iran’s medical education system

- Technology-based education (Using platforms, applications and AI)
- More competition in Vaccines and medicine development
- Internationalization
- Open education facilitation

Technology development