Original Article

Journal of Advances in Medical Education & Professionalism

Medical education in cyberspace: Critical considerations in the health system

SHAHRAM YAZDANI[1], ZOHREH KHOSHGOFTAR[1*], SOLEIMAN AHMADY[1], HASSAN RASTEGARPOUR[2], SEYED ABBAS FOROUTAN[3]

[1]Faculty of Medical Education, Shahid Beheshti University of Medical Sciences, Tehran, Iran; [2]Department of Educational Technology, Kharazmi University, Tehran, Iran; [3]Department of Physiology and Neuroscience Research Center, Faculty of Medicine, Shahid Beheshti University of Medical Sciences, Tehran, Iran

> Abstract

Introduction: Over the past few decades, two revolutionary approaches have emerged as a new form of medical education: Electronic Medical Education and Web-based Medical Education. A number of well-known medical institutions, such as Harvard and Johns Hopkins used a wide range of cyberspace capabilities to increase their competitiveness. Researchers have expressed that cyberspace will change health system's main objective of training physicians and medical education. We conducted this study to identify the health system critical considerations on core issues, involving the development of medical education on cyberspace.

Methods: In order to conduct this study, we observed the steps of a critical literature review, combined with the 'Four-phase method' adopted by Carnwell and Daly. We focused on particular literature on health and cyber system functions; it was associated with systemic approach.

Results: We developed a six-level taxonomy, Cyber level, Governance level, Ministerial level, Organizational level, Program level and Performance level, as a key solution that can be applied for the success of medical education on cyberspace. The results were summarized and appraised in more details.

Conclusion: Medical education on cyberspace is a complex interdisciplinary system. It is important that all aspects of the health systems be involved as integral to the development of cyber based medical education; without this convergence, we will be confused by the decisions made by others within the system. Health system should also communicate with those external sectors that are critical to achieving better learning on cyberspace. Integrated planning, governance and management of medical education in cyberspace are pivotal elements for the promotion.

Keywords: Medical education; Educational technology; Health information technology; Health system

*****Corresponding author:*
Zohreh Khoshgoftar,
School of Medical Education,
Shahid Beheshti University of Medical Sciences,
Tehran, Iran
Tel: +98 21 880 29747
Fax: +98 21 880 29731
Email: bkhoshgoftar@yahoo.com

Please cite this paper as:
Yazdani S, Khoshgoftar Z, Ahmady S, Rastegarpour H, Foroutan SA. Medical education in cyberspace: Critical considerations in the health system. J Adv Med Educ Prof. 2017;5(1):11-20.

Received: 8 May 2016
Accepted: 19 July 2016

Introduction

In addition to traditional experimental, theoretical and computational scientific paradigms, increasing use of cyberspace (1) in scientific settings has prompted the development of a fourth scientific paradigm, widely known as "Cyber Paradigm" (2). In the computing context, "Cyber is an Internet-related prefix, which is added to a wide range of existing concepts, to describe any person, thing, idea or space relating

to the digital world and global networks" (3). In recent studies, authors focus on rethinking the notion of modern science, by suggesting a range of cyber-related concepts, such as cyber trade, cyber security, cyber laws, cyber infrastructure, cyber learning and cyber medicine (4-9). As Koschmann (10) argues paradigm shifts in technology prompt the development of new theoretical and practical frameworks in science. Several studies provide evidence that medical education systems, in view of the cyber-paradigm shift, dynamically incorporate cyberspace capabilities (11-14). In fact, a number of well-known medical universities, such as Oxford (15), Harvard (16), Johns Hopkins (17), Sydney (18) and Tokyo (19) used a wide range of cyberspace capabilities including database application, web-based learning, simulation models and intelligent learning games to increase their competitive advantage. According to Health Across reports (20), over the past few decades, two revolutionary approaches have emerged as a new form of medical education: Electronic Medical Education (2005-2010) and Web-based Medical Education (2010-2020). However, researchers have expressed that cyberspace will change health system's main objective of training physicians and medical education once again (21).

At present, in most countries, the establishment of intelligent government (22) has increased the options for optimal use of cyberspace features in health system and medical education. Various authors have argued that the integration and sharing of policies, strategies, assets, infrastructure and human capital on cyberspace, can strengthen and expand the status of higher education (in general) and medical education (in particular) at international levels. However, it can imply interdisciplinary cooperation between information and communication technology system and health system which leads to intelligent and innovative approaches to the development of medical education on cyberspace.

This article aimed to critically review the learning systems in cyberspace, to identify particular factors that have led to successful medical education in cyberspace. The main goal of this study was to identify and to understand the health system critical issues in terms of core components and mechanisms involved in the development of medical education in cyberspace. Our assumption was that successful medical education in cyberspace required an integrated and balanced structure from higher levels to lower levels.

Methods

In this study, we closely observed the principles of a critical literature review, based on the 'Four-phase method' adopted by Carnwell and Daly (23). The critical methodology are regularly employed in the exploratory stage of research (24) to identify challenges, to get a sense of what cross-disciplinary studies have suggested and to provide directions for future research, and many studies used this method (25-27). Since studies of medical education development on cyberspace are still on exploratory phases, critical literature review was considered as the appropriate method to achieve the goal of our study. We did this review of the literature with a specific focus on health and cyber system functions; it was associated with a systemic approach.

Critical literature review usually requires including many articles and related documents in detail, to understand the main issues from different perspectives, approaches and frameworks. Boaro noted that critical review does not mean to provide just criticism; summarizing and reducing the reviewed literature to main points and expressing the most important opinions is what a critical review does (28).

The 'Four-phase method' in critical literature review consists of a) reviewing the literature of a wide area; b) exploring the key scope of the review; c) organizing the results into themes; and d) concluding and informing further studies. According to Carnwell, the researcher begins with a clear definition of the research scope and a critical appraisal of the main literature; then he or she attempts to expand the issue through seeing beyond what others have worked out, and so the researcher should identify particular components in the existing knowledge, as well as, potential knowledge gaps, next organizes the evidence in the results, discussion and conclusion and ultimately, provides directions for future research (29).

A search for reports and peer-reviewed publications was conducted in relevant databases, including PubMed, Google Scholar, ERIC (active descriptor medical education) and Web of Science. Search terms included Medical Education, Educational Technology, Health Information Technology and Health Systems Plans. We also searched related terms such as delivery concepts in cyberspace (Internet, web, online, virtual and distance), learning concepts (learning process, curriculum, learning environment and learning administer), health system concepts (stewardship, governance and management). Boolean operators were used as search strategy (30, 31). We restricted our search to reports published in or after 1990, because the cyberspace developed in the 1990s, when the uses of the Internet and digital

communication were growing intensely and the term "cyberspace" was able to represent the many phenomena that were emerging; the last date of search was 2015. We also scanned organizational reports and conference proceedings, which were relevant to the present research objectives. The reference sections and citations of results were also reviewed. This approach produced further articles, books and book chapters to be included in the study.

Due to the heterogeneity of the research field, it was very difficult to define the criteria applied to ensuring adequacy of studies in this research. In here, we point out that the inclusion criteria did not constitute a fixed set of standard criteria, but needed to be understood as broad criteria in this particular research. Anyway, we keep in mind the basic principles that the research is based on openness, interaction between the researchers and providing a clear documentation of the search strategy, information collection and analysis (32). We also observed the rules for a sound research and all decisions were made collectively (33).

Inclusion criteria were used in selecting the studies: first, those studies were selected which addressed the topics of higher education or medical education in cyberspace and were relevant to the core components or mechanisms of health system and its functions at all levels; second, the studies had to be published in English language and had open access. Studies were excluded if they reported distance learning without Internet use (such as using compact disc or audiovisual materials) and if their full access needed to be purchased. In the initial review two reviewers independently screened relevance of titles and abstracts of the studies.

Results

After excluding irrelevant studies a total of 208 documents were selected that were clustered into six levels for the present study. The documents were too heterogeneous; literature addressed a wide range of medical education topics in cyberspace, in addition to numerous interventions at disparate levels.

We identified core dimensions, components and main indices observed in the studies (Table 1). We also attempted to explain essential mechanisms that could be applied to the development of medical education in cyberspace (Table 2). We used a taxonomy-based approach to report the results. Taxonomy in informatics is defined as the practice of information classification and big data categorization; the approach in which ideas and issues are recognized, differentiated, and understood via clarification of the relationship between abstract and concrete constructs (34). Conceptual Categories is an advanced method of the taxonomy-based approaches (35).

We addressed a six-level taxonomy as a key solution that can be applied to the success of medical education on cyberspace; these include Cyber level, Governance level, Ministry

Table 1: Medical education on cyberspace: level, dimension, component and index

Levels	Dimensions	Components	Main index
Cyber level	Cyber policy Cyber technology Cyber infrastructure	Management Cyber services Web capability	Availability Accessibility Flexibility Security Mobility
Governance level	Government Stewardship Stakeholders	Policy making Resource allocation Intra-sector leadership Inter-section management	Good governance Cost savings/Cost-effectiveness Network collaboration
Ministry level	Health minister ICT minister Science minister	Strategic planning Standardization Research and development	Sustainability Accountability Capacity building Competitive advantage
Organization level	Medical school Medical research center Medical center Community medicine	Administration Research services Education services Mobile services	Interoperability Affordability Productivity Outcomes Impact
Program level	Medical education planning Medical education metaphor Cyber learning platform	Educational design Educational curriculum Cyber competencies	Output Quality Universality Capability
Performance level	Technology acceptance Technology type Rate of use	Preferences Applications Assessment	Utility Usability End user feedback

Table 2: Critical mechanisms for development of medical education on cyberspace

Levels	Views on Suggested Mechanisms to Develop Cyber-based Medical Education
Cyber level	Collaborative decision making on cyber-based medical education by common policy council or committee. Technical planning in design, development, evaluation, and management on cyber-based medical education. Technological integration of cyber infrastructure for high confidence cyber-based medical education. Assess key performance indicators (KPI) to measure and improve performance at present levels.
Governance level	Policy-planning and policy-formulation by the power elite on cyber-based medical education issues. Resource allocation and support funding mechanisms on cyber-based medical education at all level. Conflicts of interest between different stakeholders through integrated stewardship. Assess key performance indicators (KPI) to measure and improve performance at present levels.
Ministry level	Multilateral partnership between the Ministers (Health minister, ICT Minister and Science minister). Strategic analysis and strategic palming through out-of-the-box thinking on cyber-based medical education. Providing adequate facilities for current and future research and development in cyber-based medical education. Standardization for quality improvement and accreditation in order to share accountability. Assess key performance indicators (KPI) to measure and improve performance at present levels.
Organization level	Joint administrative procedures and regulatory plans on cyber-based medical education. Application of service-oriented architecture to service provision on cyberspace at all level of medical education. Use of international experience and best practices of development of medical education on cyberspace. Assess key performance indicators (KPI) to measure and improve performance at present levels.
Program level	Improve curriculum design on cyberspace through modeling global learning design (considering culture). Design and implementation cyber-based curriculum planning as development mechanism in medical education. Conduct continuing professional development and ethical proficiency through cyber-based programs. Assess key performance indicators (KPI) to measure and improve performance at present levels.
Performance level	Improve cyber literacy and enhance higher order thinking skills at all level of medical education system. Expand goals and outcomes based on learning theory of connectivism and Blooms' revised digital taxonomy. Apply best open source content management system and use learning software based on user preference. Assess key performance indicators (KPI) to measure and improve performance at present levels.

level, Organization level, Program level and Performance level. The results were summarized and appraised in more details as follows:

1- Cyber level in medical education on cyberspace:

This level has formed based on integrated capabilities of interactive web and semantic web in digital world. According to Stewart and colleagues (36) Cyber technology includes a series of computer system, data storage system, data management system and those who are able to communicate with each other via advanced network systems. Dimensions of this level have been strongly emphasized in the interdisciplinary literature; from the perspective of the Computing Research Association, Cyber technology and related services has provided endless possibilities in academic landscape all around the world (37). We found main concepts of this level as "Cyber Infrastructures". Cyber infrastructure includes network infrastructure, computing infrastructure, communication infrastructure, information infrastructure, values infrastructure, political, social and economic infrastructures (38-41). These "Hard and Soft" cyber infrastructures are necessary for a successful medical education in cyberspace. Hard Infrastructure (42) refers to large cyber-physical systems which are the integrations of computation, networking, and physical processes and are necessary for the operational functions. Soft Infrastructure (43) refers to the management framework of a cyber-system, such as cyber policy making, cyber strategic planning, cyber financial system and system of governments.

We emphasize that integrated cyber infrastructures provide a quantum leap for developing medical education in cyberspace. Sawyer stated that the poor or incomplete design of cyber- infrastructure, even in small size, led to large problems in any system that depended on cyberspace (44). Designing, implantation and evaluation of medical education in cyberspace with a look to main indices such as availability, accessibility, flexibility, security and mobility is also considered a developmental mechanism at this level. Medical education in cyberspace is still novel at specialized level, so it should receive more attention. Although the cyber infrastructure as a key asset has a strategic importance in the health system, leaders have a less comprehensive attention to it. We suggest that they should take seriously their role and participate in policy making in "Cyber Level" through an interdisciplinary communication and network collaboration.

2- Governance level in medical education on cyberspace:

Obviously the governments have the highest political level in all countries that influence the future orientation on cyber-based learning systems. In recent years, some of the core government plans of these issues have been around to create intelligent infrastructures, to enhance collaboration and to work on readiness indices (45, 46). Despite overwhelming evidence of policy initiatives in cyber issues, since 1980, there have still been some gaps between policy-makers objectives and what actually happens at the point of policy implementation (47), due to potential conflict of interest among leaders and stakeholders, which had a significant impact on implementation of formulated policies. Conflict management can improve enforcement of rules, quality of decisions, financial approach and competitive advantage on a national and international scale. Since the medical education on cyberspace consists of three structures including cyber system, learning system and medical system, different metaphors in these areas lead to important challenges such as overlapping powers and authority, interference of policies, practices and tasks, lack of cooperation among stakeholders and lack of accountability at this level. One important criticism at this level can be stewardship dysfunctions. Rasche suggested network governance model as the effective solution for stewardship of complex issues in complex systems (48). However, the best practice for developing networked stewardship in health system (especially on cyberspace) has yet to be fully understood. Researchers should attempt to bridge this gap by investigating the upstream process in health systems. We believe that integrated stewardship (49) is one of the key factors in governance level, which can have influences in the establishment and development of medical education in cyberspace. The optimized resource allocation and supported budgetary system are also critical mechanism for development of medical education on cyberspace. In addition, recognition and use of main index to supervise and assess this level is necessary; the indices mentioned above can be good governance indicators, finance metrics and collaboration indicators. Finally, we suggest "Integrated Governance" and "Stewardship Approach" as the most important mechanism for the development of medical education on cyberspace.

3- Ministry level in medical education on cyberspace:

By developing cyber technology, the roles and responsibility of ministers will take on new meaning. For example, in the development of medical education in cyberspace, the Minister of Information and Communication Technology (ICT) is accountable for cyber issues (50-52), therefore, they need to collaborate with Health minister and to be aware of main health system's policies and medical education goals for accountability. Currently, as Nagy K. Hanna (53) has emphasized, enhanced capacity of ministerial advisors for strategic analysis of learning technology, new learning environments and emerging education market is an essential key mechanism. Some researchers maintain that a country leaders' authority and the link with the chain of the organizational factors have an impact on promoting the capacity building and innovations (54, 55). Thus professional cooperation at higher level enables ministers to take on the role of successful stewards. According to Richard Heeks (56) cooperation and consultation at senior official's level can improve rule and standards effectiveness and transparency and accountability provide added value. In this regard, we emphasize the importance of the link between ministries.

It seems, there is a deficiency on creating a common strategic perspective as a key mechanism at this level, particularly on determining available capacities and potential assets that may impact on main performance in cyberspace. Sustainability, accountability, capacity building, competitive advantage were main indices that were emphasized for assessment of this level. Also internal and external evaluation was significant mechanisms for the evaluation of developmental action at this level. According to Carayannis & Campbell (50) and Smith & Leydesdorff (51), although the tricycle of government, industry and university cooperating together is a unique innovative ecosystem, their stability is affected by the political, economic, technological events. This is very important to consider and to prevent it through reinforcement of links between ministerial levels in the development of medical education on cyberspace.

4- Organization level in medical education on cyberspace:

The idea of the "university as a cyberspace" leads to a great leap in higher education architecture. Based on this change, virtualization in computational, organizational and geographical aspects, leads to integrated learning services. In cyber university model, introduced by Lee and colleagues as the third generation of virtual universities, there is no physical space as university. The complexity of modern universities increases under the influence of some factors.

These factors are stability, responsibility and quality (Strategic); availability, interoperability and safety (Technical); management, record keeping, finance, location (Instructional) and other factors such as culture, curricula, procedural requirements, activities, performance, resources, infrastructure, human resources, suppliers, capacity, and budgets (57).

The concepts mentioned above are not new in medical education system, while applying them in the medical education in cyberspace is in the early stages. We believe that extensive research is needed in this particular field. How should the medical education be designed, implemented, evaluated and developed on cyberspace? Which organizations have a significant role of upgrading the standards and protocols for cyber learning in the medical field? What virtual, financial or human resources are needed for the formation of this level? Unfortunately, it seems that many medical organizations and medical education institutes have issued a variety of strategic documents to address cyber learning and research without a clear plan to respond to the above questions (58, 59). We are confident that education administrators can focus on best practices to achieve efficiency in medical education on cyberspace and develop it based on a professional perspective. It is suggested that for the development of medical education on cyberspace, managers pay more attention to the integration of organization architecture (medical school, medical research center, medical center and community medicine) via the service-oriented architecture approaches. Service-oriented architecture is a logical framework based on the analysis of infrastructures, stakeholders and context for distribution of services in systems (60). Indicators identified to evaluate this level include interoperability, affordability, productivity, outcomes and impacts.

5- Program level in medical education on cyberspace:

This level formed based on the idea of Global Learning Design (GLD) that critical thinking as well as having different perspective on learning system is its prerequisite (61). There are many choices for curriculum design on cyberspace which has attracted less attention, from a fully-controlled design to facilitating learner ownership in its design such as User Generated Learning Environments System (UGLES). Although Learning Content Management and Learning Management Systems are dominant in medical education, User Generated Learning will move ahead. Since the development of such platform involves designing, programming and controlling of learning environment, scientists will face major challenges in future, especially by those users who had little computational thinking skills which are essential for deeper understanding of dynamic curriculum planning (62-63). In addition, curriculum planning for medical education on cyberspace should observe moral dimensions; professional development in this dimension is the main mechanism. As Albaqami argued (64), honesty, coordination, respect, reflexivity, competition, responsibility and loyalty are among the most important and well-known values at both traditional and cyber learning environments. Therefore, to know principles and codes of ethics in the field of technology and medical education is necessary to develop medical education on cyberspace; otherwise, unintended consequences may occur in relation to learning outcomes. This type of thinking about system quality is essential and it can be applied to the development of an actual medical education on cyberspace. Output, quality, universality and capability are main indices of program evaluation.

6- Performance level in medical education on cyberspace:

Currently, innovative medical software applications such as Medscape, VisualDx, Medcalc, LabGear, Uptodate, Dropbox, Resuscitation, etc. (65) are used more than before, while previous medical specialists and medical students were not even familiar with any of these applications (66). Interactive web and web modules applications (67, 68) have been the main tools of learning toolkits in cyberspace, based on Bloom's Digital Taxonomy (69). It has covered most of the learning objectives and performance on cyberspace (69, 70). The first step of "Call to Action" at this level requires cyber-literacy. Laura J. Gurak suggests that literacy in cyberspace means much more than technology literacy. He defined "Cyber Literacy" as conceptual understandings of the nature of cyber world such as awareness of what you're doing online or consequences of the cyberspace activities. Also she pointed out that the cyberspace should be navigated with awareness and emphasized on "critical competencies" for the learner to judge the legitimacy and credibility of cyber learning environments (71). At this level, technology acceptance and user preferences are generally ignored and more technologies are prescriptive. The cyber generations are diverse in their learning performance which is related to personality traits, values, attitudes and interest

of self-learning; therefore, special attention on these individual differences for design and development of medical education on cyberspace is a useful step.

Discussion

Our results have covered two areas including technological and institutional structure which are critical for medical education on cyberspace. Based on the evidence, conceptualization of medical education in cyber space as a systemic approach is essential for effective design, implementation, evaluation and development of many related topics in health system (72-77). In this study, we introduced cyber medical education, as a set of policies, decisions, strategies, processes, programs, performances and interactions in the health system architecture. Based on the above evidence, a complex map of the critical points of the medical education system on cyberspace, which was highlighted in all six taxonomy levels, emerged in our study. It is necessary to emphasize on the building of a network bridging between all dimensions, components and indices of medical education system on cyberspace (as mentioned in table 1) although it will be difficult without creative viewpoints and integrative platforms. Several mechanisms were also identified for improving and developing medical education on cyberspace (see table 2). These include mechanisms related to policy and strategy formation, cyber infrastructure management, network collaboration, cyber medical education services provision, functions and performance assessment as mentioned above. In this sense, our investigation was in line with some findings on the capabilities of the cyberspace to create new opportunities in the field of medical education (7, 11-14, 58-66) and also toward the challenges and threats that other researchers mentioned in their studies (5, 6, 25, 40, 67-73). A health system must quickly adapt to cyber science and provide medical education within cyberspace at different levels (78-80). We developed a new taxonomy for medical education on cyberspace which took into account health system structure. This taxonomy can be useful for policy makers and system designers. We believe it is useful for the understanding of medical education on cyberspace and it helps with provision of an integrated framework for development.

Conclusion

Although cyberspace creates new opportunities in medical education system, adaptation solutions are fragmented in various sectors. Development of the medical education on cyberspace is a complex interdisciplinary work. It is important that all aspects of the health systems be involved in the development of cyber-based medical education. Without this convergence, we will be blind to the decisions made by others within the system. The health system should also involve those sectors that are critical to achieving better learning on cyberspace.

Integrated planning, governance and administration are pivotal to the promotion of the medical education on cyberspace. It is clear that any kind of direct or indirect decisions related to governance level can impact on the whole medical education system. The promotion of integrated governance with a fundamental focus on policy/strategy frameworks will be generating novel innovations in future.

Limitations

Our study has a number of limitations such as: A) the sensitivity of literature searches (despite using experienced researchers and study protocol, some articles might not have been identified and therefore not included in the body of the study); in this case, our group's judgments in design and analysis increased scientific rigor. B) It was difficult to make combining results due to the wide variety of studies in the area; this work relies on researchers' expertise and experience in judgment about quality and utility to spotlight key features of learning on cyberspace that we believe have power to advance the field of medical education and C) The important dialogue in our context (IRAN) wasn't mentioned, we published opinion of Iranian experts in another article.

Future researches

Future research can explore how stewards at upstream levels impact on the development of medical education in cyberspace, what leaders say about medical education in cyberspace and the role of cyberspace in clinical learning in a health system.

Acknowledgements

This article is part of PhD thesis conducted by zohreh khoshgoftar and supervised by Dr. Yazdani, Dr. Ahmady, Dr. Rastegarpour and Dr. Foroutan. We would like to express our appreciation to Vice-President, Research of Shahid Beheshti University of Medical Sciences for financial support of this research.

Conflict of Interest: None declared.

References

1. Koepsell DR. The ontology of cyberspace: philosophy,

law, and the future of intellectual property. New York: Open Court Publishing; 2003.
2. Hey T, Tansley S, Tolle KM. The fourth paradigm: data-intensive scientific discovery. Redmond, WA: Microsoft research; 2009.
3. Dictionary.com "cyber," in The American Heritage® Abbreviations Dictionary, Third Edition [Internet]. Houghton Mifflin Company; [Cited 2015 April 05]. Available from: http://www.dictionary.com/browse/cyber.
4. Willard N. Cyber bullying and cyber threats. Eugene, OR: Center for Safe and Responsible Internet Use; 2006.
5. Tokunaga RS. Following you home from school: A critical review and synthesis of research on cyber bullying victimization. Computers in Human Behavior. 2010;26: 228-77.
6. O'Connell ME. Cyber security without cyber war. Journal of Conflict and Security Law. 2012;1;17(2):187-209.
7. Lunker M. Cyber laws: a global perspective. [Internet]. [Cited November, 2014]. Available from:http://unpanl.un.Org/intradoc/groups/public/documents/APCITY/UNPAN005846.pdf.
8. Wang MJ, Kang J. Cybergogy of engaged learning through information and communication technology: A framework for creating learner engagement, Engaged learning with emerging technologies. New York: Springer Publishing; 2006.
9. Reed J. Cyber medicine: defying and redefining patient standards of care. Ind L Rev. 2003; 37:845.
10. Koschmann T. Paradigm shifts and instructional technology: An introduction. USA: CSCL, Theory and practice of an emerging paradigm; 1996:1-23 p.
11. Tyagi SK. A study and analysis of existence and involvements of computer assisted E-Learning techniques for the improvement and development of medical education and knowledge dissemination. International Journal of Management, IT and Engineering. 2012;2(9):381-93.
12. Ellaway R, Masters K. AMEE Guide 32: e-Learning in medical education Part 1: Learning, teaching and assessment. Med Teach. 2008;30(5):455-73.
13. Masters K, Ellaway R. E-Learning in medical education Guide 32 Part 2: Technology, management and design. Med Teach. 2008;30(5):474-89.
14. Cook DA. How much evidence does it take? A cumulative meta-analysis of outcomes of simulation-based education. Med Educ. 2014;48:750–60.
15. The University of Oxford [Internet]. London: The University; c2015 [Cited Jul 15, 2015]. Available from:http://www.oxfordmedicaleducation.com/about/.
16. The University of Harvard [Internet]. London: The University; c2015 [Cited Jul 15, 2015]. Available from:https://hms.harvard.edu/departments/medical-education.
17. The Johns Hopkins University [Internet]. USA: The University; c2015 [Cited Jul 15, 2015]. Available from:http://www.hopkinsmedicine.org/.
18. The University of Sydney [Internet]. Australia: Office of Medical school; c2015 [Cited Jul 15, 2015]. Available from:http://sydney.edu.au/medicine/research/units/networks.php.
19. The University of Tokyo [Internet]. Japan: Tokyo medical and dental University; 2015c [Cited Jul 15, 2015]. Available from:http://www.tmd.ac.jp/english/labs/toshozyouhou/repository/index.html.
20. McLean R, Richards BH, Wardman JI. The effect of Web 2.0 on the future of medical practice and education: Darwikinian evolution or folksonomic revolution?. Medical Journal of Australia. 2007;187(3):174.
21. Welsh ET, Wanberg CR, Brown KG, Simmering MJ. E-learning: emerging uses, empirical results and future directions. International Journal of Training and Development. 2003;7(4):245-58.
22. Wagner C, Cheung K, Lee F, Ip R. Enhancing e-government in developing countries: managing knowledge through virtual communities. The Electronic Journal of Information Systems in Developing Countries. 2003;14:1-20.
23. Carnwell R, Daly W. Strategies for the construction of a critical review of the literature. Nurse education in practice. 2001; 1(2):57-63.
24. Malterud K. Qualitative research: standards, challenges, and guidelines. The lancet. 2001; 358(9280):483-8.
25. Borgman CL, Abelson H, Dirks L, Johnson R, Koedinger KR, Linn MC, et al. Fostering learning in the networked world: The cyberlearning opportunity and challenge. A 21st century agenda for the National Science Foundation. Aganda: Report of the NSF task force on cyberlearning; 2008.
26. Patton MQ. Two decades of developments in qualitative inquiry a personal, experiential perspective. Qualitative social work. 2002;1(3):261-83.
27. McGaghie WC, Issenberg SB, Petrusa ER, Scalese RJ. A critical review of simulation-based medical education research: 2003–2009. Med Educ. 2010; 44(1):50-63.
28. Boaro M, Vicario M, De Leitenburg C, Dolcetti G, Trovarelli A. The use of temperature-programmed and dynamic/transient methods in catalysis: characterization of ceria-based, model three-way catalysts. Catalysis Today. 2003;77(4):407-17.
29. Morrow SL. Quality and trustworthiness in qualitative research in counseling psychology. Journal of counseling psychology. 2005;52(2):250.
30. Haig A, Dozier M. BEME Guide no 3: systematic searching for evidence in medical education--Part 1: Sources of information. Med Teach. 2003;25(4):352-63.
31. Haig A, Dozier M. BEME guide no. 3: systematic searching for evidence in medical education--part 2: constructing searches. Med Teach. 2003; 25(5):463-84.
32. Demuth C. Ensuring Rigor in Qualitative Research within the Field of Cross-Cultural Psychology. Germany: International Association for Cross-Cultural Psychology; 2013:34 p.
33. Morrow SL. Quality and trustworthiness in qualitative research in counseling psychology. Journal of counseling psychology. 2005;52(2):250.
34. Trochim WM. An introduction to concept planning for planning and evaluation. Evaluation and program planning. 1989;12(1):1-6.
35. Department of Information and Computer Science. A proposed method of conceptual clustering for structured and decomposable objects. California: Springer US; 1986. 67-70 p.

36. Stewart CA, Simms S, Plale B, Link M, Hancock DY, Fox GC. What is cyber infrastructure? In Proceedings of the 38th annual ACM SIGUCCS fall conference, 2010 Oct 24; Virginia. Virginia: USA; 2010.
37. Ainsworth S, Honey M, Johnson WL, Koedinger KR, Muramatsu B, Pea RD, et al. Cyber infrastructure for education and learning for the future: A vision and research agenda. Sri Lanka: National Science Foundation; 2005.
38. Zhang D, Nunamaker JF. Powering e-learning in the new millennium: an overview of e-learning and enabling technology. Information Systems Frontiers. 2003;5(2):207-18.
39. Omidinia S, Masrom M, Selamat H. Review of E-Learning and ICT Infrastructure in Developing Countries (Case Study of Iran). American Journal of Economics and Business Administration. 2011;3(1):120-5.
40. Cavusoglu H, Al-Natour S, Cavusoglu H. ICT value creation at four levels of analysis: review of extant research and a new conceptual model. In 8th International Conference on Enterprise Systems, Accounting and Logistics; 2011 July 10th to 13th; Thassos Island. Thassos Island: Greece; 2011.
41. Bowker GC, Baker K, Millerand F, Ribes D. Toward information infrastructure studies: Ways of knowing in a networked environment, In International handbook of internet research. Pennsylvania: Springer Science and Business Media; 2009; 97-117 p.
42. Wan J, Chen M, Xia F, Di L, Zhou K. From machine-to-machine communications towards cyber-physical systems. Computer Science and Information Systems. 2013;10(3):1105-28.
43. Coelho CMDCS. Modes of governance and public service efficiency [dissertation]. The University of Birmingham, Institute of Local Government Studies School of Public Policy; 2007. Available from: https://core.ac.uk/download/files/121/78006.pdf.
44. Sawyer S. Data Wealth, Data Poverty, Science and Cyber infrastructure 1. Prometheus. 2008;26(4):355-71.
45. Sofaer A, Clark D, Diffie W. Cyber security and international agreements. In National Research Council, Proceedings of a Workshop on Deterring Cyberattacks; 2009 3th May; USA; 2009.
46. David PA. Towards a cyber infrastructure for enhanced scientific collaboration: Providing its' soft'foundations may be the hardest part. London: Oxford Internet Institute; 2004.
47. Conole G. Bridging the gap between policy and practice: A reflective review and looking forward to the future. Journal of e-Learning and Knowledge Society. 2010;6(1):13-27.
48. Rasche A. Collaborative Governance 2.0. Corporate Governance: The international journal of business in society. 2010;10(4):500-11.
49. Veillard JH, Brown AD, Barış E, Permanand G, Klazinga NS. Health system stewardship of National Health Ministries in the WHO European region: concepts, functions and assessment framework. Health Policy. 2011;103(2):191-9.
50. Carayannis EG, Campbell DF. 'Mode 3'and 'Quadruple Helix': toward a 21st century fractal innovation ecosystem. International Journal of Technology Management. 2009;46(3-4):201-34.
51. Lawton Smith H, Leydesdorff L. The Triple Helix in the context of global change: dynamics and challenges. Prometheus. 2014; 32(4):1-6.
52. Ministry of Information and Communications Technology of Iran [Internet]. Tehran: Minister of ICT; 2015 [Cited 7 may, 2015]. Available from: https://www.ict.gov.ir/en/minister. Persian.
53. Hanna NK. E-Leadership institutions for the knowledge economy. World Bank Institute Working Paper. Washington, DC: World Bank. 2007
54. DasGupta P. Literature review: e-leadership. Emerging Leadership Journeys. 2011;4(1):1-36.
55. Hanna NK. Why National Strategies are needed for ICT-enabled Development. World Bank Staff Paper. Washington, DC: World Bank. 2003.
56. Heeks R. The approach of senior public officials to information technology-related reform: lessons from India. Public Administration & Development. 2000;20(3):197.
57. Lee O, Im Y. The emergence of the cyber-university and blended learning in Korea, The handbook of blended learning: Global perspectives, local designs. New Jersey, United States: John Wiley & Sons, Inc. 2006:281-95 p.
58. Schwartzstein RM, Huang GC, Coughlin CM. Development and implementation of a comprehensive strategic plan for medical education at an academic medical center. Acad Med. 2008;83(6):550-9.
59. Mantas J, Ammenwerth E, Demiris G, Hasman A, Haux R, Hersh W, et al. Recommendations of the International Medical Informatics Association (IMIA) on education in biomedical and health informatics-first revision. ActaInformaticaMedica. 2010;18(1):4.
60. Marks EA, Bell M. Service Oriented Architecture (SOA): A Planning and Implementation Guide for Business and Technology. New Jersey, United States: John Wiley & Sons, Inc. 2006. 376 p.
61. Hovland K. Global learning: Defining, designing, demonstrating. American Association of Colleges and Universities. New York: NAFSA; 2014.
62. Wing JM. Computational thinking and thinking about computing. The Royal Society. 2008;366(1881):3717-25.
63. Wang VC. Encyclopedia of Information Communication Technologies and Adult Education Integration: Conventional Online Teaching vs. Andragogical Online Teaching. California: IGI. 2010:68 p.
64. Albaqami N. Critical Investigation of Virtual Universities: Applying the UK Structure to Saudi Arabia [dissertation]. UK: De Montfort University Faculty of Technology; 2014.
65. Husain I, Misra S, Wodajo F. iMedicalApps [Internet]. [Updated 2014 June 17; cited December 21, 2015]. Available from: http://www.imedicalapps.com/forums/topic/med-school-apps-survival-pack.
66. Buijink AW, Visser BJ, Marshall L. Medical apps for smartphones: lack of evidence undermines quality and safety. Evid Based Med. 2013;18(3):90-2.
67. Ruiz JG, Mintzer MJ, Leipzig RM. The impact of e-learning in medical education. Acad Med. 2006;81(3):207-12.
68. Schilling K, Wiecha J, Polineni D, Khalil S. An interactive web-based curriculum on evidence-based

medicine: design and effectiveness. Family Medicine-Kansas City. 2006;38(2):126.
69. Churches A. Bloom's digital taxonomy: Abgerufenunter [Internet]. [Cited May 8, 2015]. Available from: http://edorigami. wikispaces. com/file/view/bloom% 27s+ Digital+ taxonomy+ v3. 2009 Jan; 1.
70. Anderson LW, Krathwohl D. A Taxonomy for Learning, Teaching and Assessing: a Revision of Bloom's Taxonomy of Educational Objectives. New York: Longman; 2001.
71. Gurak LJ. Cyberliteracy: Navigating the Internet with awareness. USA: Yale University; 2003.
72. Clark D. Characterizing cyberspace: past, present and future [Internet]. [Cited March 8, 2010]. Available from: Massachusetts Institute of Technology website: http://web. mit. Edu/ecir/pdf/clark-cyberspace. pdf. 2010 Mar.
73. Karsenti T, Charlin B. Information and communication technologies (ICT) in medical education and practice: The major challenges. International Journal of Technologies in Higher Education. 2008;5(2):68-81.
74. Wong G, Greenhalgh T, Pawson R. Internet-based medical education: a realist review of what works, for whom and in what circumstances. BMC medical education. 2010;10(1):1.
75. Houshyari AB, Bahadorani M, Tootoonchi M, Gardiner JJ, Peña RA, Adibi P. Medical education and information and communication technology. Journal of education and health promotion. 2012;1:3.
76. Greenhalgh T. Computer assisted learning in undergraduate medical education. BMJ. 2001;322(7277):40-4.
77. Kebaetse MB, Nkomazana O, Haverkamp C. Integrating eLearning to Support Medical Education at the New University of Botswana School of Medicine. Electronic Journal of e-Learning. 2014;12(1):43-51.
78. Frenk J, Chen L, Bhutta ZA, Cohen J, Crisp N, Evans T, et al. Health professionals for a new century: transforming education to strengthen health systems in an interdependent world. The lancet. 2010;376(9756):1923-58.
79. Al-Wardy NM. Medical Education Units. Sultan Qaboos University Medical Journal. 2008;8(2):149-56.
80. Jwayyed S, Stiffler KA, Wilber ST, Southern A, Weigand J, Bare R, et al. Technology-assisted education in graduate medical education: a review of the literature. Int J Emerg Med. 2011; 4:51.