



Abbas Khakpour*
Department of Education,
Faculty of Humanity,
University of Malayer,
Malayer, Iran

*University of Malayer,
4 Kilometers Malayer-Arak
road
Malayer, 6571995863
Iran

Tel: +98 8138290814
Fax: +98 813339880
Email:
khakpour@malayeru.ac.ir

Effectiveness of Knowledge Acquisition in Medical Education: An argumentative literature review of the resources's requirements

Background: The economic foundation and competitive advantage of medical organizations depend on their reliance on knowledge and its effective management. Knowledge Management (KM) consists of interconnected processes developed for acquiring, organizing, transferring, applying, and reproducing knowledge. Knowledge acquisition is a fundamental issue in educational organizations, especially in those responsible for medical education development. Knowledge resources and users are two major factors affecting the acquisition of medical knowledge.

Methods: Argumentative literature review is used in this study. The Search sources include PubMed and Google Scholar databases. The keywords for the search terms included "Knowledge management and medical education, healthcare and medicine. Inclusion criteria were: English and Persian language papers, Original published papers, Medical-focused articles and Articles published in the last fifty years. Exclusion criteria were: Articles written in languages other than English and Persian, Articles not related to the medical sciences and Conference and non-original papers. The study questions focuses on three components: repositories, content and ICT, including: 1) What are the requirements of medical "knowledge repositories" for optimal knowledge acquisition?, 2) What are the requirements of medical "knowledge content" for optimal knowledge acquisition?, And 3) what are the " ICT" requirements for optimal knowledge acquisition?

Results: Argumentative review of literature describe and summarize the principles of knowledge acquisition in medical education, focusing on knowledge resources and its components including: repositories, content, and Information and Communication Technology.

Conclusion: Considering the fundamental role of medical universities in the development of medical knowledge and practice on one hand, and the importance of innovative and knowledge-based activities on the other hand, these universities should constantly benefit from the findings of different areas of medical science in training medical students. The acquisition and management of modern medical knowledge and techniques can help medical professors and students examine curriculum contents with respect to modern technological developments and medical education approaches. These processes would also lead to constructive developments and changes in medical education.

Keywords: Knowledge Acquisition, Knowledge Resources, Medical Education

فاعلية اكتساب المعرفة في التعليم الطبي: دراسة مراجعة جدلية لمتطلبات الموارد

الخلفية والهدف: يعتمد الأساس الاقتصادي والميزة التنافسية لمنظمات التعليم الطبي على اعتمادها على المعرفة والإدارة الفعالة. تتضمن إدارة المعرفة (KM) الجهات المترابطة هي: اكتساب، تنظيم، نقل، تطبيق وإنتاج المعرفة. في المؤسسات التعليمية، يعد اكتساب المعرفة قضية أساسية خاصة بالنسبة لمسؤولي تطوير التعليم الطبي. مصادر المعرفة و مستخدمها هما العاملان الرئيسيان المؤثران في اكتساب المعرفة الطبية.

الطريقة: الطريقة المستخدمة في هذه الدراسة كانت هي "مراجعه تفكيريه في الادبيات الخلفية". تتضمن موارد البحث قواعد بيانات PubMed و Google Scholar و الكلمات الرئيسية التي تم البحث عنها تضمنت مصطلحات "اداره التعليم و المعرفة الطبية، الرعاية الصحية و الطب". معايير التضمن كانت: مقالات طبية حقيقية باللغة الإنجليزية و الفارسية نُشرت في الخمسين عامًا الماضية. كانت معايير الاستبعاد هي المقالات المكتوبة بلغات أخرى غير الإنجليزية و الفارسية و مقالات لا علاقة لها بالعلوم الطبية و أوراق المؤتمرات و الأوراق غير الأصلية. تشمل أسئلة الدراسة المكونات الثلاثة للمستودعات و المحتوى و تكنولوجيا المعلومات و الاتصالات على النحو التالي: (١) ما هي متطلبات "مستودعات المعرفة الطبية" لاكتساب المعرفة المثلى؟ (٢) ما هي متطلبات "محتوى المعرفة الطبية" لاكتساب المعرفة الأمثل؟ و (٣) ما هي متطلبات "تكنولوجيا المعلومات و الاتصالات" لاكتساب المعرفة الأمثل؟

النتائج: من خلال التركيز على مصادر المعرفة و مكوناتها (المستودعات، و المحتوى، و تكنولوجيا المعلومات و الاتصالات)، تم وصف مبادئ اكتساب المعرفة في التعليم الطبي و تلخيصها باستخدام طريقة "مراجعه تفكيريه في الادبيات الخلفية".

الخلاصة: بالنظر إلى الدور الأساسي للجامعات الطبية في تطوير المعرفة الطبية و الممارسة من ناحية، و أهمية الأنشطة المبتكرة و القائمة على المعرفة من ناحية أخرى، يجب أن تستفيد هذه الجامعات باستمرار من نتائج مجالات العلوم الطبية المختلفة في تدريب طلاب الطب. يمكن الاكتساب و إدارة المعرفة و التقنيات الطبية الحديثة أن يساعد أساتذة الطب و الطلاب على فحص محتويات المناهج الدراسية فيما يتعلق بالتطورات التكنولوجية الحديثة و أساليب التعليم الطبي. ستؤدي هذه العمليات أيضًا إلى تطورات و تغييرات مفيدة في التعليم الطبي.

الكلمات المفتاحية: اكتساب المعرفة، مصادر المعرفة، التعليم الطبي

اثر بخشی اکتساب دانش در آموزش پزشکی: مطالعه ای مروری استدلالی بر الزامات منابع

زمینه و هدف: بنیان اقتصادی و مزیت رقابتی سازمانهای آموزش پزشکی به میزان آنکا آنها به دانش و مدیریت مؤثر آن بستگی دارد. مدیریت دانش شامل فرایندهای بهم پیوسته اکتساب، سازماندهی، انتقال، کاربرد و تولید دانش است. در سازمان های آموزشی اکتساب دانش به ویژه برای متولیان توسعه آموزش پزشکی، موضوعی بنیادین محسوب میشود. منابع دانش و کاربران دو عامل اصلی مؤثر در اکتساب دانش پزشکی هستند.

روش: روش مورد استفاده در این مطالعه از نوع "مرور استدلالی پیشینه" می باشد. منابع جستجو شامل پایگاه داده های پایمد (PubMed) و گوگل اسکالر (Google Scholar) است. کلمات کلیدی مورد جستجو مشتمل بر اصطلاحات "مدیریت دانش و آموزش پزشکی، مراقبت های بهداشتی و پزشکی" بود. معیارهای ورود به مطالعه عبارت بودند از: مقالات انگلیسی و فارسی اصیل یا محوریت پزشکی که در پنجاه سال گذشته منتشر شده است. معیارهای خروج از مطالعه عبارت بودند از مقالاتی که به زبانهای دیگری غیر از انگلیسی و فارسی نگاشته شده اند، مقالات بی ارتباط با علوم پزشکی، مقالات کنفرانسی و مقالات غیر اصیل. سوالات مطالعه شامل سه مؤلفه مخازن، محتوا و ICT به شرح زیر است: (١) الزامات "مخازن دانش پزشکی" برای کسب بهینه دانش چیست؟ (٢) الزامات "محتوای دانش پزشکی" برای کسب بهینه دانش چیست؟ (٣) الزامات "ICT" برای کسب بهینه دانش چیست؟

یافته ها: با تمرکز بر روی منابع دانش و مؤلفه های آن (مخازن، محتوا، و فناوری اطلاعات و ارتباطات)، اصول اکتساب دانش در آموزش پزشکی، با استفاده از روش "مرور استدلالی پیشینه" توصیف و تلخیص گردیده است.

نتیجه گیری: با توجه به نقش بنیادین دانشگاههای علوم پزشکی در توسعه دانش و عمل پزشکی از یک سو و اهمیت فعالیتهای نوآورانه و دانش بنیان از سوی دیگر دانشگاهها باید در آموزش دانشجویان پزشکی دائماً از یافته های حوزه های مختلف علوم پزشکی بهره برداری نمایند. اکتساب و مدیریت دانش و فنون نوین پزشکی می تواند به اساتید پزشکی و دانشجویان کمک کند تا محتوی برنامه درسی را با توجه به پیشرفت های فن آوری مدرن و رویکردهای آموزش پزشکی بررسی کنند. این فرایندها همچنین به پیشرفت های سازنده و تغییر در آموزش پزشکی منجر می شود.

واژه های کلیدی: اکتساب دانش، منابع دانش، آموزش پزشکی

بر علمی میدان میں معیار حصول علم ہوتا ہے اور یہ امر متعدد طرح سے موثر واقع ہوتا ہے۔ ایک مطالعہ جس میں ماخذ و منابع کے تقاضوں کا جائزہ لیا گیا ہے

بیک گراؤنڈ: علم طب کی تعلیم دینے والے اداروں کی معیشتی بنیاد معیاری حصول علم اور مدیریت علم پر منحصر ہوتی ہے۔ نالج مینجمنٹ میں حصول علم، منظم طریقے سے تعلیم، علم کو دوسروں تک پہنچانا، علم کا عملی استعمال، اور علم میں مزید ترقی کرنا شامل ہے۔ یہ سارے امور طبی تعلیم دینے والے اداروں کے لئے بنیادی حیثیت رکھتے ہیں۔

روش: اس استدلالی تحقیق میں PubMed اور Google Scholar جیسی سائٹوں سے نالج مینجمنٹ اور تعلیم طب، نیز حفظان صحت اور طب جیسے الفاظ سے سرچ کیا گیا تھا۔ تحقیق میں صرف انگریزی اور فارسی کے اصل مقالے شامل کئے گئے تھے۔ یہ مقالے محض طبی تحقیقی مقالے تھے جو گذشتہ پچاس برسوں میں لکھے گئے تھے۔ اس تحقیق میں غیر طبی مقالات، کانفرنسوں میں پیش کئے جانے والے مقالات اور کاپی شدہ مقالات شامل نہیں کئے گئے تھے۔

تحقیق میں تین سوالات کئے گئے تھے جو اس طرح سے ہیں، پہلا سوال یہ تھا کہ علم طب کے مخازن (کتب اور علم طب کے نہایت عالم و فاضل اساتذہ) کے تقاضے کیا ہیں؟ دوسرا سوال یہ تھا کہ علم طب کے نصاب کے تقاضے کیا ہیں؟ اور ICT کے تقاضے کیا ہیں؟ **نتیجے:** علم کے منابع اور اسکے عناصر جیسے علمی مخازن، مضامین، اور انفارمیشن ٹکنالوجی سے طبی تعلیم میں حصول علم کے طریقوں اور پہلے کی کئی تحقیقات کو مد نظر رکھ کر آگے بڑھنے پر تاکید کی گئی ہے۔

سفارش: علم طب کو فروغ دینے میں ایک طرف میڈیکل یونیورسٹیاں اور کالج بنیادی کردار کی حامل ہیں تو دوسری طرف نالج بیسڈ طریقوں سے نوآوری اور جدت پسندی کی بھی نہایت اہمیت ہے بالخصوص میڈیکل تعلیم میں اسکی اہمیت دو چندان ہوجاتی ہے لہذا میڈیسن کے مختلف شعبوں میں ان روشوں سے استفادہ کیا جانا چاہیے۔ حصول علم اور نالج مینجمنٹ کے ذریعے اساتذہ اور طلبا نصاب کو اپڈیٹ کرسکتے ہیں۔ یہ کام انفارمیشن ٹکنالوجی کے بغیر ناممکن ہے۔ البتہ اساتذہ اساتذہ ان طریقوں سے تعلیم دینے کی جدید روشوں سے آشنا ہوسکتے ہیں۔ مندرجہ بالا طریقے حصول علم میں تعمیری کردار ادا کرتے ہیں اور ان سے میڈیکل کی تعلیم میں انقلاب آسکتا ہے۔

کلیدی الفاظ: حصول علم، نالج مینجمنٹ، طبی تعلیم

INTRODUCTION

A fundamental question raised in medical education studies is “how knowledge is created and organized in doctors’ minds”. Most efforts made to answer this question have so far been focused on teaching methods and techniques, basic and clinical education approaches, or the integration of illness scripts into encapsulated knowledge (1). However, by applying the emergent concept of knowledge management in other areas (such as trade, commerce, and services), the above question can be answered with a new and different approach. KM is “a set of principles, tools and practices that enable people to share, translate and apply what they know to create value and improve effectiveness”. In other words, organizational KM includes “intertwined, regular, targeted, and coherent socio-technical functions developed to promote the absorption, acquisition, production, organization, storage, retrieval, sharing, distribution, transfer, use, development and assessment of experiences and knowledge assets (tacit and explicit) for creating competitive advantage and value added through improving the quantity and quality of organizational decisions and actions (at all levels), making changes to technical, administrative, and structural strategies, and realizing wise organization” (2). KM is considered a new management tool that helps healthcare organizations effectively manage their internal and external knowledge. Successful organizations understand why they must manage knowledge, develop plans to achieve their objective, and devote time and energy to relevant activities (3). For the World Health Organization (WHO), the main objective of KM is to fill the knowledge gap between (and within) countries (4). Based on the above definitions, there is a close connection between medical education management and knowledge acquisition as a KM process. In academic terms, medical education discipline addresses the principles of learning and teaching in medical sciences. Knowledge acquisition is based on anthropological-social and technological issues aimed to extract and acquire knowledge from intra/extra-organizational resources. Knowledge resources (including medical information and knowledge) are the main assets in the healthcare industry. The main issue is that knowledge holders and recipients must efficiently link information associated with various disciplines in order to expand and distribute knowledge (5). Today, with the increasing growth of access to e-resources and cyberspace, these resources have become common tools for education and knowledge acquisition. In medical sciences taking advantage of this opportunity, which deals with the lives of human beings, is of particular significance as those involved in this area can rapidly disseminate relevant information in the medical community through this platform. To develop the acquisition of knowledge from e-resources and get the maximum benefits of this method, necessary infrastructures and standards must be provided, and the best method must be selected and implemented (6). The most important goal specified in medical education, especially in medical curricula, is the acquisition of knowledge by students; however, few studies and texts are available on the principles of medical knowledge acquisition. The principles

of knowledge acquisition should focus on two general axes, namely resources-content and user-situation. According to Meyer’s Knowledge Management Life-Cycle Model (7), resources and users are the two essential components of knowledge acquisition in all organizations: knowledge resources from which knowledge is absorbed and extracted, and knowledge gainers who must absorb and capture the knowledge. Therefore, the principles of knowledge acquisition can be described in two categories: 1. those related to the medical knowledge resources, and 2. those related to the medical knowledge users. This article presents definitions for organizational knowledge as well as knowledge resources and specifies principles related to medical knowledge resources and their constructive outcomes for medical education.

Organizational Knowledge and its Resources

Without providing a proper definition of knowledge, it would be difficult to manage and acquire it. Various definitions of knowledge have been presented in different articles and books. However, no consensus has so far been reached on the nature of knowledge. Jones (8) believed that no such consensus has been achieved even in the history of mankind. According to Davenport and Prusak (1998: 5), knowledge is a fluid mixture of framed experiences and systemized values, information, and expert views that provides a framework for evaluating and incorporating new information and experiences (9). With regard to the intertwined nature of knowledge and practice in medical education, Milton (10) defined knowledge as the ability, skill and expertise in manipulation, transfer, and creation of data, information and ideas to perform tasks, make decisions, and solve problems more skillfully.

In addition to proper perception of knowledge, deep understanding of knowledge resources is also essential for acquiring knowledge. Medical knowledge resources include tangible and intangible resources in which knowledge is stored. Tangible knowledge resources mainly consist of explicit knowledge and information that can be retrieved and acquired via knowledge repositories (libraries, databases, etc.). However, a large amount of valuable medical knowledge (which is mostly tacit) lies in intangible resources; that is inside the minds of medical intellectuals (specialists and experts). Educational systems should provide students with this kind of knowledge.

METHODS

The argumentative literature review was used in this study. Argumentative literature review, as the name implies, examines literature selectively in order to support or refute an argument, deeply imbedded assumption, or philosophical problem already established in the literature. It should be noted that a potential for bias is a major shortcoming associated with argumentative literature review (11). Argumentative literature review in methodology of medicine studies was originally developed and used by McCullough et al (12) for evaluating normative literature. This method was also applied by Coleman (13) to clarify what actually is meant epistemologically by African

bioethics *Vis a Vis*, Western bioethics. Also, Rossitto and his colleagues (14) illustrated Challenges and Promises for Planning Future Clinical Research into Bacteriophage Therapy against *Pseudomonas aeruginosa* in Cystic Fibrosis by argumentative literature review.

The Search sources included PubMed and Google Scholar databases. The keywords for the search terms included "Knowledge management and medical education" and Knowledge management and health. Inclusion criteria were: 1- English and Persian language papers, 2- Original published papers, 3- Medical-focused articles, and 4- Articles published in the last fifty years. Exclusion criteria were: 1) Articles written in languages other than English and Persian, 2) Articles not related to the medical sciences, and 3) Conference and non-original papers. The study questions focused on three components: repositories, content, and ICT including: 1) What are the requirements of medical "knowledge repositories" for optimal knowledge acquisition?, 2) What are the requirements of medical "knowledge content" for optimal knowledge acquisition?, and 3) What are the "ICT" requirements for optimal knowledge acquisition?.

RESULTS

Requirements for Knowledge Acquisition Resources:

In the discussion of medical knowledge resources, researchers and authorities must take into account three components of medical knowledge repositories, medical knowledge content, and medical knowledge technology. Experimental evidence has been used to confirm each of the principles and arguments. Components: The sources of medical knowledge, empirical principles and evidence supporting it are summarized in Table 1. These components and principles can be described as follows:

1. Medical Knowledge Repositories

In medical science universities, institutional repositories contain numerous resources with different contents and forms. The contents of these repositories may be fully scientific or they may contain published or unpublished management, educational, and research contents. The medical knowledge repositories are used to store, protect and provide access to scientific works of medical students and researchers. An institutional repository is a database with a set of services to collect, store, and index, protect, and publish scientific research findings in digital formats (15). According to Allard et al. (2005), these repositories collect and store the intellectual output of universities and organizations (16). Although several factors affect the effectiveness of knowledge acquisition, powerful knowledge repositories have a great potential in facilitating successful knowledge acquisition. The following principles are essential for the design and development of medical knowledge repositories in accordance with the KM requirements:

1.1 Digitization of Contents: The institutional knowledge repositories stored in medical universities contain written and digital resources. Providing digital content along with the use of suitable technology enables researchers to easily search and retrieve knowledge. Therefore, all resources,

including written physical resources, should be converted into searchable and retrievable digital resources. Besides these benefits, provision of digital content also reduces retrieval time and enables us to better manage costs. According to Scott et al (2016), Benefits of digitized records included: access from multiple locations, better prepared ward rounds, improved inpatient handovers and an improved timeline of patient events (17).

1.2 Accessibility and Searchability: Providing access to institutional knowledge repositories through search engines is very important; therefore, authorities should take into account the indexability and accessibility of knowledge resources available in institutional repositories of Iranian medical science universities. Development of appropriate indexing and searching processes significantly increases the citation rates of open-access articles compared with traditionally published articles (18). High citation rates increase the impact factor of journals and their citation index. In addition, accessibility can affect students' motivation. Based on the frustration-aggression hypothesis, when an activity ends in failure, the motivation for performing that activity is decreased. Successful access to information may increase one's motivation for searching and acquiring more knowledge.

1.3 Elimination of Redundant Knowledge Repositories (Organizational Agility):

Inflated organizational memory and knowledge repositories do not necessarily indicate strong knowledge repositories, because in the knowledge management discussion, it is very important to refine knowledge and eliminate obsolete knowledge. According to Dalkir (2013), it is necessary to understand which parts of the knowledge base are unnecessary in order to sustain competitive advantage and effectiveness (19). Today, monitoring and enhancing the quality of knowledge is a fundamental strategy in medical education. The changes made to the higher education system around the world, increases in community needs, progresses in knowledge, and reforms applied to medical teaching approaches have forced authorities of the world's top medical schools to review and revise medical education resources and curricula (20). Rapid advances in science and technology and obsolescence of previous findings and information highlight the need for providing up-to-date knowledge to students. Many experts have faced serious problems because of the rapid growth in the volume of medical information. Students can be relieved from going through huge amounts of bulky, non-classified and non-scientific resources by providing them with precisely planned curricula through identification and selection of credible and up-to-date resources and books, the study of which would in fact be a waste of time.

2. Medical Knowledge Content

The term content refers to all types of digital resources, such as articles, reports, dissertations, newsletters, bulletins, lectures, photos, research data, research projects, guides, administrative reports, minutes, and even multimedia resources. Some scholars have argued that content is the most important systemic factor influencing the success of KM systems (21). In the discussion of content management,

medical education authorities take into account the following issues:

2.1 Comprehensiveness (paying attention to various types of knowledge, especially tacit knowledge): Authorities must simultaneously pay attention to clinical knowledge and documented knowledge. More attention is paid to documented knowledge in knowledge repositories. Today, in medical education, an evidence-based medical practice involves integrating individual clinical expertise with the best clinical evidence available in systematic research, which highlights the importance of comprehensiveness. According to Sackett, good doctors use their individual clinical expertise along with the best available external evidence, because neither alone is sufficient. Without clinical expertise, available clinical evidence may be ignored, or excellent external evidence may be inapplicable to, or inappropriate for a patient (22). Medical education systems should prepare the ground for transferring the expert knowledge to young medical practitioners and students. What is today transferred as expert knowledge through internship is only part of professors' tacit knowledge. Along with paying attention to the health of patients, physicians must pay attention to [and raise their awareness about] the physical, mental and social health, and vitality of community. Therefore, medical knowledge should contain both explicit and tacit knowledge. This principle refers to the comprehensiveness of institutional knowledge. A major challenge facing medical education is the accumulation of documented explicit knowledge and ignoring tacit knowledge. As Stephen Henry, Richard Zaner, and Robert Dittus explained in their *Academic Medicine* article, evidence-based medicine means something much more specific than the general notion that "medical decisions should be based on the best, most current information available" (23). This is due to the fact that documented explicit knowledge can be organized and stored far more easily and less costly than tacit knowledge (*i.e.* the experiences of expert and skillful physicians).

2.2 Different Content Formats: Formal medical education repositories based in medical universities mostly share written contents. This type of knowledge sharing mostly focuses on a codified approach toward knowledge flow (24) where the flow of personal knowledge is often neglected. According to Boisot (25), codified knowledge can be more easily organized and distributed; however, today, technological advancements have enabled us to organize and share a large part of medical knowledge and experiences through the content of educational videos, podcasts, lectures, etc. Studies showed that new content formats developed via new technologies (such as podcasts) are welcomed in academic settings (26-27). The use of various formats for knowledge transfer enhances creativity and flexibility in educational systems. Besides books, journals and theoretical knowledge, medical knowledge repositories should also cover tacit knowledge and skills through modern educational materials. However, according to Wyatt, few studies have addressed tacit KM techniques in healthcare industry (28).

2.3 Human Unity in Medical Science: Extreme

specialization is a detrimental agent in medical systems. Bertalanffy (29) was the first to raise the discussion of systems thinking in biology. A human being must first be considered as a system and in medical science, the knowledge of all relevant sub-systems - which have shaped various medical specialties -, the comprehensive nature of the system, and the relationships between various system elements should be taken into account during diagnosis and treatment procedures. Some studies (30) indicated that extreme specialization can increase the number of medical errors. Addressing human unity reduces medical errors and gives doctors the deeper understanding of various aspects of a disease and treatment outcomes.

2.4 Up-to-date Contents: New medical research areas, such as nanotechnology and genetics, are growing at an astonishing pace (31). Many issues are involved in the design of sites and knowledge transfer technologies; however, according to Kim et al. (32), the most important criterion for evaluation of a site is the content of the site, which includes information quality and accuracy. According to Towle, the education system must be better able to respond to rapid changes in the outside world and involve employers and users of health services (33). Up-to-date content of a medical education system helps it keep pace with new changes and innovations. This issue also creates a balance between medical knowledge and practice. In other words, young doctors must be prepared to deal with new (technological and clinical) medical issues in hospitals.

2.5 Validity and Reliability of Knowledge: Modern advances in information technology have provided students with rapid access to various sources of information and knowledge; however, it is an essential issue to assess the validity of scientific contents and claims. To assess the validity of a document, the credibility of its knowledge sources, data collection tools, research position, and generalizability of its findings are examined. Scholars face many challenges when assessing the content validity of documents, especially in the case of digital and web-based contents. Some have challenged the validity of these resources (34), and some believe that these resources are ambiguous and contradictory in terms of intervention, diagnosis, definitions, adverse effects, risk factors, *etc* (35). In addition, different and contradictory evaluations of medical records (36) highlight the need for paying more attention to the credibility and validity of acquired knowledge. In addition, due to the growing penetration rate of technology in medical activities, students should be aware of possible errors in measurement devices. To enhance the credibility and validity of medical knowledge, it is necessary to pay attention to quantity-based knowledge, as well as qualitative research and interpretations (37), which mainly contain valuable tacit knowledge.

3. Information and Communication Technology (ICT)

Facilitating acquisition of medical knowledge is among the most important educational goals of technology-based medical education (38). The effectiveness and efficiency of technology in the acquisition of knowledge depends on many components including:

3.1 Knowledge Categorization: Proper knowledge categorization improves access to knowledge resources. Target groups using knowledge should always be taken into account when they organize and classify the knowledge resources. As Milton (39) stated, the main motto of KM is to provide the right knowledge in the right format, at the right time and place, to the right people, i.e. those who need that knowledge. For example, one may wonder why young doctors have fewer clients (patients) in societies like Iran. This is not due to their lack of knowledge, but people's hesitations about the transfer of medical experts' tacit knowledge to students. In addition, knowledge repositories of medical universities may contain both general and specific knowledge; however, as a result of scientific advances and general knowledge development, a large part of "specific" knowledge of the past is considered "general" in the present time. This kind of knowledge should be properly categorized. According to Whyte and Classen (40), a desirable organizational memory should contain both explicit and tacit knowledge; however, some tacit knowledge is not practically considered as tacit. Proper knowledge categorization improves access to relevant knowledge and enhances time management as well as the effectiveness of the KM system. According to Liao and Lee (2002), some data mining (DM) methods rely on categorized data (41).

3.2 Monitoring and Managing Information Seeking Behavior of Medical Students: Dawes and Sampson (2003) conducted a study on information seeking behavior of physicians and found that the most frequently used information resource was written sources. Asking colleagues was the second resource and database was the primary resource only in one study. Factors including ease of access, habit, reliability, high quality, speed, and applicability raise the likelihood of a successful information seeking behavior. The lack of time to search, huge amounts of information materials, forgetfulness, the belief that there may be no answer, and lack of urgency may interfere with the process of seeking answers. Dawes and Sampson (2003) argued that due to extensive changes to information seeking behavior [in recent years], information need and information resources must be further categorized. The accurate planning of information delivery to physicians is essential to empower them, keep them up-to-date, and facilitate the knowledge transfer process (42).

3.3 Selecting the effective Technology Tailored to the Desired Knowledge and Knowledge Acquisition Process: Information technologies offer several knowledge delivery services in the area of medical science. PubMed provides more than 29 million citations for medical literature from MEDLINE and other relevant journals. Various technologies (such as intranet, recovery engines, databases, data mining, and SharePoint) have been developed for KM. According to Dalkir (43), each of these technologies can be used for certain KM processes. Content development and management technologies that are effective in the acquisition of tacit knowledge should be the focus of knowledge acquisition processes.

3.4 Accepting and Managing Knowledge Acquisition through Social Networks: Today, professional social

networks are also important sources, especially for acquiring tacit knowledge. There are many professional social networks (e.g. Sermo, Doximity, DailyRound, and WeMeduu.) aimed at sharing medical knowledge. Some of these networks (such as the Student Doctors Network) provide a good environment for medical students to acquire and share knowledge and experience. Unlike structured technologies, such as data repositories and databases, social networks are not structured platforms. Structured technologies use a fairly similar language; however, according to Yeh et al. (44), it is difficult to transfer knowledge from an expert (medical expert) to a computer, because medical experts do not speak the same scientific language. Studies showed that although there are many challenges, social networks play a major role in medical education and innovation (45,46).

3.5 Empowering Medical Students through IT Literacy: Technology literacy is a very fundamental issue in medical education. Technology and information literacy are two major components of research literacy in education. They help medical students develop their capabilities to acquire knowledge and participate in medical projects (47). Considering the growing impact of technology on content and information management, it would be impossible to effectively acquire knowledge in the absence of technology literacy. Information literacy enables students to identify information resources to acquire knowledge.

DISCUSSION

Knowledge resources are an important component of knowledge management. The purpose of this review study was to develop principles for medical knowledge resources. Although there is some research on the subject of knowledge resources, first of all, these studies are not focused on medical knowledge sources and, secondly, they are not comprehensive, and are highly dispersed and lack a systematic view of the subject. This paper, while using the subject literature as arguments to support the proposed principles, provides a more comprehensive picture of the principles of medical knowledge resources.

Various commercial and industrial organizations benefit from KM; however, this issue has not been well addressed in medical education. In this regard, authorities can benefit from the experiences of commercial organizations and companies. The use of KM [as a strategy] in health and medical education can lead to education improvement and medical service development. While many countries depend largely on KM, the progress of KM usage in healthcare sector of developing countries is not satisfactory. However, there is a good prospect for KM in the health sector of developing countries, if conscious efforts are made to apply it (48). Although the role of KM in the health sector can be studied from many aspects, few studies have focused its role in transforming medical education and knowledge acquisition practices.

Knowledge acquisition is among the most important KM processes. It is also considered the main goal of the medical education system. Therefore, modern education management systems should utilize the findings of

Table 1. Knowledge resource requirements (claims) and implications for K acquisition (evidence)

| Components | Principles (Claim) | Evidence |
|--|--|---|
| Medical Knowledge Repositories | Digitization of Contents | access to multiple locations, better prepared ward rounds, improved inpatient handovers and an improved timeline of patient events (15) |
| | Accessibility and Searchability | increases the citation rates (16) |
| | Elimination of Redundant Knowledge Repositories | Eliminating obsolete medical knowledge Up-to-date knowledge acquisition and knowledge effectiveness Keeping pace with the speed and flow of medical knowledge (17-18) |
| Medical Knowledge Content | Comprehensiveness | Transferring expert knowledge and development of experience in medical education (20-21) |
| | Different Content Formats | various formats for knowledge transfer enhance creativity and flexibility (24-26) |
| | Human Unity in Medical Science | Extreme specialization can increase the number of medical errors (28). |
| | Up-to-date Contents | responding to rapid changes in the outside world (31) |
| | Validity and Reliability of Knowledge | There are challenges in the validity of resources (32-34). Attention to quantity-based knowledge, as well as qualitative and interpretations (35). |
| Information and Communication Technology (ICT) | Knowledge Categorization | Some data mining methods, rely on categorized data (39.) |
| | Monitoring and Managing Information Seeking Behavior | Some Factors raise the likelihood of a successful information seeking behavior (40). |
| | Selecting the effective Technology | Each of technologies can be used for certain KM processes (41). |
| | Accepting and Managing Knowledge Acquisition through Social Networks | Social networks play a major role in medical education (43-44). |
| | Empowering Medical Students through IT Literacy | developing capabilities in knowledge acquiring (45) |

knowledge management. According to Meyer & Zack (49), two basic components (user and resources) and their interactions must be analyzed in the discussion of knowledge acquisition. In the medical education system, students are considered the users in the knowledge management system, whose main purpose is to acquire knowledge. In medical education, knowledge resources include tangible (repositories) and intangible (the memory of medical experts) resources. Developing students' ability to search, retrieve and learn, motivating them to acquire knowledge, developing learning capacity, eliminating redundant and obsolete medical knowledge, keeping pace with the speed of knowledge transformations, transferring expert knowledge, developing experience, reducing errors, filling the gap between educational and clinical settings, and selecting the right technology are among the outcomes of proper design and development of knowledge resources in the medical education system.

There are various methods for review studies, categorized by scholars such as, Grant and Boot (50), Samnani et al. (51), etc. Each research method has its limitations, of which this research is not an exception. Although Argumentative Review is a flexible, creative, and defensible way of selecting the research literature to support the researcher's assumptions or proposed principles, the selection of literature and its background are limited to the principles proposed. Therefore, a part of the valuable research literature might be neglected. In other words, the proposed components and principles are not necessarily limited to what is presented in

the article. Future researchers can help confirm and refine the results with other research methods (such as unstructured interviews, etc.). Furthermore, Effective acquisition of knowledge can be prevented by several other factors (such as motivation, ability, and culture), which were not addressed in this study as it was mainly focused on knowledge resources (repositories, content, and technology). The factor known as "user" must be examined in separate studies.

Given the fundamental importance of medical education institutions in the production and development of medical knowledge and practice on one hand, and the importance of innovative and knowledge-based activities in medical education on the other hand, these institutions must use continuously the findings of various fields of Medical and educational sciences. Findings and theories of knowledge management can develop new medical techniques, and thus help professors and medical students to examine the curriculum according to the advances of modern technology and medical education approaches. Applying knowledge management findings will pave the way for constructive advances and changes in medical education. In general, the promotion of medical education system requires benefiting from the findings of knowledge management in various areas.

In general, the promotion of medical education system requires benefiting from the findings of knowledge management in various areas. Based on the findings of this area, digitization of contents and the accessibility, perpetual

accumulation, and agility of knowledge repositories should be taken into consideration. In addition, issues such as comprehensiveness of contents, tacit knowledge, production and presentation of different contents in various formats, the use of up-to-date contents, the validity and reliability of knowledge, and regarding human beings as a system should be considered in medical knowledge. Obviously, development of knowledge acquisition process requires proper categorization of knowledge, management of student information seeking behavior, management of professional social networks, application of proper technology tailored to the specific knowledge, and acquisition and development of information literacy.

Generally, this study considers three components of medical knowledge resources (repository, content, and technology) and proposes 13 principles. Following each proposed principle, supporting arguments and empirical evidence are also provided. The results of the study provide a comprehensive and systematic knowledge of the sources of medical knowledge and its principles. Simultaneous attention to three components of repositories, content, and technology can lead to the strengthening of knowledge management systems and the development of medical education as well as its effectiveness. In addition, the results of the research and the proposed principles can assist quantitative researchers in designing tools and measuring these principles in medical education institutions.

Based on the findings of this area, digitization of contents and the accessibility, perpetual accumulation, and agility of knowledge repositories should be taken into consideration.

In addition, issues such as comprehensiveness of contents, tacit knowledge, production and presentation of different contents in various formats, the use of up-to-date contents, the validity and reliability of knowledge, and regarding human beings as a system should be considered in medical knowledge. Obviously, development of knowledge acquisition process requires proper categorization of knowledge, management of student information seeking behavior, management of professional social networks, application of proper technology tailored to the specific knowledge, and acquisition and development of information literacy. Effective acquisition of knowledge can be prevented by several other factors (such as motivation, ability, and culture), which were not addressed in this study, as it was mainly focused on knowledge resources (repositories, content, and technology). The factor known as "user" must be examined in a separate article.

Ethical consideration : Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

ACKNOWLEDGEMENT

I appreciate all people who helped me writing this manuscript.

Financial support: None

Conflict of Interests: None to be declared.

REFERENCES

- Schmidt Henk G, Remy MJP Rikers. How expertise develops in medicine: knowledge encapsulation and illness script formation. *Medical education*. 2007; 41(12): 1133-9.
- Khakpour A. Knowledge management in educational organizations: opportunities and challenges. In 7th international knowledge management conference, Beheshti International. Conference center, Teheran, Iran; 2015.
- Omotayo FO. Knowledge management as an important tool in organizational management: A review of literature. *Library Philosophy and Practice*, (e-journal) 2015. Available at: <https://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=3330&context=libphilprac>
- Bolarinwa OA, Salaudeen AG, Akande TM. Overview of Knowledge Management Applications in Health Care Delivery of Developing Countries. *Academic Research International*. 2012;3(3):38.
- Stroetmann B, Aisenbrey A. Medical Knowledge Management in Healthcare Industry. *Engineering and Technology, International Journal of Health and Medical Engineering*. 2012; 6(4): 531-6.
- Dargahi H, Ghazi Saidi M, Ghasemi M. The role of e-learning in Medical Sciences Universities. *Payavard*. 2008; 1 (2) :20-29.
- Meyer M, Zack M. The design and implementation of information products. *Sloan Management Review*. 1996; 37(3): 43-59.
- Jones, W.T. A history of Western philosophy. New York: Harcourt Brace, 1952.
- Davenport TH, Prusak L. Working knowledge: How organizations manage what they know. Harvard Business Press; 1998.
- Milton NR. Knowledge acquisition in practice: a step-by-step guide. Springer Science & Business Media; 2007.
- USC Libraries. (2014). Research Design. USC (University of South Carolina) Libraries: Retrieved August 20, 2015 from www.library.sc.edu.
- McCullough LB, Coverdale JH, Chervenak FA. Argument-based medical ethics: a formal tool for critically appraising the normative medical ethics literature. *American journal of obstetrics and gynecology*. 2004;191(4):1097-102.
- Coleman AM. What is "African Bioethics" as used by Sub-Saharan African authors: An argumentative literature review of articles on African bioethics. *Open Journal of Philosophy*. 2017;7(1):31-47.
- Rossitto M, Fiscarelli EV, Rosati P. Challenges and promises for planning future clinical research into bacteriophage therapy against *Pseudomonas aeruginosa* in cystic fibrosis. An argumentative review. *Frontiers in microbiology*. 2018; 9:775.
- Barton MR, Waters MM. Creating an institutional repository: LEADIRS workbook. 2004.
- Allard S, Mack TR, Feltner-Reichert M. The librarian's role in institutional repositories: A content analysis of the literature. *Reference services review*. 2005;33(3):325-36.
- Scott PJ, Curley PJ, Williams PB, Linehan IP, Shaha SH. Measuring the operational impact of digitized hospital records: a mixed methods study. *BMC medical informatics and decision making*. 2016;16(1):143.
- Harnad S, Brody T, Vallieres F, Carr L, Hitchcock S, Gingras Y, et al. The access/impact problem and the green and gold roads to open access: An update. *Serials review*. 2008;34(1):36-40.

19. Dalkir K. Knowledge management in theory and practice. Routledge; 2013.
20. Abdolazade Estakhry G, heidarzadeh A, yazdani S, Taheri ezbarami Z. Identification of Top Medical School's Educational Structure in the World. *rme*. 2014; 6 (2) :19-27.
21. Ramezanpour A, Golshahi Rad S. Evaluation of study pattern and the attitude of medical students and residents about study resources (books and notes) in Zanjan University of Medical Sciences - 2013-2014. *J Med Educ Dev*. 2015; 8(19) :41-52.
22. Sackett DL. Evidence-based medicine. In *Seminars in perinatology 1997* (Vol. 21, No. 1, pp. 3-5). WB Saunders.
23. Henry SG, Zaner RM, Dittus RS. Viewpoint: moving beyond evidence-based medicine. *Acad Med*. 2007;82(3):293.
24. Hansen MT, Nohria N, Tierney T. 1999. What's your strategy for managing knowledge. *The knowledge management yearbook 2000-2001*, pp.1-10.
25. Boisot MH. Knowledge assets: Securing competitive advantage in the information economy. OUP Oxford; 1998.
26. Eash EK. Podcasting 101 for K-12 librarians. *COMPUTERS IN LIBRARIES-WESTPORT-*. 2006;26(4):16.
27. Flanagan B, Calandra B. Podcasting in the classroom. *Learning & Leading with Technology*. 2005;33(3):20-3.
28. Wyatt JC. 10. Management of explicit and tacit knowledge. *Journal of the Royal Society of Medicine*. 2001;94(1):6-9.
29. Von Bertalanffy L. General system theory. *New York*. 1968;41973(1968):40.
30. Hashem A, Chi MT, Friedman CP. Medical errors as a result of specialization. *Journal of Biomedical Informatics*. 2003;36(1-2):61-9.
31. Wickramasinghe N. Building a learning healthcare organization by fostering organizational learning through a process centric view of knowledge management. *International Journal of Innovation and Learning*. 2008;5(2):201-16.
32. Kim P, Eng TR, Deering MJ, Maxfield A. Published criteria for evaluating health related web sites. *Bmj*. 1999;318(7184):647-9.
33. Towle A. Continuing medical education: Changes in health care and continuing medical education for the 21st century. *Bmj*. 1998;316(7127):301-4.
34. Flanagan AJ, Metzger MJ. Perceptions of Internet information credibility. *Journalism & Mass Communication Quarterly*. 2000;77(3):515-40.
35. Berland GK, Elliott MN, Morales LS, Algazy JI, Kravitz RL, Broder MS, et al. Health information on the Internet: accessibility, quality, and readability in English and Spanish. *Jama*. 2001; 285(20):2612-21.
36. Van Melle MA, Zwart DL, Poldervaart JM, Verkerk OJ, Langelaan M, Van Stel HF, et al. Validity and reliability of a medical record review method identifying transitional patient safety incidents in merged primary and secondary care patients' records. *BMJ open*. 2018;8(8):e018576.
37. Malterud K. The art and science of clinical knowledge: evidence beyond measures and numbers. *The Lancet*. 2001;358(9279):397-400.
38. Guze PA. Using technology to meet the challenges of medical education. *Transactions of the American Clinical and Climatological Association*. 2015; 126:260.
39. N. R. Milton, Knowledge acquisition in practice, *British Library Cataloguing in Publication Data*, 2007.
40. Whyte G, Classen S. Using storytelling to elicit tacit knowledge from SMEs. *Journal of Knowledge Management*. 2012;16(6):950-62.
41. Liao SC, Lee IN. Appropriate medical data categorization for data mining classification techniques. *Medical informatics and the Internet in medicine*. 2002;27(1):59-67.
42. Dawes M, Sampson U. Knowledge management in clinical practice: a systematic review of information seeking behavior in physicians. *International journal of medical informatics*. 2003;71(1):9-15.
43. Dalkir K. Knowledge Management Theory and Practice (3rd ed.). Cambridge, MA: The MIT Press, 2017.
44. Yeh YJ, Lai SQ, Ho CT. Knowledge management enablers: a case study. *Industrial Management & Data Systems*. 2006;106(6):793-810.
45. Cheston CC, Flickinger TE, Chisolm MS. Social media use in medical education: a systematic review. *Academic Medicine*. 2013;88(6):893-901.
46. Masic I, Sivic S, Pandza H. Social Networks in medical education in Bosnia and Herzegovina. *Materia socio-medica*, 2012; 24(3):162.
47. Zhou Z, Liu Z. The effects of medical students' information literacy on participation in scientific research projects. *Chinese Journal of Medical Education Research*. 2016;15(5):524-8.
48. Bolarinwa OA, Salaudeen AG, Akande TM. Overview of Knowledge Management Applications in Health Care Delivery of Developing Countries. *Academic Research International*. 2012;3(3):38.
49. Meyer MH, Zack MH. The Design and Development of. *Sloan Management Review*. 1996.
50. Grant MJ, Booth A. A typology of reviews: an analysis of 14 review types and associated methodologies. *Health Information & Libraries Journal*. 2009; 26(2):91-108.
51. Samnani SS, Vaska M, Ahmed S, Turin T.C. Review typology: The basic types of reviews for synthesizing evidence for the purpose of knowledge translation. *Journal of the College of Physicians and Surgeons Pakistan*. 2017; 27(10):635-41.