# E-LEARNING IN RADIOLOGY EDUCATION: A 2009 OVERVIEW

**A. AMIR MONIR SHAFIK, MD**
*Lecturer of Radiodiagnosis*
*Director of the e-Learning Unit*
*Mansoura School of Medicine*
*Mansoura University*
*Website* www.AmirSradiology.net.tc
*e-mail* amirmonirali@yahoo.com
*mobile* 0105233142

**Abstract**
Purpose of the review: The purpose of this review is to discuss the rise and role of the recent e-Learning educational resources available to the radiology and medical imaging community internationally and in Mansoura University.
Context: Recent developments of particular importance include the growth of 'Web 2.0' e-learning resources, the development of the concepts of 'open access' and 'information philanthropy', and the expansion of web-based medical simulation software products. In addition, peer review of online educational resources has now come of age.
Summary: The worldwide web has made available a large variety of valuable medical radiology information and education resources only dreamed of two decades ago. To a large extent, these developments in e-learning represent a shift in the focus of medical education resources to emphasize free access to materials and to encourage collaborative educational development efforts. Fortunately, Mansoura University is on the international cutting edge with a new promising experience.

Keywords: e-learning, radiology, web-based medical education, Mansoura University

## Introduction

Since the launching of the Internet, a revolution in access to information has taken place, with implications for both conventional and distance education. Web-based medical education technologies now allow for techniques not previously dreamed of [1–6], and clinicians now have available countless online journals, educational sites, discussion forums, search engines, podcasts, wikis, and blogs that they can use without charge. A small 2009' selection is provided in a sampling of free educational resources likely to interest radiology students and professional radiology educators:

1. A digital library of radiology education resources and a good educational website for a radiologist's knowledge refreshment ( www.radiologyeducation.com)
2. An international platform for quality assurance of web-based radiology e-learning resources (www.elearning-radiology.com)

3. A web based interactive teaching file server for radiology education ( www.radiologyteacher.com)
4. A comprehensive internet site for radiologists and related professionals in the medical imaging community. AuntMinnie features the latest international news and information about medical imaging (www.auntminnie.com)
5. A good website for radiology tutorials (www.radiologytutorials.com)
6. LearningRadiology is an award-winning, radiologic teaching site for medical students, educators and those starting out in radiology ( www.learningradiology.com)
7. AmirSradiology (the author's website), is an internationally accredited, Egyptian website for the radiology, e-learning and total quality management resources on the internet. It originates from the Mansoura University and is by far the only internationally accredited website among the Egyptian universities nationwide (www.AmirSradiology.net.tc)

**Recent Trends in Radiology e-Learning Development**

Easily accessed and updated, web pages are a particularly useful means of providing all kinds of radiology information. Links to related documents and support for tables, graphics, and multimedia objects like video clips can usually be managed with minimal difficulty. As a result, web pages have proven to be very popular for radiology education [7-8].

Web pages are primarily built using the HTML language or one of its successors [9–12]. While one can write web pages directly in HTML using almost any text editor, most developers prefer to use a specialized editor, and there are a number of free HTML editors available. Professionals usually use packages such as Macromedia's Dreamweaver or Microsoft's Expression Web. Although these are excellent, comprehensive, general-purpose web page editors, they are not especially friendly to beginners.

Regardless of the editor chosen, consideration must also be given to proper web-design principles [13–15]. Where appropriate, consideration should also be given to adding interactivity to the process. Web-based interactivity, discussed later, can be implemented in various ways. For instance, a web page may ask a question, and offer a number of possible answers. Depending on the student's response, the web page can provide a different commentary. Other forms of web-based interactivity may involve the use of discussion forums or online surveys and polls. Advanced interactivity may also be achieved using JavaScript, a popular web programming language, as well as via other specialized languages. Another point concerns website maintenance. All good web sites need periodic updating, otherwise, the content becomes dated, hyperlinks become broken and other problems arise [16–18,19,20].

**What is Web 2.0 and why is it important?**

The original launch of the web circa 1994 soon developed into a series of offerings that took the online world by storm. Early products soon included corporate and personal websites, web-based mail, Internet commerce, Internet radio, etc. For convenience, some authors describe this 'original' web version as Web 1.0. Since then, however, the web has developed so much that some authors now use the term 'Web 2.0' to describe the many recent developments that stress openness, sharing, cooperation and collaboration among web users [21-25]. Such developments include Wikis, blogs, podcasts and RSS feeds. These are described as follows:

1. Wiki – a collaborative website whose content is open (freely accessible) and can be edited by anyone who is duly authorized. The name comes from the Hawaiian word wiki, meaning to hurry or swift. The best known Wiki is Wikipedia ( http://www.wikipedia.org/), which as of this writing has over 2.4 million articles in English. A list of medical Wikis is available at http://www.davidrothman.net/list-of-medical-wikis.
2. Blog – a website intended for online audiences containing a diary-like account of events and personal insights, often containing themes with political or social overtones. Short for 'Web log'.
3. Podcast – a downloadable audio or video presentation for replay on a personal media player such as Apple's iPod. Most podcasts are available by free subscription from sources such as itunes.com or podcast.com. Anesthesiologists may want to sample some anesthesiology-related podcasts available at http://radiology.medpod101.com/blogs/wordpressmu/.
4. RSS (really simple syndication) – a web resource known as a 'feed' based on the 'extensive markup language' (XML) that scans the web to provide links to content in which one has previously indicated an interest.

While a formal definition of Web 2.0 that everyone agrees on would be hard to find, one way of understanding it would be to point out its emphasis on participation through open applications and services, rather than define it (as others might) in terms of newer languages such as AJAX or XML, or advanced online applications such as Google Maps or Wikipedia. The emphasis in Web 2.0 is thus on developing applications that get smarter and more comprehensive the more people use them (leveraging collective efforts and intelligence), rather than emphasizing any technical properties or specifications. Another emphasis in Web 2.0 is on automatically granting permission to use existing content in new and exciting ways ('information philanthropy') [26]. Yet another focus is that of services over software.

The free online encyclopedia, Wikipedia (http://www.wikipedia.org/), is sometimes held out as a one of the best examples of Web 2.0, with its open access and its participation model. However, its openness in allowing anyone to participate has led to criticism [27], even though there is evidence that it may be no less accurate than commercial encyclopedias [28]. Still, such concerns have led to the launching of more rigorously edited online encyclopedias such as Scholarpedia ( http://www.scholarpedia.org/) and Citizendium (http://citizendium.org/). For instance, the approach of Scholarpedia is to complement Wikipedia, exhaustively covering a few narrow fields (such as computational neuroscience).

## Information philanthropy

Recent years have seen the growth of a movement called 'information philanthropy' [26], which aims to provide quality intellectual property for free (by definition, Philanthropy is the act of donating money, goods, services, time and/or effort to support a beneficial cause, with a defined objective and with no financial reward to the donor). This material might be textbooks, graphic illustrations, photographs, videos, and even raw scientific data. In all such cases, the creator/owner of the material makes it freely available to individuals with possible restrictions such as not allowing the material to be used for commercial purposes. In a great many cases such materials are governed by a 'creative commons' license (see below).

## Interactivity and the 'constructivist' approach to education

Constructivism is the view that knowledge is 'constructed' by the learner by testing ideas, concepts, and approaches based on existing knowledge and experience. Constructivist theory holds that students learn best when they actively (often collaboratively) participate in problem solving and critical thinking.

Many adult learning experts argue that traditional lecture-based teaching all too often encourages passive learning instead of the development of higher order cognitive skills. Arguing that active involvement is essential for learning, they suggest that adults learn best using techniques such as group discussion, simulation exercises, and problem solving.

One educational element that has been advocated as a means to achieve active learning is 'interactivity', as it is well matched to the constructivist model of learning. The Oxford English Dictionary defines interactivity as reciprocally active, allowing a two-way flow of information between source and user, responding to the user's input. The nature of the 'interaction' will vary with factors such as the subject domain (e.g. philosophy versus physics), and format (e.g. conventional versus distance education) [29].

The importance of interactivity in learning is nicely illustrated by the fact that a number of publications such as the Journal of Interactive Learning Research address this topic. Similarly, Harnard [30] has pointed out that electronic publication (and especially publication via the Internet) provides a dimension of interactivity in document publication that is radically new. One example of this is the fact that numerous journals now allow readers to post feedback concerning recently published radiology journal articles at the journal's website. For instance, in the case of the American Journal of Radiology, the journal's Rapid Responses feature allows visitors to its website to posts 'e-letters' that will neither be cited nor indexed.

Various learners and instructors will have preferences regarding interactivity, and some forms of education will rely on some forms of interactivity more than others. Regardless, the wise use of interactivity will help 'engage' students and help ensure an enduring learning experience. One particularly engaging form of interactivity is the use of multiple-choice questions (MCQs). These not only make the material more

engaging but also help detect learning gaps. In recent years the most popular format for radiology MCQs is the 'pick the best single answer' format [31,32].

Until recently, educational technology was not especially capable of maintaining a high degree of interactivity with a learner. This matter is expected to change favorably as software technology continues to become more sophisticated and as computer hardware advances in speed and power. In particular, advances in artificial intelligence and educational authoring systems will likely impact on computer-based interactivity. Still, radiology computer-based learning is much more complex than working through a textbook, and many students who are uncomfortable with computers see no reason to deviate from a curriculum based on well written radiology textbooks, particularly when accompanied by study guides and solutions manuals.

Many advocates of radiology computer-mediated distance education draw attention to the helpful aspects offered by computer-based methods and understate the kinds of communicative and technical difficulties learners may experience. When our students use complicated equipment in their learning environment, it is important to ensure the technologies used help rather than hinder them. Our radiology students using unfamiliar technologies may experience frustration, anxiety, and confusion. These include computer hardware problems, software problems, as well as difficulties with Internet access. Files may mysteriously 'disappear'. Attachments sent by e-mail may be 'lost' in transit. Random 'disconnects' from the Internet may frustrate the user. Unless students are moderately familiar with computers, substantial effort may be expended on technology-related issues rather than learning the intended materials.

As a result, technologies that are awkward, unintuitive, or present the learner with a steep learning curve may hinder interaction and learning. Various means by which technology can harm include haphazard, unintuitive, or disorganized user interfaces; poor screen layout; poor use of fonts and icons; systems that respond too slowly to user inputs; or systems that crash frequently. As a detailed discussion of this is beyond the scope of this review, books by design gurus Nielsen [33] and Norman [34] are recommended as a good place to start.

Studies show that technical problems can occasionally make the educational undertaking into a negative experience. For instance, Hara and Kling [35] studied an American web-based distance education course and noted that three interrelated sources accounted for most such problems: 'lack of prompt feedback, ambiguous instructions on the web, and technical problems'. They concluded that these frustrations 'inhibited their educational opportunity'. In a related paper [36] similar concerns were voiced.

The importance of interactivity in medical education is supported by a landmark meta-analysis of the effectiveness of formal continuous medical education by Davis et al. [37], who showed that traditional didactic methods do not generally lead to a change of clinical practice, or to an improvement in health outcomes, whereas interactive techniques are more likely to. As result, some regulatory bodies specifically mandate that a portion of the time of an approved educational event should be allocated for interactive learning, such as in the form of a question period.

## Web-based medical simulation systems

In many respects, simulators offer the ultimate in interactivity and appear to have an excellent future in radiology education. Computer-based simulators used in medical education fall into four general categories: screen-based text simulators, screen-based graphical simulators, manikin-based simulators, and virtual reality trainers. I briefly discuss the first two of these here, as both can be web-based.

Screen-based text simulators create verbal scenarios in which the user picks one of several responses and, based on the response, a new text scenario is produced. For instance, in a scenario involving a patient presenting with a severe headache, the user may be offered options such as prescribing an analgesic or getting a computed tomography scan of the head. On the basis of the user's choice, a new narrative is generated and more choices are offered. Being purely text-based, these simulators are relatively simple to construct, making them popular in early medical simulation efforts. However, as they lack graphical elements, they are rarely used today.

Screen-based graphical simulators aim to recreate elements of reality in graphic form on a computer screen. Usually, only a mouse interface is involved. As these simulations may help one understand the conceptual theory underlying clinical practice, they usually do not confer actual practical skills, their strength lying in an ability to help one understand abstract concepts while remaining portable and relatively inexpensive.

## Peer review of online educational materials

When an instructor selects teaching resources – especially in the case of medical teaching resources – he or she wants some assurance that the material is timely, accurate, well written, and developed using sound pedagogical principles. Such assurances, some would argue, can be best obtained via a process of peer review. As the peer-review process in scientific publishing is as old as scientific publishing itself, the idea of peer-review procedures for educational resources in relatively new. However, it is clearly an idea whose time has come.

Typically, two or more expert referees who are particularly knowledgeable in the subject matter being discussed review scientific materials submitted for publication. Their comments and opinions form the basis upon which an editor will decide whether or not to publish the submitted material, and with what changes, if any. By contrast, formal peer review of educational materials remains relatively uncommon. Historically, this was because, until recently, publishing educational resources such as books was usually done in conjunction with a publishing house with its own internal quality control system. For instance, some book companies employ prepublication internal and external reviews to establish whether a manuscript is worthy of publication and to determine how it might be enhanced.

With the rise of the Internet, however, the landscape has changed, and publishing no longer requires enormous expense and the cooperation of a publishing house. The prevalence of electronic scholarly publishing has thus increased dramatically in recent years, largely as a consequence of the reach and immediacy of the Internet and its ability to handle varied forms of electronic media.

The idea of establishing a peer-review process for educational resources is not entirely new. For instance, Project Merlot, located at http://merlot.org/, seeks to provide high-quality teaching materials in a number of disciplines of higher education. It conducts reviews along three dimensions: quality of the content, usefulness as a teaching tool, and ease of use.

For peer-reviewed medical education materials, MedEdPORTAL, an offering from the Association of American Medical Colleges (AAMC), maintains an online presence at http://www.aamc.org/mededportal. According to its website MedEdPORTAL 'is a web-based tool that promotes collaboration across disciplines and institutions by facilitating the exchange of peer-reviewed educational materials, knowledge, and solutions' and serves 'as a central repository of high quality educational materials such as PowerPoint presentations, assessment materials, virtual patient cases, and faculty development materials'. Any medical educator may submit materials for possible publication on MedEdPORTAL. The material is then screened by an AAMC staff member to ensure that it meets the minimal requirements for inclusion and does not violate patient privacy. Suitable material is then assigned to three reviewers, at least one of whom will have expertise in the content area, and at least another of whom who will have expertise in the educational format of the material.

Another peer-reviewed medical resource is The Health Education Assets Library (HEAL), which maintains an online presence at http://www.healcentral.org/. Established in 2000, HEAL has grown over time to provide over 22 000 resources such as images, video clips, audio clips, PowerPoint slide sets, documents in PDF format, etc.

HEAL, MERLOT and MedEdPORTAL all make use of the well known creative commons copyright system with their works. In general, all resources in these collections are licensed for free use, reproduction, and modification by users according to the specific terms of the creative commons license associated with that resource.

Despite these encouraging developments, formal peer review of educational resources remains uncommon. However, with academic credit now starting to be granted to individuals who produce freely downloadable peer-reviewed educational material such as that offered by HEAL and MedEdPORTAL, the volume and quality of such resources is bound to increase over time.

**Our local experience**

Matching with the great advances in the field of e-learning and medical education nowadays, much efforts are made by individual staff members in Mansoura University to catch up. Concerning radiology, the author's website "AmirSradiology"

has emerged to provide a preliminary local experience in the field of e-learning. "AmirSradiology" website has been awarded accreditation from the International Health On the Net foundation (HON), a United Nations' accrediting organization that establishes quality standards for the medical websites on the net. I am proud to be the only Egyptian University Staff Member to receive this accreditation. The seal of approval is an important indicator of quality and means that visitors can trust that "AmirSradiology" is a reliable and privacy protected source of e-content and information.

As part of the accreditation process, the website has been evaluated against international standards for content, privacy, security and quality oversight. The standards, which are developed by a broad-based committee of health website experts, are to provide a consistent benchmark for quality. By applying for and receiving this accreditation, "AmirSradiology" has demonstrated a commitment to quality web standards, it is crucial to our nation's welfare and it is important to have organizations that are willing to measure themselves against those standards.

The accreditation standards cover a variety of user privacy and security concerns such as privacy disclosure, content development and management, as well as interface procedures for links displayed on the website. The standards also evaluate the net publishing process, its policies and procedures and quality oversight that exist behind the forward-facing website.

HON, an independent nonprofit organization, is a leader in promoting medical internet quality through accreditation and certification programs. HON's standards keep pace with the rapid changes in the health care systems, and provide a mark of distinction for health care websites to demonstrate their commitment to quality and accountability. Through its broad-based governance structure and inclusive standards, HON ensures that all stakeholders are represented in setting meaningful measures for the health care web. For more information, http://www.hon.ch/Global/.

## Conclusion

The worldwide web has made available a number of high-quality medical educational resources especially for radiologists, many of which are completely free and were developed collaboratively. Important developments in the arena of e-Learning include the growth of Web 2.0 resources, open access policies for educational materials, the growth of information philanthropy, and peer review of online educational resources. Fortunately, Mansoura University is on the international cutting edge with a new promising experience.

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