European Journal of Radiology 83 (2014) 2277–2287

Contents lists available at ScienceDirect

European Journal of Radiology

journal homepage: www.elsevier.com/locate/ejrad

Review Article

Evaluation of use of e-Learning in undergraduate radiology education: A review

Saad Zafar[a,1], Saima Safdar[a,*], Aasma N. Zafar[b,2]

[a] Riphah International University, Islamabad, Pakistan
[b] Radiology Department, Senior Registrar Shifa College of Medicine and Assistant Consultant Shifa International Hospital, Islamabad, Pakistan

ARTICLE INFO

Article history:
Received 19 July 2014
Accepted 28 August 2014

Keywords:
Education
e-Learning
Radiology
Undergraduate
Medical education

ABSTRACT

Purpose: The aim of this review is to investigate the evaluative outcomes present in the literature according to Kirkpatrick's learning model and to examine the nature and characteristics of the e-Learning interventions in radiology education at undergraduate level.
Materials and methods: Four databases (PubMed, MEDLINE, Embase, Eric) are searched for publications related to the application of e-Learning in undergraduate radiology education. The search strategy is a combination of e-Learning and Mesh and non Mesh radiology and undergraduate related terms. These search strategies are established in relation to experts of respective domains. The full text of thirty pertinent articles is reviewed. Author's country and study location data is extracted to identify the most active regions and year's are extracted to know the existing trend. Data regarding radiology subfields and undergraduate year of radiology education is extracted along with e-Learning technologies to identify the most prevalent or suitable technologies or tools with respect to radiology contents. Kirkpatricks learning evaluation model is used to categorize the evaluative outcomes reported in the identified studies.
Results: The results of this analysis reveal emergence of highly interactive games, audience response systems and designing of wide range of customized tools according to learner needs assessment in radiology education at undergraduate level. All these initiatives are leading toward highly interactive self directed learning environments to support the idea of life-long independent learners. Moreover, majority of the studies in literature regarding e-Learning in radiology at undergraduate level are based on participant satisfaction followed by participant results or outcomes either before or after an intervention or both. There was no research particularly demonstrating performance change in clinical practice or patient outcome as they may be difficult to measure in medical education. Thus clinical competences and performances are highly affected by pretentious learning environments.

1. Introduction

e-Learning may be defined as the act of learning through use of electronic means to enhance understanding, to improve skills or to gain experience [1]. With the increase in web technology and increase in the electronic information the Internet has become the preferred medium for e-Learning in the field of education.

Medical education requires a variety of material; educational, graphical, physical, and factual information. The traditional medical education involves the use of texts, lectures, images, and books. This old style of medical education is enhanced through incorporating e-Learning strategies. With the advancement in the technology, electronic learning has become an essential asset in the field of medical education [2], especially in radiology education because of intense imaging involved in the study.

Radiology education is important not only for radiographers or doctors specializing in radiology but is equally important for junior doctors and undergraduate medical students so that they do not miss any critical finding while reviewing images [3].

In medical education, radiology teaching is a significant part of the undergraduate medical curriculum. It is said to be the mandatory building block (70%) in medical field and its teaching is involved in every medical year although the proportion varies from year to year. The importance of undergraduate radiology education is explicitly mentioned in recent surveys [4–6]. Moreover, the use of electronic learning in medical institutions is on the rise and

* Corresponding author at: Riphah International University, Main Campus Hajj Complex Road, Sector I-14, Islamabad, Pakistan. Tel.: +92 3330710370.
E-mail addresses: saad.zafar@riphah.edu.pk (S. Zafar), saima.safdar@riphah.edu.pk, safdarsaima@ymail.com (S. Safdar), aasmarad@gmail.com (A.N. Zafar).
[1] Tel.: +92 3225006588.
[2] Tel.: +92 3315428047.

http://dx.doi.org/10.1016/j.ejrad.2014.08.017
0720-048X/

according to a survey e-Learning is involved in 70% of the time in radiology teaching throughout the European medical institutions [5]. The present research focuses on the outcome achieved through the use of electronic learning in radiology education.

The research work on e-Learning in radiology education can be seen in the recent literature [7–9] but the review presented in this paper is differentiated from these studies on the following basis that (1) the scope of the review is limited to radiology education at the undergraduate level; (2) the review is based on search results from four databases (PubMed, MEDLINE, Embase, Eric); (3) a standardized selection process PRISMA flow diagram [10] of Systematic Literature Review SLR is used in the present study for identifying the relevant evidences and (4) Kirkpatricks four level evaluation model is used for evaluating learning outcomes. The use of Kirkpatricks model helps evaluate the learning outcomes. These kinds of evaluation reviews are essential in identifying the learning formats that are most effective in enhancing learning and knowledge retention. These studies are also beneficial in identifying strategies that help in practice change.

2. Research question

What are the evaluative outcomes (learner satisfaction, learning outcome, practice change and health outcome) through the use of e-Learning in radiology education?

3. Materials and methods

In this review four databases were searched (1) PubMed Central, (2) MEDLINE, (3) Embase and (4) Eric. The purpose of including Eric – a non-medical database – was to avoid biasness and to get a wide range of evidences that may be present in the non-medical literature. The papers published during January 2003 to December 2013 were included in the review. The objective of the search was to select those studies that reported on the use of e-Learning in radiology education at the undergraduate level. The search strategy used is given below:

("Radiology" [Mesh] OR "Radiography" [Mesh] OR "radiography" [Subheading] OR "Radiology, Interventional" [Mesh] OR "Radiology Information Systems" [Mesh] OR "Radiation Oncology" [Mesh] OR "Nuclear Medicine" [Mesh] OR "Radiology Department, Hospital" [Mesh]) AND ("Education, Medical, Undergraduate" [Mesh] OR "Students, Medical" [Mesh] OR "medical students" OR "medical student" OR undergraduate OR "undergraduate medical education" OR "undergraduate medical") AND ("distributed learning" OR "e-Learning" OR "computer assisted instruction" OR "distance learning" OR "distance education" OR "web based learning" OR "web based training" OR "computer based training" OR "online education" OR "online learning" OR "internet based learning" OR "learning management system" OR "blended learning" OR "mobile learning" OR "computer aided instruction" OR "internet based training" OR "virtual education" OR "multimedia learning" OR "technology enhanced learning").

As the search results show only the MEDLINE indexed articles when using the Mesh terms (as described in the Fact Sheet MEDLINE, PubMed, and PMC (PubMed Central)), therefore, in order to obtain other PubMed related articles we searched it without any mesh terms and obtained 10 unique articles. A standardized selection process of SLR is used in the present study for identifying the relevant evidences. The search yielded a total of 130 papers. This selection process is summarized in Fig. 1.

The search terms for e-Learning are finalized after consulting with senior e-Learning experts while the medical terms were finalized in consultation with experts from medical education.

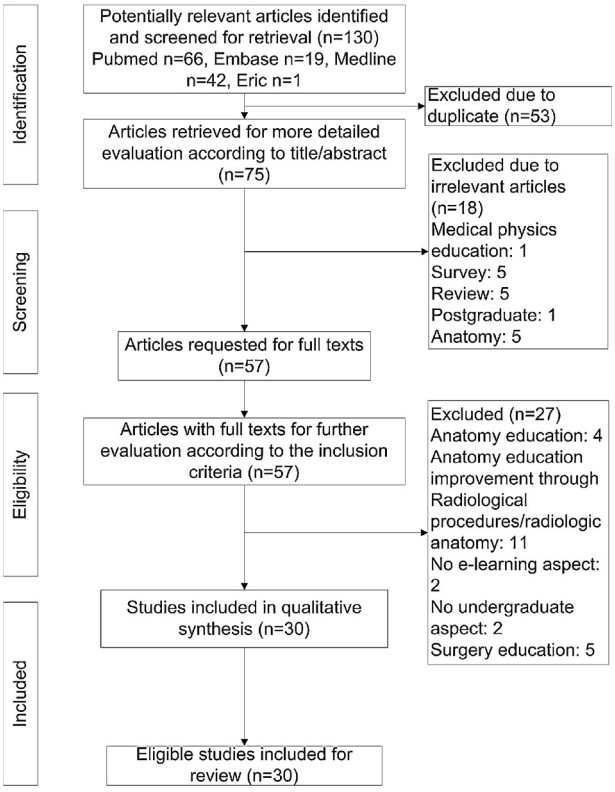

Fig. 1. Selection process of e-Learning in radiology education at undergraduate level.

3.1. Data extraction

The full text of all 30 papers was exported into NVIVO for data extraction and analysis. The extraction fields include: Name of Journals, Year of Publication, Authors Country, Study Location, Study Settings, University Conducting the Study, e-Learning Initiatives, Tools and Technologies, e-Learning Interventions, Radiology Subfields, Medical Student Undergraduate Year, Medical Research Methodologies (Randomized, Cohort, Case Series, Cross Sectional, etc.), and Experimental Designs in medical research.

4. Results

This review is based on the analysis of thirty relevant studies selected in the period between January, 2003 and December, 2013. The detailed selection process is shown in Fig. 1. The selection of evidences is based on standard SLR selection process involving four steps identification, screening, eligibility and including the eligible studies. These studies are retrieved from selected databases using the search string described in previous Section 3. In this study identification yielded a total of 130 papers from four selected databases (PubMed = 66, Embase = 19, MEDLINE = 42, and Eric = 1). The screening involved selection of studies based on title or abstract. Thus, 57 studies were short-listed during screening. In the next step eligibility of papers were evaluated through full-text reading. This resulted in selection of 30 out of total of 57 studies. These are the final studies included for qualitative analysis.

Out of thirty selected evidences, majority of the studies were published in Academic Radiology ($n = 9$) and European Journal of Radiology ($n = 5$). The details of journal distribution are given in the Appendix A Fig. A1. While the year wise distribution is like a saw tooth with rise and fall in the total number of publications in alternative years (see Fig. A2)