The effectiveness of internet-based e-learning on clinician behavior and patient outcomes: a systematic review protocol

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Review question/objective

The objective of this systematic review is to identify, appraise and synthesize the best available evidence for the effectiveness of internet-based e-learning programs on health care professional behavior and patient outcomes.

Background

Technological innovation has not only impacted social change in recent years but has been the prime driver of educational transformation.1 The newest consumers of post-secondary education, the so-called 'digital natives', have come to expect education to be delivered in a way that offers increased usability and convenience.2 Health care professionals (HCPs) in the clinical setting, particularly those in rural and remote communities, are no different.3-5 Today's health workforce has a professional responsibility to maintain competency in practice through achieving a minimum number of hours of continuing professional development.6 Consequently, HCPs seeking professional development opportunities are reliant on sourcing these independently according to individual learning needs.7 However, difficulties exist in some health professionals' access to ongoing professional development opportunities, particularly those with limited access face-to-face education8,9 due to geographical isolation or for those not enrolled in a formal program of study.10,11 These issues challenge traditional methods of teaching delivery; electronic learning (e-learning) is at the nexus of overcoming these challenges.

The term e-learning originated in the mid-1990s as the internet began to gather momentum.1 Electronic learning can be broadly defined as any type of educational media that is delivered in an electronic
form. Terms such as computer-assisted learning, online learning, web-based learning and e-learning are often used synonymously but all reflect knowledge transfer via an electronic device. This broad definition allows for a gamut of multimedia to be used for the purpose of constructing and assessing knowledge. Multimedia typically used in e-learning range from the now archaic Compact Disc Read-Only Memory (CD-ROMs), to the simple Microsoft PowerPoint, or the more advanced and complex virtual worlds such as Second Life. Electronic learning can be delivered in asynchronous or synchronous formats, with the latter (for example interactive online lectures via platforms such as BlackboardCollaborate or WebEx) more commonly used in formal educational settings according to set timetables of study.

Person-to-person interactivity is an important enabler of knowledge generation and while functionalities such as web 1.0 (discussion board and email) and more recently web 2.0 (Wikis and blogs) allow for this to occur both synchronously and asynchronously, it is usually utilized in formal educational contexts only. However, the economy of formal education does not allow for free access to courses which proves challenging for HCPs seeking quality educational opportunities who choose not to undergo a formal program of study or are just looking to meet a specific learning need. Alternatively, asynchronous e-learning is a more learner-centred approach that affords the opportunity to engage in learning at a time and location that is convenient and enables the learner to balance professional development with personal and work commitments. These learning opportunities are self-directed and do not require a human to facilitate learning, rather, technology officiates/facilitates the learning process and, in the asynchronous e-learning context, the learner negotiates meaning independently.

Health-related e-learning research has focused on several domains including media comparative designs, self-efficacy, user satisfaction, instructional design, knowledge outcomes, clinical skills development, and facilitators/barriers to its use. The benefits of e-learning are well documented in terms of increased accessibility to education, efficacy, cost-effectiveness, learner flexibility and interactivity. However, some fundamental methodological and philosophical flaws exist in e-learning research, not least the use of comparative design studies. Comparison between e-learning and traditional teaching methods are illogical and methodologically flawed because comparison groups are heterogeneous, lack uniformity and have multiple confounders that cannot be adjusted for. As early as 1994, researchers in computer-assisted learning were citing these limitations and called for a fresh research agenda in this area. Cook repeated this call in 2005 and again in 2009 and noted a paucity of research related to patient or clinical practice outcomes. Electronic learning is not an educational panacea and research needs to progress from pre- and post-interventional and comparative designs that evaluate knowledge increases and user satisfaction. It is time to move towards determining whether improved self-efficacy or knowledge gained through e-learning improves patient outcomes or influences clinical behavior change and whether these changes are sustained. In order to develop the empirical evidence base in e-learning, research needs to be guided by established theoretical frameworks and use validated instruments to move from assessing knowledge generation towards improving our understanding of whether e-learning improves HCP behavior and more importantly, patient outcomes.

One suitable framework that is congruent with e-learning research is Kirkpatrick’s four levels of evaluation. Kirkpatrick’s model is hierarchically based with level one relating to student reaction and how well the learner is satisfied with the education program. Level two pertains to learning and the
evaluation of knowledge, level three expands on this and considers whether the education has influenced behavior. In the context of this review, behavior change is any practice that is intrinsically linked with the outcomes of the e-learning program undertaken. Finally, level four evaluates the impact on outcomes such as cost benefit or quality improvements. The majority of e-learning research has focused on participant experience and knowledge acquisition, outcomes that correspond with the first two levels of Kirkpatrick’s model. To date, few studies have examined the effectiveness of internet-based e-learning programs on HCP behavior, which aligns with Level 3 of Kirkpatrick’s model.

Studies exist that use self-reported measures of intention to change behavior, however self-reported intention to change does not necessarily translate into actual behavior change. Studies that have not used self-reported measures of behavior change have used objectively measured evaluation criteria including objective structured assessment of technical skills (OSATS) using various methods including simulation task trainers and clinical simulations using standardized patients scored by a panel of experts using standardized assessment tools. Carney et al. used a national reporting and data system to measure the impact of a single one hour e-learning program undertaken by radiologists (n=31) aimed at reducing unnecessary recall during mammography screening. Carney et al. reported a null effect and attributed this to the complexities of behavior change, suggesting that longer term reinforcement of principles relating to mammography recall was required to effect behavior change. These findings also suggest that a multi-modal intervention may be required in order to reduce excessive recall rates in this area, rather than a single intervention. Contrary to Carney et al., Pape-Koehler et al. and Smeekins et al. reported positive findings using randomized controlled designs to test the efficacy of e-learning interventions on individual’s surgical performance and the detection of child abuse, respectively. Pape-Koehler et al. used a 2x2 factorial design to demonstrate that an e-learning intervention significantly improved novice surgeon (n=70) surgical performance of a laparoscopic cholecystectomy (change between pre-post test OSATS p=0.001) when used in isolation or in combination with a practical training session compared to practical training alone. Smeekins et al. demonstrated that a 2 hour e-learning program improved nurses’ (n=25) ability to detect child abuse in an emergency department. The nurses in the intervention (n=13) group demonstrated significantly better (p=0.022) questioning techniques and consequently, higher quality history taking, to determine children at risk of child abuse when compared with the control group who received no training at all.

These three exemplar studies demonstrate the broad range of applications e-learning has in HCP education, as each study used different designs, had different subject areas and target health care professionals. This reflects the conceptual and practical challenges of the area of research that addresses levels three of Kirkpatrick’s model. For this reason, the e-learning research agenda in health should focus on whether knowledge generated through e-learning is able to be re-contextualized into clinical practice, and influence sustained clinical behavior change and patient outcomes.

A preliminary search of PubMed, CINAHL, The Cochrane Library, The JBI Database of Systematic Reviews and Implementation Reports, ERIC and PROSPERO was conducted to determine if a systematic review on the topic of interest already existed. This search identified four systematic reviews that specifically reviewed outcome measures of knowledge and skill improvement in the domain of e-learning. Two examined research conducted in nursing, with the other two in orthodontics. Lahti et al. systematic review examined the impact of e-learning on nurses’ and nursing students’ knowledge, skills and satisfaction. Lahti et al. were unable to demonstrate a statistical difference
between cohorts undertaking e-learning compared to conventional teaching methods, findings that were not replicated by Du et al.\textsuperscript{45} This may be due to the decision by Lahti et al. to include studies that utilized CR-ROM and that, despite being published in 2014, the actual review took place in 2010 and did not capture several significant studies published after this date. The systematic review by Du et al.\textsuperscript{45} examined the efficacy of online distance education in terms of knowledge acquisition and retention, and skill performance in employed nurses and nursing students. This review identified nine randomized controlled trials (RCTs) of which five studies considered skill performance. Four of these studies demonstrated superior or equivalent improvement in skills compared to control groups. Similar findings were noted in two other systematic reviews conducted by Al-Jewair et al.\textsuperscript{46,47} who concluded that computer-aided learning was at least as efficacious as conventional teaching methods in improving knowledge in undergraduate and postgraduate orthodontic students and educators.

These reviews included blended and fully online studies of varying instructional design quality. Seven out of the nine studies identified by Du et al. utilized interactive elements to facilitate communication between students and teachers which would confound the results of the review given that interactivity in this manner is known to improve the user experience and knowledge outcomes.\textsuperscript{48} To date, there are no database-indexed systematic reviews that identify, appraise and synthesize the best available evidence for the effectiveness of internet-based e-learning programs on HCP behavior and patient outcomes using objectively administered evaluation criteria.

Keywords
E-learning; clinician behavior; patient outcomes

Inclusion criteria

Types of participants
This review will consider studies whose participants were HCPs in any health care context.

For the purpose of this review, a HCP will be any individual who requires a degree qualification to practice in their respective field

Types of intervention(s)
This review will consider studies that evaluated an internet-based e-learning program.

For the purposes of this review internet-based e-learning programs are defined as any asynchronous educational intervention that is mediated electronically via the internet.

Types of outcomes
This review will consider studies that include the following outcome measures:

- Impact on clinician behavior measured using objectively administered evaluation criteria
- Impact on patient outcomes measured using objectively administered evaluation criteria

For the purposes of this review, impact on clinician behavior is defined as the degree to which the intervention influenced their ability to perform the skill for which the intervention was designed. For the purposes of this review, impact on patient outcomes is defined as the degree to which patients’ health care outcomes were affected (either positively or negatively) as a result of the intervention.
Types of studies

This review will consider any RCTs and quasi-RCTs. In the absence of RCTs and quasi-RCTs, other research designs such as non-randomized before and after studies and analytical and descriptive observational studies will be considered.

Search strategy

The search strategy aims to find both published and unpublished studies using a variety of databases. A three-step search strategy will be utilized in this review. An initial limited search of MEDLINE and CINAHL will be undertaken followed by analysis of the text words contained in the title and abstract, and of the index terms used to describe article. A second search using all identified keywords and index terms will then be undertaken across all included databases. Thirdly, the reference lists of all identified reports and articles will then be searched for additional studies. Studies in English published from 2004 to August, 2014 will be considered for inclusion in this review. This time frame was selected on the basis that recent systematic reviews in the domain of e-learning (Du et al.45 and Lahti et al.38) identified suitable papers from the year 2004 onwards.

The databases to be searched include:

• CINAHL
• Cochrane - CENTRAL
• Embase
• ERIC
• MEDLINE
• Mosby’s Index
• Scopus

Grey literature

A search for unpublished studies using Google Scholar, Mednar and Proquest will be undertaken to locate any relevant policies, government reports, dissertations, theses and conference proceedings.

Initial Search Terms

The following search terms will be used:

• Internet-based learning, computer based learning, computer assisted learning, web based learning, online learning, e-learning, distance education, internet, educational technology, information communication and technology
• Clinical assessment, psychomotor skill, behavior
• Patient outcomes
• Quantitative
• Healthcare professional
Assessment of methodological quality

Papers selected for retrieval will be assessed by two independent reviewers for methodological validity prior to inclusion in the review using standardized critical appraisal instruments from the Joanna Briggs Institute Meta-Analysis of Statistics Assessment and Review Instrument (JBI-MAStARI) (Appendix I). Any disagreements that arise between the reviewers will be resolved through discussion, or with a third reviewer.

Data collection

Two reviewers will extract data independently from papers included in the review using the standardized data extraction tool from JBI-MAStARI (Appendix II). The data extracted will include specific details about the interventions, populations, study methods and outcomes of significance to the review question and specific objectives.

Data synthesis

Quantitative data will, where possible be pooled in statistical meta-analysis using JBI-MAStARI. All results will be subject to double data entry. Effect sizes expressed as odds ratio (for categorical data) and weighted mean differences (for continuous data) and their 95% confidence intervals will be calculated for analysis. Heterogeneity will be assessed statistically using the standard Chi-square and also explored using subgroup analyses based on the different quantitative study designs included in this review. Where statistical pooling is not possible the findings will be presented in narrative form including tables and figures to aid in data presentation where appropriate. These results will be combined to arrive at a conclusion from the research

Conflicts of interest

The authors declare no conflicts of interest exist.

Acknowledgements

This systematic review is being conducted as part of Peter Sinclair’s PhD.
References


34. Friedman CP. The research we should be doing. Acad Med. 1994;69(6):455-7.
Appendix I: Appraisal instruments

MAStARI appraisal instrument

### JBI Critical Appraisal Checklist for Randomised Control / Pseudo-randomised Trial

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<th>Question</th>
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Overall appraisal: Include □ Exclude □ Seek further info. □

Comments (Including reason for exclusion)

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### JBI Critical Appraisal Checklist for Descriptive / Case Series

**Reviewer**  
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**Overall appraisal:**  
**Include**  
**Exclude**  
**Seek further info**

**Comments (Including reason for exclusion)**

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Appendix II: Data extraction instruments

MAStARI data extraction instrument

**JBI Data Extraction Form for Experimental / Observational Studies**

Reviewer: __________________ Date: __________________

Author: __________________ Year: __________________

Journal: __________________ Record Number: ____________

**Study Method**

- RCT
- Quasi-RCT
- Longitudinal
- Retrospective
- Observational
- Other

**Participants**

Setting

Population

**Sample size**

Group A: ________________ Group B: ________________

**Interventions**

Intervention A

Intervention B

Authors’ Conclusions:

Reviewers’ Conclusions:
Study results

### Dichotomous data

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