



Article

A Randomised Controlled Trial Comparing the Effect of E-learning, with a Taught Workshop, on the Knowledge and Search Skills of Health Professionals

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Abstract

Objective - The aim of the trial was to establish whether there is a significant difference in terms of knowledge and skills, between self-directed learning using a web-based resource, compared with a classroom based interactive workshop, for teaching health professionals how to search. The outcomes measured were knowledge of databases and study designs, and search skills.

Methods - The study design was a randomised controlled trial (RCT). 17 health professionals were randomised into one of two groups – one group (EG) received access to a search-skills web resource, and the other group received a search workshop (WG) taught by a librarian. Participants completed pre- and post-intervention tests involving multiple choice questions and practical searching using clinical scenarios.

Results - 9 WG and 6 EG participants completed both pre-and post-intervention tests. The test results were blindly marked using a score chart developed with two other librarians. For question formulation and devising a search strategy, all participants obtained a score that was the same or better after receiving the intervention (both WG and EG), but statistical analysis showed that the only significant outcomes were for the WG devising a search strategy ($p=0.01$) and preferring to search using MeSH after receiving the taught workshop ($p=0.02$). The Mann-Whitney test showed there were no significant differences in any of the

outcomes ($p>0.05$), between the WG and the EG. The statistical analyses must be viewed with caution due to the small sample size.

Conclusion - There were no significant differences in knowledge of databases and study design, or search skills, when the WG and the EG were compared. Although many participants obtained a score that was higher post-intervention, only devising a search strategy and preferring to search using MeSH were statistically significant for the WG. The question of whether a taught workshop and an e-learning module are of equal effectiveness in teaching search skills, is an important one for health librarians involved in user education, and was a justifiable topic to propose and conduct research. The fact that the results are mainly inconclusive due to the small sample size is disappointing, but does not diminish the importance of conducting the study.

Background

Searching for evidence is an essential skill for any health professional wishing to apply evidence to practice. Training health professionals to search databases is thought to improve their skills and knowledge, but evidence of this in the literature is not extensive. A systematic review in early 2003 found that there is some evidence of a positive impact of search skills training for health professionals (Garg and Turtle 33-41); however, the studies included were small or methodologically poor.

A randomised trial published after this review found that a 3 hour educational workshop was more effective than no training in improving question formulation and use of databases by doctors (Cheng 22-33). More recently, a study measuring the effect of an evidence-based practice workshop on the knowledge, skills, behaviour and attitudes of occupational therapists (published in Dec 2005 after completion of this trial), also found improvements in knowledge of, attitudes to, and confidence with searching and appraisal (McCluskey and Lovarini). Health librarians regularly teach directional search workshops, but do not know whether these social cognitive learning methods are more effective than other educational methods. Self-directed online, or e-learning,

is becoming more widespread, but there is little evidence to show whether this is an effective training method. Indeed, very few studies were found examining the use of e-learning as a method of teaching health professionals in any subject areas. A review of e-learning in continuing medical education found that 6 out of 16 studies involving internet-based education of health professionals showed a positive change in participant knowledge when compared with traditional teaching formats; the remaining studies showed no difference in levels of knowledge (Wutoh, Boren, and Balas 20-30). In 2005, a qualitative study looking at a randomised trial comparing directed learning and self-directed learning, found no statistically significant differences between the two groups in terms of evidence-based knowledge, skills, and attitudes of medical students (Bradley et al. 149-77).

As the literature on this subject is not extensive, the author designed and conducted a research study between Sept 2004 and Sept 2005. A research proposal was developed and a grant received from the HeLicon Research in the Workplace Award 2003/04 (<http://www.ifmh.org.uk/RIWA2003-4.html>). This paper presents the methods and results of a RCT comparing two different educational interventions for

teaching search skills to health professionals.

Objectives

The aim of the trial was to establish whether there is a significant difference in terms of knowledge and skills, between self-directed learning using a web-based resource directed by participants, compared with a classroom based interactive workshop directed by a librarian, for teaching health professionals how to search.

A common method of proceeding is to test a hypothesis, often called the null hypothesis. The null hypothesis is that there is no difference between the two interventions being compared (i below). It was also relevant to have a second null hypothesis – that there would be no difference before and after either educational intervention (ii below)

i) there will be no difference between those health professionals receiving an online learning intervention using a web-based resource, and those receiving a classroom based workshop intervention, in terms of knowledge of databases and study designs, and the skills of formulating a question, designing a search strategy and selecting appropriate citations

ii) there will be no difference in terms of a health professionals' knowledge of databases and study designs, and the skills of formulating a question, designing a search strategy and selecting appropriate citations, before and after an educational intervention

Testing these hypotheses involves a comparison of the effectiveness of two different interventions, so a RCT was chosen as the most appropriate study design. The outcomes measured were knowledge of databases and study designs, and search skills. Ethical approval was obtained from the relevant research ethics committee.

Methods

The study population was a convenience sample – health professionals working for the Oxfordshire Radcliffe Hospitals NHS Trust (ORHT). Recruitment was by invitation letter, sent by post to departments and/or by email. Contact details were obtained from the Trust intranet and the email lists provided by Trust librarians. Posters and leaflets about the trial were displayed in the hospital.

Recruitment was self-selecting – participants registered for the trial after responding to an email, letter or poster. These participants may have had more interest in the topic of search skills than your average health professional – this could be because they have no searching skills and wish to learn, or because they have attended similar sessions before and are more experienced searchers.

Inclusion criteria were very broad – participants must work within the ORHT, and have access to the Internet either at work or home.

The trial

On arrival all participants completed a “search exercise” using a computer. The search exercise had two sections – the first contained multiple choice questions (MCQs) and was designed to test knowledge about databases and study designs. The second section involved a practical search using PubMed (www.pubmed.gov) to test participants' skills at structuring a search on a given scenario (see *Appendix 1*). Participants were randomly assigned to one of two groups, using computer generated random numbers.

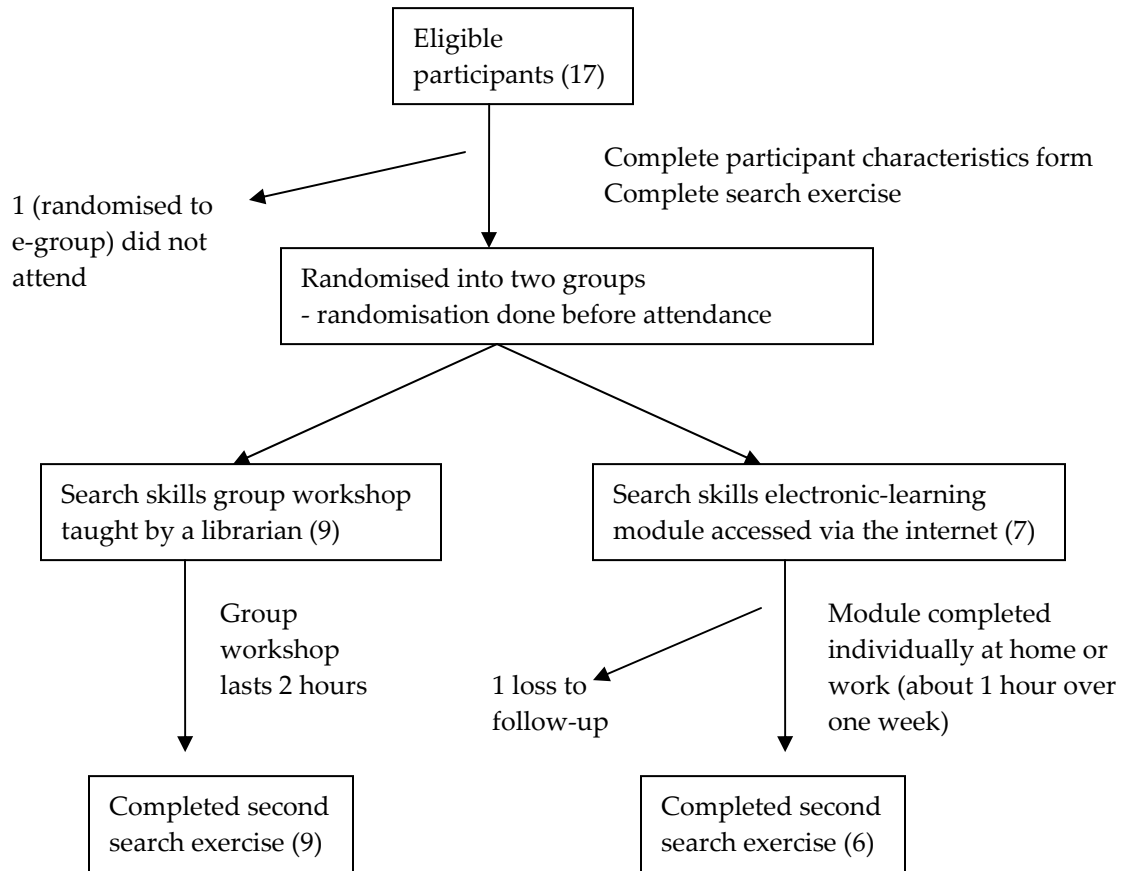


Figure 1: Flow Chart Showing Trial Stages and Numbers of Participants

Those participants allocated to the workshop group (WG) then attended a 2 hour search skills workshop taught by a librarian (the author did not teach the workshop session in order to prevent any possible bias). Those participants allocated to the e-learning group (EG) were shown how to access the online learning module by the author, and asked to complete as much of the module as they could, in one week. One week later, participants were sent (via post and/or email) the second “search exercise” containing a different scenario, and asked to complete and return.

In order to minimise the possibility that one scenario was easier to search for than the other, the order in which participants completed the search exercises was assigned

randomly, again by computer generated random numbers.

Interventions in more detail

The online learning resource was designed by the author. It was made available on the web, but was password protected so that only EG participants could access it. The content included question formulation, study design, free text, thesaurus and Boolean searching, and examples of searching PubMed and the Cochrane Library.

Before the trial, the online learning module was piloted on a general practitioner and a nurse. They were asked to comment on the usability, the time taken to complete the



Figure 2: Screen Picture Showing the Online Learning Module

module, and the content covered. These suggestions were then incorporated into the module ready for use in the trial.

The WG was taught by an experienced librarian, who used methods such as presentations, live internet demonstrations and interactive group work. The workshop was carefully planned by the librarian and

author to deliver content on exactly the same topics covered by the online learning resource. Teaching examples were also the same as those contained in the online learning module. Participants were able to practice their own searches during the session, with help and advice from the librarian.

		WG (n=9)	EG (n=6)
Gender:	Female	6	4
	Male	3	2
Age (years):	21 - 30	0	4
	31 - 40	1	2
	41 - 50	6	0
	51 - 60	2	0
Job:	Doctor	3	3
	Nurse	4	2
	Allied Health	0	1
	Manager	2	0
Attended previous search session?	Yes in last 3 months	1	1
	Yes > 1 year ago	2	1
	No	6	4

Table 1: Baseline Participant Characteristics

Results

Despite the randomisation procedure, the ages of participants in the two groups differed – those in the online learning group were a lot younger than those in the workshop group. Stratified randomisation could have been used to help keep the characteristics of participants (e.g. age) the same across both groups, but this was not undertaken – stratified randomisation is quite complicated and requires certainty about which participant characteristics might influence the intervention outcome (Roberts and Torgerson 1301).

Marking of the search exercises

The author was 'blind' as to which search exercises had been completed by a particular person or to which group they had been allocated. There was no indication on the search exercises as to which had been completed before or after the interventions, to reduce any inadvertent bias. Existing scenarios/score charts for testing search skills were available, but at the time of planning, no one tool appeared to fit the study requirements exactly (Vogel, Block, and Wallingford 327-30; Rosenberg et al. 557-63; Burrows and Tylman 471-76; Bradley et al. 194-201; Dorsch, Aiyer, and Meyer 397-406).

The author collaborated with two other librarians to develop a 'gold standard' for formulating a question from a scenario, developing a search strategy and selecting appropriate citations. This information was used in conjunction with the tools in the literature to develop a score chart (*see Appendix 2*); the exercises were graded in each of the categories above according to a scale Excellent, Good, Fair, Poor. Each exercise received a grading for question formulation, search strategy and citation selection, plus a mark for the number of correct Multiple Choice Questions (*see Tables 2-7*). A random selection of the search

exercises were marked by another librarian in order to validate the marking; no differences in scores were observed.

Summary of scores

Question formulation

- All participants received a score that was the same or better after receiving the intervention (both WG and EG)

Search strategy

- All participants received a score that was the same or better after receiving the interventions (both WG and EG)
- The majority of WG increased their score by at least 1 after receiving the intervention
- Most of the EG scores were the same before and after receiving the intervention

Citation selection

- The majority of participants received a score that was the same or better after receiving the intervention (both WG and EG)
- 1 participant in each group received a worse score after receiving the intervention

Statistical analysis

Analysis was carried out using a statistical software package. The Mann-Whitney test (a nonparametric method testing the significance of the difference between the distributions of two independent samples) showed there were no significant differences in any of the outcomes ($p > 0.05$), between the WG and the EG. Thus, the null hypothesis is accepted, although due to the small numbers of participants in this trial, the statistical analyses have limited value.

Workshop Wilcoxon test ns/r <5

E-group

Wilcoxon test ns/r <5

Participant No.	Before	After	Difference	Participant No.	Before	After	Difference
001	3	3	0	003	4	4	0
002	3	3	0	004	3	4	1
005	4	4	0	006	3	4	1
007	3	4	1	010	4	4	0
008	2	3	1	014	3	4	1
009	4	4	0	015	3	4	1
011	3	4	1				
012	4	4	0				
013	4	4	0				

Mann-Whitney test z = -1, p = 0.32

Table 2: Question Formulation (Excellent = 4 Good = 3 Fair = 2 Poor = 1)

Workshop Wilcoxon test W= -36, ns/r = 8, p=0.01

E-group

Wilcoxon test ns/r <5

Participant No.	Before	After	Difference	Participant No.	Before	After	Difference
001	2	3	1	003	2	3	1
002	1	3	2	004	2	4	2
005	2	2	0	006	2	2	0
007	1	3	2	010	2	2	0
008	2	3	1	014	2	2	0
009	1	2	1	015	2	2	0
011	1	3	2				
012	1	2	1				
013	2	4	2				

Mann-Whitney test z = 1.71, p = 0.09

Table 3: Search Strategy (Excellent = 4 Good = 3 Fair = 2 Poor = 1)

Workshop Wilcoxon test $W = -11$, $ns/r = 5$, $p > 0.05$

E-group Wilcoxon test $W = -8$, $ns/r = 5$, $p > 0.05$

Participant No.	Before	After	Difference	Participant No.	Before	After	Difference
001	3	4	1	003	3	4	1
002	2	2	0	004	1	3	2
005	3	3	0	006	4	4	0
007	3	4	1	010	4	2	-2
008	3	3	0	014	1	4	3
009	3	3	0	015	1	2	1
011	1	4	3				
012	1	4	3				
013	4	3	-1				

Mann-Whitney test $z = -0.29$, $p = 0.77$

Table 4: Citation Selection (Excellent = 4 Good = 3 Fair = 2 Poor = 1)

Workshop Paired t-test $t = 2.29$, $df = 8$, $p = 0.05$

E-group Paired t-test $t = -2.08$, $df = 5$, $p = 0.09$

Participant No.	Mark Before	Mark After	Difference	Participant No.	Mark Before	Mark After	Difference
001	2	2	0	003	1	4	3
002	3	1	-2	004	3	3	0
005	2	3	1	006	1	2	1
007	2	3	1	010	1	5	4
008	1	3	2	014	0	3	3
009	2	4	2	015	2	1	-1
011	0	3	3				
012	0	2	2				
013	4	5	1				

T-test for independent samples $t = -0.06$, $df = 13$, $p = 0.95$

Table 5: Multiple Choice Correct Answers (maximum 6)

Workshop

E-group

Participant No.	Study limits before?	Study limits after?	Participant No.	Study limits before?	Study limits after?
001	No	No	003	No	No
002	No	No	004	Yes	Yes
005	No	No	006	No	Yes
007	No	Yes	010	No	No
008	Yes	Yes	014	No	No
009	No	No	015	No	Yes
011	No	Yes			
012	No	Yes			
013	Yes	Yes			

Table 6: Did the Participant use Appropriate Study Design Limits? (Yes or No)

Workshop Wilcoxon test $W = -28$, $ns/r = 7$, $p = 0.02$

E-group Wilcoxon test $ns/r < 5$

Participant No	prefer MeSH (before)	prefer MeSH (after)	Difference	Participant No	prefer MeSH (before)	prefer MeSH (after)	Difference
001	2	3	1	003	2	1	-1
002	1	3	2	004	2	3	1
005	1	3	2	006	3	3	0
007	1	3	2	010	1	3	2
008	1	3	2	014	1	3	2
009	1	2	1	015	1	1	0
011	2	2	0				
012	2	3	1				
013	3	3	0				

Mann-Whitney test $z = 0.82$, $p = 0.41$

Table 7: Searching Preference - when I search Medline, I prefer to use MeSH (thesaurus) rather than keywords (Yes = 3 Neutral = 2 No = 1)

This shows that the WG and the EG performed equally as well for all outcomes in question. However, were these interventions effective, or were the groups performing equally as *badly* as each other? To test if either of these educational interventions were actually effective in teaching health professionals to search, the before/after results were analysed using the Wilcoxon Signed-Ranks test (a nonparametric test for the significance of the difference between the distributions of two non-independent samples involving matched pairs).

For devising a search strategy, the WG performed significantly better ($p=0.01$) after receiving the librarian-taught workshop. This group also preferred to search using MeSH after receiving the workshop ($p=0.02$). There was no significant difference in citation selection or knowledge of databases and study designs before and after receiving either intervention. The null hypothesis is therefore accepted, except for the outcome of devising a search strategy, where the WG performed significantly better after the intervention. Again, these statistical analyses only have limited value owing to the small sample size.

Discussion

The results show that knowledge and skills were increased in most outcomes, but not significantly. Perhaps a single workshop or a brief e-learning module is not long enough to learn how to search effectively; learning search skills may take time to sink in, and should be practiced regularly to have an effect – the follow up time of a week may have been too short for participants to have digested and used their knowledge and skills effectively. Evidence-based skills have been shown to improve and to be retained in a clinically integrated situation (Bradley et al. 194-201; Coomarasamy and Khan 1017), so setting the study in an academic/learning situation may lead to less knowledge and skill retention.

This study had some limitations. Recruitment was by self-selection, but participants were being measured against their own baseline skill level

(however good or poor that was) in a before/after study, so this should not have influenced the results unduly. Two participants dropped out of the online learning group – the first did not turn up and later phoned to say they had a clinical emergency (randomisation was done before the participants arrived, so they did not know they had been allocated to the elearning group). The second drop-out did not complete the second search exercise, even after repeated contacting, citing that they were too busy (it was not clear if they were too busy to use the online learning module at all, or just too busy to complete the exercise afterwards).

Clinical staff proved difficult to recruit to the research study resulting in a small sample size which limits the results. Health professionals may have been encouraged to participate by offering incentives such as prizes (book tokens, wine etc), but funding for this in a small study is problematic. Recruitment difficulties may be one reason why a large number of studies comparing the effectiveness of search skills interventions for healthcare professionals are not available. Using medical students is much easier and large established groups are available for use in research studies. However the information needs, skills and knowledge of medical students and health professionals are different, and must be examined separately.

Issues such as the difficulty of obtaining up-to-date contact lists for staff (various staff lists were considerably out of date), plus the perceived importance of the outcomes by the health professional can affect the recruitment (Rahman et al. 38-40; Traynor et al. 790-95; Veitch et al. 399-406). Consequently, the group of people of particular interest to health librarians is actually one of the most difficult to study. Recruitment numbers for this study were very low leading to frustration when time has been spent developing the methodology for a trial. Only 17 participants registered and were deemed eligible for inclusion. The reasons for low recruitment in this trial were specifically:

- many staff names and contact details were incorrect, out-of-date or unavailable
- email addresses of hospital staff were not readily available
- clinical staff reported that they found it difficult to obtain permission to attend non-mandatory training
- some staff did not have the time or interest to participate in a trial
- the ethical approval process reduced time available to recruit participants
- training rooms were not always available on the hospital sites

It is significant that learning how to search and use good quality health information, in order to assist and improve patient care, is not considered mandatory! Published studies with small sample sizes can be easily criticised due to their lack of statistical power, but the reasons why recruitment is so difficult became apparent during this trial.

As this was an educational trial recruiting only health professionals, with no obvious risks associated, ethical approval was expected to be easy to obtain. However, due to recent changes in the ethical application process in the UK, all health related research requires the completion of a long (68 page) form (<http://www.corec.org.uk/>), and the provision of additional documentation including a protocol and peer review of the proposal. To a novice researcher some sections seemed irrelevant or were difficult to complete as the form did not differentiate between a multi-million pound drug trial involving patients and an international team of investigators, and a local educational trial involving health professionals. Further management approval (research governance) was also required from the hospital where the research took place, involving completion of additional forms and letters. Obtaining ethical approval therefore took almost 4 months and delayed recruitment for the trial.

Articles published in the British Medical Journal suggest this is not an isolated experience (Mayor 1258-5f;Wald 282-84;Jamrozik 286-87;Bentley and Enderby 361;Elwyn et al. 847); clinical researchers

have reported that the ethical committee application procedure can impede, delay or distort their research, or prevent them from starting altogether. One editorial from a Director for Public Health states:

"...bureaucratic barriers, such as the length and complexity of the COREC forms and the dual hoops of research ethics and governance, are putting off those considering starting smaller locally based studies." (Bentley and Enderby 361)

The research question and multiple outcomes may have been a bit too ambitious for a small research study, and concentrating solely on development of a search strategy might have been easier. Future research questions could be limited to the effectiveness of interventions for search strategy development.

To a novice researcher, and a practicing librarian, a number of issues became apparent during the course of the study. This led to the development of a list of tips (box 1) that researchers may want to consider when planning a research study.

Conclusion

This paper has presented the methods and results of a randomized trial seeking to compare two interventions for teaching search skills to health professionals. For question formulation and devising a search strategy, all participants received a score that was the same or better after receiving the intervention (both WG and EG). However, statistical analysis showed that the only significant outcomes were for the WG devising a search strategy and preferring to search using MeSH after receiving the workshop intervention. There were no significant differences in any of the outcomes when the WG and the EG were compared.

The question of whether a taught workshop and an e-learning module are of equal effectiveness in teaching search skills, is an important one for health librarians involved in user education, and

- conduct a thorough literature search; your question may already have been answered
- read books on research methods to try and get an overview of the subject
- apply for ethical and management approval as soon as the study is initiated, and try to obtain help in completing it; this will reduce delays in the process
- the population that practitioners' would like to study are often the most difficult to engage or recruit; this does not mean they should be ignored
- recruitment of staff, especially clinical staff, may be difficult, but start the recruitment process early, use different contact methods and make the inclusion criteria as wide as possible
- collaborate with other librarians or researchers where possible; conducting a research study individually while also maintaining a full-time job is very time consuming
- don't feel inadequate when things go wrong; often you have no control over them
- don't give up; without research into the issues that matter, evidence-based librarianship would not be possible

Box 1: Tips for Planning Research

was a justifiable topic to propose and conduct research. The fact that the results are mainly inconclusive due to the small sample size is disappointing, but does not diminish the importance of conducting the study.

By discussing the main issues and problems experienced during this study, it is hoped other practitioners' intending to undertake research will have a clearer picture of the processes involved, be able to learn from any mistakes made in this study, and have a realistic idea of the problems that may be encountered, some of which may be insoluble. Additionally, it is hoped other researchers' will build on the methodology used in this study to conduct further research into the effectiveness of interventions for teaching search skills to health professionals.

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