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# **B** Evidence Based Library and Information Practice

# Research Article

# A Systematic Review of Information Literacy Programs in Higher Education: Effects of Faceto-Face, Online, and Blended Formats on Student Skills and Views

Alison L. Weightman Director, Specialist Unit for Review Evidence (SURE) University Library Service Cardiff University Cardiff, United Kingdom Email: <u>WeightmanAL@cardiff.ac.uk</u>

Damian J. J. Farnell Lecturer in Medical Statistics School of Dentistry Cardiff University Cardiff, United Kingdom Email: FarnellD@cardiff.ac.uk

Delyth Morris Subject Librarian University Library Service Cardiff University Cardiff, United Kingdom Email: <u>MorrisD13@cardiff.ac.uk</u>

Heather Strange Research Associate SE Wales Trials Unit Cardiff University, United Kingdom Email: <u>StrangeHR1@cardiff.ac.uk</u>

Gillian Hallam Information Literacy Project Manager University of Queensland Brisbane, Australia Email: <u>g.hallam@library.uq.edu.au</u>

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### Abstract

**Objective** – Evidence from systematic reviews a decade ago suggested that face-to-face and online methods to provide information literacy training in universities were equally effective in terms of skills learnt, but there was a lack of robust comparative research. The objectives of this review were (1) to update these findings with the inclusion of more recent primary research; (2) to further enhance the summary of existing evidence by including studies of blended formats (with components of both online and face-to-face teaching) compared to single format education; and (3) to explore student views on the various formats employed.

**Methods** – Authors searched seven databases along with a range of supplementary search methods to identify comparative research studies, dated January 1995 to October 2016, exploring skill outcomes for students enrolled in higher education programs. There were 33 studies included, of which 19 also contained comparative data on student views. Where feasible, meta-analyses were carried out to provide summary estimates of skills development and a thematic analysis was completed to identify student views across the different formats.

**Results** – A large majority of studies (27 of 33; 82%) found no statistically significant difference between formats in skills outcomes for students. Of 13 studies that could be included in a metaanalysis, the standardized mean difference (SMD) between skill test results for face-to-face versus online formats was -0.01 (95% confidence interval -0.28 to 0.26). Of ten studies comparing blended to single delivery format, seven (70%) found no statistically significant difference between formats, and the remaining studies had mixed outcomes. From the limited evidence available across all studies, there is a potential dichotomy between outcomes measured via skill test and assignment (course work) which is worthy of further investigation. The thematic analysis of student views found no preference in relation to format on a range of measures in 14 of 19 studies (74%). The remainder identified that students perceived advantages and disadvantages for each format but had no overall preference.

**Conclusions** – There is compelling evidence that information literacy training is effective and well received across a range of delivery formats. Further research looking at blended versus single format methods, and the time implications for each, as well as comparing assignment to skill test outcomes would be valuable. Future studies should adopt a methodologically robust design (such as the randomized controlled trial) with a large student population and validated outcome measures.

### Introduction

The provision of information literacy (IL) education for students is an established and

valued role within university libraries. There are many definitions of IL but this can be broadly described as, "knowing when and why you need information, where to find it, and how to evaluate, use and communicate it in an ethical manner" (CILIP, 2017). IL training has been shown to result in an increase in student skills and understanding compared to no instruction (Koufogiannakis & Wiebe, 2006; Weightman, Farnell, Morris & Strange, 2015).

Around a decade ago, two systematic reviews of IL interventions in higher education looked at the *specific* question of online versus face-to-face instruction in academic libraries (Koufogiannakis & Wiebe, 2006; Zhang, Watson & Banfield, 2007). Both reviews concluded that online provision was as effective as face-to-face training in terms of skills learned but noted the lack of robust comparative studies.

Since the reviews were published, further studies of 'taught' student IL provision comparing traditional versus online delivery have been completed, including studies looking at blended (with components of both online and face-to-face teaching) compared to single format delivery. There are suggestions from the library setting of theoretical benefits to a blended approach (such as the 'flipped classroom' where students study online in advance of the face to face session), particularly for the more technical and practical skills involved in information literacy (Arnold-Garza, 2014). The potential benefits of blended teaching include the effective use of class time, more active learning, allowance of individual learning styles, and speed (Arnold-Garza 2014). Such techniques are increasingly being used across academic settings, suggesting that these will become the 'new traditional model[s]' (Brown, 2016).

A recent meta-analysis of 45 studies of online and face-to-face learning across the education and subject spectrum, from secondary to higher education, concluded that students in online learning conditions performed modestly better than those receiving face-to-face instruction. However, this analysis indicated a significant difference only for the blended versus face-toface and not the online versus face-to-face conditions (Means, Toyama, Murphy & Baki, 2013). The authors noted that blended formats tended to involve additional learning time and resources which could explain the findings. A further systematic review and meta-analysis of 44 studies exploring knowledge acquisition in health education (Liu et al., 2016) concluded that blended learning was more effective, or at least as effective, as single format learning but that the result should be treated with caution given the huge variation between studies.

We could not identify any review level evidence from the IL literature on blended versus other learning formats with similar curricula/contact times and 'hard' outcomes such as skills acquisition. Neither was there a systematic summary of student views on the different formats.

Thus, the aims of this research study were to carry out an up-to-date systematic review of research into IL programs in higher education to:

- (i) confirm or refute the findings of the earlier reviews in terms of the relative effectiveness of traditional (face-to-face) and online (web or computer based) educational provision by the inclusion of more recent studies;
- (ii) expand the scope of the review to include comparative studies of blended versus single format delivery; and
- (iii) systematically explore the views of research participants from each study on their perceptions of the differing formats.

### Methods

We undertook a systematic review of controlled studies to summarize the findings of comparative research studies using both quantitative and qualitative methods. We extracted data on student skills as assessed after exposure to each delivery format and completed a thematic analysis of student views identified within the research.

Studies were identified via a comprehensive search for published and unpublished papers comparing face-to-face and online information literacy programs using database searching and supplementary search methods.

### Search strategy

We searched seven relevant databases for formally published research publications or 'grey literature' in higher education or libraries in October 2016: British Education Index; ERIC; Proquest Dissertations and Theses (Index to Theses); Librarians' Information Literacy Annual Conference (LILAC) Abstracts; Library, Information Science & Technology Abstracts (LISTA); LOEX Conference Abstracts; Open Grey; Scopus.

Text words and phrases were identified from the authors' knowledge of the subject area and existing known literature. Text mining for common words and phrases using the free software, *Termine* (National Centre for Text Mining 2012) was also used to identify the most relevant search terms to use in text word searching. This software used the titles and abstracts from a set of 42 papers that explored information literacy education taught to students in universities. A set of search terms and associated subject headings were developed for LISTA (Table 1) and then adapted for each database.

We sought recent studies (from January 1995 onwards) to assure relevance to the modern and higher speed internet architecture, and the widescale adoption of database searching in libraries.

In addition, the extensive use of supplementary search methods increased the sensitivity of the search (i.e., the ability to identify the vast majority of relevant papers). These methods included reference list follow up, unpicking of related systematic reviews for primary research studies, citation tracking (via Scopus and Google Scholar), expert contact and hand searching of the 2016 editions of a number of journals: *College* and Research Libraries; Communications in Information Literacy; Evidence Based Library and Information Practice; Health Information & Libraries Journal; Journal of Academic Librarianship; Journal of Information Literacy; Journal of the Medical Library Association; portal: Libraries & the Academy.

### Inclusion and exclusion criteria

The criteria for selection of studies are provided in Table 2. The training had to be described as information literacy or library skills, with a statement that equivalent content was covered within each format to avoid any potential for bias as a result of differing curricula.

### Study selection

After removing duplicates and clearly irrelevant citations (unrelated to library-based training), study selection at both title/abstract and full-text stages was undertaken independently by two authors. Any disagreements at either stage were resolved by recourse to a third reviewer.

### Quality assessment and data extraction

Two authors independently appraised each included study using criteria specifically developed for educational interventions. We used the Glasgow checklist for educational interventions (Morrison, Sullivan, Murray & Jolly, 1999), adapted to include the questions from the ReLIANT checklist for library based educational interventions (Koufogiannakis, Booth & Brettle, 2005). A quality commentary for each paper was agreed by discussion and these commentaries, along with summary data from each study on skill related outcomes and any student views, were extracted by one author and checked by another. The study detail, including the IL content of each intervention, was summarized in the detailed data extraction

Table 1 Search Terms for LISTA

S1 AND S2 AND S3 (1995-2016)

**S3** TI (Test score OR learning outcome OR effective\* OR student performance OR control group OR randomised OR pretest OR pre-test OR posttest OR post-test OR randomized OR trial OR controlled OR efficacy OR impact OR evaluat\*) OR AB (Test score OR learning outcome OR effective\* OR student performance OR control group OR randomised OR pretest OR pre-test OR post-test OR post-test OR randomized OR trial OR controlled OR efficacy OR impact OR randomized OR trial OR controlled OR efficacy OR impact OR randomized OR trial OR controlled OR efficacy OR impact OR randomized OR trial OR controlled OR efficacy OR impact OR randomized OR trial OR controlled OR efficacy OR impact OR evaluat\*)

**S2** (DE "College Students" OR DE "College Freshmen" OR DE "College Seniors" OR DE "College Transfer Students" OR DE "First Generation College Students" OR DE "Graduate Students" OR DE "In State Students" OR DE "On Campus Students" OR DE "Out of State Students" OR DE "Preservice Teachers" OR DE "Two Year College Students" OR DE "Undergraduate Students" ) OR ( TI ( College student\* OR freshman OR first-year OR undergrad\* OR freshmen OR sophomore\* OR universit\* OR higher education OR academic OR taught postgraduate\*) OR AB ( College student\* OR freshman OR first-year OR undergrad\* OR freshmen OR sophomore\* OR universit\* OR higher education OR academic OR taught postgraduate\*) )

**S1** DE Information Literacy OR TI ( (Information litera\* OR library instruct\* OR library skill\* OR acrl il standard OR information competen\* OR bibliographic instruct\* OR library research OR il concept OR instruction librarian) OR ((Research skill\* OR electronic information or information retrieval or ebm skill OR electronic resource\* OR instructional method OR user train\* OR user education OR literacy instruct\* OR hands-on instruction OR research strateg\* OR evidence-based OR print workbook OR instructional format OR social medi\* learning OR online tutor\*) AND librar\*)

AB: Word(s) in the abstract; DE: Descriptor (assigned by indexer); S: Set of terms; TI: Word(s) in the title; \*= truncation term.

table (Appendix 1) with summary data provided in Table 3.

# Data synthesis

We carried out a synthesis of the findings across the body of evidence on skills outcomes and student views.

We combined the study findings for skills outcomes by meta-analysis when studies provided means, sample sizes, and standard deviations for the outcomes. Meta-analysis forms a pooled result based on all studies by finding an average of the outcomes from each study. For fixed-effects meta-analysis, the results of each study are "weighted" by the variance (i.e., the overall standard error squared) for the difference in means for each study when forming this average. Thus, those studies that are more accurate (often those studies with larger sample sizes) make a greater contribution to the result. A similar weighting occurs for random effects meta-analysis, except that heterogeneity (in variances and effects sizes) is accounted for also in the weighting process. The included studies used different types of tests (and thus had different maximum possible test

Population	<ul> <li>Undergraduates and postgraduates aprolled in higher education</li> </ul>
ropulation	• Ondergraduates and postgraduates enfoned in higher education
	coursework programs
Intervention	An information literacy intervention comparing face-to-face and online
	delivery formats with a formal assessment of student skills (via a test,
	diagnostic essay, or end-of-course exam)
Comparators	1. Face-to-face
	2. Online
	3. 'Blended' (with face-to-face and online components)
Outcomes	Primary outcome
	Change in information literacy skills
	Secondary outcomes
	• Student views on the educational format(s)
Limits	Studies published since January 1995
Types of evidence	Randomized and non-randomized controlled studies
included	
Exclusions	• Sessions for research postgraduates, unless as part of a formal 'taught'
	program, such as a research methods course
	• Sessions for professional trainees, not based at the University (e.g. junior
	health professionals based in hospital or primary care sites)
	• Comparisons involving differing face-to-face formats only, or differing
	online formats only
	Different curricula for each learning format
	• Students not from the same cohort (e.g. different year groups for different
	formats)

Table 2 Inclusion/Exclusion Criteria

scores) so a standardized mean difference (SMD = difference in means divided by the standard deviation) was employed.

A Forest plot (Lewis & Clark, 2001) shows both the results of each individual study and the pooled results of meta-analysis. The pooled results are identified by the diamonds within the Forest plot, where the middle of the diamond gives the pooled point-value estimate for the SMD and its edges give the associated 95% confidence interval (CI). For specific studies, the point-value estimate of the SMD is indicated by the central symbol and the associated 95% CI for the SMD is indicated by the horizontal line. An overall meta-analysis that included all studies, irrespective of subgroup, was carried out using standard statistical software (STATA V13). When the number of studies included in metaanalysis was large enough (i.e., equal to or greater than about 10 studies), any evidence of bias was assessed by funnel plots, Egger's and Begg's test of small sample size effects.

Heterogeneity was assessed by  $I^2$  scores and P < 0.05 from a chi-squared test of heterogeneity before deciding whether to carry out a randomeffects or fixed effects meta-analysis. Randomeffects meta-analysis takes into account both the variability within each individual study (shown by the confidence intervals for each study) and variability between the different studies (i.e., variability of the point-estimates of the SMD). This approach tends to lead to larger confidence intervals than fixed-effects meta-analysis, which includes only variability within each individual study.

(1) We also carried out a thematic analysis of information on student views, where available within the comparative studies, using methods described by Braun and Clarke (2006) to generate descriptive themes. Initially, each paper was examined line by line, by two authors independently. Codes (features of the options expressed) were assigned to relevant sentences and paragraphs. These codes were then organized, via discussion, into related areas to construct descriptive themes that best reflected students' views on the different teaching formats. All data on student views from each paper were then imported into Nvivo 10 software (QSR International Pty Ltd., 2012) for analysis.

### Results

Of 5,313 records identified via the various search strategies employed (Figure 1), 33 studies met the inclusion criteria for providing a direct comparison between traditional and online IL education, and these studies were included in the review. Summary data from all studies are provided in Table 3. Detailed information on study characteristics and the results of skills assessments is available (Appendix 1).

# Study Quality

Of the 33 studies, 11 were randomized controlled trials (Brettle & Raynor, 2013; Churkovich & Oughtred, 2002; Goates et al., 2016; Greer et al., 2016; Koenig & Novotny, 2001; Kraemer et al., 2007; Lechner, 2007; Schilling, 2012; Shaffer, 2011; Swain et al., unpub; Vander Meer & Rike, 1996), whereas the remaining studies were (non-randomized) controlled before and after studies.

The vast majority of research was carried out in the U.S. (26 studies; 79%). Of the remaining seven studies, three were based in the U.K.

(Brettle & Raynor, 2013; Walton & Hepworth, 2012; Swain et al., 2015 unpub.), two in Australia (Churkovich & Oughtred, 2002; Salisbury & Ellis, 2003), one in Canada (Bordignon et al., 2016) and one in the Czech Republic (Kratochvil, 2014).

The 11 studies that used a randomized controlled design were less prone to bias since the study design increased the likelihood that the student groups were well matched. However, most of the studies had some methodological limitations (Table 3).

Of the 33 studies, 25 did not pilot or validate the test instrument. Only two studies carried out formal validity testing (Brettle & Raynor, 2013; Mery et al., 2012a) with a further five piloting the test before use (Bordignon et al. 2016; Burhanna et al., 2008; Churkovich & Oughtred, 2002; Kratochvil, 2014; Swain et al., 2015 unpub.). Finally, one study used a predetermined rubric for marking (Goates et al., 2016).

Of the 33 studies, 17 included mean IL test scores with standard deviations and could be included in the meta-analyses (Alexander & Smith, 2001; Anderson & May, 2010; Beile & Boote, 2005; Brettle & Raynor, 2013; Churkovich & Oughtred, 2002; Germain, Jacobson & Kaczor, 2000; Goates, Nelson & Frost, 2016; Greer, Hess & Kraemer, 2016; Lantzy, 2016; Mery, Newby & Peng, 2012a; Shaffer, 2011; Silk, Perrault, Ladenson & Nazione, 2015; Swain, Weightman, Farnell & Mogg unpub.; Vander Meer & Rike, 1996; Walton & Hepworth, 2012; Wilcox Brooks, 2014).

The results from the studies were 'heterogeneous' (i.e., effect sizes or variances varied considerably) and so a random-effects meta-analysis was used. A sensitivity analysis was carried out in order to study the effects of heterogeneity that was here driven by just one or two "outlying" studies in each comparison. These studies were systematically removed from the meta-analyses. This process did not change



Flow diagram ('n' indicates the number of studies).

the overall results of meta-analysis very greatly: i.e., effect sizes and associated 95% confidence intervals remained broadly constant and the statistical significance (or not) of all two-group comparisons remained unchanged. Clearly though, caution should be exercised when interpreting pooled results of meta-analysis when the heterogeneity is high. Of the 33 studies, 21 provided data on participants' views (Anderson & May, 2010; Beile & Boote 2005; Burhanna, Eschedor Voelker & Gedeon, 2008; Byerley, 2005; Churkovich & Oughtred, 2002; Gall, 2014; Goates et al., 2016; Holman, 2000; Kaplowitz & Contini, 1998; Koenig & Novotny, 2001; Kraemer, Lombardo & Lepkowski, 2007; Lantzy, 2016; Nichols, Shaffer & Shockey, 2003; Nichols Hess, 2014; Schilling, 2012; Shaffer, 2011; Silk et al., 2015; Silver &

# Table 3

Summary of Included Studies

Study details	Population and Setting	Methods	Outcomes:	Outcomes: Views	Limitations
			Skills		
First author	Setting:	Interventions:	Neutral	Favoured online	Researcher was both
and year:	Western Kentucky	(1) Face-to-face	No pretest. Mean	Preference for the online	teacher and
Alexander	University, U.S.	(2) Online	scores posttest	course in terms of:	investigator. Students
2001			for skill levels:	• perceived	self-selected for online
	Participants:	Hours of contact time:	82.6 (traditional)	benefits/effectiveness	course. No pretest. No
Study	88 undergraduates on	14x 1h course (face-to-	and 85 (online).	of course (p<0.05)	piloting or validation
Design:	Library Media course	face) vs. self-paced		comfort in doing	of test. No information
CBA, posttest		(online)	Follow-up	library research	on participant loss.
only			period: N/S	(p<0.01).	
Delivered by:					
Graduate					
student (FtF);					
Course					
coordinator					
(online)					

First author and year: Anderson 2010 Study Design: CBA Delivered by: Librarian	Setting: University of North Texas, U.S. Participants: 103 undergraduates on Introduction to Communication course	Interventions: (1) Face-to-face (2) Blended (3) Online Hours of contact time: Entire course: 3 x 50 minute sessions	Neutral Skills increased with no significant differences between formats (p>0.1) other than research assignment (persuasive presentation) scores higher for online (p=0.000). Follow-up period: 5 weeks	-	Teaching content, student characteristics & treatment may have varied between groups. No information on characteristics. No validation of tests. Pretest scores high so difficult to assess any benefit.
First author and year: Beile 2005 Study Design: CBA Delivered by: Librarian	Setting: University of Central Florida, U.S. Participants: 49 postgraduates on research methods course	Interventions: (2) Face-to-face (3) Blended (4) Online Hours of contact time: FtF 70 min. Online ~80 min	Neutral Skills increased with no significant differences between formats. Follow-up period: N/S	<i>Neutral</i> Confidence/self-efficacy levels increased in all groups with no significant differences between formats.	Teaching content, student characteristics & treatment may have varied between groups. No information on characteristics. No validation of tests. Response rates varied.
First author and year: Bordignon 2016 Study Design: CBA	Setting: Seneca College, Toronto, Canada Participants: 110 undergraduates on foundation English	Interventions: (1) Online videos (2) FtF Hours of contact time: Not stated	<i>Neutral</i> Skills increased in both formats with no clear differences between them.	-	No information on student characteristics. Participation was optional and students self-selected. MCQs changed for the two groups. No overall test

Delivered by:	composition course				results.
Librarian			Follow-up		
			period:		
			Immediately		
			post-training		
First author	Setting:	Interventions:	Neutral	-	Loss of participants
and year:	University of Salford,	(1) Face-to-face	Skills increased		was explained but
Brettle 2013	U.K.	(2) Online	(p=0.001) with no		only 71% completion
			significant		and no intention to
Study Design:	Participants:	Hours of contact time:	differences		treat analysis.
RCT	77 undergraduate	1 hour	between formats		
	nursing students		(p=0.263).		
Delivered by:	Ŭ				
Librarian			Follow-up		
			period: 1 month		
First author	Setting:	Interventions:	No pretest.	Neutral	Students self-selected
and year:	Kent State University,	Library tour	Neutral	The majority of students in	type of course, and
Burhanna 2008	Ohio U.S.	(1) Face-to-face	Greater	both formats agreed that	whether they
		(2) Online	understanding of	• The course was	participated in survey.
Study Design:	Participants:		library services	effective/beneficial	Over half of in-person
CBA	313 undergraduates on	Hours of contact time:	in online group	and they were	participants selected
	orientation program	0.5h	(92% compared	Comfortable in asking	by instructor. No
Delivered by:			with 82.6%; no	for help from library	pretest. No validation
Librarian			significance	staff	of test.
			levels) although	More comfortable in	
			no difference in	doing library research	
			knowledge	More likely to use the	
			gained.	library	
			Follow-up	5	
			period: N/S		
			•		
First author	Setting:	Interventions:	Neutral	Unclear	FtF course introduced
and year:	University of Colorado,	(1) Face-to-face	Skills increased	No useable data – views of	three databases while
Byerley 2005	U.S.	(2) Blended – FtF with	slightly in each	online groups only were	online course

Study Design: CBA Delivered by: Librarian	<b>Participants:</b> 141 undergraduates in English 141 course	online (3) Online <b>Hours of contact time:</b> Not stated	group. The mean score for the blended group was significantly different from the FtF although not the online group. Follow-up period: ~8 weeks	sought.	introduced only one. Different numbers for each format and no information on characteristics. Test not piloted or validated.
First author	Setting:	Interventions:	Favoured face-to-	Favoured face-to-face	Group sizes and
and year:	Deakin University,	(1) Face-to-face	face	There was no difference in	student origins varied
Churkovich	Geelong, Australia	(2) Blended	Skills increased	confidence/self-efficacy	and no information on
2002		(3) Online	in each group	levels of the FtF and	characteristics. Test
	Participants:		with a greater	blended classes although a	trialed although only
Study Design:	174 undergraduate	Hours of contact time:	improvement in	significant improvement in	with secondary
cRCT	sociology students	Unclear	FtF compared to	both compared to the	students & comments
			other formats	There was a clear	from academic staff.
Delivered by:			(statistically	proference for the class	significanco
Librarian			significant).	compared to the online	significance.
			Follow-up	course with 14/15 positive	
			period: N/S	comments versus 3/9	
			1	positive comments.	
First author	Setting:	Interventions:	Neutral	Favoured online?	Small sample size. No
and year:	University of Iowa, U.S.	Library induction	Skills increased	Online orientation 'seemed	useable posttests for
Gall 2014		(1) Face-to-face	in each group	to' increase confidence/self-	no instruction (off
	Participants:	(2) Online	although no	efficacy in choosing	campus) group. No
Study Design:	27 postgraduates in	(3) No instruction	significant	databases (awareness of	information on
СВА	social work on campus	<b>.</b>	differences	library resources).	characteristics. Loss of
	(numbers off campus	Hours of contact time:	between groups.		participants not
Delivered by:	unclear)	FtF 50 mins. Online self-			discussed. Test not

Librarian		paced	Follow-up period: N/S		piloted or validated. No confidence intervals or statistical tests.
First author	Setting:	Interventions:	Neutral	-	Numbers varied
and year:	University at Albany,	(1) Face-to-face	Skills increased		between groups and
Germain 2000	New York, U.S.	(2) Online	in each group		no information on
			with no		student characteristics.
Study Design:	Participants:	Hours of contact time:	differences		Tests not validated.
CBA	303 undergraduate on	FtF 55 mins	between formats.		
	gen. education program	Online 15-55 mins			
Delivered by:			Follow-up		
Librarian			<b>period:</b> 1.5 to 6		
			weeks		
First author	Setting:	Interventions:	No pretest	Neutral	Randomization
and year:	Brigham Young	(1) Face-to-tace	Favoured face-to-	Positive comments on	method not described.
Goates 2016	University, Utah, U.S.	(2) Blended	face	perceived effectiveness of	No information on
			Assignment	skills development similar	student characteristics.
Study Design:	Participants:	Hours of contact time:	scores (a rubric	for both formats	
RCT	122 undergraduates	50 mins	graded search		
	(primarily life sciences)		strategy) were		
Delivered by:	on advanced writing		higher for		
Librarian	course.		students		
			feceiving FtF		
			101111at (p<0.01)		
			Follow-up		
			neriod.		
			Immediately		
			after training		

First author	Setting:	Interventions:	No pretest	-	No information on
and year:	Oakland University,	(1) Online	Neutral		student characteristics
Greer 2016	Michigan, U.S.	(2) Blended	The exam scores		or drop outs. Test not
Linked to			of the two		validated.
Kraemer 2007	Participants:	Hours of contact time:	groups were		
	257 undergraduates on	Online self-paced?	nearly identical.		
Study Design:	writing & rhetoric	Blended self-paced? plus			
cRCT	course	1h instruction	Follow-up		
			period:		
Delivered by:			Unstated but		
Librarian			short-term		
<b>T</b> <sup>1</sup> ( )	C 111	T ( )			T 1.1
First author	Setting:	Interventions:	Neutral	Neutral	Low completion rate
and year:	University of North	(1) Face-to-face	Neutral Skills increased	Neutral No perceived differences in	Low completion rate online.
and year: Holman 2000	Setting: University of North Carolina at Chapel Hill,	<ul><li>(1) Face-to-face</li><li>(2) Online (CAI)</li></ul>	Neutral Skills increased in each group	No perceived differences in effectiveness/benefits. Pace	Low completion rate online. Length/intensity of
Hirst author and year: Holman 2000	Setting: University of North Carolina at Chapel Hill, U.S.	<ul><li>(1) Face-to-face</li><li>(2) Online (CAI)</li><li>(3) No instruction</li></ul>	Neutral Skills increased in each group with no	No perceived differences in effectiveness/benefits. Pace of online course and clarity	Low completion rate online. Length/intensity of formats varied.
And year: Holman 2000	Setting: University of North Carolina at Chapel Hill, U.S.	<ul><li>(1) Face-to-face</li><li>(2) Online (CAI)</li><li>(3) No instruction</li></ul>	Neutral Skills increased in each group with no statistically	Neutral No perceived differences in effectiveness/benefits. Pace of online course and clarity of FtF course preferred.	Low completion rate online. Length/intensity of formats varied. Posttest timing varied.
First author and year: Holman 2000 Study Design: CBA	Setting: University of North Carolina at Chapel Hill, U.S. Participants:	<ul> <li>(1) Face-to-face</li> <li>(2) Online (CAI)</li> <li>(3) No instruction</li> <li>Hours of contact time:</li> </ul>	Neutral Skills increased in each group with no statistically significant	Neutral No perceived differences in effectiveness/benefits. Pace of online course and clarity of FtF course preferred.	Low completion rate online. Length/intensity of formats varied. Posttest timing varied. Groups were different
And year: Holman 2000 Study Design: CBA	Setting: University of North Carolina at Chapel Hill, U.S. Participants: 125 undergraduates on	<ul> <li>Interventions:</li> <li>(1) Face-to-face</li> <li>(2) Online (CAI)</li> <li>(3) No instruction</li> <li>Hours of contact time:</li> <li>FtF: 40 or 60 mins. CAI</li> </ul>	Neutral Skills increased in each group with no statistically significant difference	Neutral No perceived differences in effectiveness/benefits. Pace of online course and clarity of FtF course preferred.	Low completion rate online. Length/intensity of formats varied. Posttest timing varied. Groups were different sizes and minimal
First author and year: Holman 2000 Study Design: CBA Delivered by:	Setting: University of North Carolina at Chapel Hill, U.S. Participants: 125 undergraduates on English Composition	<ul> <li>Interventions:</li> <li>(1) Face-to-face</li> <li>(2) Online (CAI)</li> <li>(3) No instruction</li> <li>Hours of contact time:</li> <li>FtF: 40 or 60 mins. CAI</li> <li>30 - 45 mins</li> </ul>	Neutral Skills increased in each group with no statistically significant difference between formats.	Neutral No perceived differences in effectiveness/benefits. Pace of online course and clarity of FtF course preferred.	Low completion rate online. Length/intensity of formats varied. Posttest timing varied. Groups were different sizes and minimal information on
First author and year: Holman 2000 Study Design: CBA Delivered by: Librarian	Setting: University of North Carolina at Chapel Hill, U.S. Participants: 125 undergraduates on English Composition and Rhetoric course	<ul> <li>Interventions:</li> <li>(1) Face-to-face</li> <li>(2) Online (CAI)</li> <li>(3) No instruction</li> <li>Hours of contact time:</li> <li>FtF: 40 or 60 mins. CAI</li> <li>30 - 45 mins</li> </ul>	Neutral Skills increased in each group with no statistically significant difference between formats.	Neutral No perceived differences in effectiveness/benefits. Pace of online course and clarity of FtF course preferred.	Low completion rate online. Length/intensity of formats varied. Posttest timing varied. Groups were different sizes and minimal information on characteristics. No
First author and year: Holman 2000 Study Design: CBA Delivered by: Librarian	Setting: University of North Carolina at Chapel Hill, U.S. Participants: 125 undergraduates on English Composition and Rhetoric course	<ul> <li>Interventions:</li> <li>(1) Face-to-face</li> <li>(2) Online (CAI)</li> <li>(3) No instruction</li> <li>Hours of contact time:</li> <li>FtF: 40 or 60 mins. CAI</li> <li>30 - 45 mins</li> </ul>	Neutral Skills increased in each group with no statistically significant difference between formats. Follow-up	Neutral No perceived differences in effectiveness/benefits. Pace of online course and clarity of FtF course preferred.	Low completion rate online. Length/intensity of formats varied. Posttest timing varied. Groups were different sizes and minimal information on characteristics. No piloting or validation
First author and year: Holman 2000 Study Design: CBA Delivered by: Librarian	Setting: University of North Carolina at Chapel Hill, U.S. Participants: 125 undergraduates on English Composition and Rhetoric course	<ul> <li>Interventions:</li> <li>(1) Face-to-face</li> <li>(2) Online (CAI)</li> <li>(3) No instruction</li> <li>Hours of contact time:</li> <li>FtF: 40 or 60 mins. CAI</li> <li>30 - 45 mins</li> </ul>	Neutral Skills increased in each group with no statistically significant difference between formats. Follow-up period: N/S	Neutral No perceived differences in effectiveness/benefits. Pace of online course and clarity of FtF course preferred.	Low completion rate online. Length/intensity of formats varied. Posttest timing varied. Groups were different sizes and minimal information on characteristics. No piloting or validation of test.

First author	Setting:	Interventions:	Neutral	Unclear	No information on
and year:	UCLA, U.S.	(1) Face-to-face (lecture)	Skills increased	No useable data – views of	group characteristics.
Kaplowitz 1998		(2) Online (CAI)	in each group	online group only were	No content
	Participants:		with no	sought.	info/validation of test.
Study Design:	423 biology	Hours of contact time:	differences		Only those completing
CBA	undergraduates	50 minutes (lecture), 45-	between formats.		pre/posttests
		60 minutes (CAI)			evaluated. No
Delivered by:			Follow-up		confidence intervals or
Teaching			period: ~12		p values.
assistants			months		
First author	Setting:	Interventions:	Neutral	Neutral	Information lacking
First author and year:	<b>Setting:</b> University of Illinois at	<b>Interventions:</b> (1) Fact to face	<i>Neutral</i> Skills increased	Neutral Confidence/self-efficacy	Information lacking on timing/mode of FtF
First author and year: Koenig 2001	<b>Setting:</b> University of Illinois at Chicago, U.S.	Interventions: (1) Fact to face (2) Online	<i>Neutral</i> Skills increased in each group	Neutral Confidence/self-efficacy increased in both groups	Information lacking on timing/mode of FtF session. Students self-
<b>First author</b> <b>and year:</b> Koenig 2001	<b>Setting:</b> University of Illinois at Chicago, U.S.	Interventions: (1) Fact to face (2) Online	<i>Neutral</i> Skills increased in each group with no	<i>Neutral</i> Confidence/self-efficacy increased in both groups although no difference	Information lacking on timing/mode of FtF session. Students self- selected for format.
First author and year: Koenig 2001 Study Design:	Setting: University of Illinois at Chicago, U.S. Participants:	Interventions: (1) Fact to face (2) Online Hours of contact time:	Neutral Skills increased in each group with no differences	Neutral Confidence/self-efficacy increased in both groups although no difference between groups.	Information lacking on timing/mode of FtF session. Students self- selected for format. Tests not validated.
First author and year: Koenig 2001 Study Design: RCT	Setting: University of Illinois at Chicago, U.S. Participants: Undergraduates	Interventions: (1) Fact to face (2) Online Hours of contact time: FtF unclear	Neutral Skills increased in each group with no differences between formats.	<i>Neutral</i> Confidence/self-efficacy increased in both groups although no difference between groups.	Information lacking on timing/mode of FtF session. Students self- selected for format. Tests not validated. Drop outs noted
First author and year: Koenig 2001 Study Design: RCT	Setting: University of Illinois at Chicago, U.S. Participants: Undergraduates (number unstated) on a	Interventions: (1) Fact to face (2) Online Hours of contact time: FtF unclear Online 50 mins	<i>Neutral</i> Skills increased in each group with no differences between formats.	<i>Neutral</i> Confidence/self-efficacy increased in both groups although no difference between groups.	Information lacking on timing/mode of FtF session. Students self- selected for format. Tests not validated. Drop outs noted although numbers on
First author and year: Koenig 2001 Study Design: RCT Delivered by:	Setting: University of Illinois at Chicago, U.S. Participants: Undergraduates (number unstated) on a communication course	Interventions: (1) Fact to face (2) Online Hours of contact time: FtF unclear Online 50 mins	Neutral Skills increased in each group with no differences between formats. Follow-up	Neutral Confidence/self-efficacy increased in both groups although no difference between groups.	Information lacking on timing/mode of FtF session. Students self- selected for format. Tests not validated. Drop outs noted although numbers on the course not stated.
First author and year: Koenig 2001 Study Design: RCT Delivered by: Librarian	Setting: University of Illinois at Chicago, U.S. Participants: Undergraduates (number unstated) on a communication course	Interventions: (1) Fact to face (2) Online Hours of contact time: FtF unclear Online 50 mins	Neutral Skills increased in each group with no differences between formats. Follow-up period: N/S	<i>Neutral</i> Confidence/self-efficacy increased in both groups although no difference between groups.	Information lacking on timing/mode of FtF session. Students self- selected for format. Tests not validated. Drop outs noted although numbers on the course not stated.
First author and year: Koenig 2001 Study Design: RCT Delivered by: Librarian	Setting: University of Illinois at Chicago, U.S. Participants: Undergraduates (number unstated) on a communication course	Interventions: (1) Fact to face (2) Online Hours of contact time: FtF unclear Online 50 mins	Neutral Skills increased in each group with no differences between formats. Follow-up period: N/S ('end of module')	<i>Neutral</i> Confidence/self-efficacy increased in both groups although no difference between groups.	Information lacking on timing/mode of FtF session. Students self- selected for format. Tests not validated. Drop outs noted although numbers on the course not stated.

First author and year: Kraemer 2007 Linked to Greer 2016 Study Design: cRCT Delivered by: Librarian	Setting: Oakland University, Michigan, U.S. Participants: 224 undergraduates on Rhetoric composition class	<ul> <li>Interventions:</li> <li>(1) Face-to-face</li> <li>(2) Blended online plus FtF</li> <li>(3) Online (WebCT)</li> <li>Hours of contact time:</li> <li>FtF 3h. Blended self- paced plus 2h. Online self-paced</li> </ul>	<i>Favoured blended</i> Skills increased in each group (p<0.0000) with a significantly greater pre-post improvement in the blended compared to the online only group (p=0.023). <b>Follow-up</b> <b>period:</b> N/S	<i>Neutral</i> Similar levels of satisfaction (perceived effectiveness/benefits) across groups.	High pretest scores (~70%) limited value of test scores. Lack of information on student characteristics. Test not piloted or validated.
First author and year: Kratochvil 2014 Study Design: CBA Delivered by: Librarian	Setting: Masaryk University, Czech Republic Participants: 251 Medicine undergraduates & postgraduates	Interventions: (1) Face-to-face (2) Online Hours of contact time: Unclear. Possibly 3x2.5h sessions for FtF	Unclear Skills increased in each group although unclear if any differences between groups. Follow-up period: N/S	-	Unsuitable question construction in test and not validated. Different student groups for each format. No information on numbers or characteristics. Could have been major differences in treatment.
First author and year: Lantzy 2016 Study Design: CBA	Setting: California State University, U.S. Participants: 64 undergraduates in a kinesiology course	Interventions: (1) Face-to-face (2) Online Hours of contact time: 1.25 hours	Neutral Both groups showed highly significant pre- post test score increases (p<0.0001) but	Neutral No significant differences across formats in views re: confidence/self-efficacy clarity of presentation responsiveness of instructor	No information on student characteristics. Tests were not piloted or validated.

Delivered by: Librarian First author	Setting:	Interventions:	there were no significant differences between groups. Follow-up period: Immediately after training Favoured face-to-	_	Different sized groups
and year:	Richard Stockton	(1) Face-to-face	face		and no information on
Lechner 2007	College of New Jersey,	(2) Online	% change pre to		characteristics. Only
Study Design:	0.5.	Hours of contact time:	the online group		tests Much higher
RCT	Participants:	Not stated. Online	and 18.1% for the		pretest scores in online
	27 occupational/physical	probably self-paced.	FtF group.		group. No confidence
<b>Delivered by:</b> Librarian	therapy postgraduates		Follow-up period: N/S (probably same day)		intervals or p values.
First author	Setting:	Interventions:	Favoured online	-	Content and delivery
and year:	University of Arizona,	(1) Face-to-face (tutor)	Skills increased		varied between
1viery 2012a,	0.5.	(2) Face-to-face	the EtE librarian		characteristics and
20120	Participants.	(instantial) (3) Online	and online		some selection by
Study Design:	660 undergraduates on		groups but not in		instructors. Much
CBA	English compositional	Hours of contact time:	the tutor group		larger online group
	course	FtF 50 mins. Online over	The online group		(570 students
Delivered by:		10 weeks	performed better		compared to circa 30

FtF: Tutor (1);			than FtF groups		in other groups). No
Librarian (2);			in both skills test		discussion of
Online:			(Mery 2012a)		participant loss.
Librarian			and assignment		
			scores		
			(bibliography		
			quality) (Mery		
			2012b).		
			Follow-up		
			period: N/S		
First author	Setting:	Interventions:	Neutral	Neutral	No information on the
and year:	State University of New	(1) Face-to-face	Skills increased	No differences between	characteristics of each
Nichols 2003	York (SUNY), U.S.	(2) Online	slightly in each	groups re:	group. Test not
			group although	<ul> <li>perceived</li> </ul>	described or validated.
Study Design:	Participants:	Hours of contact time:	no difference	benefits/effectiveness	No information on
CBA	64 undergraduates on	FtF 50 mins. Online	between groups.	satisfaction	loss of participants.
	English composition	unclear		confidence levels	
Delivered by:	course		Follow-up	preference for format	
Librarian			period: N/S		

First author	Setting:	Interventions:	Neutral	Neutral	Very little
and year:	Oakland University,	(1) Face-to-face	Skills increased	No significant differences	methodological
Nichols Hess	Rochester, U.S.	(2) Online	in each group	between formats in:	information. Different
2014			with no	• Comfort in asking for	numbers in each
	Participants:	Hours of contact time:	difference	help	group and no
Study Design:	31 undergraduate	FtF not stated	between groups.	• Using library resources	information on
CBA	sociology students	Online self paced		Students receiving FtF	student characteristics.
			Follow-up	instruction valued the	Test not piloted or
Delivered by:			period:	personal connection and	validated. Only
Librarian			Up to two	responsiveness of	completers analyzed.
			months	instructor.	Not possible to assess
				Those receiving online	statistical significance
				instruction valued the	of results.
				convenience and ability to	
				repeat sections.	
First author		Interventions:	Neutral	-	Only students
and year:	Setting:	(1) Face-to-face	No pretest. No		designated as
Orme 2004	Indiana University, U.S.	(2) Blended online	statistically		'successful' (passing
		(TILT) plus FtF	significant		TILT quizzes or
Study Design:	Participants:	(3) Online only (TILT)	difference		seminar) were
CBA	128 business		between groups.		included in the study.
	undergraduates	Hours of contact time:			Exact content, length
Delivered by:		Unstated	Follow-up		and intensity of
Librarian			<b>period:</b> ~10		teaching for each
			weeks (next		cohort not clear. Test
			semester)		not validated. No
					pretest.
First author	Setting:	Interventions:	Neutral	-	No detail on content,
and year:	University of	(1) Face-to-face (lecture)	Skills increased		length or intensity of
Salisbury 2003	Melbourne, Australia	(2) Face-to-face (hands	in each group		each mode of delivery.
		on)	although no		No student
Study Design:	Participants:	(3) Online	clear differences		characteristics. No
CBA	282 history/film		between groups.		validation of test. No
	undergraduates	Hours of contact time:			confidence intervals or

Delivered by:		1 hour	Follow-up		p values.
specialist			penda. 193		
First author and year: Schilling 2012 Study Design: RCT Delivered by: Librarian	Setting: Indiana University, U.S. Participants: 128 medical undergraduates	Interventions: (1) Face-to-face (2) Online Hours of contact time: 1.5 h	NeutralNo statisticallysignificantdifferencebetween groupsin MEDLINEsearching score.Follow-upperiod:Two weeks forskills test:15 weeks for	No pretest <i>Neutral</i> No significant differences between formats in terms of: • Perceived effectiveness • Likelihood of using library (more)	No information on student characteristics. No validation of test. No confidence intervals with results.
			attitudes survey		
First author	Setting:	Interventions:	Neutral	Favoured face-to-face*	Tests were not
and year:	University of New York	(1) Face-to-face	Skills increased	The FtF group had higher	validated. *Online
Shaffer 2011	at Oswego, U.S.	(2) Online	in each group although no	satisfaction scores on the 5- point Likert scale (4.03 viz	group experienced technical difficulties.
Study Design:	Participants:	Hours of contact time:	difference	3.41).	
RCT	59 postgraduates on a research methods course	~2 hours	between groups.		
Delivered by:			Follow-up		
Librarian			period: N/S		
First author	Setting:	Interventions:	Neutral	Neutral	No information on
and year:	Midwestern University,	(1) Face-to-face	Skills increased	No significant differences	student characteristics.
Silk 2015	U.S.	(2) Online	in each group	in:	Tests not piloted or
			with no	Confidence/self-	validated. Only those
Study Design:	Participants:	Hours of contact time:	significant	efficacy	who completed post
CBA	232 undergraduates on	1 hour	difference	engagement/dynamism	and delayed posttest

<b>Delivered by:</b> Librarian	an organization communication course		between groups. The online group was more successful in finding research articles (87.4% vs. 78.0%, p=0.063). Follow-up period: 4 weeks	of instruction.	were included - ca 50% attrition in FtF and 59% in online.
First author	Setting:	Interventions:	Neutral	Unclear	Students allowed to
and year:	University of South	(1) Face-to-face	No pretest. No	Marginally greater number	self-select group.
Silver 2007	Florida, U.S.	(2) Online	posttest difference	in online group saying they were more confident or	Student characteristics varied (and different
Study Design:	Participants:	Hours of contact time:	between groups.	much more confident after	year groups were
CBA	295 psychology	FtF Not stated. Online	0.11	instruction (88.4% vs.	used). Test was not
	undergraduates	self-paced (allowed one	Follow-up	78.3% for FtF).	validated. No pretest.
Delivered by:	0	week)	period: N/S	,	1
Librarian		,	1		
First author	Setting:	Interventions:	Neutral	Neutral	Limited information
and year:	Cardiff University, U.K.	(1) Face-to-face	Skills increased	Overall no significant	on characteristics. Test
Swain 2015		(2) Online	in each group	differences in	was piloted although
	Participants:		although no	• comfort in asking for	not validated. Only 58
Study Design:	58 dental	Hours of contact time:	significant	library assistance	students attended
RCT	undergraduates	FtF 50 mins. Online:	difference	preference for format	training but 60
		Self-paced within 50 min	between groups.	other than tendency to	claimed training
Delivered by:		slot		favour of the format	received at posttest.
Librarian			Follow-up	allocated.	
			period: 5 days		

First author	Setting:	Interventions:	Neutral	Neutral	All students had
and year:	Western Michigan	(1) Face-to-face	Skills increased	No difference in perceived:	access to tutorial. Test
Vander Meer	University, U.S.	(2) Online	in each group	Confidence/self-	not piloted or
1996			although no	efficacy	validated. Only 53%
	Participants:	Hours of contact time:	significant	Clarity	completion of posttest.
Study	186 undergraduates on	Not stated.	difference	• Interest	No characteristics
Design:	high school/University		between groups	Online group perceived	although large
RCT	transition course		(p<0.05).	greater enjoyment (p=0.05)	samples with similar
					baseline skill and
Delivered by:			Follow-up		survey results.
Librarian			<b>period:</b> ~10		
			weeks (end of		
			semester)		
First author	Setting:	Interventions:	No pretest	-	Groups different sizes
and year:	Staffordshire University,	(1) Blended	Neutral		and no student
Walton 2012	U.K.	(2) Intermediate: FtF	Students in the		characteristics.
		plus access to online	blended group		Assessors not blinded
Study	Participants:	materials	made greater use		to group. Evaluation
Design:	35 sport and exercise	(3) Face-to-face	of evaluative		criteria not validated.
CBA	undergraduates		criteria than		Small sample size.
		Hours of contact time:	those in the		Four times as much
Delivered by:		Blended 4x50 mins	intermediate or		contact time for the
Librarian		Others 50 mins	FtF groups but		blended vs. FtF and
			this was not		intermediate formats.
			statistically		
			significant.		
			Follow-up		
			period:		
			Not stated,		
			possibly at end		
			of 5 week		
			intervention		
			period		

First author	Setting:	Interventions:	Neutral	Unclear	Hours of contact time
and year:	Northern Kentucky	(1) Blended	No significant	No useable data – views of	not stated. No
Wilcox Brooks	University, U.S.	(2) Face-to-face	differences	the blended group only	information on
2014			between groups	were sought.	student characteristics.
	Participants:	Hours of contact time:	in bibliographic		Outcome measures
Study	38 undergraduates in	Not stated	analysis of final		not piloted or
Design:	advanced composition		course paper.		validated
CBA	courses				
			Follow-up		
Delivered by:			period:		
Librarian			Not stated		
First author	Setting:	Interventions:	Neutral	Favoured face-to-face	Slightly different
and year:	University of Oklahoma,	(1) Face-to-face	Skills increased	General preference for FtF	numbers in groups
Wilhite 2004	U.S.	(2) Online	in each group	with higher scores from FtF	and pretest scores are
		(3) No instruction	when compared	group for	very different
Study	Participants:		to control	Satisfaction	suggesting
Design:	44 business	Hours of contact time:	(p=0.010)	Clarity	characteristics varied
CBA	undergraduates	Not stated. 45 min video	although no	Length of course	across groups. Test not
	-		significant	_	piloted or validated.
Delivered by:			difference		Issues for online
Librarian			between		group.
			intervention		
			groups (p=0.75).		
			Follow-up		
			period: N/S		

*CBA*: Controlled before and after study; *cRCT*: Cluster randomized controlled trial; FtF: Face-to-Face; N/S: Not stated; *RCT*: Randomized controlled trial

Shaded rows are papers included in the meta-analysis

Nickel, 2007; Swain et al., unpub; Vander Meer & Rike, 1996; Wilhite, 2004). In all cases this information related to views expressed by students rather than the library staff delivering the interventions (Table 3).

### Skills

Of the 33 studies, 8 did not include a pretest (Alexander & Smith, 2001; Burhanna et al., 2008; Goates et al., 2016; Greer et al., 2016; Orme, 2004; Schilling, 2012; Silver & Nickel, 2007; Walton & Hepworth, 2012). The remaining 25 studies all noted an increase in skills from pretest to posttest across delivery formats.

A total of 12 studies could be included in a meta-analysis, which indicated that a significant increase in skills occurred from pre- to posttest. The overall result from meta-analysis for the SMD change was 1.02 (95% Confidence Interval [CI]: 0.75 to 1.29) for face-to-face delivery (Figure 2) and 0.92 (95% CI: 0.57 to 1.26) for online delivery (Figure 3).

Overall, and as suggested by the pre- to postresults, there was compelling evidence that skills acquired through IL teaching are comparable for face-to-face and online delivery methods. Of the 33 studies, 27 (82%) reported that there was no statistically significant difference in skills learned via face-to-face and online delivery formats. For one study the results were unclear because of analysis weaknesses (Kratochvil, 2014), two favoured online delivery (Lechner, 2007; Mery et al., 2012a), two favoured face-toface delivery (Churkovich & Oughtred, 2002; Goates et al., 2016) and one favoured the blended delivery option (Kraemer et al., 2007).



### Figure 2

Change in information literacy skills pre- to post-instruction face-to-face.



Change in information literacy skills pre- to post-instruction online

For the 13 studies that could be included in a meta-analysis the SMD (95% CI) for face-to-face compared to online instruction was -0.01 (-0.28 to 0.26) (Figure 4).

There was not enough data to assess whether there was any difference between skills outcomes and contact time, time to follow-up, delivery method (librarian or non-librarian) or study design. However, there appeared to be no obvious associations from looking at the data.

Findings were mixed for the ten studies that included a blended delivery arm (Anderson & May, 2010; Beile & Boote, 2005; Byerley, 2005; Churkovich & Oughtred, 2002; Goates et al., 2016; Greer et al., 2016; Kraemer et al., 2007; Orme, 2004; Walton & Hepworth, 2012; Wilcox Brooks, 2014), although seven of these studies (70%) found no statistically significant difference between blended and other formats in terms of test or assignment outcomes. Of the ten, one study (Byerley, 2005) noted that the blended method provided greater skill development than the face-to-face provision, although this was not significant compared to online provision. Another study (Goates et al., 2016) noted higher posttest scores for students receiving a face-toface versus blended format (p<0.01). A further study (Kraemer et al., 2007) found a significantly greater pre-post improvement in the blended learning compared to the online learning group.

For those studies that could be included in a meta-analysis, there was no statistically significant difference between blended and single format training in terms of skills learnt. The SMD comparing blended to online or face-to-face instruction were 0.15 (95% CI, -0.03 to



Comparison of information literacy skills for face-to-face vs. online instruction.

0.34; 4 studies) and 0.36 (-0.03 to 0.75; 3 studies) respectively (Figure 5).

Based on the studies that could be included in a meta-analysis, the single format training appeared to be more effective than blended training when skills were measured via a specific assignment such as a piece of persuasive presentation research (Anderson & May, 2010) or a rubric graded search strategy (Goates et al., 2016). (Figure 5) Three further studies looked at specific assignments; two via bibliography assessment within a piece of course work (Mery et al., 2012b; Wilcox Brooks, 2014) and one by a search strategy assessment (Schilling, 2012). Mery et al. (2012b) observed a statistically significant improvement in the online compared to the face-to-face group but the other two studies found no difference between face-to-face and blended (Wilcox Brooks, 2014) or online vs. face-to-face groups (Schilling, 2012). No conclusions can be based on this limited evidence.

### Student views

Overall there was evidence that students felt that the different delivery methods had their advantages and disadvantages. However, the findings are mixed with no clear preference for one method over another. Of the 22 studies gathering information on student views, 3 collected data from students exposed to the online (Byerley, 2005; Kaplowitz & Contini, 1998) or blended (Wilcox Brooks, 2014) training only.



Comparison of information literacy skills for online or face-to-face instruction versus blended instruction.

From the 19 studies gathering views on both types of format, 14 (74%) found that students expressed no preference at all in relation to format (Table 3). In the five studies finding variations in student views between formats, two studies found that the online course was favoured in terms of perceived benefits, attitudes to the course, and comfort in carrying out library research (Alexander & Smith, 2001) or increased self-efficacy (a belief in one's ability to succeed) in choosing databases to search (Gall, 2014). Three studies identified a preference for face-to-face delivery in terms of greater confidence following training (Churkovich & Oughtred, 2002; Shaffer, 2011) or higher satisfaction in general and around the clarity and length of training (Wilhite, 2004). The online group experienced technical difficulties in the studies by Shaffer (2011) and Wilhite (2004). Findings from the themes identified in intervention studies analyzing student views on face-to-face versus online formats are summarized in Figure 6. Where the findings for a particular measure are neutral, this shows that there was no clear preference from students concerning the online and face-to-face formats.

There were not enough data to guide conclusions concerning perceptions of blended versus single format. However from three studies comparing all three types of format, two found that the views of students across formats were neutral (Beile 2005, Kraemer 2007) while one noted a preference for the face-to-face format in terms of confidence/self-efficacy (Churkovich 2002). A study comparing face-toface and blended formats found no differences in perceived skills (Goates 2016).

### **Study Design Features**

The interventions in 30 of the 33 studies were delivered by librarians. Face-to-face teaching was delivered by graduate students (Alexander & Smith, 2001) or teaching assistants (Kaplowitz & Contini, 1998) in two studies. There was no difference in skills between the face-to-face and online groups at posttest in both studies. Only the study by Alexander and Smith (2001) included comparative information on student views and they found a preference for the online option. Mery et al. (2012a) provided the only direct comparison between the deliverers of the intervention, with two face-to-face groups; one trained by librarians and the other by course tutors. The researchers found that skills increased significantly in the librarian and online groups, but not in the tutor group.

Of 21 studies providing information on face-toface contact time, the typical time period was 50-60 minutes (12 studies, see Table 3). The longest contact time was for the study by Alexander (2001) where graduate students delivered 14 one-hour sessions. The results for the skills test (posttest only) were neutral, but students voiced a preference for the online training. The shortest contact time was 0.5 hour (Burhanna et al., 2008), where the researchers reported a trend towards greater skills development in the online group but no difference in student views.



# Figure 6

Analysis of student views on face-to-face versus online formats [numbers of studies].

Only 14 studies provided information on the follow-up period between training and the skills test, where the range of follow-up periods was immediately post-training to 12 months (see Table 3). There was no statistically significant difference between the two formats in terms of skills retained in 13 studies. There was a statistically significant improvement in the faceto-face group in Goates et al. (2016), where skills were measured immediately post-training.

For the 11 randomized controlled trials, 7 studies (64%) found no difference in skills between the formats tested (Brettle & Raynor, 2013; Greer et al., 2016; Koenig & Novotny, 2001; Schilling, 2012; Shaffer, 2011; Swain et al., unpub; Vander Meer & Rike, 1996), 3 favoured face-to-face training (Churkovich & Oughtred, 2002; Goates et al., 2016; Lechner, 2007) and 1 favoured the blended approach (Kraemer et al., 2007).

Of the 11 randomized controlled trials, 8 explored student views, with 2 favouring the face-to-face format (Churkovich & Oughtred, 2002; Shaffer, 2011) and 6 (75%) with neutral findings (Goates et al., 2016; Koenig & Novotny, 2001; Kraemer et al., 2007; Schilling, 2012; Swain et al., unpub; Vander Meer & Rike, 1996).

### Discussion

Despite the methodological shortcomings of many of the studies included in this review, there is consistent evidence across the body of comparative studies that:

- Face-to-face (traditional) teaching strongly increases information literacy (IL) skills when assessed directly preand post-teaching.
- Online (web-based) teaching strongly increases IL skills when assessed directly pre- and post-teaching.
- The increase in skills as a result of teaching is broadly comparable for face-to-face and online teaching methods.
- Students do not express a clear

preference for one format over another although they perceive some differences in the delivery methods (and advantages and disadvantages of each).

The findings from our review of student skills are in keeping with a systematic review evaluating the impact of online or blended and face-to-face learning of clinical skills in undergraduate nurse education (McCutcheon, Lohan, Traynor & Martin, 2015). On the basis of 19 published papers, the authors concluded that online teaching of clinical skills was no less effective than traditional means.

Definitive evidence on the effectiveness of blended learning methods compared to single format teaching is limited although it appears that test score outcomes for single and blended format teaching are similar. The potential differences between outcomes, as measured by assignment and test performance, is intriguing and worthy of further study. One might identify test scores and assignment scores as measuring the different outcomes of cognitive (factual knowledge) and behavioural (skills needed to complete a task) aspects of information literacy, respectively.

While the majority of studies that had a potentially more reliable methodology (i.e. the 11 randomized controlled trials) demonstrated neutral findings, four of the studies favoured face-to-face or blended approaches. Many of the studies had some methodological shortcomings however.

Across the full body of the 33 studies reviewed here, it seems that the choice of format can be left to the educator. Given our awareness of the increase in the use of online and blended formats for IL teaching, from personal experience and the published literature, this confirmation is welcome. Both the student context (e.g., campus-based or distance learners) and cohort sizes are likely to be decisive factors. Blended learning is perceived by academic staff as being more time consuming (Brown, 2016), although we could not find any empirical evidence to confirm or refute this perception; nor were any studies identified comparing preparation time for single format face-to-face vs. online sessions.

One development opportunity for the online context is the personalized online learning environment using adaptive learning software (Nguyen, 2015). This is an exciting prospect for enhancing student learning in the increasingly online arena of information searching that remains to be explored.

### Limitations

The authors cannot guarantee that all relevant studies were identified although this review is based on an extensive search for published and unpublished research studies. The quality of the included studies is moderate at best. Only 11 studies adopted the randomized controlled trial design, which should minimize the potential for bias, and only 7 piloted or validated the skills tests used. Heterogeneity across studies was high so the meta-analysis results should be interpreted with caution. There is also relatively little evidence from outside the U.S.

### **Conclusions and Implications for Practice**

The body of research evidence suggests that information literacy training is equally effective, and well received, across a range of delivery methods. The format can vary to suit the requirements of the student population and the educational situation. In the light of these findings, in our institutions we are confident in moving towards a greater use of online options, particularly for routine IL sessions such as library orientations for new students and for access by individuals at 'point of need'.

Future comparative studies should aim to minimize the potential for bias, perhaps by adopting a randomized controlled design. These studies should also employ a large population and they should use validated test instrument(s). More high quality research comparing blended and single format delivery methods will be valuable, along with exploration to unravel the potential dichotomies in outcomes from specific assignments (marked course work) as opposed to IL skills tests. Further research into the time and resource implications for educators in delivering teaching via these different methods would also be useful.

Once these studies have been completed it should be possible to provide clearer guidance to educators, perhaps along the lines of a 'decision aid' to guide the choice of teaching format for particular contexts and student groups.

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	No Instruction versus Face-To-Face Instruction				
Year N	Name			SMD (95% CI)	Weigh
Test Sco	pres				
2001 0	Cooper Moore		-	0.58 (0.34, 0.82)	19.94
2004 0	Drme			0.14 (-0.35, 0.62)	13.43
2008 N	Meyer			0.28 (0.06, 0.50)	20.52
2012 M	Mery		*	0.66 (0.14, 1.18)	12.64
2012	lic	-		0.00 (-0.41, 0.41)	15.38
2015 F	Rinto			0.31 (-0.51, 1.13)	7.51
2015 H	Karimi			1.40 (0.78, 2.02)	10.57
Subtotal	(I-squared = 68.3%, p = 0.004)	$\langle$	>	0.45 (0.18, 0.72)	100.00
Assignm	ent Scores				
2011 F	Fitzpatrick		•	0.62 (0.30, 0.94)	100.00
Subtotal	(I-squared = .%, p = .)	<	>	0.62 (0.30, 0.94)	100.00
NOTE: V	Veights are from random effects and	alysis			

### Appendix A Meta-analysis: Traditional Versus No Instruction

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# Appendix B

Additional file: Evidence Table: Effectiveness