

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

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Résumé de l'article

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 meta-analysis, 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.

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Research Article

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

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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 meta-analysis, 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-to-face 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 wide-scale 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 & Brett, 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 posttest OR post-test 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 (see Appendix) 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

Table 2
Inclusion/Exclusion Criteria

Population	<ul style="list-style-type: none"> Undergraduates and postgraduates enrolled in higher education coursework programs
Intervention	<ul style="list-style-type: none"> 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	<ol style="list-style-type: none"> Face-to-face Online 'Blended' (with face-to-face and online components)
Outcomes	<p><i>Primary outcome</i></p> <ul style="list-style-type: none"> Change in information literacy skills <p><i>Secondary outcomes</i></p> <ul style="list-style-type: none"> Student views on the educational format(s)
Limits	Studies published since January 1995
Types of evidence included	Randomized and non-randomized controlled studies
Exclusions	<ul style="list-style-type: none"> 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)

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 meta-analysis 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 random-effects or fixed effects meta-analysis. Random-effects 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 (see Appendix).

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

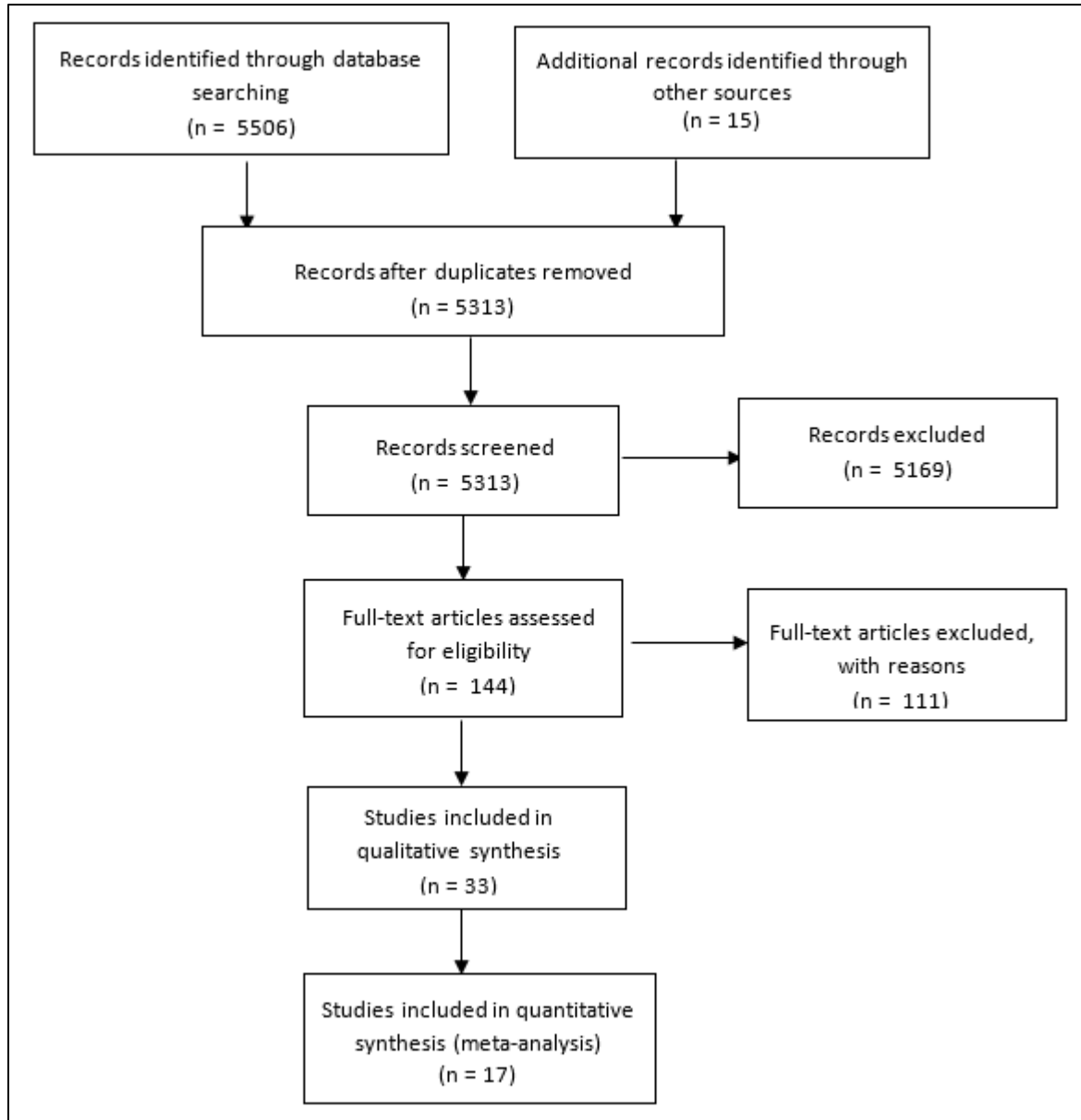


Figure 1
Flow diagram ('n' indicates the number of studies).

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: Skills	Outcomes: Views	Limitations
<p>First author and year: Alexander 2001</p> <p>Study Design: CBA, posttest only</p> <p>Delivered by: Graduate student (FtF); Course coordinator (online)</p>	<p>Setting: Western Kentucky University, U.S.</p> <p>Participants: 88 undergraduates on Library Media course</p>	<p>Interventions: (1) Face-to-face (2) Online</p> <p>Hours of contact time: 14x 1h course (face-to-face) vs. self-paced (online)</p>	<p><i>Neutral</i></p> <p>No pretest. Mean scores posttest for skill levels: 82.6 (traditional) and 85 (online).</p> <p>Follow-up period: N/S</p>	<p><i>Favoured online</i></p> <p>Preference for the online course in terms of:</p> <ul style="list-style-type: none"> perceived benefits/effectiveness of course (p<0.05) comfort in doing library research (p<0.01). 	<p>Researcher was both teacher and investigator. Students self-selected for online course. No pretest. No piloting or validation of test. No information on participant loss.</p>

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

Delivered by: Librarian	composition course		Follow-up period: Immediately post-training		results.
First author and year: Brettle 2013	Setting: University of Salford, U.K.	Interventions: (1) Face-to-face (2) Online	<i>Neutral</i> Skills increased (p=0.001) with no significant differences between formats (p=0.263).	-	Loss of participants was explained but only 71% completion and no intention to treat analysis.
Study Design: RCT	Participants: 77 undergraduate nursing students	Hours of contact time: 1 hour	Follow-up period: 1 month		
Delivered by: Librarian					
First author and year: Burhanna 2008	Setting: Kent State University, Ohio U.S.	Interventions: Library tour (1) Face-to-face (2) Online	No pretest. <i>Neutral</i> Greater understanding of library services in online group (92% compared with 82.6%; no significance levels) although no difference in knowledge gained.	<i>Neutral</i> The majority of students in both formats agreed that <ul style="list-style-type: none"> • The course was effective/beneficial and they were • Comfortable in asking for help from library staff • More comfortable in doing library research • More likely to use the library 	Students self-selected type of course, and whether they participated in survey. Over half of in-person participants selected by instructor. No pretest. No validation of test.
Study Design: CBA	Participants: 313 undergraduates on orientation program	Hours of contact time: 0.5h	Follow-up period: N/S		
Delivered by: Librarian					
First author and year: Byerley 2005	Setting: University of Colorado, U.S.	Interventions: (1) Face-to-face (2) Blended – FtF with	<i>Neutral</i> Skills increased slightly in each	<i>Unclear</i> No useable data – views of online groups only were	FtF course introduced three databases while online course

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

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

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

<p>First author and year: Kaplowitz 1998</p> <p>Study Design: CBA</p> <p>Delivered by: Teaching assistants</p>	<p>Setting: UCLA, U.S.</p> <p>Participants: 423 biology undergraduates</p>	<p>Interventions: (1) Face-to-face (lecture) (2) Online (CAI)</p> <p>Hours of contact time: 50 minutes (lecture), 45-60 minutes (CAI)</p>	<p><i>Neutral</i> Skills increased in each group with no differences between formats.</p> <p>Follow-up period: ~12 months</p>	<p><i>Unclear</i> No useable data – views of online group only were sought.</p>	<p>No information on group characteristics. No content info/validation of test. Only those completing pre/posttests evaluated. No confidence intervals or p values.</p>
<p>First author and year: Koenig 2001</p> <p>Study Design: RCT</p> <p>Delivered by: Librarian</p>	<p>Setting: University of Illinois at Chicago, U.S.</p> <p>Participants: Undergraduates (number unstated) on a communication course</p>	<p>Interventions: (1) Fact to face (2) Online</p> <p>Hours of contact time: FtF unclear Online 50 mins</p>	<p><i>Neutral</i> Skills increased in each group with no differences between formats.</p> <p>Follow-up period: N/S ('end of module')</p>	<p><i>Neutral</i> Confidence/self-efficacy increased in both groups although no difference between groups.</p>	<p>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.</p>

<p>First author and year: Kraemer 2007</p> <p>Linked to Greer 2016</p> <p>Study Design: cRCT</p> <p>Delivered by: Librarian</p>	<p>Setting: Oakland University, Michigan, U.S.</p> <p>Participants: 224 undergraduates on Rhetoric composition class</p>	<p>Interventions: (1) Face-to-face (2) Blended online plus FtF (3) Online (WebCT)</p> <p>Hours of contact time: FtF 3h. Blended self-paced plus 2h. Online self-paced</p>	<p><i>Favoured blended</i></p> <p>Skills increased in each group ($p < 0.0000$) with a significantly greater pre-post improvement in the blended compared to the online only group ($p = 0.023$).</p> <p>Follow-up period: N/S</p>	<p><i>Neutral</i></p> <p>Similar levels of satisfaction (perceived effectiveness/benefits) across groups.</p>	<p>High pretest scores (~70%) limited value of test scores. Lack of information on student characteristics. Test not piloted or validated.</p>
<p>First author and year: Kratochvil 2014</p> <p>Study Design: CBA</p> <p>Delivered by: Librarian</p>	<p>Setting: Masaryk University, Czech Republic</p> <p>Participants: 251 Medicine undergraduates & postgraduates</p>	<p>Interventions: (1) Face-to-face (2) Online</p> <p>Hours of contact time: Unclear. Possibly 3x2.5h sessions for FtF</p>	<p><i>Unclear</i></p> <p>Skills increased in each group although unclear if any differences between groups.</p> <p>Follow-up period: N/S</p>	<p>-</p>	<p>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.</p>
<p>First author and year: Lantzy 2016</p> <p>Study Design: CBA</p>	<p>Setting: California State University, U.S.</p> <p>Participants: 64 undergraduates in a kinesiology course</p>	<p>Interventions: (1) Face-to-face (2) Online</p> <p>Hours of contact time: 1.25 hours</p>	<p><i>Neutral</i></p> <p>Both groups showed highly significant pre-post test score increases ($p < 0.0001$) but</p>	<p><i>Neutral</i></p> <p>No significant differences across formats in views re:</p> <ul style="list-style-type: none"> • confidence/self-efficacy • clarity of presentation • responsiveness of instructor 	<p>No information on student characteristics. Tests were not piloted or validated.</p>

Delivered by: Librarian			there were no significant differences between groups. Follow-up period: Immediately after training		
First author and year: Lechner 2007 Study Design: RCT Delivered by: Librarian	Setting: Richard Stockton College of New Jersey, U.S. Participants: 27 occupational/physical therapy postgraduates	Interventions: (1) Face-to-face (2) Online Hours of contact time: Not stated. Online probably self-paced.	<i>Favoured face-to-face</i> % change pre to post = 8.1% for the online group and 18.1% for the FtF group. Follow-up period: N/S (probably same day)	-	Different sized groups and no information on characteristics. Only 63% completed both tests. Much higher pretest scores in online group. No confidence intervals or p values.
First author and year: Mery 2012a, 2012b Study Design: CBA Delivered by:	Setting: University of Arizona, U.S. Participants: 660 undergraduates on English compositional course	Interventions: (1) Face-to-face (tutor) (2) Face-to-face (librarian) (3) Online Hours of contact time: FtF 50 mins. Online over 10 weeks	<i>Favoured online</i> Skills increased significantly in the FtF librarian and online groups but not in the tutor group. The online group performed better	-	Content and delivery varied between formats. No student characteristics and some selection by instructors. Much larger online group (570 students compared to circa 30

FtF: Tutor (1); Librarian (2); Online: Librarian			than FtF groups in both skills test (Mery 2012a) and assignment scores (bibliography quality) (Mery 2012b). Follow-up period: N/S		in other groups). No discussion of participant loss.
First author and year: Nichols 2003 Study Design: CBA Delivered by: Librarian	Setting: State University of New York (SUNY), U.S. Participants: 64 undergraduates on English composition course	Interventions: (1) Face-to-face (2) Online Hours of contact time: FtF 50 mins. Online unclear	<i>Neutral</i> Skills increased slightly in each group although no difference between groups. Follow-up period: N/S	<i>Neutral</i> No differences between groups re: <ul style="list-style-type: none"> • perceived benefits/effectiveness • satisfaction • confidence levels • preference for format 	No information on the characteristics of each group. Test not described or validated. No information on loss of participants.

<p>First author and year: Nichols Hess 2014</p> <p>Study Design: CBA</p> <p>Delivered by: Librarian</p>	<p>Setting: Oakland University, Rochester, U.S.</p> <p>Participants: 31 undergraduate sociology students</p>	<p>Interventions: (1) Face-to-face (2) Online</p> <p>Hours of contact time: FtF not stated Online self paced</p>	<p><i>Neutral</i> Skills increased in each group with no difference between groups.</p> <p>Follow-up period: Up to two months</p>	<p><i>Neutral</i> No significant differences between formats in:</p> <ul style="list-style-type: none"> • Comfort in asking for help • Using library resources <p>Students receiving FtF instruction valued the personal connection and responsiveness of instructor. Those receiving online instruction valued the convenience and ability to repeat sections.</p>	<p>Very little methodological information. Different numbers in each group and no information on student characteristics. Test not piloted or validated. Only completers analyzed. Not possible to assess statistical significance of results.</p>
<p>First author and year: Orme 2004</p> <p>Study Design: CBA</p> <p>Delivered by: Librarian</p>	<p>Setting: Indiana University, U.S.</p> <p>Participants: 128 business undergraduates</p>	<p>Interventions: (1) Face-to-face (2) Blended online (TILT) plus FtF (3) Online only (TILT)</p> <p>Hours of contact time: Unstated</p>	<p><i>Neutral</i> No pretest. No statistically significant difference between groups.</p> <p>Follow-up period: ~10 weeks (next semester)</p>	<p>-</p>	<p>Only students designated as 'successful' (passing TILT quizzes or seminar) were included in the study. Exact content, length and intensity of teaching for each cohort not clear. Test not validated. No pretest.</p>
<p>First author and year: Salisbury 2003</p> <p>Study Design: CBA</p>	<p>Setting: University of Melbourne, Australia</p> <p>Participants: 282 history/film undergraduates</p>	<p>Interventions: (1) Face-to-face (lecture) (2) Face-to-face (hands on) (3) Online</p> <p>Hours of contact time:</p>	<p><i>Neutral</i> Skills increased in each group although no clear differences between groups.</p>	<p>-</p>	<p>No detail on content, length or intensity of each mode of delivery. No student characteristics. No validation of test. No confidence intervals or</p>

Delivered by: Information specialist		1 hour	Follow-up period: N/S		p values.
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	<i>Neutral</i> No statistically significant difference between groups in MEDLINE searching score. Follow-up period: Two weeks for skills test: 15 weeks for attitudes survey	No pretest <i>Neutral</i> No significant differences between formats in terms of: <ul style="list-style-type: none"> Perceived effectiveness Likelihood of using library (more) 	No information on student characteristics. No validation of test. No confidence intervals with results.
First author and year: Shaffer 2011 Study Design: RCT Delivered by: Librarian	Setting: University of New York at Oswego, U.S. Participants: 59 postgraduates on a research methods course	Interventions: (1) Face-to-face (2) Online Hours of contact time: ~2 hours	<i>Neutral</i> Skills increased in each group although no difference between groups. Follow-up period: N/S	<i>Favoured face-to-face*</i> The FtF group had higher satisfaction scores on the 5-point Likert scale (4.03 viz 3.41).	Tests were not validated. *Online group experienced technical difficulties.
First author and year: Silk 2015 Study Design: CBA	Setting: Midwestern University, U.S. Participants: 232 undergraduates on	Interventions: (1) Face-to-face (2) Online Hours of contact time: 1 hour	<i>Neutral</i> Skills increased in each group with no significant difference	<i>Neutral</i> No significant differences in: <ul style="list-style-type: none"> Confidence/self-efficacy engagement/dynamism 	No information on student characteristics. Tests not piloted or validated. Only those who completed post and delayed posttest

Delivered by: 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 and year: Silver 2007 Study Design: CBA Delivered by: Librarian	Setting: University of South Florida, U.S. Participants: 295 psychology undergraduates	Interventions: (1) Face-to-face (2) Online Hours of contact time: FtF Not stated. Online self-paced (allowed one week)	<i>Neutral</i> No pretest. No posttest difference between groups. Follow-up period: N/S	<i>Unclear</i> Marginally greater number in online group saying they were more confident or much more confident after instruction (88.4% vs. 78.3% for FtF).	Students allowed to self-select group. Student characteristics varied (and different year groups were used). Test was not validated. No pretest.
First author and year: Swain 2015 Study Design: RCT Delivered by: Librarian	Setting: Cardiff University, U.K. Participants: 58 dental undergraduates	Interventions: (1) Face-to-face (2) Online Hours of contact time: FtF 50 mins. Online: Self-paced within 50 min slot	<i>Neutral</i> Skills increased in each group although no significant difference between groups. Follow-up period: 5 days	<i>Neutral</i> Overall no significant differences in <ul style="list-style-type: none"> • comfort in asking for library assistance • preference for format other than tendency to favour of the format allocated. 	Limited information on characteristics. Test was piloted although not validated. Only 58 students attended training but 60 claimed training received at posttest.

<p>First author and year: Vander Meer 1996</p> <p>Study Design: RCT</p> <p>Delivered by: Librarian</p>	<p>Setting: Western Michigan University, U.S.</p> <p>Participants: 186 undergraduates on high school/University transition course</p>	<p>Interventions: (1) Face-to-face (2) Online</p> <p>Hours of contact time: Not stated.</p>	<p><i>Neutral</i></p> <p>Skills increased in each group although no significant difference between groups ($p < 0.05$).</p> <p>Follow-up period: ~10 weeks (end of semester)</p>	<p><i>Neutral</i></p> <p>No difference in perceived:</p> <ul style="list-style-type: none"> • Confidence/self-efficacy • Clarity • Interest <p>Online group perceived greater enjoyment ($p = 0.05$)</p>	<p>All students had access to tutorial. Test not piloted or validated. Only 53% completion of posttest. No characteristics although large samples with similar baseline skill and survey results.</p>
<p>First author and year: Walton 2012</p> <p>Study Design: CBA</p> <p>Delivered by: Librarian</p>	<p>Setting: Staffordshire University, U.K.</p> <p>Participants: 35 sport and exercise undergraduates</p>	<p>Interventions: (1) Blended (2) Intermediate: FtF plus access to online materials (3) Face-to-face</p> <p>Hours of contact time: Blended 4x50 mins Others 50 mins</p>	<p>No pretest</p> <p><i>Neutral</i></p> <p>Students in the blended group made greater use of evaluative criteria than those in the intermediate or FtF groups but this was not statistically significant.</p> <p>Follow-up period: Not stated, possibly at end of 5 week intervention period</p>	<p>-</p>	<p>Groups different sizes and no student characteristics. Assessors not blinded to group. Evaluation criteria not validated. Small sample size. Four times as much contact time for the blended vs. FtF and intermediate formats.</p>

<p>First author and year: Wilcox Brooks 2014</p> <p>Study Design: CBA</p> <p>Delivered by: Librarian</p>	<p>Setting: Northern Kentucky University, U.S.</p> <p>Participants: 38 undergraduates in advanced composition courses</p>	<p>Interventions: (1) Blended (2) Face-to-face</p> <p>Hours of contact time: Not stated</p>	<p><i>Neutral</i> No significant differences between groups in bibliographic analysis of final course paper.</p> <p>Follow-up period: Not stated</p>	<p><i>Unclear</i> No useable data – views of the blended group only were sought.</p>	<p>Hours of contact time not stated. No information on student characteristics. Outcome measures not piloted or validated</p>
<p>First author and year: Wilhite 2004</p> <p>Study Design: CBA</p> <p>Delivered by: Librarian</p>	<p>Setting: University of Oklahoma, U.S.</p> <p>Participants: 44 business undergraduates</p>	<p>Interventions: (1) Face-to-face (2) Online (3) No instruction</p> <p>Hours of contact time: Not stated. 45 min video</p>	<p><i>Neutral</i> Skills increased in each group when compared to control (p=0.010) although no significant difference between intervention groups (p=0.75).</p> <p>Follow-up period: N/S</p>	<p><i>Favoured face-to-face</i> General preference for FtF with higher scores from FtF group for</p> <ul style="list-style-type: none"> • Satisfaction • Clarity • Length of course 	<p>Slightly different numbers in groups and pretest scores are very different suggesting characteristics varied across groups. Test not piloted or validated. Issues for online group.</p>

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 post- results, 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-to-face delivery (Churkovich & Oughtred, 2002; Goates et al., 2016) and one favoured the blended delivery option (Kraemer et al., 2007).

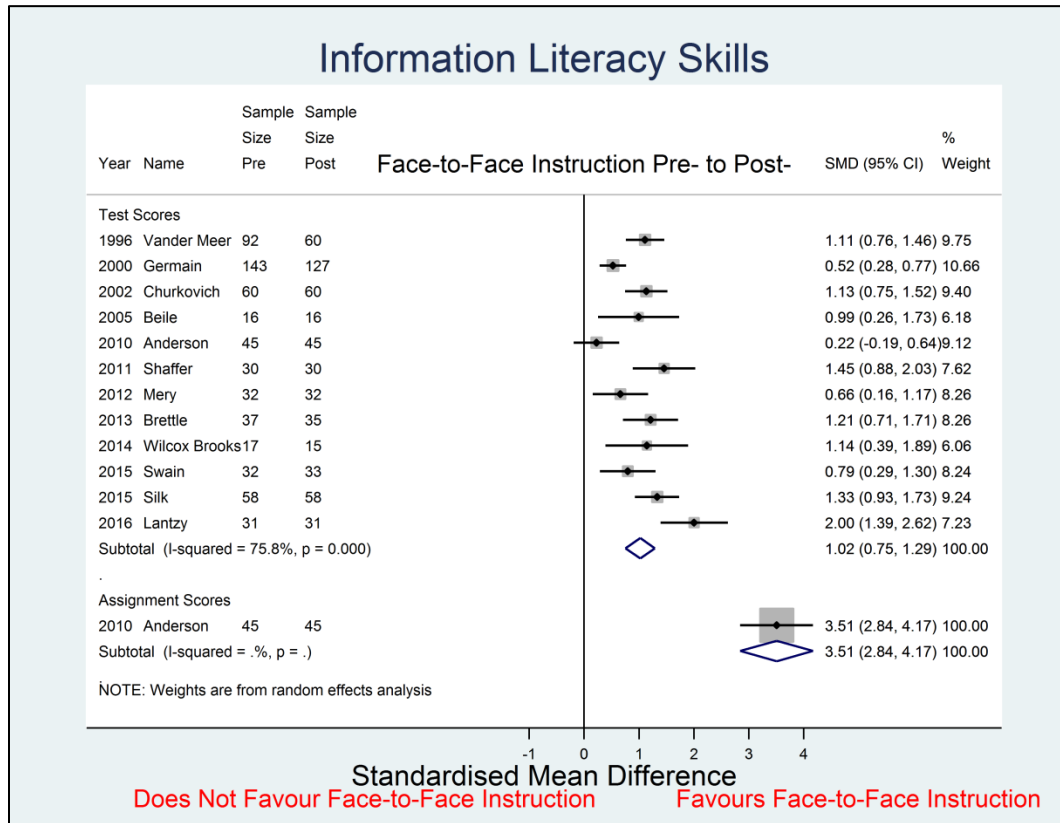


Figure 2 Change in information literacy skills pre- to post-instruction face-to-face.

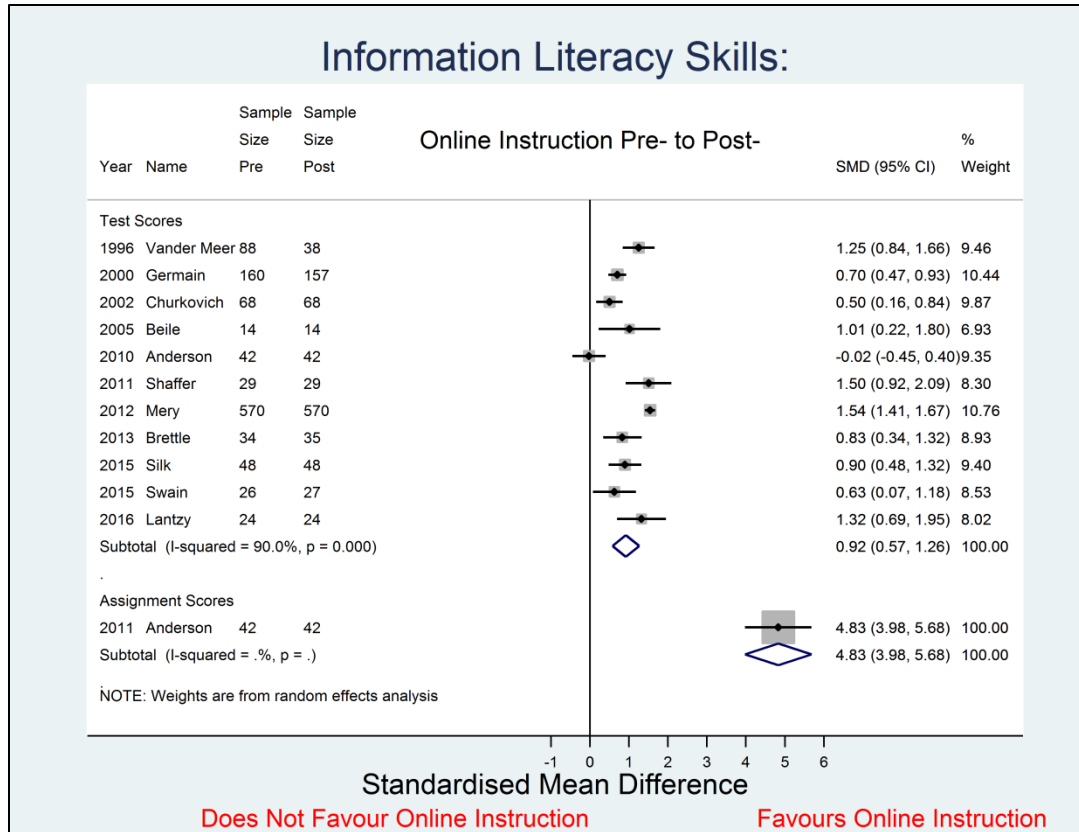


Figure 3
Change in information literacy skills pre- to post-instruction online

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-to-face 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

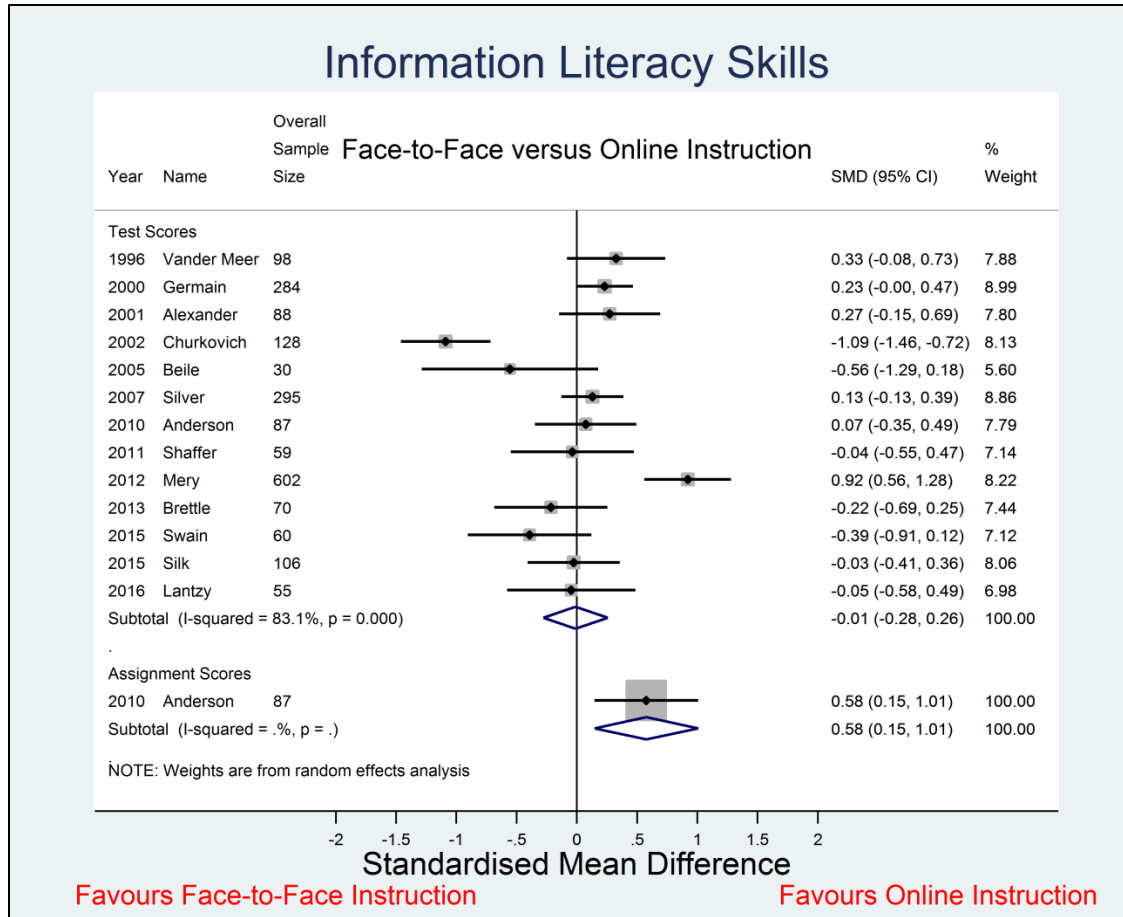


Figure 4
Comparison of information literacy skills for face-to-face vs. online instruction.

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.

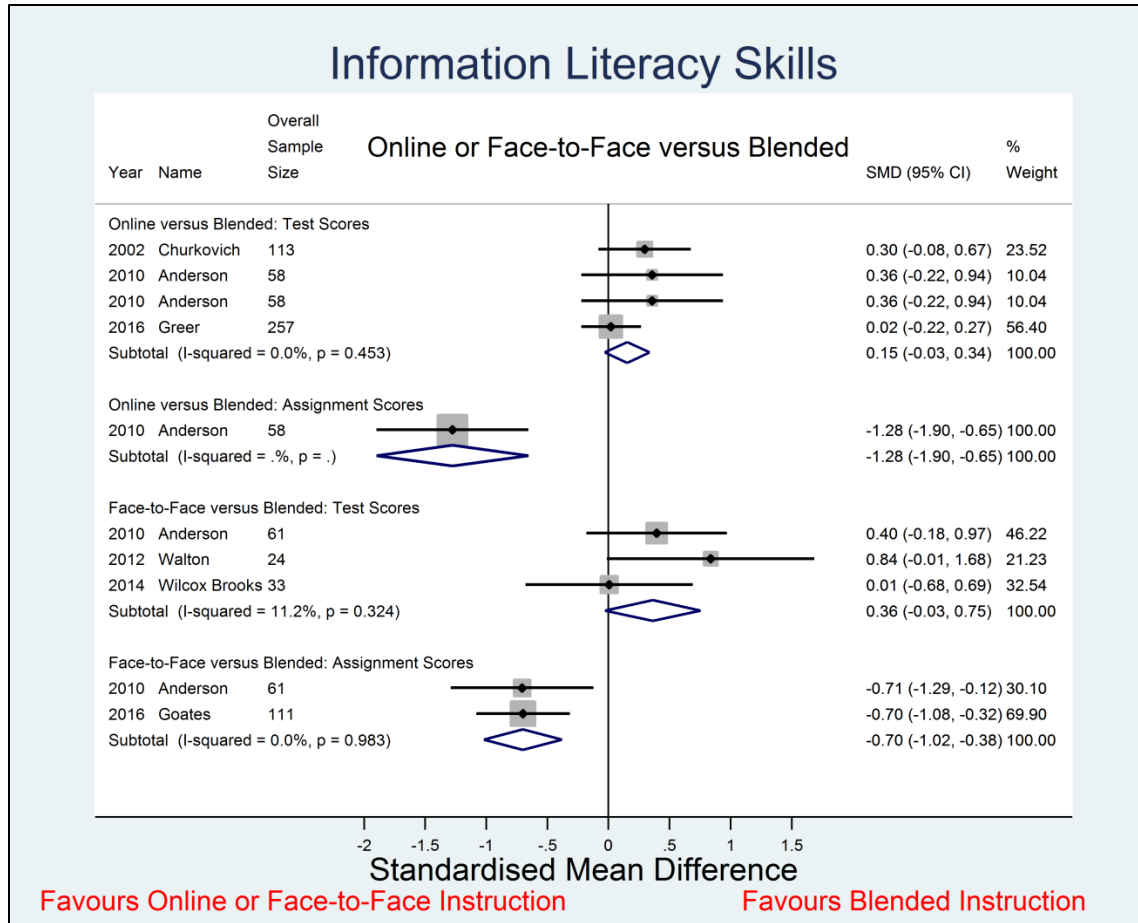


Figure 5 Comparison of information literacy skills for online or face-to-face instruction versus blended instruction.

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-to-

face 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-to-face 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.

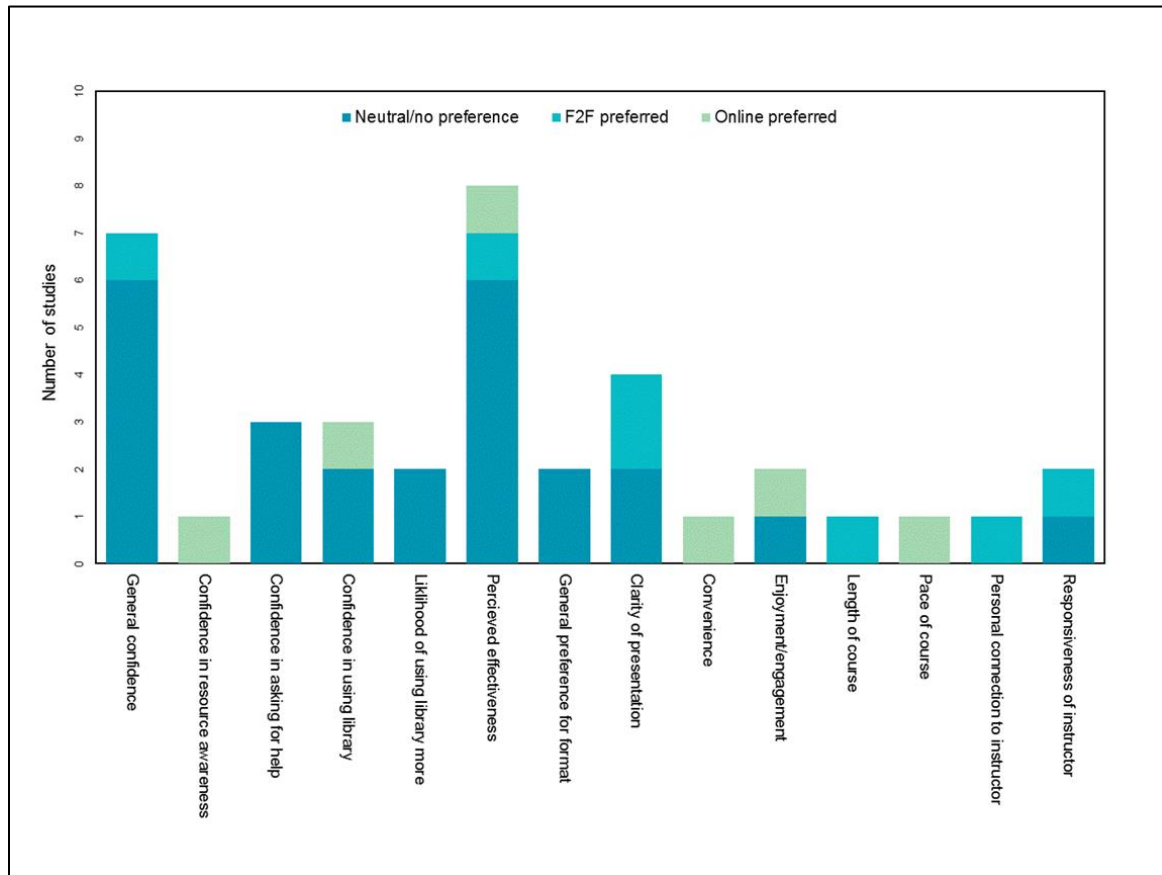


Figure 6 Analysis of student views on face-to-face versus online formats [numbers of studies].

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 face-to-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 pre- and 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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Appendix

Additional file: [Evidence Table: Effectiveness](#)