Article

Re-visioning library support for undergraduate educational programmes in an academic health sciences library: A scoping review

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Abstract

McMaster University's Health Sciences Library (HSL) began to transition to a new liaison service model in early 2018. One of its librarians sought to understand how an academic health sciences library can optimise its support for academic undergraduate programmes. This scoping review of the literature was pursued with the aim to submit an informed recommendation to HSL's new Education and Lifelong Learning team, so the library could shift its approach to information literacy instruction in a manner that would optimise its outcomes for students and improve relationships with faculty staff.

The author searched seven databases: Library, Information Science & Technology Abstracts (LISTA), ProQuest ERIC, OVID Embase, EBSCO CINAHL, OVID Medline, Web of Science and PapersFirst. She developed a robust and comprehensive search strategy that used a combination of subject headings and keywords to describe information literacy, metaliteracy, libraries and health sciences education. The author also hand-searched bibliographies of seminal publications to broaden her search for relevant literature.

The findings in this review indicate that metaliteracy as a concept has not been intentionally implemented into information literacy training at academic health sciences libraries. The review finds that it is preferable to integrate information literacy skills directly into course or programme curricula and align those skills with the evidence-based practice skills undergraduates are already learning. Further, establishing a programme that builds on these skills gradually throughout the duration of the academic programme, rather than one-shot library instruction, is also preferred. To achieve success, libraries must build strong collaborative relationships with faculty staff.

The author provides recommendations for practice that reflect the findings of this review. Other academic health libraries may benefit from this review by taking into consideration its findings and subsequent recommendations.

Keywords

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1. Introduction

In early 2017 librarians at McMaster University's Health Sciences Library (HSL) investigated alternative models for the provision of liaison services in academic health sciences libraries (Banfield & Petropoulos, 2017). This investigation led to a transition away from the traditional

programme-based liaison service model and towards a functional team model that included a team of librarians dedicated to the support of educational programmes and lifelong learning within McMaster University's Faculty of Health Sciences. This transition prompted several questions about how the provision of programme support might change as the library shifts to the functional team model. The author viewed this change as an opportunity to re-examine the way librarianship has been practised within this organisation and to challenge its librarians to think differently about how they approach library support for educational programmes.

In 2011 Trudi Jacobson and Thomas Mackey began to challenge librarians to reframe information literacy (IL) as a metaliteracy (ML) based on the premise that all types of literacy have IL theory at their foundation. In reframing IL as a ML, libraries can support the various literacy needs of their communities, give these communities the skills they need to adapt to new changes to information and by extension support lifelong learning by helping individuals become adaptive learners (Jacobson & Mackey, 2011).

In this digital era, information is produced at a rapidly expanding rate in proportions and through platforms never before seen in our history. In the library community of practice, it is generally accepted that it is the role of libraries and librarians to assist users as they navigate a precipitously expanding landscape of information. Librarians have taken on the role of teaching IL skills to their user communities and in an environment where information is expanding exponentially, it is critical to rethink what IL is, what IL skills look like, and how to engage students in a discussion that will promote their understanding of IL. Since ML is a reframing of IL, much of the literature still refers to IL, so the terms IL and ML will be used interchangeably, although the author acknowledges that these terms are not necessarily synonymous.

2. Background

In 2009, David Bawden and Lyn Robinson, of City University London, published an article ominously titled 'The dark side of information: overload, anxiety and other paradoxes and pathologies'. The article discusses the complex causes of information overload and the changing information environment with the introduction of Web 2.0 (Bawden & Robinson, 2009). They specifically identify science and healthcare as two specialty areas where information overload is a recognisable issue and they also posit that 'it has been a matter of concern to information specialists in all environments, including academic… libraries' (Bawden & Robinson, 2009, p.184).

In a changing and expanding information environment where information in any format could be, or not be, valid, and where that information has the ability to change at any given moment, Trudi Jacobson and Thomas Mackey have led the practice of librarianship towards ML. ML requires information literate users to draw on their metacognitive skills in order to successfully engage with information, and produce it, in all formats.

Mackey and Jacobson's argument in favour of reframing IL as ML is founded on the principle that IL rests at the foundation of several other types of literacies such as, but not limited to, cyber literacy, digital literacy, visual literacy, and media literacy. The concept of ML closes the gap between IL and other literacy types and strengthens the connection between them (Jacobson & Mackey, 2011). Metaliteracy is described as 'a unified construct that supports the acquisition, production, and sharing of knowledge in collaborative online communities' (Jacobson & Mackey, 2011, p.62). It 'integrates emerging technologies and unifies multiple literacy types. [It] places a particular emphasis on producing and sharing information in a participatory digital environment' (Jacobson & Mackey, 2011, p.70).

Mackey and Jacobson argue that information is not static, but a dynamic entity, and that the previous authority on IL, the Association of College and Research Libraries' (ACRL) *Information*

Literacy Competency Standards for Higher Education (2000) was 'developed prior to the astonishing rise of social media and collaborative online communities and do[es] not fully address the information knowledge required to participate in these new environments' (Jacobson & Mackey, 2011, p.63). In contrast, metaliterate learners recognise they are both consumers and producers of information and they are metacognitive learners – they must think about their thinking while they engage with information (Mackey & Jacobson, 2014). This is where traditional skills-based IL instruction, as found in one-shot instruction for example, falls short.

Mackey and Jacobson were also influential in the production of the ACRL's more recent guide to IL, the *Framework for Information Literacy for Higher Education* (2015). The Framework draws upon six frames, rather than competencies, to emphasise a more theoretical approach to IL instruction. As with metaliteracy, it is more applicable to current and emerging information environments.

Jacobson and Mackey, as well as the Framework, challenge librarians to move away from the one-shot library instruction sessions towards a developmentally-focused integration into the students' academic programme (Association of College and Research Libraries, 2015). ML pushes the traditional boundaries of IL because information is now ubiquitous, plentiful in varying degrees and multiple formats, and it evolves swiftly. It:

> Applies to all stages and facets of an individual's life. It is not limited to the academic realm, nor is it something learned once and for all… ML focuses on *adaptability* [emphasis mine] as information environments change and the *critical reflection* [emphasis mine] necessary to recognize new and evolving needs in order to remain adept (Jacobson & Mackey, 2016, p. xv-xvi)

As HSL transitions to a functional team liaison model for the delivery of its services, the library is presented with a significant opportunity to shift HSL's traditional approach to the IL instruction it currently provides to support educational programmes. Before the transition to functional teams, six librarians at HSL provided liaison services that included, but were not limited to, content tailored to a course or programme or general library instruction (Banfield & Petropoulos, 2017). The new liaison model creates space for HSL to pursue the development of educational programme support that extends beyond skills-based learning and builds the metacognitive skills of the learners in the Faculty of Health Sciences (FHS). Such an approach has the potential to encourage students to become adaptive learners and thus support their journeys as lifelong learners.

3. Methods

Inspired by Mackey and Jacobson's invitation to librarians to revision IL as a ML, this scoping review aims to answer three questions within the specific context of undergraduate health education in an effort to inform the decision making of HSL's newly formed Education and Lifelong Learning function team:

> RQ1.   What is the landscape of literature on IL support in undergraduate health sciences programmes?
> RQ2.   How prevalent is the emerging concept of ML in health sciences librarianship practice?
> RQ3.   Has the emerging theory of ML influenced or shaped the delivery of IL programmes and instruction in academic health sciences libraries for undergraduate students?

In order to learn more about existing approaches to IL instruction in undergraduate health sciences education and whether or not ML has gained traction in the discipline, a scoping review was selected as the appropriate approach to a review of the literature. The goal of a scoping review is to map key concepts of the literature within a specific field and to identify the major themes that emerge from a thorough and comprehensive literature search (Peters et al., 2017). Unlike a systematic review, a scoping review can include case studies and other qualitative research and is not limited to specific study types and cumulative data is not synthesised to answer a narrow, specific, and often clinical, question. Health sciences education is unique from other disciplines in that it emphasises and prioritises decision-making based on the use of appropriate existing evidence, which is accompanied by the requirement to produce highly skilled information literate programme graduates. A comprehensive literature review that focuses specifically on the health sciences stands to benefit and inform both librarians and faculty staff in health sciences faculties. Library and information sciences (LIS) literature, whether it focuses on theory or professional practice, is widely varied in its approaches, methodology and theoretical foundations and as a result, a systematic review of empirical evidence would not accurately portray IL or ML in health sciences. A scoping review, in this case, allows for a more accurate representation of existing literature and takes into consideration the unique requirements of undergraduate health sciences educational programmes.

In January and February 2019 the author conducted a comprehensive literature search in the following article databases: Library, Information Science & Technology Abstracts (LISTA), ProQuest ERIC, OVID Embase, EBSCO CINAHL, OVID Medline, Web of Science and PapersFirst, using a combination of subject headings and keywords to describe IL, ML, academic libraries and health sciences education (Appendix A). To establish a deeper understanding of ML for background, articles discussing general ML theoretically were reviewed, but not included in the results of the scoping review. The author also hand searched any relevant publications, including those who cited or were cited by Trudi Jacobson and Thomas P. Mackey in their seminal works on ML. A protocol was not published for this review.

Articles were excluded for any of the following reasons:

- The library involved is not affiliated with an academic institution or support undergraduate health education
- The population of the study or report are librarians, health practitioners, graduate students, patients, researchers, professionals, members of the public, or mature students
- The main focus of the article is functional health literacy, information seeking behaviour without IL education, training programmes for librarians and other professionals, undergraduate programmes not supported by the author's HSL, or graduate programmes in health reference services
- The geographic location of the study or report fell outside Australia, Britain, Canada, New Zealand, or the United States of America to control for literature from English-speaking Western nations
- The article was published prior to 2006. The first publication of the term ML was in 2011, but the author applied a buffer of 5 years prior to this to account for the possibility that it may have evolved from earlier literature or conference presentations

Articles were selected for inclusion if they discussed a health sciences programme or course and the involvement of the library in supporting IL within the scope of health sciences education. For the purpose of this review, 'health sciences' was limited to undergraduate educational programmes offered by the authors' institution. These include: anatomy, biomedical

engineering, health sciences, kinesiology, medicine, midwifery, nursing, pharmacology and physician assistant.

4. Results

The author's database searches yielded 2,336 original results. After screening by title and abstract, the author screened once more using the full-text of the articles. 59 articles were retrieved for inclusion in the scoping review (see Appendix B).

4.1 What is the landscape of the literature on IL or ML support in undergraduate health sciences programmes?

Table 1 provides a summary chart of the literature included in this review, organised by article type. Much of the literature published about academic health sciences libraries and their support of IL in undergraduate health sciences programmes are case studies. Secondary to reports on individual cases at specific libraries are research articles that either investigate the impact of a specific library's IL programme, whether it is embedded in a curriculum or course, or not, or evaluate the existing or post-intervention IL skills of students who have received, or are about to receive, IL training. Some articles in the latter category also make recommendations for practice based on the findings shared.

The results of the research studies have a tendency to be so institution specific that the results are not generalisable. Instead, these studies serve as demonstrations of successful IL programmes created by health sciences libraries, often, in collaboration with faculty. Moreover, a common thread between the studies is dubious methodology. There is a clear tendency to collect data using methods that require students to self-report their perceived skill-levels or confidence in understanding IL. This has not gone unnoticed. For example, Martzoukou and Abdi scrutinise health IL studies for their data collection methods and weak methodologies (Martzoukou & Sayyad Abdi, 2017). However, the author found at least one study that reports its collection and analysis evidence with enough scientific rigor to afford the study credibility (Ivanitskaya, O'Boyle & Casey, 2006). Overall, the research methods reported in this body of literature is a significant weakness and must be taken into consideration when assessing the findings reported in individual studies. A small portion of the literature sought to evaluate the IL skills of undergraduate health sciences students and make recommendations for practice based on the findings.

Comprehensive literature reviews were limited. Two focus entirely on IL in undergraduate health sciences education. One specifically examines international trends in e-health literacy, and is therefore not within the scope of this review (Haruna & Hu, 2018). The other investigates the best way to facilitate the development of IL skills among undergraduate health sciences students (Munn & Small, 2017). A broader scoping review that was not retrieved by the literature search explores IL for everyday life and includes a small section on health. It provides commentary on some of the articles included in this review (Martzoukou & Sayyad Abdi, 2017).

Finally, a handful of articles discussed IL as a general topic which either included or did not include health science education. For example, Lawless, Toronto & Grammatica (2016) produce a concept comparison between health literacy and IL; Adams (2014) compares evidence-based practice (EBP) with the ACRL Standards while Knapp & Brower (2014) examine the impact of the ACRL Framework on health sciences librarianship.

Nursing education represented the largest portion, more than medical education, undergraduate health sciences or other specific disciplines, of the literature retrieved and selected for this review. Of the 59 articles selected for inclusion in this review, 37.3% (n=22) used the terms related to nursing or nursing education in the article title directly, or they were published in a nursing or nursing education journal. This could be a reflection of Phelps, Hyde and Planchon

Wolf (2015), who proposed that a relationship between librarians and faculty is required to ensure information literacy standards in nursing are met in nursing education and that nursing, as a profession, generally values the expertise of librarians (Phelps, Hyde & Planchon Wolf, 2015).

The general consensus in the nursing literature is that IL is an essential skill for nursing students (Arndt, 2009; Hopkins et al., 2011; Morgan et al., 2007; Murray & Preston, 2016; Wink & Todd, 2018) and it is deeply intertwined with the skills required to meet EBP competencies. IL is a central focus in nursing education and practice and it is included in the American Association of Colleges of Nursing's 2008 publication *Essentials for Baccalaureate Education for Professional Nursing Practice* (Lawless et al., 2016).

Table 1: Included articles by study type

Year	Author	Title	Source
	Case studies		
2006	Barnett-Ellis, P.; Restauri, S.	Nursing student library usage patterns in online courses: Findings and recommendations	Internet Reference Services Quarterly
2012	Beck, S.; Blake-Campbell, B.; McKay, D.	Partnership for the advancement of information literacy in a nursing program	Community & Junior College Libraries
2015	Bendriss, R.; Saliba, R.; Birch, S.	Faculty and librarians' partnership: Designing a new framework to develop information fluent future doctors	Journal of Academic Librarianship
2015	Brooks, S.V.; Bigelow, S.	Preparing students for research: Faculty/librarian collaboration in a pre-doctoral physical therapy research course	Health Information & Libraries Journal
2013	Clairoux, N.; Desbiens, S.; Clar, M.; Dupont, P.; St-Jean, M.	Integrating information literacy in health sciences curricula: A case study from Quebec	Health Information & Libraries Journal
2016	Curtis, R.	Information literacy advocates: Developing student skills through a peer support approach	Health Information & Libraries Journal
2018	Diaz, S.; Walsh, A.	Promoting evidence-based practice and information literacy through an undergraduate nursing journal club	Pennsylvania Libraries: Research & Practice
2012	Eldredge, J.D.; Morley, S.K.; Hendrix, I.C.; Carr, R.D.; Bengtson, J.	Library and informatics skills competencies statements from major health professional associations	Medical Reference Services Quarterly
2018	Fleming-Castaldy, R.P.	Developing occupational therapy students' information and historical literacy competencies: An interprofessional collaborative project	Journal of the Medical Library Association
2009	Forster, M.	'SEARCH for Health': developing a credited module in health information skills	New Review of Academic Librarianship
2016	Franzen, S.; Bannon, C.M.	Merging information literacy and evidence-based practice in an undergraduate health sciences curriculum map	Communications in Information Literacy
2015	Funnell, P.	Drop-in sessions as an effective format for teaching information literacy: A case study in the Medical and Dental Libraries at Queen Mary University of London	Journal of Information Literacy
2006	Haines, M.; Horrocks, G.	Health information literacy and higher education: The King's College London approach	Library Review
2008	Hamilton, L.	Embedding information literacy into the prehospital care curriculum	Journal of Emergency Primary Health Care

Year	Author	Title	Source
	Case studies		
2010	Hegarty, N.; Carbery, A.	Piloting a dedicated information literacy programme for nursing students at Waterford Institute of Technology libraries	Library Review
2015	Hoberecht, T.; Randall, K.; Schweikhard, A.J.	Library tutorials in an allied health evidence-based practice class	Medical Reference Services Quarterly
2011	Hopkins, B.; Callister, L.C.; Mandleco, B.; Lassetter, J.; Astill, M.	Librarians as partners of the faculty in teaching scholarly inquiry in nursing to undergraduates at Brigham Young University	Science & Technology Libraries
2008	Innes, G.	Faculty-librarian collaboration: An online information literacy tutorial for students	Nurse Educator
2013	Jakubec, S.L.; Astle, B.J.	Students connecting critical appraisal to evidence-based practice: A teaching-learning activity for research literacy	Journal of Nursing Education
2012	Janke, R.; Pesut, B.; Erbacker, L.	Promoting information literacy through collaborative service learning in an undergraduate research course	Nurse Education Today
2009	Leasure, A.R.; Delise, D.; Clifton, S.C.; Pascucci, M.A.	Health information literacy: Hardwiring behavior through multilevels of instruction and application	Dimensions of Critical Care Nursing
2014	McCulley, C.; Jones, M.	Fostering RN-to-BSN students' confidence in searching online for scholarly information on evidence-based practice	Journal of Continuing Education in Nursing
2016	Miller, M.; Neyer, L.	Mapping information literacy and written communication outcomes in an undergraduate nursing curriculum	Pennsylvania Libraries: Research & Practice
2007	Morgan P.D.; Fogel J.; Hicks P.; Wright L.; Tyler I.	Strategic enhancement of nursing students' information literacy skills: Interdisciplinary perspectives	The ABNF Journal: Official Journal of the Association of Black Nursing Faculty in Higher Education, Inc
2012	Morley, S.K.; Hendrix, I.C.	'Information Survival Skills': A medical school elective	Journal of the Medical Library Association
2018	Muellenbach, J.M.; Houk, K.M.; Thimons, D.E.; Rodriguez, B.	Integrating information literacy and evidence-based medicine content within a new School of Medicine curriculum: Process and outcome	Medical Reference Services Quarterly
2010	Muir, G.; Heller-Ross, H.	Is embedded librarianship right for your institution?	Public Services Quarterly
2016	Murray, A.; Preston, H.	Empowering international nursing students to become effective library users	Health Information & Libraries Journal
2018	Nizami, S.; Renon, F.	Integrated information rich engineering course design	2018 40th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC)
2010	Phillips, R.M.; Bonsteel, S.H.	The faculty and information specialist partnership: Stimulating student interest and experiential learning	Nurse Educator
2013	Powell, C.A.; Ginier, E.C.	Lessons learned: Year-by-year improvement of a required information competency course	Medical Reference Services Quarterly
2018	Quilty, M.; Dawe, L.	Online tutorials help medical students be 'research ready'	InCite

Year	Author	Title	Source
	Case studies		
2009	Schutt, M.A.; Hightower, B.	Enhancing RN-to-BSN students' information literacy skills through the use of instructional technology	Journal of Nursing Education
2017	Sin, M.-K.; Bliquez, R.	Teaching evidence-based practice to undergraduate nursing students	Journal of Professional Nursing : Official Journal of the American Association of Colleges of Nursing
2018	Spring, H.	Teaching and learning in action	Health Information & Libraries Journal
2018	Tagge, N.	Leveraging accreditation to integrate sustainable information literacy instruction into the medical school curriculum	Journal of the Medical Library Association
2011	Ware, F.	The development of a blended learning approach to delivering information skills training to large health related student audiences with limited staff resource	Health Information & Libraries Journal
2010	Xiao, J.	Integrating information literacy into Blackboard	Library Management
	Research articles		
2009	Arndt, R.M.	Library and information literacy	Journal of Emergency Nursing
2011	Carr, S.; Iredell, H.; Newton-Smith, C.; Clark, C.	Evaluation of information literacy skill development in first year medical students	Australian Academic & Research Libraries
2007	Craig, A.; Corrall, S.	Making a difference? Measuring the impact of an information literacy programme for pre-registration nursing students in the UK	Health Information & Libraries Journal
2011	Cullen, R.; Clark, M.; Esson, R.	Evidence-based information-seeking skills of junior doctors entering the workforce: An evaluation of the impact of information literacy training during pre-clinical years	Health Information & Libraries Journal
2013	Eldredge, J.D.; Bear, D.G.; Wayne, S.J.; Perea, P.P.	Student peer assessment in evidence-based medicine (EBM) searching skills training: An experiment	Journal of the Medical Library Association
2006	Ivanitskaya, L.; O'Boyle, I.; Casey, A.M.	Health information literacy and competencies of information age students: Results from the interactive online Research Readiness Self-Assessment (RRSA)	Journal of Medical Internet Research
2008	Kloda, L.A.	Health information literacy in Canadian medical curricula: An opportunity for librarians?	Journal of Hospital Librarianship
2008	Nayda, R; Rankin, E	Information literacy skill development and lifelong learning: Exploring nursing students' and academics' understandings.	Australian Journal of Advanced Nursing
2014	Rana, G.K.	Information empowerment: Predeparture resource training for students in global health.	Journal of the Medical Library Association
2018	Russell, F.; Rawson, C.; Freestone, C.; Currie, M.; Kelly, B.	Parallel lines: A mixed methods impact analysis of co-curricular digital literacy online modules on student results in first-year nursing	College & Research Libraries
2017	Saliba, R.; Mussleman, P.; Fernandes, M.; Bendriss, R.	Promoting information literacy of pre-medical students through project-based learning: A pilot study	International Journal of Education and Literacy Studies

Year	Author	Title	Source
Systematic or scoping review			
2018	Haruna, H.; Hu, X.	International trends in designing electronic health information literacy for health sciences students: A systematic review of the literature	Journal of Academic Librarianship
2017	Munn, J.; Small, J.	What is the best way to develop information literacy and academic skills of first year health science students? A systematic review	Evidence Based Library & Information Practice
Information literacy as general topic			
2014	Adams, N.E.	A comparison of evidence-based practice and the ACRL Information Literacy Standards: Implications for information literacy practice	College & Research Libraries
2014	Knapp, M.; Brower, S.	The ACRL framework for information literacy in higher education: Implications for health sciences librarianship	Medical Reference Services Quarterly
2016	Lawless, J.; Toronto, C.E.; Grammatica, G.L.	Health literacy and information literacy: A concept comparison	Reference Services Review
2015	Phelps, S.F.; Hyde, L.; Planchon Wolf, J.	Introducing information literacy competency standards for nursing	Nurse Educator
2018	Secker, J.	The revised CILIP definition of information literacy	Journal of Information Literacy
2012	Welty, E.; Hofstetter, S.; Schulte, S.J.	Time to re-evaluate how we teach information literacy	College & Research Libraries News
2018	Wink, D.M.; Todd, A.	Nursing education and the 21st century library	Nurse Educator

4.2 How prevalent is the emerging concept of ML in health sciences librarianship practice?

Early in the appraisal of the selected literature it became evident that Mackey and Jacobson's proposal to revision IL as a ML has not formally gained traction within the health sciences. Of the 59 articles included in this review, not one used the emerging term 'metaliteracy'. However, one article did acknowledge that IL provides the foundation for historical literacy (Fleming-Castaldy, 2018), a reflection of the theory underlying Mackey and Jacobson's vision. Further, other articles mentioned a holistic approach to IL and EBP instruction whereby students are encouraged to learn about critical appraisal and application of information by producing information themselves (Jakubec & Astle, 2013; Morley & Hendrix, 2012).

Although ML is not explicitly used in articles about IL in health sciences libraries, this does not necessarily suggest that the concept has been missed. The deeply entrenched nature of EBP or evidence-based medicine (EBM) in health education, which is necessarily intertwined with IL, teaches students in health programmes, at least in part, that it is not enough to simply find, retrieve and use health information, but they must also be able to engage with it by using it in their decision-making and respond to it by reflecting on their own knowledge and expertise. These very concepts are the budding foundations of metaliteracy.

4.3 Has the emerging theory of ML influenced or shaped the delivery of IL programmes and instruction in academic health sciences libraries for undergraduate students?

Due to the fact that the literature did not explicitly address metaliteracy in relation to undergraduate health sciences educational programmes, it is impossible to definitively answer this final research question. It is possible that many health librarians are reframing their approach to IL as a metaliteracy but have not yet reported doing so in the literature. However, the evidence collected for this review strongly suggests that IL programmes have been shaped by EBP.

5. Discussion

The author identified two major themes within the literature: 1) Emphasis on the impact of librarian–faculty collaboration, and; 2) IL, health IL, and its relationship with EBP or EBP.

Although the literature was not limited to these two themes, they do well to summarise the body of literature that address IL in undergraduate health sciences education. Outlier themes include, but are not limited to, generalised assessments of IL competencies on EBP, EBM, or librarianship and communicating changes in IL competencies and predicting their impact on health sciences librarianships.

5.1 Theme 1: Librarian–faculty collaboration

Overall, the literature presents evidence to suggest that embedding librarians within an assignment, course or programme is an optimal method for exposing students to opportunities to develop their IL.

An example of collaboration at the course level includes librarians who worked with faculty to develop a required course for first year health sciences students. The librarian was fully embedded into the course curriculum. She contributed to the building of the course outline and participated as a co-instructor. The initiative for the creation of this course came from the faculty's director who wanted 'the library's cooperation in planning and co-teaching a course in accessing, organizing, reading, and analyzing the biomedical research literature' (Powell & Ginier, 2013, p.292).

A required course in first year is an attractive approach to integrating ML instruction into a programme and is supported by Bendriss et al. (2015) who aligned IL instruction with course content and proposed 'integration of research skills into a specific course as the most effective method to successfully teach IL' (Bendriss, Saliba & Birch, 2015, p.822). However, since ML includes, but is not limited to, behavioural skills (how to search) and metacognition (learning about learning), limiting the librarian's involvement to first year risks minimising the librarian's impact on student learning. It may even contribute to students' misplaced confidence in their literacy skills; a small, but important, sub-theme of this review wherein students' reported confidence in their IL is not reflected in the skills or knowledge they were asked to demonstrate (Craig & Corrall, 2007; Cullen, Clark & Essen, 2011; Merkley, 2014).

Other examples of collaboration include faculty and a librarian working together to develop a research course to develop a matrix of IL standards to establish a relationship between the ACRL Standards and a normative model of physical education (Brooks & Bigelow, 2015); a collaboration to produce an assignment that corresponds with learning outcomes that is also included in a course's assessment strategy (Innes, 2008); a service learning project facilitated by a nurse and a librarian within an undergraduate research course (Janke, Pesut & Erbacker, 2012); and a collaborative effort between a faculty member and a librarian to integrate IL instruction into an EBP assignment (Sin & Bliquez, 2017).

Apart from collaboration within specific courses or assignments, programme-wide faculty-librarian collaboration is another sub-theme of the literature and the degree of such collaboration is institution-specific. For example, at the University of Montreal, the health library is integrated in the core curriculum for biomedical sciences and participation in its workshops is 'generally mandatory… most assignments are graded and represent 5 or 10% of the course's final mark' (Clairoux et al., 2013, p.203). Although many collaborative partnerships result in multi-year or multi-phase collaborations over the span of an entire degree programme (Craig & Corrall, 2007; Eldredge et al., 2012; Haines & Horrocks, 2006; Leasure et al., 2009; Spring, 2018; Tagge, 2018), the literature trends toward partnerships between librarian and faculty for building IL into a specific assignment (Diaz & Walsh, 2018; Franzen & Bannon, 2016; Innes, 2008; Janke & Rush, 2014; Sin & Bliquez, 2017) or course (Funnell, 2015; Hamilton, 2013; McCulley & Jones, 2014; Muellenbach et al., 2018; Munn & Small, 2017; Xiao, 2010).

Collaboration with faculty at any level provides both librarians and faculty staff with opportunity. The librarian gains the opportunity to contribute to the development of IL or ML competencies and the faculty gain a better understanding of IL beyond database searching. Nayda & Rankin suggest it enhance[s] both academics' and students' understanding of IL as a concept as well as its connection to success in lifelong learning (2008).

A particularly interesting approach to teaching IL to health sciences students was the merging of IL competencies and EBP competencies. This merge drew on the ACRL *Framework*, the ACRL Standards, and the steps of EBP. The authors suggest that the alignment of IL with EBP gave the librarian and faculty member a 'shared language' and that 'by creating a curriculum map, collaborative efforts [between faculty and librarians] became more meaningful and classroom library instruction became necessary for successful completion of research-based discipline-specific assignments' (Franzen & Bannon, 2016, p.249).

Beyond mapping between skills, the integration of IL or health IL skills with instruction in EBP or EBM is another prominent theme in the literature that receives commentary from both faculty and librarians.

5.2 Theme 2: IL and EBP

Evidence-based medicine (EBM), also referred to as evidence-based practice (EBP) outside of medicine, was pioneered by Dr. Gordon Guyatt in 1992. It requires the physician to define a patient problem by asking a specific question and understand the information required to answer the question; to be able to search for published literature that meets these requirements; to critically appraise the literature retrieved; to apply the evidence learned from the literature to the patient problem; and to evaluate the approach taken (Guyatt et al., 1992). The ability to ask a question, understand one's information need and to efficiently retrieve the literature that can meet that need are tenets of IL world-wide. The participation of libraries in the teaching of EBP appears to be a natural fit.

With its emphasis on the use of evidence to guide decision-making in health care practice, it is no surprise that IL instruction has a natural home in EBP or EBM courses. However, as with collaboration, what this looks like in practice is largely institution-specific. Further, the intertwined nature of EBP and IL theory is deeply entrenched in the academic literature, with many articles treating IL theory as a necessary component of learning EBP in undergraduate health science education, specifically within the context of undergraduate medicine and nursing curricula.

Which IL competency standards academic libraries use as a point of reference to facilitate the relationship between IL and EBP depends on the educational institution in question and its proximity to a national governing body. In the United States and Canada the ACRL Framework

is the preferred authoritative reference, with the exception of those in nursing education who also refer to the *IL Competency Standards For Nursing* (ACRL, 2013) that addresses the specific needs of nursing education and practice. In the UK, SCONUL's *Seven Pillars of Information Literacy* (SCONUL,1999) along with CILIP's definition (Secker, 2018) is the authority and in Australia and New Zealand, it is the ANZIL IL Framework. There is also a defined pattern in articles published before and after the introduction of the ACRL Framework, in that in the United States and Canada specifically, there is a noticeable transition from references to the ACRL Standards to the Framework. The impact of these documents and of EBP on the work of health sciences librarians has been documented and reflected upon within the literature (Adams, 2014; Knapp & Brower, 2014; Welty, Hofstetter & Schulte, 2012).

Some articles in this review qualify health IL in undergraduate education as a more specific type of IL, grounded in an understanding of different health research methodologies, study designs, the hierarchy of evidence and its symbiotic relationship with EBP (Forster, 2009; Haines & Horrocks, 2006; Haruna & Hu, 2018; Ivanitskaya et al., 2006; Janke et al., 2012; Kloda, 2008; Leasure et al., 2009). This understanding is, at times, a result of faculty-librarian collaboration. For example, Forster (2009) developed a health-specific IL training module for students, after receiving feedback from health sciences faculty that generic IL instruction is insufficient to draw a connection between IL and EBP (Forster, 2009). At King's College London, a main driver of IL is 'the emergence of EBP in the health sciences' (Haines & Horrocks, 2006, p.9) which acknowledges that information need identification and retrieval is a crucial aspect of EBP.

King's College London's approach is not unique. Undergraduate health sciences programmes are synchronising EBP education with IL instruction. What this synchronisation looks like is unique to each institution. It ranges from having faculty teach critical appraisal and application while librarians focus on information searching and retrieval, to having students work directly with clinicians to answer a clinical question with assistance from librarians (Diaz & Walsh, 2018; Hoberecht, Randall & Schweikhard, 2015; Hopkins et al., 2011; Innes, 2008; Janke et al., 2012; Phillips & Bonsteel, 2010). Beyond instructional approaches that synchronise IL and EBP, there is a general recognition that IL is instrumental in the development of lifelong learners, which echoes one of Mackey and Jacobson's arguments for the reframing of IL as a ML – that the goal of ML is to produce university graduates who are adaptive, lifelong learners.

In limited cases, the relationship between IL and EBP reflects some elements of ML. Morley and Hendrix (2012) describe their aim 'to present the information cycle from inception through dissemination phases' (p.298). Jakubec and Astle (2013) describe an assignment that required students to appraise the evidence used in existing health policies, conduct their own rigorous search of the current literature and make adjustments, if appropriate, to the policies based on the evidence they retrieved and appraised (Jakubec & Astle, 2013). The latter project effectively guides students to become consumers and producers of information, another tenet of reframing IL as a ML.

Based on the two themes identified, the two preferred approaches to IL in undergraduate health sciences education are collaboration between faculty and libraries in the development and delivery of IL instruction, or the alignment of IL skills with EBP. However, the intentional reframing of IL as ML is not yet indicated within the published literature, which suggests there might be a gap in the acceptance of reframing IL as a ML. There are some discussions that draw connections and identify relationships between information literacy and EBP as instrumental in the development of lifelong learning skills, which suggests that while it may not be intentional, an understanding of the complexities of IL as it relates to EBP is emerging. It may be no surprise that traditional one-shot instruction sessions are not sufficient to produce graduates and future health professionals who become adaptive lifelong learners.

Applying Mackey and Jacobson's ML theory, academic health sciences libraries and faculty members could mutually benefit from collaborating to build academic programmes or course curricula that aim to matriculate graduates who are critically engaged with information in all formats, who understand the implications of using or producing information, and who have the potential to become engaged, adaptive life-long learners. The process of curriculum mapping can 'assist academic librarians' efforts to strategically and intentionally identify appropriate curriculum access points for IL instruction' (Buchanan, Webb, Houk, & Tingelstad, 2015. p. 97).

Although curriculum mapping is an enormous undertaking, it has the potential to radically shift a library's approach to instruction by cultivating relationships with faculty members, placing IL instruction within specific contexts (such as EBP), building on previous instruction, and introducing higher-level theoretical concepts, which could produce adaptive lifelong learners in the health professions. To have a lasting impact, IL instruction could be scaffolded so that novice researchers can meet specified benchmarks before they progress to develop a deeper understanding of information as expert researchers. Revisioning IL as ML creates some room to grow to allow space for important conversations around the consumption and production of information within a health context, such as how to create or consume information in participatory online environments.

Nursing education has a strong presence in this conversation, and therefore more research or case studies are needed about these two themes in disciplines outside of nursing in order for a review such as this to present a balanced landscape of the literature as it pertains to undergraduate health sciences educational programmes. Based on the findings of this review, it is unclear whether the nursing field is as disparately active compared to other health fields, or if it is more active in publishing their efforts. Contributions from fields outside of nursing would balance the literature.

6. Recommendations for practice

The author recommends that health sciences libraries, that have an opportunity to revisit the way information literacy instruction is provided, pilot a curriculum mapping project with an interested department or school. This work could involve the development of a curriculum map for existing assignments in required courses, specifically those that focus on EBP. The library can integrate elements of ML as a reframed vision of IL into these assignments to develop students' skills as they move through the programme. However, there is no evidence to suggest that reframing IL as ML will have an impact on students' information skills.

Academic libraries are uniquely positioned to embed ML skills into the curricula of educational programmes to set up new graduates for success as they pursue a career or higher education. Librarians at HSL are poised to shift the library's approach to support for educational programmes and are encouraged to cultivate close relationships with faculty in order to facilitate a collaborative relationship with faculty members. A pilot project to integrate ML deeply within a programme could help the librarians put ML instruction into practice as they transition to a functional team liaison model. Some goals of this work could be:

1. Embed the librarian into the curriculum of educational programmes in FHS with in-class instruction, but also as a consultant to assist with the integration of ML learning outcomes into existing assignments (e.g. incorporate a reflection exercise that asks the student to record their approach to searching, explore the challenges and successes they experienced, and what they learned)
2. Develop a curriculum map of EBP or other relevant field-specific competencies and align them with the *Framework* or *Competency Standards*
3. Submit recommendations to the faculty to embed ML within the curriculum on a progressive scale.

7. Conclusion

This scoping review has explored the landscape of the literature about IL in undergraduate health sciences education. It has investigated the prevalence of ML within health sciences librarianship and whether ML has influenced or shaped the delivery of IL instruction or support. It has found that while ML has not gained traction in the published literature, some concepts associated with ML theory are scattered within some IL instructional programmes. There is however, some evidence to suggest that collaboration between faculty and librarians, as well as the alignment of IL and EBP is a preferred approach to IL instruction within undergraduate health programmes. This evidence must be understood with some caution due to the imbalanced representation of nursing education within the literature. The author recommends that librarians who support undergraduate programmes in health sciences work with faculty to collaboratively map a curriculum that progresses throughout the academic programme and can be aligned to principles of EBP.

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Appendix A: Literature searches by database

OVID Medline – January 11, 2019

1	exp information literacy/	4505
2	Computer Literacy/	1636
3	Information Seeking Behavior/	1899
4	information literacy.mp.	514
5	information literate.mp.	16
6	digital literacy.mp.	95
7	digital* literate.mp.	5
8	computer literacy.mp.	1883
9	computer literate.mp.	91
10	metaliterate.mp.	0
11	metaliteracy.mp.	2
12	or/1-11	8390
13	exp Medicine/	1056761
14	exp Education, Medical/	154621
15	Health Science.mp.	3044
16	medicine.mp.	782967
17	medical.mp.	1506832
18	exp Anatomy/	385512
19	exp Education, Nursing/	80350
20	Midwifery/	18292
21	exp Pharmacology/	165344
22	exp Physician Assistants/	5318
23	exp Biomedical Engineering/	10837
24	nursing.mp.	573381
25	anatomy.mp.	453754
26	midwife*.mp.	25369
27	midwive*.mp.	17522

28	pharmacology.mp.	2996384
29	physician assistant.mp.	1220
30	biomedical.mp.	168927
31	or/13-30	6835415
32	exp Libraries/	9852
33	Librarians/	979
34	librar*.mp.	174822
35	or/32-34	174822
36	12 and 31 and 35	315

EBSCO LISTA – January 18, 2019

	Search ID#	Search Terms	Search Options	Actions
☐	S8	S3 AND S6 AND S7	Search modes - Boolean/Phrase	View Results (790)
☐	S7	(S4 OR S5)	Search modes - Boolean/Phrase	Rerun · View Det
☐	S6	(S1 OR S2)	Search modes - Boolean/Phrase	Rerun · View Det
☐	S5	librar*	Search modes - Boolean/Phrase	Rerun · View Det
☐	S4	(DE "ACADEMIC libraries") OR (DE "ACADEMIC librarians")	Search modes - Boolean/Phrase	Rerun · View Det
☐	S3	Medicine OR medical OR anatomy OR nurs* OR midwife* OR Midwive* OR pharmacology OR physician assistant OR biomedical or "health science"	Search modes - Boolean/Phrase	Rerun · View Det
☐	S2	"information literacy" OR "information literate" OR "digital literacy" OR "digital* literate" OR "computer literacy" OR "computer literate" OR metaliterate OR metaliteracy	Search modes - Boolean/Phrase	Rerun · View Det
☐	S1	((DE "INFORMATION literacy" OR DE "ELECTRONIC information resource literacy" OR DE "HEALTH literacy" OR DE "INTERNET literacy" OR DE "MEDIA literacy") OR (DE "TECHNOLOGICAL literacy" OR DE "COMPUTER literacy" OR DE "ELECTRONIC information resource literacy")) OR (DE "METALITERACY")	Search modes - Boolean/Phrase	Rerun · View Det

ProQuest ERIC – January 18, 2019

((MAINSUBJECT.EXACT("Information Utilization") OR MAINSUBJECT.EXACT("Information Skills") OR MAINSUBJECT.EXACT("Computer Literacy") OR MAINSUBJECT.EXACT("Library Skills") OR MAINSUBJECT.EXACT("IL") OR MAINSUBJECT.EXACT("Multiple Literacies") OR MAINSUBJECT.EXACT("Information Seeking")) OR noft(IL) OR noft(information literate) OR noft(digital literacy) OR noft(digital* literate) OR noft(computer literacy) OR noft(computer literate) OR noft(metaliterate) OR noft(ML)) AND (MAINSUBJECT.EXACT.EXPLODE("Medical Education") OR MAINSUBJECT.EXACT.EXPLODE("Anatomy") OR (MAINSUBJECT.EXACT.EXPLODE("Nursing") OR

MAINSUBJECT.EXACT.EXPLODE("Nursing Education")) OR
MAINSUBJECT.EXACT("Medicine") OR MAINSUBJECT.EXACT.EXPLODE("Pharmacology")
OR MAINSUBJECT.EXACT.EXPLODE("Allied Health Personnel") OR
MAINSUBJECT.EXACT.EXPLODE("Biomedicine") OR noft("health science" OR medicine OR
medical OR nursing OR anatomy OR midwife* OR midwive* OR pharmacology OR "Physician
Assistant" OR biomedical)) AND (MAINSUBJECT.EXACT.EXPLODE("Library Instruction") OR
MAINSUBJECT.EXACT.EXPLODE("Academic Libraries") OR
MAINSUBJECT.EXACT.EXPLODE("Information Scientists") OR noft(librar*))

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((kw: Information and kw: literacy) OR (kw: computer and kw: literacy) OR ((kw: Information and
kw: Seeking and kw: Behavior) OR (kw: information and kw: literate) OR (kw: digital* and kw:
literate) OR (kw: digital and kw: literacy) OR (kw: computer and kw: literacy) OR (kw: computer
and kw: literate) OR kw: metaliterate) OR kw: ML) and (kw: medicine OR kw: medical OR kw:
health w science OR kw: anatomy OR kw: nurs* OR kw: midwife* OR kw: midwive* OR kw:
pharmacology OR kw: physician w assistant OR kw: biomedical) and kw: librar*

EBSCO CINAHL

				Search modes			
☐	S1	🔊	(MH "Information Literacy+")	Search modes - Boolean/Phrase	🔍 Rerun	ⓘ View Details	✎ Edit
☐	S2	🔊	(MH "Computer Literacy")	Search modes - Boolean/Phrase	🔍 Rerun	ⓘ View Details	✎ Edit
☐	S3	🔊	(MH "Information Seeking Behavior")	Search modes - Boolean/Phrase	🔍 Rerun	ⓘ View Details	✎ Edit
☐	S4	🔊	""information literacy""	Search modes - Boolean/Phrase	🔍 Rerun	ⓘ View Details	✎ Edit
☐	S5	🔊	"information literate"	Search modes - Boolean/Phrase	🔍 Rerun	ⓘ View Details	✎ Edit
☐	S6	🔊	""digital literacy""	Search modes - Boolean/Phrase	🔍 Rerun	ⓘ View Details	✎ Edit
☐	S7	🔊	"digital* literate"	Search modes - Boolean/Phrase	🔍 Rerun	ⓘ View Details	✎ Edit
☐	S8	🔊	"computer literacy"	Search modes - Boolean/Phrase	🔍 Rerun	ⓘ View Details	✎ Edit
☐	S9	🔊	"computer literate"	Search modes - Boolean/Phrase	🔍 Rerun	ⓘ View Details	✎ Edit
☐	S10	🔊	""metaliterate""	Search modes - Boolean/Phrase	🔍 Rerun	ⓘ View Details	✎ Edit
☐	S11	🔊	"metaliteracy"	Search modes - Boolean/Phrase	🔍 Rerun	ⓘ View Details	✎ Edit
☐	S12	🔊	(MH "Medicine+")	Search modes - Boolean/Phrase	🔍 Rerun	ⓘ View Details	✎ Edit
☐	S13	🔊	(MH "Education, Medical+")	Search modes - Boolean/Phrase	🔍 Rerun	ⓘ View Details	✎ Edit
☐	S14	🔊	"health science"	Search modes - Boolean/Phrase	🔍 Rerun	ⓘ View Details	✎ Edit

	S15	medicine	Search modes - Boolean/Phrase	Rerun	View Details	Edit
	S16	medical	Search modes - Boolean/Phrase	Rerun	View Details	Edit
	S17	anatomy	Search modes - Boolean/Phrase	Rerun	View Details	Edit
	S18	(MH "Anatomy+")	Search modes - Boolean/Phrase	Rerun	View Details	Edit
	S19	(MH "Education, Nursing+")	Search modes - Boolean/Phrase	Rerun	View Details	Edit
	S20	(MH "Midwifery+")	Search modes - Boolean/Phrase	Rerun	View Details	Edit
	S21	(MH "Education, Midwifery") OR (MH "Students, Midwifery") OR (MH "Students, Nurse Midwifery")	Search modes - Boolean/Phrase	Rerun	View Details	Edit
	S22	(MH "Education, Pharmacy")	Search modes - Boolean/Phrase	Rerun	View Details	Edit
	S23	(MH "Education, Physician Assistants") OR (MH "Students, Physician Assistant")	Search modes - Boolean/Phrase	Rerun	View Details	Edit
	S24	(MH "Education, Biomedical Engineering")	Search modes - Boolean/Phrase	Rerun	View Details	Edit
	S25	nursing	Search modes - Boolean/Phrase	Rerun	View Details	Edit
	S26	midwife*	Search modes - Boolean/Phrase	Rerun	View Details	Edit
	S27	midwive*	Search modes - Boolean/Phrase	Rerun	View Details	Edit
	S28	pharmacology	Search modes - Boolean/Phrase	Rerun	View Details	Edit
	S29	physician assistant	Search modes - Boolean/Phrase	Rerun	View Details	Edit
	S30	biomedical	Search modes - Boolean/Phrase	Rerun	View Details	Edit
	S31	(MH "Libraries+")	Search modes - Boolean/Phrase	Rerun	View Details	Edit
	S32	(MH "Librarians+")	Search modes - Boolean/Phrase	Rerun	View Details	Edit
	S33	librar*	Search modes - Boolean/Phrase	Rerun	View Details	Edit

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# 4	458	#3 AND #2 AND #1
		Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan=All years
# 3	296,515	TOPIC: (librar*)
		Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan=All years
# 2	1,996,944	TOPIC: ((medicine OR medical OR health science OR anatomy OR nurs* OR midwife* OR midwive* OR pharmacology OR physician assistant OR biomedical))
		Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan=All years
# 1	32,171	TOPIC: ((Information and literacy) OR (computer and literacy) OR (Information and Seeking and Behavior) OR (information and literate) OR (digital* and literate) OR (digital and literacy) OR (computer and literacy) OR (computer and literate) OR (metaliterate) OR (metaliteracy))
		Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan=All years

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1 information literacy/

2 information seeking/

3 human computer interaction/

4 Information literacy.mp.

5	information literate.mp.
6	digital literacy.mp.
7	digital* literate.mp.
8	computer literacy.mp.
9	computer literate.mp.
10	metaliterate.mp.
11	media literacy.mp.
12	or/1-11
13	exp education/
14	exp student/
15	Instruct*.mp.
16	educat*.mp.
17	student.mp.
18	teach*.mp.
19	program.mp.
20	programs.mp.
21	training.mp.
22	or/13-21
23	exp medicine/
24	exp medical education/
25	Health Science.mp.
26	medicine.mp.
27	medical.mp.
28	exp anatomy/
29	exp nursing education/
30	midwifery education/
31	midwifery student/
32	exp pharmacology/
33	biomedical engineering/
34	nursing.mp.

35 anatomy.mp.

36 midwife*.mp.

37 midwive*.mp.

38 pharmacology.mp.

39 physician assistant.mp.

40 biomedical.mp.

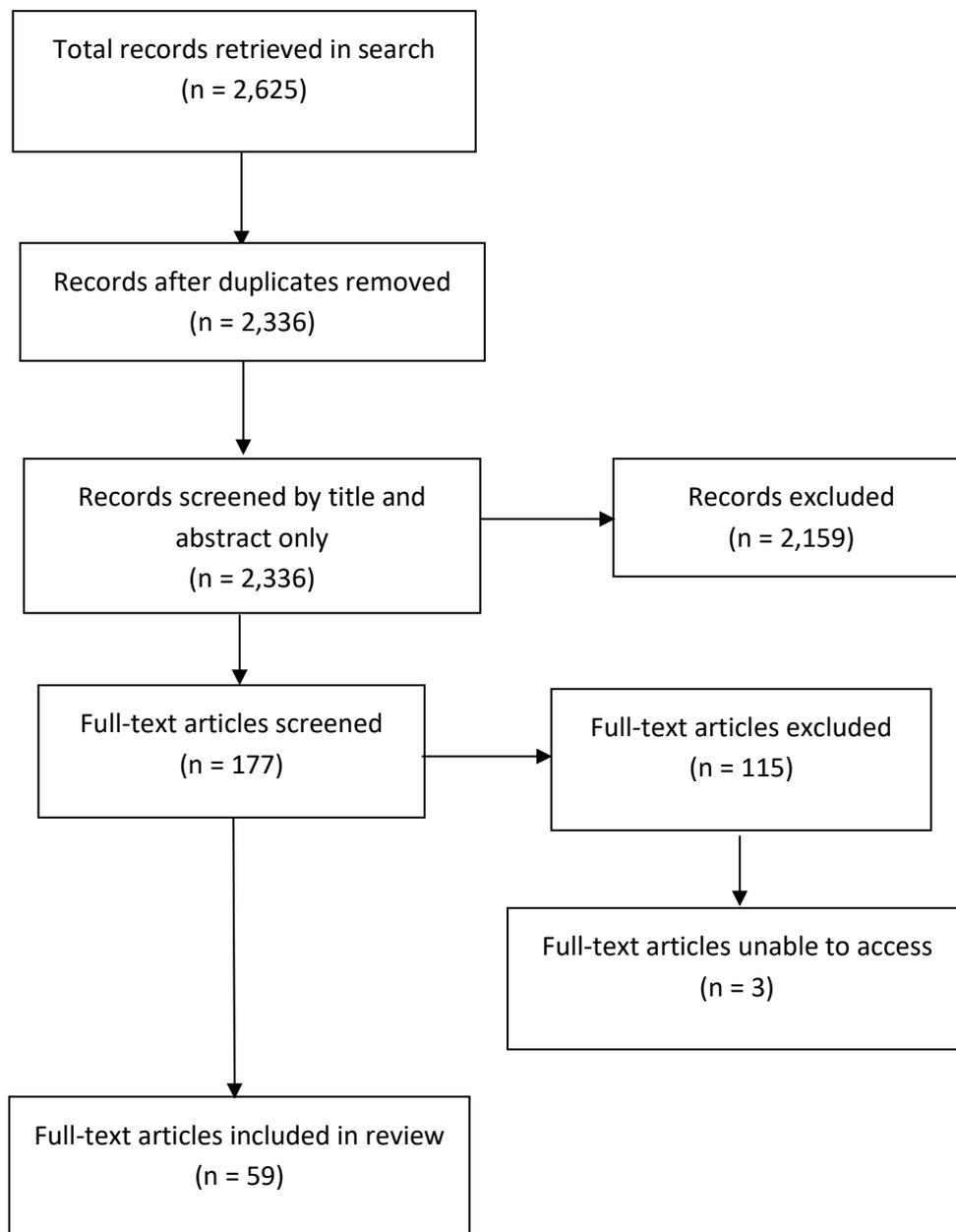41 or/23-40

42 exp library/

43 exp librarian/

44 librar*.mp.

45 or/42-44

46 12 and 22 and 41 and 45

47 12 and 41 and 45

Appendix B: Flow diagram of article retrieval process

```
┌─────────────────────────────────┐
│ Total records retrieved in search │
│          (n = 2,625)              │
└─────────────────────────────────┘
                │
                ▼
┌─────────────────────────────────┐
│ Records after duplicates removed  │
│          (n = 2,336)              │
└─────────────────────────────────┘
                │
                ▼
┌─────────────────────────────────┐        ┌─────────────────────────┐
│ Records screened by title and     │───────▶│   Records excluded        │
│      abstract only                │        │      (n = 2,159)          │
│          (n = 2,336)              │        └─────────────────────────┘
└─────────────────────────────────┘
                │
                ▼
┌─────────────────────────────────┐        ┌─────────────────────────┐
│ Full-text articles screened       │───────▶│ Full-text articles excluded│
│          (n = 177)                │        │      (n = 115)            │
└─────────────────────────────────┘        └─────────────────────────┘
                │                                        │
                │                                        ▼
                │                           ┌─────────────────────────────┐
                │                           │ Full-text articles unable to access│
                │                           │          (n = 3)              │
                │                           └─────────────────────────────┘
                ▼
┌─────────────────────────────────┐
│ Full-text articles included in review│
│          (n = 59)                 │
└─────────────────────────────────┘
```

Based on: Moher, D., Liberati, A., Tetzlaff, J., Altman, D. G. The PRISMA Group (2009). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA Statement. *PLoS Med 6(7)*: e1000097. https://doi.org/10.1371/journal.pmed.1000097