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Information literacy curriculum mapping in the health sciences: A scoping review

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Abstract

Instructional medical librarians are uniquely positioned in a context governed by multiple instructional frameworks emerging from librarianship and the professions with which they liaise. Yet very little literature exists on medical librarians' use of curriculum mapping to align their instruction with these frameworks. This review illuminates the current state of curriculum mapping in medical librarianship.

We searched five bibliographic databases for articles published between 2010 and August 2021 and centred on information literacy (IL) curriculum mapping within a health sciences university context. Studies were included based upon pre-determined inclusion and exclusion criteria. Data were extracted using an instrument developed primarily a priori, with some codes developed emergently in response to preliminary review of the data.

We included 127 studies focused on curriculum mapping, of which only 24 included structures which might be considered "curriculum maps". Across all 127 studies included, The Association of College & Research Libraries' Information Literacy Competency Standards for Libraries for Higher Education was the most-used IL framework, though versions of evidence-based practice were used more often, with a great deal of diversity and incomplete reporting on how these frames informed instruction of discrete concepts and skills. Within the 24 articles containing

figurative curriculum maps, the same diversity of concepts and incomplete reporting was present, with librarians mapping IL frameworks to classroom activities more often than learning outcomes or competencies.

Development of curricular maps aligning discrete IL concepts and skills with different disciplinary contexts is needed to provide instructors with a modular structure they might implement in their own contexts. To further the identification of best practices, future research should examine existing curricular maps made by librarians.

Keywords

curriculum development; curriculum mapping; Framework for Information Literacy in Higher Education; health sciences libraries; information literacy; medical education; US

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1. Introduction

1.1 Background

Curriculum mapping is an aspect of instructional design which conceptually (and often visually) organises and communicates four main components of a curriculum: what is taught, how it is taught, when it is taught, and how it is assessed (Harden, 2001). In practice, curriculum maps are diverse, encompassing various instructional elements from lists of courses and associated learning outcomes to degree requirements. These maps may be visually expressed as tables, word-clouds, or flow-charts (Harden, 2001; Lowe & Stone, 2010; Wang, 2011).

The benefits of curriculum mapping are many and may be conceptualised as increasing either transparency or integration of information literacy (IL) curricula. Transparency is fostered among faculty, librarians, and students by demonstrating links between different aspects of the curriculum (Harden, 2001; Kononowicz et al., 2020), as well as illuminating differences between the intended/declared, designed, communicated, taught/enacted, learned, and hidden curricula (Harden, 2001; Sterz et al., 2019). The removal of redundant course content is an additional benefit for students and their librarians. The curriculum mapping process diminishes the possibility that the same content might be offered in similar one-shots across multiple courses and instead structures the delivery of IL instruction across an entire programme of study at points of need, directly integrating with course assignments, learning outcomes, and curricula.

Perhaps more importantly for academic medical librarians, curriculum mapping is a promising strategy for implementing long-term IL programs. IL curriculum mapping supports the integration of IL instruction as a core aspect of a university's curriculum (Buchanan et al., 2015; McGuinness, 2007), focused as it is upon aligning instruction with learning outcomes and standards. The creation and implementation of an IL program provides continuity that is not possible when the foundation for IL instruction is dependent on partnerships with individual faculty members.

Curriculum mapping as a professional practice is more common in some disciplines than others, though it remains a niche practice overall, with a remarkable lack of consistency in the reporting of the process itself (Gulbis et al., 2021; Rawle et al., 2017). In a 2017 review including 187 articles, Rawle et al. found a majority of retrieved articles mapping curriculum were from STEM disciplines, with medicine accounting for the greatest percentage within their set (25.3%) (Rawle et al., 2017). Yet more recently, in 2021 Gulbis found very little information on curriculum

mapping related specifically to competency-based medical education (Gulbis et al., 2021). This is surprising given the necessity of curriculum tracking and reporting required for programme accreditation as well as the availability of the Association of American Medical Colleges' electronic "Curriculum Inventory and Reports" database, which facilitates the identification of learning objectives and experiences (*Curriculum Inventory*, n.d.).

Across academic librarianship generally, the state of curriculum mapping is much the same. Rawle's review found Library and Information Sciences (LIS) articles to rank near the top (fifth) of the 22 disciplines represented in their 187 article review, though with a percentage (5.9%) much smaller than medicine (25.3%) (Rawle et al., 2017). In 2015, Buchanan described the literature on curriculum mapping in libraries as "limited" (p.96) and "not plentiful" (p.97) (Buchanan et al., 2015). As of this writing, a cursory search of the Library, Information Science and Technology Abstracts database with the search phrase "curriculum mapping" returns a total of just 50 results. However, interest in curriculum mapping may be accelerating, as CE-granting courses in curriculum mapping are currently being offered by organisations such as the Library Juice Academy ('Curriculum Mapping Information Literacy for Academic Librarians', n.d.).

The sub-discipline of medical librarianship seems to bear out the trend of a small portion of the literature exploring curriculum mapping with divergent methodologies and reporting. Perhaps the most prominent example comes from the Association of College & Research Libraries Health Sciences Interest Group (ACRL HSIG). In 2011, the group created a mapping document connecting the ACRL IL Standards to the American Association of Colleges of Nursing Essentials Series for Baccalaureate and Masters Level Nurses. This was part of the foundational work that would lead to that group's information competency standards for nursing (Phelps, 2013). Two years later in 2013 Dalton reported no model of medical librarianship IL instruction existed (Dalton, 2013). Determining whether Dalton's conclusion was or is still correct would depend on one's definition of a "model" and whether a curriculum map qualifies—an impossible question to answer given the diversity of curriculum-mapping processes and aforementioned inconsistency and incomplete reporting on this practice (Gulbis et al., 2021).

Positioning IL as the single focus of curriculum mapping within librarianship reflects the field's treatment of IL as a universal skill, summative of all aspects of librarianship practice. However, it is important to recognize that definitions of IL, as well as associated values, skills, and concepts, differ across the globe, and "have been primarily created for use in developed countries and are grounded in Western thought and social structures" (ACRL, 2017, p. 5). Though a single acronym is used throughout this paper for IL, as authors we acknowledge that there are myriad interpretations and contexts in which IL may be conceptualised. The frameworks tracked in this review are those discovered in the articles themselves, and represent various continents and institutionalised conceptualisations of IL, from the United States' ACRL Standards (2000) and Framework (2016), to the United Kingdom's Society of College, National, and University Libraries (SCONUL) Seven Pillars of Information Literacy (2011) and A New Curriculum for Information Literacy (ANCIL) (Secker & Coonan 2011), to New Zealand's ANZIL (Bundy, 2004) and Australia's Research Skill Development (RSD) framework (Willison, O'Regan, & Kuhn, 2018).

1.2 Local context

The impetus for this research study was primarily practical and borne out of extreme institutional and departmental change. The Library of the School of Medicine and Health Sciences serves the medical school and various health sciences programs as well as the University of North Dakota's College of Nursing and Professional Disciplines for a total population of students and

faculty of around 2,000. The library is not directly affiliated with the main campus library, and is within the School of Medicine and Health Sciences. Within the last seven years the School of Medicine moved to a new building, and the library was converted from a large physical location with print collections and librarians at a central reference desk to a minimal physical space—a single information desk, with all collections provided electronically and librarians distributed across academic department offices in an embedded model. During the same time period, the library also saw a significant turnover in all staff positions, with seven of 11 current staff joining within the last three years. Further, five of the six instructional librarians are still early in their career or new to medical librarianship.

With a majority of staff being new to the University of North Dakota, as well as medical librarianship, and few policies existing within the department to guide instruction, this scoping review was undertaken to guide the development of internal curriculum mapping policies and documentation. Of particular interest was the idea of distilling IL domains, activities, and learning outcomes to their core concepts and skills in order to facilitate mapping of librarian-developed instruction to diverse disciplines' curricula and accreditation documentation. Such modular documentation would also enable librarians to more easily compare and share learning outcomes and instructional tools, even while liaising with diverse disciplines within Medicine, Biochemistry, and Occupational Therapy.

The scoping review methodology was selected to explore and identify themes as well as gaps within current practice (Arksey & O'Malley, 2005; Peters et al., 2015). The scope of this review is intentionally broad to reflect the authors' needs: we were interested in all academic medical library research that connected frameworks or standards with concepts, skills, or learning outcomes. We also knew from preliminary searching that the concept of curriculum mapping is far from standardised within Library and Information Science literature—with authors pulling terminologies and frameworks from diverse fields and epistemologies to discuss their own efforts in this arena—increasing certainty that the broad focus of a scoping review was appropriate.

The guiding questions and extraction instrument for this research were developed from IL activities, learning outcomes, and themes identified within existing instructional materials created previously by department instructional librarians (authors Olson and Denis).

2. Methods

The following research questions guided our review:

- **RQ 1: Context:** What is the context within which librarians conceptualise IL curricula? What type of research supports IL curriculum mapping? What are the attributes of learners who are party to mapped IL curricula?
- **RQ 3: Frameworks:** What IL frameworks do librarians use to map IL curricula? What non-LIS disciplinary or professional association frameworks are included?
- **RQ 5: IL Concepts and Skills:** Which IL skills and concepts were included in curriculum mapping by librarians, and how were they delineated?

In our review, "learner" refers to any student, faculty member, clinician, or librarian who is a recipient of IL instruction.

2.1 Data sources and literature searching

We searched five bibliographic databases for articles: Academic Search Premier (EBSCO), CINAHL (EBSCO), Eric (EBSCO), Embase (Elsevier), and LISTA (EBSCO). PubMed was initially included in our search, but pilot testing revealed a remarkable amount of "noise" (irrelevant or inappropriate articles) in the results of the searches, and so PubMed as a database was dropped and replaced by Embase. Other databased were chosen for either their health sciences, interdisciplinary, or Librarianship focus.

2.2 Search strategy

Our search terms were developed based on our research questions. In preliminary searches we discovered wide variation in terminology used to describe curriculum mapping and designed our search phrases to reflect this. The terms centred on five main concepts: curriculum mapping, IL, academic libraries, health sciences disciplines, and universities.

We balanced the broad scope of our search terms by limiting our search to articles published after 2010, and our search strategies are described in detail in supplemental Appendix A.

2.3 Citation management

We utilised Microsoft (MS) Excel to store data, de-duplicate citations, and manipulate article sets for export. We used Zotero, an open-source citation management tool, to manage and format bibliographic information and to double-check the deduplicating of our initial article result set.

2.4 Inclusion and exclusion criteria

For inclusion in the review, authors identified the following criteria:

- Authorship or representation of a librarian's perspective
- Primary focus on IL curriculum or mapping of IL competencies within a health sciences context

Articles that reviewed prior publications, were written in a language other than English, focused on public or consumer health literacy, or were published prior to 2010 were excluded.

2.5 Study selection and screening

A two-step process was used for article review: article titles and abstracts were considered first using the aforementioned criteria, and only those retained after this first step went through a full article review. The initial title and abstract level screening was completed by two authors (Olson and Yarborough), who reviewed each article independently and then resolved disagreements via discussion and consensus. Two hundred articles were identified for full-text review. Full articles were obtained, and each was again independently (though not anonymously) reviewed by a pair of authors (Olson, Yarborough, Bates, Barnett, Denis, and Westall), this time with the full text of the article under consideration for inclusion. Disagreements regarding the full article screening were again resolved via discussion and consensus.

2.6 Data extraction

We built our extraction instrument in a shared MS Excel spreadsheet which included codes grouped by theme. The codes in our instrument were developed as a team based on our initial research questions:

- **RQ 1: Context**
  - researcher status
  - type of research
  - number of participants
  - learner level
  - learner/collaborator discipline
- **RQ 3: Frameworks**
  - IL framework
  - curriculum map
- **RQ 5: IL Concepts and Skills**
  - IL concepts and skills

During our pilot testing, several codes which addressed the research question on context were eliminated for being extraneous to our focus and/or too difficult to code reliably given the diversity in reporting detail within our data set. The dropped codes were: purpose of study, motivation for study, type of primary research, and type of secondary research.

We coded the possible responses within each theme category by marking a zero (not present) or one (present), adding information in a free-text notes fields for each category where appropriate. Some theme categories, such as “IL framework”, could have multiple codes for each frame referenced. Other theme categories, such as “curriculum map”, were limited to one code at a time, as they could be either present (one) or not (zero).

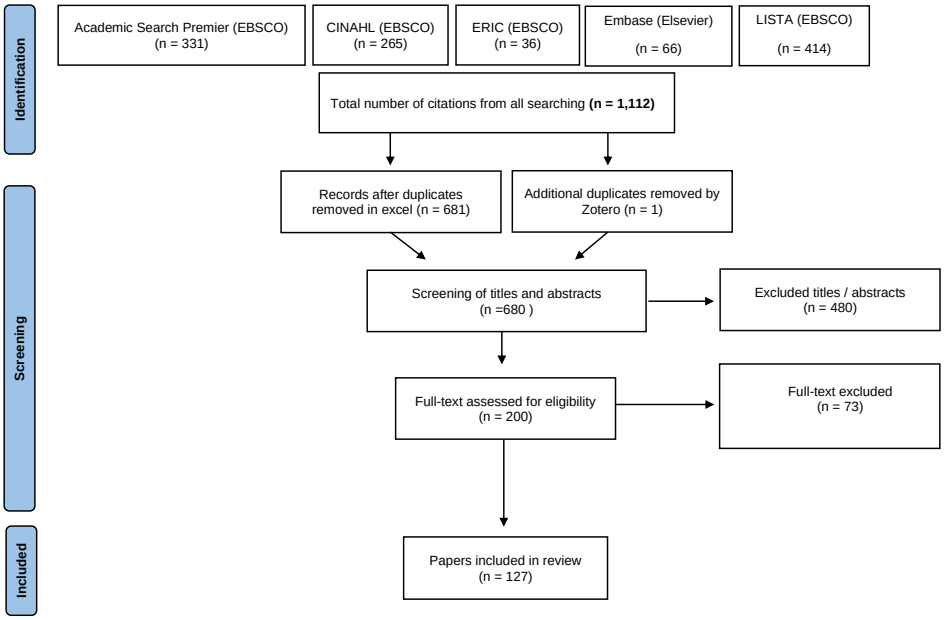
An initial pilot test of the extraction instrument was carried out using a randomly selected sample of 25 articles from our results, with two authors pilot coding each randomly selected article. This pilot test contributed to the refinement of definitions within our codebook and the development of additional codes for certain categories within the extraction instrument. The article map code was developed, for example, to allow us to differentiate between the larger body of articles in our data set which merely reference curriculum mapping in a less discrete manner with the smaller subset of articles we discovered in our set which include tables visually mapping instructional elements to frameworks or theories.

After testing and refining the extraction instrument, all remaining included article results were divided among the authors in duplicate for coding. Two authors independently screened each article using our extraction instrument. Our full extraction instrument is available in supplemental Appendix B.

3. Results

From our initial de-duplicated set of 680 article results, we identified 200 articles for full-text review, 73 of which were found to fulfil our exclusion criteria. We retained 127 articles for inclusion and data extraction. (PRISMA diagram in Figure 1).

Figure 1: PRISMA diagram



3.1 Context

Our first research question focused on the context in which librarians carry out curriculum mapping projects, and the following codes were designed to provide data to answer this question: institution, researcher status, type of research, learner level, learner/collaborator discipline, and purpose of study.

Given our inclusion criteria for IL within library contexts, we hypothesised that librarians would be research participants and/or authors on the majority of articles. We were interested in how the researchers positioned themselves and whether there would be trends in their librarian or faculty status. We found 117 articles (92%) explicitly identified the professions of the researchers in either the body of the text or author contact information: 109 articles (85%) explicitly identified researchers as librarians; 49 (38%) identified faculty, while only one mentioned tenure (00.7%); and 14 articles (11%) identified the researchers as other professionals such as practitioners and doctoral students. A full 12 articles (9%) made no mention of any researcher's profession or status, while a separate 12 (9%) stated, either in the text or within biographical information, that librarian authors were also faculty.

Codes for the types of research represented by the articles were based on broad categories designed to capture the level of evidence of current IL curriculum mapping literature: primary or secondary research (Agoritsas et al., 2015), with "commentaries" and "other" included to account for journal publication trends and diversity. We found most articles to be primary research (n=84, 66%), with commentaries being the next most numerous (n=20, 15%), followed by secondary research (n=14, 11%) and "other" (n=12, 9%).

Most articles concerned instruction delivered to undergraduate learners (n=60, 47%), though graduates were present almost as often (n=50, 39%) -- most likely a reflection of the high number of graduate degrees in health sciences and medical schools. A smaller number of learners were faculty (n=14, 11%) or clinicians (n=19, 14%), though their representation is not

minimal, and a sizeable portion of learners were coded as “other” (n=29, 22%), being community practitioners unaffiliated with the university, or librarians themselves.

The learners were most often from nursing disciplines (n=50, 39%), followed by medicine (n=37, 29%). A high number of articles centred on groups of mixed disciplines or disciplines not included in our coding instrument, such as veterinary science, pharmacy, midwifery, dietetics, or optometry.

Table 1: Learner level and discipline*

Learner discipline	Article count		Learner level	Article count
general	11		undergraduate	60
medical	37		graduate	50
nursing	50		faculty	14
occupational therapy	12		clinician	19
physical therapy	10		fieldwork preceptor	3
sports medicine	2		other	29
masters of public health	3			
physician assistant	2			
biomedical	6			
social work	4			
other**	46			

*we define “graduate” as including pre-residency medical school students

**“other” code included: veterinary, generic health sciences, dentistry, engineering, pharmacy, sociology, midwifery, speech language pathology, dietetics, law, optometry, biological sciences, biomedical, biochemistry, bioinformatics, biopharmaceutical, psychiatry, biomedical engineering, etc.

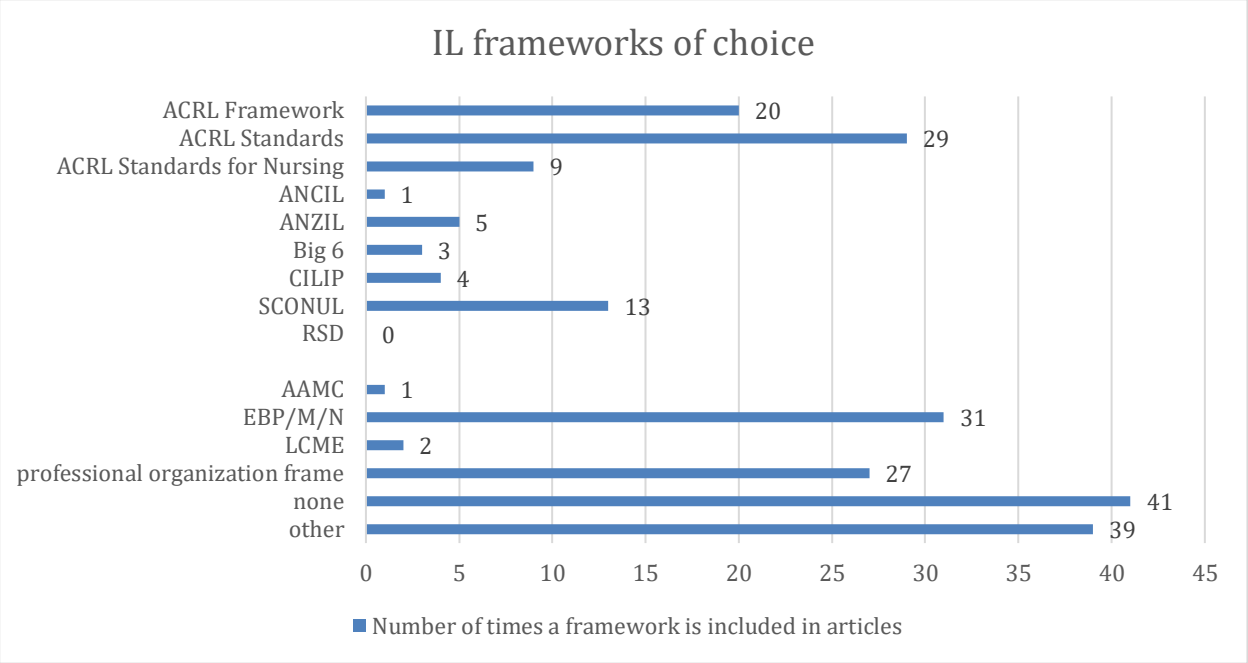
3.2 Frameworks

Our coding of IL frameworks reflects any reference to a framework, even if it was in passing and not explicitly instrumental in the presented research or curriculum/a. Within our set of articles focused on IL curricula, the use of IL frameworks was not pervasive: out of 127 articles, a large portion reference no IL frameworks (n=41, 32%). Overall, the ACRL Standards were referenced most often (n=29, 28%), followed by the ACRL Framework (n=20, 16%).

We discovered a comparable split between references to the ACRL Standards and Framework across time: 12 of the 56 articles (21%) published in 2014 or earlier reference the Standards, while 20 of the 71 (28%) published in 2016 or later reference the Framework. Five of the 10 articles published in 2015 continue to reference the older Standards, with just one of those five simultaneously referencing the newly announced Framework. In 2016 or later, there are two instances of articles referencing the older Standards but not the newer Framework, and both of these articles were published in 2018 (Russell et al., 2018; Schweikhard et al., 2018).

Similarly, the number of articles referencing no frameworks at all is comparable across these two decades, with 20 of the 56 (36%) published between 2010 and 2014 and 19 of the 71 (27%) published between 2015 and 2020 referencing no IL frameworks at all.

Figure 2: IL framework of choice*



*articles could be coded multiple times for referencing multiple codes, total framework codes: 225

Acronyms: ACRL: Association of College and Research Libraries (United States); ANCIL: A New Curriculum for Information Literacy (United Kingdom); ANZIL: Australian and New Zealand Information Literacy Framework (New Zealand); CILIP: Chartered Institute of Library and Information Professionals (United Kingdom); SCONUL: Society of College, National, and University Libraries Seven Pillars of Information Literacy Framework (United Kingdom); RSD: Research Skill Development Framework (Australia); AAMC: Association of American Medical Colleges (United States); EBP/M/N: Evidence-based Practice/Medicine/Nursing (United States); LCME: Liaison Committee on Medical Education (United States)

Several other IL frameworks were referenced, including ANCIL (n=1, 0.4%), ANZIL (n=5, 2%), the BIG 6 (n=3, 1%), CILIP (n=4, 2%), and SCONUL (n=13, 6%), though not at rates anywhere near comparable to the ACRL IL Standards (n=29, 13%) and Framework (n=20, 9%) (percentages in this sentence are based on the 225 total codes marked for frameworks, rather than the 127 articles in the final dataset). The Research Skill Development Framework (RSD) was not referenced in any article.

Frameworks from outside of librarianship or the IL literature were used with regularity to map or plan IL curricula. Indeed, if Evidence Based Practice (EBP), including its Evidence Based Medicine or Nursing permutations, were counted as one IL framework, then that would be the single most popular framework of all (n=31, 14%), referenced in two more articles than the ACRL Standards, the most-used IL framework.

There was an even higher number of references to numerous additional frameworks captured in an “other” column in our extraction instrument, (n=39, 18%), and a striking heterogeneity of

frameworks within this “other” code, from researcher-authored theoretical models (Kolstad, 2015) to university-specific (Brooks & Bigelow, 2015) or government-issued frameworks of competencies (Ryba & Pledger, 2016) being used alongside more traditional library frameworks to map or develop IL curricula.

The “purpose of study” category was eliminated from our extraction instrument in favour of a “curriculum map” category, which was less reliant on interpretation because it required the article to contain a figure in which frameworks were literally mapped to instructional elements such as learning outcomes or classroom activities. Of the total 127 article set, 24 (19%) contain curriculum maps. Of these, 10 were published between 2010 and 2014 and 14 between 2015 and 2020.

A majority of the 14 mapping articles published between 2015 and 2020 continue to use the older ACRL Standards (n=10, 41% of all curriculum-map possessing articles, 7% of total article set), with seven of these using the older Standards exclusive of other IL frameworks (n=7, 29% of all curriculum map-possessing articles, 5% of total article set). Only a small minority of articles published since 2015 use the ACRL Framework in their maps (n=4, 16% of curriculum map-possessing articles, 3% of total article set), and three of these additionally include the older Standards (n=3, 12% of curriculum map-possessing articles, 2% of total article set).

Table 2: Articles with curriculum maps, frameworks, competencies, and measures

Articles with curriculum maps	**Contents of curriculum maps: frameworks*, competencies, and measures**									
article	ACRL Standards (2000)	ACRL HSIG (2013)	ACRL Framework (2016)	EBP/M/N (1996)	SCONUL (2011)	ANZIL (2004)	accreditation competencies	professional association competencies	instructional measures (with notes on how authors labeled the measures)	other
(Adams, 2014)	1			1					1 “ACRL performance indicactors” and “ACRL outcomes”	
(Allen, 2017)	1		1						1 “course prefix title” and “course title with link to tutorial” and “tutorial learning objectives”	
(Alpi & Hoggan, 2016)	1								1 “Health Professions (Research Literature)” [they read literature and coded their own 74onceptua concepts from it]; “Veterinary Mentor Objectives (CVM)”; Articulated	

									Proposed Veterinary Research TCs (Novel)"	
(Argüelles, 2012)	1			1				1	1 "results" and "instruction outline" and "learning activities"	
(Argüelles, 2016)	1		1	1				1	1 within "essential competencies" aligns "themes" and "information research process" activities; also has table relating ACRL "Information Literacy Framework" with "Nursing Process"	
(Bendriss et al., 2015)	1								1 "class", "year", "learning objectives", "assessment/Clicker questions", DeLib 101 Questions Applicable" mapped to courses labeled "EAP Foundation", "Writing Seminar 1", "Writing Seminar 2", and "Biology"	
(Boden & Murphy, 2012)									1 Topic Section Content Existing Exercises & Proposed Content Revisions; "literature search curriculum" and "Krathwohl's 2002 Taxonomy table"	
(Boruff & Thomas, 2011)	1								1 "Learning activities", format of session: "workshop" and/or "lecture"	

(Bradley, 2013)	1						1			
(Brooks & Bigelow, 2015)	1							1	1 “course objectives” and “Springfield college information literacy across the curriculum Matrix of objectives by general education and disciplines based on ACRL standards”	
(Carr et al., 2011)						1			1 “survey items related to standard”	
(Dalton, 2013)					1					1
(Dawes, 2019)			1						1 “Faculty conceptions teaching IL” and “IL concepts identified by faculty”	
(Franzen & Bannon, 2016)	1		1	1					1 “instruction” and “assignment”	
(Frati et al., 2020)	1			1					1 “case-based learning”, “problem based learning”, and “inquiry based learning”	
(Kolstad, 2015)				1					1 ACRL standards “steps” and “assignments”	
(Kolstad, 2017)	1								1 [unlabeled]	
(M. Miller & Neyer, 2016)	1						1	1		
(R. K. Miller, 2012)	1						1		1 “knowledge requirements”	

(Phelps, 2013)	1							1		
(Simons et al., 2012)	1								1 “Australian School of Advanced Medicine Performance indicator” and “assessment criteria”	
(Tagge, 2018)	1						1		1 “Library-led clinical reasoning conferences (CRCs) learning outcome”	
(Williams & Ntiri, 2018)									1 “curriculum objective” and “topic covered”	
(Wissinger et al., 2018)		1							1 “outcome” and “performance indicator”	

* Acronyms: ACRL: Association of College and Research Libraries (United States); HSIG: Health Sciences Interest Group; EBP/M/N: Evidence-based Practice/Medicine/Nursing (United States); SCONUL: Society of College, National, and University Libraries Seven Pillars of Information Literacy Framework (United Kingdom); ANZIL: Australian and New Zealand Information Literacy Framework (New Zealand)

The elements most commonly included in curriculum maps were aspects of the instruction context, i.e., themes, competencies, learning outcomes, module titles, course activities and assignments, and in one case, survey instrument questions, all recorded as “instructional measures” in Table 2. The diversity of language with which these elements were represented in the 12 published articles’ maps defied more detailed coding which might have illuminated more clearly what exactly librarians were mapping when they mapped curricula. For example, some elements were unlabelled (Kolstad, 2013), while others used unclear labels like “knowledge requirements” (Miller, 2012) and “results” (Argüelles, 2012). Only four of the 12 mapping articles (33%) referred to learning outcomes, using the phrases “learning objectives” (Bendriss et al., 2015; Allen, 2017), “course objectives” (Brooks & Bigelow, 2015), and “curriculum objective” (Williams & Ntiri, 2018). [See Appendix C for full coding of all articles and transcription of mapping articles’ various “instructional elements”].

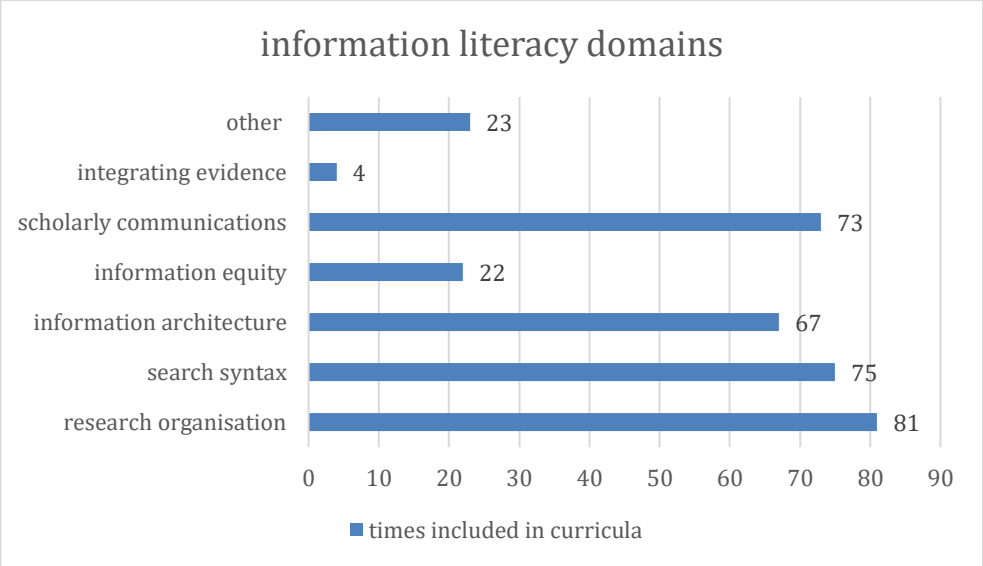
We found no correlation between faculty status and curriculum mapping as a practice, as none of the articles which presented figures of curriculum maps in the article text were those which explicitly identified librarians as being faculty.

3.3 Concepts and skills

We coded the articles to reveal which skills and competencies are most often included in or reported on in articles focused on IL curriculum mapping in health sciences contexts. While testing our preliminary extraction instrument, we initially coded at a highly detailed level, coding each specific skill and concept present in an article. However, this level of detail proved unsustainable and, at times, inappropriate, given the wildly varying wording and scope of the items being coded. It was impossible to read between the lines of, for example, a database activity that was not described in any detail in order to record which skills or concepts were covered. For this reason, we decided to shift from coding each specific concept and skill to coding larger categories of IL concepts and skills represented in the text, which we will refer to as "domains." [Full detail on our arrangement of concepts and skills within larger IL domains is provided in Appendix B].

Most articles reported learning outcomes/activities centred on research organisation (n=81, 63% of total article set, 23% of all concept/skill codes), closely followed by search syntax (n=75, 59% of total article set, 21% of all concept/skill codes), scholarly communication (n=73, 57% of total article set, 21% of all concept/skill codes), and finally information architecture (n=67, 52% of total article set, 19% of all concept/skill codes). Issues of equity and access were less present (n=22, 17% of total article set, 6% of all concept/skill codes) with "integrating evidence" (n=4, 3% of total article set, 1% of all concept/skill codes) being the only domain to appear with less frequency.

Figure 3a: Domains of IL concepts & skills*



*each study may have been coded with more than one domain, total domains marked=345

Figure 3b: Domains of IL concepts & skills*

Information Literacy Domains	Exemplar concepts and skills
research organisation	This domain was coded if any of the following concepts and skills were discovered in the article: research conceptualization; clinical question; citation managers; research process documentation
search syntax	This domain was coded if any of the following concepts and skills were discovered in the article: search terms; term modifiers; Boolean operators; proximity; field codes

Information architecture	This domain was coded if any of the following concepts and skills were discovered in the article: database navigation; citation mining; controlled vocabularies; algorithmic "relevancy"; algorithms; subscriptions
information equity	This domain was coded if any of the following concepts and skills were discovered in the article: access; ethical reuse
scholarly communications	This domain was coded if any of the following concepts and skills were discovered in the article: types of evidence; quality of evidence; credibility of evidence; evidence-based practice; metrics; altmetrics; legal licensing; publication process
integrating evidence	This domain was coded if any variation of the word "integrate" was coupled with the word "evidence"
other	This domain was coded if any other skills or concepts not represented by any of the other domains were present

The "other" category (n=23, 18% of total article set, 7% of all domain codes) represents a diverse range of skills, concepts, and domains which may or may not be a part of "information literacy," but which were included in IL curricula by librarians and collaborators. Some examples of concepts and skills marked in this "other" IL domain category were lifelong learning (Diekema et al., 2019), reading skills (Eldermire et al., 2019), and use of principles of design (Wissinger et al., 2018). We did not originally conceptualise "integrating evidence" within our extraction instrument as an IL domain, but decided to add it after preliminary testing of our instrument revealed a notable minority of articles including this specific wording.

4. Discussion

4.1 Limitations

This study was undertaken in the fall of 2019 and fell prey to a number of setbacks due to the coronavirus pandemic, as well as unrelated local turnover of nearly 50% of staff in the authors' library. Updates to the initial article set may reveal a shift in the trends depicted in our results in terms of librarians referencing IL frameworks, including mapping documentation in their publications or explicitly defining the skills and concepts contained in their instruction.

4.2 Conclusions

Current health sciences-specific IL mapping literature is focused on description of how medical librarians teach rather than on conceptualising what medical librarians teach within foundational IL and disciplinary frameworks. Literature about mapping IL often lacks an actual definition of IL itself. Close to half of the authors in our dataset publishing articles on IL mapping in health sciences contexts write about designing an IL programme without reporting grounding their work in an IL framework, defining IL in their own words, or describing what skills or concepts they believe represent this specific kind of literacy. It seems a shared understanding of IL is assumed, which, if it existed, might eliminate the need to provide a definition or reference to a specific framework. However, the diversity of IL concepts and skills present in the literature undermines this assumption.

The smaller subset of 12 articles with figurative curriculum maps continue the trend of the larger dataset with regard to diversity of conceptualisation of IL, using terminology so varied that we were unable to categorise what aspects of their curricula librarians were mapping. Allen's 2017 article includes a curriculum map (p. 259) which has learning objectives mapped to both the

ACRL standards and framework (Allen, 2017). Some of the included learning objectives include skills and concepts, for example “Use advanced search strategies (i.e., Boolean, phrase searching) to search Cochrane’s database” explicitly calls out Boolean and phrase searching, while others, like “Distinguish between popular and peer-reviewed sources”, could be more explicit in terms of what kinds of behaviour students will be exhibiting, and what skills or concepts enable them to distinguish between these concepts (Allen, 2017).

Bendriss et al.’s 2015 article contains another example of learning outcomes mapped to ACRL standards in addition to various course titles, assessment questions and activities (Bendriss et al., 2015). Additionally, Bendriss et al.’s article contains another table entitled a “logic model” which maps learning outcomes not only to expected “impact” on students, but to the associated institutional resources (“inputs”), “activities”, and assessment (“outputs”) (Bendriss et al., 2015, Appendix A, Table A.2).

Rendering judgement on which curriculum maps are better than others, in general, is difficult. If, as Buchanan asserts, a library lacks ownership of a curriculum, and “Therefore, curriculum mapping efforts in libraries must evaluate how library instruction is mapped to existing curricula”, then any figure with two axes and some representation of both librarian instruction and the curricula of their liaison department would constitute a curriculum map (Buchanan et al., 2015). While perhaps true, this definition is not very useful from the perspective of anyone attempting to build a good curriculum map. Harden’s definition of curriculum mapping as a structure which communicates what/when/how things are taught and assessed is much more illuminating and appropriate as an assessment instrument (Harden, 2001). Given Harden’s definition, Bendriss et al.’s map is a success and Allen’s is not, as the latter does not include the learning activities, the “how” (Harden, 2001; Bendriss et al., 2015; Allen, 2017)).

Interestingly, Harden’s definition of curriculum mapping would not necessarily require librarians to include IL standards or frameworks in a curriculum map, but this is what all but one of the curriculum maps in our dataset have done (Harden, 2001). These standards might stand in for the “what”, or even the “how”, but equally a librarian might just conceptualise the “what” as “database searching” rather than “Searching as strategic exploration” (ACRL, 2016), and arguably the former is a more informative “what”. This may be why we saw a majority of the curriculum maps in our dataset continue to reference the older ACRL Standards (2000) even after the ACRL Framework (2016) was published; the standards, as competencies, were created to be measurable, and therefore have more concrete language (as opposed to the Framework, which centres on threshold concepts) which is helpful when articulating “what” or “how” you are teaching a concept or skill.

In general, the diversity in librarian IL curriculum mapping practices, as well as increasing specialisation within librarianship itself, signals a growing need for the kind of cognitive scaffolding curriculum mapping provides (Buchanan et al., 2015; Harden, 2001; Sterz et al., 2019). Data literacy and scholarly communications in particular are emerging as sub-specialties of their own in response to current events and institutional trends, such as the new United States National Institutes of Health Policy for Data Management and Sharing (US National Institutes of Health, 2020), and the move to a pass/fail grade for the United States medical school STEP Exam (*USMLE Step 1 Transition to Pass/Fail Only Score Reporting | USMLE*, n.d.). The latter will likely lead students to more vigorously pursue other means of distinguishing themselves such as publication, which in turn could lead to more instruction by medical librarians in scholarly communications. Those librarians hired as specialists in these areas will require clarification of which concepts and skills fall under the purview of medical librarians, and

how they connect to the curricula and accreditation standards of the departments with which they liaise.

Meanwhile, IL themes like equity in information access (of especial importance to healthcare practitioners who require access to the most recent, highest quality evidence and must also understand their patients' access to information) may remain niche rather than core aspects of IL unless explicitly conceptualised within the curriculum mapping literature and/or medical librarians' shared definition of IL.

Further, the role of EBP within IL curriculum mapping needs further study: EBP as a practice within health disciplines is important (Sackett, 1996), and librarians are currently employing EBP as an IL framework in curriculum mapping literature more often than actual IL frameworks. This is without explicitly conceptualising points of convergence and divergence between EBP and IL, both at the higher level of IL domains as well as that of more concrete concepts and skills. For example, information "credibility" and "quality" are core aspects of EBP and of the utmost importance to both librarians and healthcare providers; however, Adams (2014) notes

> there is a divergence between the evaluative methods advanced by IL practitioners and EBP practitioners, in that librarians guide students to consider the authority of the information producer as a gauge of quality while EBP practitioners do not favor authority as a desired construct in evaluating quality (p. 238).

The librarian's role during instruction about evaluating quality is not explicitly discussed in the health sciences IL mapping literature—there are no discussions about determining authority or internal validity, or perhaps more importantly, about which skills demonstrate mastery of these concepts.

The paucity of explicit definitions of IL, how specific skills and concepts fit within IL frameworks, and how these map to health sciences' disciplinary curricula and accreditation standards is connected to a lack of shared language around curriculum mapping and the lack of a standardised reporting format for publishing curriculum mapping research. A lack of required coursework on instructional design in MLIS graduate education likely contributes to this issue (Turner, 2016); librarians may not be aware of the utility of curriculum mapping or its relevance to their own instruction contexts.

Resource scarcity and faculty status may be other factors influencing medical librarians' IL curriculum mapping practices. Our study was unable to establish any correlation between faculty status and IL curriculum mapping: only 12 of the articles within our 127-article set explicitly communicated that librarians were faculty, and none of these were the 24 articles that included curriculum maps. Further research is needed to clarify the role of faculty status or organisational culture on IL curriculum mapping by medical librarians.

Currently, instructional librarians cannot apply what is learned in others' curriculum mapping research into their own context without themselves first doing a series of very heavy lifts: reading between the lines of current IL curriculum mapping literature to figure out what others have done and its relevance to their own context, teaching themselves how to do curriculum mapping, isolating IL concepts and skills for themselves, and finally mapping their own IL curricula. To make matters more difficult, several of these tasks seem to be catch-22s: for example, a working knowledge of curriculum-mapping vocabulary is necessary to efficiently search for literature on curriculum mapping.

4.3 Future steps

The paucity and incomplete reporting of curriculum mapping documentation (Gulbis et al., 2021) demonstrates the need for more health sciences libraries to report on their research with sufficient detail to enable others to build upon their work.

We encourage researchers publishing their work on curriculum mapping in academic health sciences libraries to explicitly state their own context as well as the various conceptual structures underpinning their instruction, from foundational frameworks to specific skills and concepts at the centre of their instruction, using standardised language to structure and reference aspects of instruction when mapping to IL frameworks.

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Appendix A: Search Strategies

Academic Search Premier	(program OR curricul* OR "course objectives" OR standards OR "concept map" OR "model" OR structur* OR framework OR schema OR epistemology OR "competency based education") AND ("information literacy" OR "critical thinking" OR "metacognition" OR "research skills") AND (librar* OR "information centre" OR "information center") AND ("health sciences" OR "allied health" OR nursing OR medic* OR "occupational therapy" OR "physical therapy" OR medical laboratory science" OR "public health" OR "physician assistant" OR biomedic*) AND (education OR graduate OR college OR university OR academ* OR "Medical Schools")
CINAHL	(program OR learn* OR info* OR curricul* OR structur* OR framework OR schema OR epistemology) AND ("information literacy" OR "critical thinking" OR "outcomes of education" OR "access to information" OR "research skills") AND librar* AND ("health sciences" OR "health education" OR "libraries, health sciences" OR "education, health sciences" OR "education, medical" OR "allied health" OR nursing OR medic*) AND (education OR graduate OR college OR university OR academ*)
ERIC	(program OR curricul* OR (DE "Curriculum Development") OR "course objectives" OR "learning objectives" OR (DE "Behavioral Objectives") OR standards OR "concept map" OR "model" OR structur* OR framework OR schema OR (DE "Program Development") OR epistemology OR competenc*) AND ("information literacy" OR (DE "Information Literacy") OR "critical thinking" OR "metacognition" OR "research skills") AND (librar* OR "information centre" OR "information center") AND ("health sciences" OR (DE "Health Sciences") OR "allied health" OR nursing OR medic* OR (DE "Medicine") OR "occupational therapy" OR "physical therapy" OR medical laboratory science" OR "public health" OR "physician assistant" OR biomedic*) AND (graduate OR college OR university OR academ* OR "Medical School*" OR (DE "Medical Schools") OR student)
Embase	('library'/exp OR librar*) AND ('medical school'/exp OR 'health education'/exp or 'education'/exp) AND ('curriculum development'/exp OR 'curriculum'/exp OR 'education program'/exp OR 'educational model'/exp OR 'educational theory'/exp) AND ('information literacy'/exp OR "research skills") AND ("health sciences" OR "allied health" OR nursing OR medic* OR "occupational therapy" OR "physical therapy" OR "medical laboratory science" OR "public health" OR "physician assistant" OR biomedic* OR "Medical School Faculty")
LISTA	(program OR curricul* OR "course objectives" OR "learning objectives" OR standards OR "concept map" OR "model" OR structur* OR framework OR schema OR epistemology OR competenc*) AND ("information literacy" OR (DE "INFORMATION literacy"health) OR "critical thinking" OR "metacognition" OR "research skills") AND (librar* OR "information centre" OR "information center") AND ("health sciences" OR "allied health" OR nursing OR medic* OR "occupational therapy" OR "physical therapy" OR medical laboratory science" OR "public health" OR "physician assistant" OR biomedic*) AND (graduate OR college OR university OR academ* OR "Medical School*" OR (DE "MEDICAL school information services") OR student OR (DE "MEDICAL librarianship"))

Appendix B: Extraction Instrument

code category	coding type	code	count
researcher status	each article can be coded multiple times	librarian	109
		faculty	49
		tenured faculty	1
		not mentioned	12
		other	14
type of research	each article may be coded only once	primary	84
		secondary	14
		commentary	20
		other	12
number of participants	each article may be coded only once	one to ten	5
		eleven to thirty	11

		31-60	12
		61-100	9
		101+	37
		system-wide	2
		not disclosed	10
learner level	each article can be coded multiple times	undergrad students	60
		grad students	50
		faculty	14
		clinicians	19
		fieldwork preceptors	3
		other	29
learner/collaborator discipline	each article can be coded multiple times	general	11
		med	37
		nursing	50
		occupational therapy	12
		physical therapy	10
		sports medicine	2
		population/public health	3
		physician assistant	2
		biomedicine	6
		social work	4
		other	46
IL frameworks	each article can be coded multiple times	ACRL total	40
		other	28
		none	39
		prof org frame	27
		LCME	2
		EBP/M/N	31
		AAMC	1
		RSD	0
		SCONL	13
		CILIP	4
		Big6	3
		ANZIL	5
		ANCIL	1
		ACRL Standards for Nursing	9
		ACRL Standards	29
		ACRL Framework	20
		other frameworks	28
curriculum mapping	each article may be coded only once	has curriculum map	24
		does not have curriculum map	103
curriculum map contents	each article can be coded multiple times	ACRL Standards	16
		ACRL HSIG	1
		ACRL Framework	4
		EBP/M/N	6
		SCONUL	1
		ANZIL	1
		other framework	1
		instructional element	20
IL concepts and skills	each article can be coded multiple times	research organization (concepts and skills coded here: research conceptualization; clinical question; citation managers; research process documentation)	81
		search syntax	75

		(concepts and skills coded here: search terms; term modifiers; Boolean operators; proximity; fields)	
		information architecture (concepts and skills coded here: database navigation; citation mining; controlled vocabularies; relevancy; algorithms; digital divide; subscriptions)	67
		information equity (concepts and skills coded here: access; ethical reuse)	22
		scholarly communications (concepts and skills coded here: types of evidence; quality of evidence; credibility of evidence; evidence-based practice; metrics; altmetrics; legal licensing; publication process)	73
		integrating evidence	4
		other	23

Abbreviations: AAMC: American Association of Medical Colleges; ACRL: Association of College and Research Libraries; ANCIL: A New Curriculum for Information Literacy; ANZIL: Australian and New Zealand Information Literacy Framework; CILIP: Chartered Institute of Library and Information Professionals; EBP/M/N: Evidence-based Practice/Medicine/Nursing; HSIG: Health Sciences Information Group; LCME: Liaison Committee on Medical Education; SCONUL: Society of College, National, and University Libraries; RSD: Research Skill Development Framework