Metadata-literacy

1 Introduction

This literature review focuses on research supporting the concept of metadata-literacy. It builds on the work of the reviews on information literacy (IL), information organization (IO), and user-perspectives, using the IL framework and the IO tasks identified along with the information theories investigated in user perspectives. The interest in metadata-literacy in this review is grounded in the observation that information practice is driven by changes in how users create, access, and share information in digital environments. These activities appear to be under-represented in current 'consumer' focused models of the information-user. While there are a number of possible frameworks which could be used to analyze the use of metadata in these environments, using a literacy framework focuses the discussion on actions from a participant context as opposed to a system or capabilities context. The concept of an information participant as opposed to 'user' is used in this literature review to reflect the active roles of their information interaction.

1.1 A gap in IL research

Use of digital information for teaching and learning purposes is increasingly common (Churches, 2008a). Despite the interest in use of information technology and digital information in educational settings, using technology for learning purposes is complicated by the lack of established methods and theories (Lajoie & Azevedo, 2006) . Lajoie and Azevedo (2006) for example call for partnerships between educators and researchers and recommend that these partnerships should address clear educational objectives and provide ready access and training to current technology. Tuominen, Savolainen, and Talja (2005) observe that there has been little research into the relationship between information technology and information literacy (p. 330). They observe that IL has historically focused on attempting to define objective standards for information access and use rather than focusing on context dependent evaluation of literacy (Tuominen, et al., 2005). Tuominen, Savolainen, and Talja point specifically to a gap in IL literature on social and collaborative aspects of IL.

While IL research has produced a number of models, frameworks, and best practice recommendations, it has also remained fairly focused on the individual process of information interaction. As was discussed in the IL literature review, some research has focused on different types of literacy such as digital, media, socio-constructionist, and cultural literacy while other research focused on educational goals and outcomes. This review seeks to investigate the roles that metadata and information organization play across these types of literacies. Metadata-literacy is an example of a meta-literacy in that it informs a number of specific literacies and addresses skills and concepts which are applicable in multiple environments. While it might be argued that literacy research may not need such a perspective, the trend in this area is to continue to advance literacy research by questioning previous approaches in the face of new educational, social, and technological developments. In fact, the continued emphasis on the need for literacy instruction is evidence of a strong methodological and theoretical platform which is responsive to changes in social and technological influences. The focus of this work is to identify what role metadata and information organization play in participants' concept of literacy.

One of the research gaps discussed in the information literacy review is a lack of focus on how students structure and manage their own information resources (Nicol, Littlejohn, & Grierson, 2005, p. 32). Nicol, Littlejohn, and Grierson (2005) suggest for example that "information structuring is not completely natural to students and that they may need focused preparation for this task especially in the context of specific types of digital environments" (p. 46). Research in the use of complex information structures is relevant as Hert et al.'s (2007) work observes that metadata is often used by non-experts. This perspective underscores the important relationship between information structures and the activities of learning and knowledge production. It also confirms the value of understanding these structures or metadata when interacting with digital information systems. Related to this concept, researchers are calling for more investigation into the impact of electronic resources and Information Communication Technology (ICT) on learning and knowledge (Kirkwood, 2006; Rowley & Urquhart, 2007). Although metadata-literacy is an emerging concept related to this area, there is value placed on its role in ICT. Inter

(2007) for example compares current attitudes towards metadata literacy to those that surrounded computer literacy during the early adoption of computers in libraries.

1.2 A literacy framework

The literacy framework that was created in the IL review allows the investigation of metadata literacy to be framed with a focus on participant perspectives and theoretical models. This framework focuses on three teacher and three participant perspectives within the information literacy area. Teacher perspectives focus on the role of pedagogy, information and learning theory, and environment in a literacy element. Participant or student perspectives tend to focus on specific skills and conceptual knowledge, both of which are related to the context in which these skills and concepts are used. By mapping these six concepts onto a table as represented in Figure 1 and comparing the perspectives, this framework provides a way to examine specific elements of metadata literacy.

Figure 1 Literacy framework: Participant and teacher perspectives

Teacher **Participant**	Pedagogical theory	Information and Learning theory	Environmental role
Skills	How are skills taught or conveyed?	What is the underlying theory of the value of specific skills?	What types of specific skills are employed?
Conceptual knowledge	How does the teacher convey concepts?	What role does the concept play in informing a learning or information theory?	What conceptual or generalized knowledge is required in this environment?

Skill/concept context	What are the necessary elements to teach this literacy concept or skill?	Are the assumptions of the theory valid in this given context?	What role does this environment play in this literacy context?

This review investigates metadata literacy from each of the areas in the framework. The purpose of this investigation is to identify specific skills, concepts, environments, and supporting theories and models of metadata literacy.

2 What is metadata-literacy?

2.1 Overview of literature

Metadata-literacy is not a well defined concept in the literature. The Education Resources Information Center (ERIC) thesaurus (ERIC, 2007) has both terms for metadata and information skills but not for metadata-literacy. Searches for the term metadata-literacy, and meta-literacy return no hits in the ERIC database, Association for Computing Machinery (ACM) digital Library, IEEE digital library, Library Literature, or Library and Information Science Abstracts (LISA). A search strategy which resulted in a set of results relevant to this area of research focused on the term "information skills." This term resulted in significant results in the above databases including 532 results in ERIC, 76 results in the ACM Digital Library, and 633 results in LISA. When combined with the concepts organization or metadata search results scoped down considerably (59 articles in ERIC, 9 articles in ACM Digital Library, and 23 articles in LISA). Information literacy (IL) was indexed as a separate topic from the concept of information skills in these databases but tended to coincide in the research articles. The concept of information skills is defined in the ERIC thesaurus as "Basic to expert-level informational abilities, involved in finding information, and reading, analyzing, interpreting, applying, maintaining, and communicating it skillfully and appropriately" (ERIC, 2008). The definition

includes a note to be sure to not confuse the term with information literacy which it defines as "The ability to access, evaluate, and use information from a variety of sources" (ERIC, 2008). The ERIC thesaurus considers information skills to be a more general term than information literacy and as identified in the information literacy literature review also includes a host of terms for different types of literacies for specific disciplines including computer, scientific, visual, social, and technological literacy.

The literature that does discuss concepts of metadata from a use or literacy perspective tends to focus on one of three areas of research. First, research investigates the conceptual role that information structure plays in the information retrieval process. For example, Barzilia and Zohar (2008) found that information acquisition, which they discuss as knowledge of the domain of research, is both a pre-condition for effective information retrieval and extended-learning (Barzilai & Zohar, 2008, p. 44). Second, research focuses on identifying skills which satisfy a specific metadata need, task, or document. Hert et al. (2007) for example describe metadata studies which focus on how users interact with metadata and it in specific task related contexts . Finally, some studies investigate instances of metadata and information organization as part of their IL framework. Walczak and Jackson (2007) investigate the ability to catalog and analyze found information and Pinto, Fernández-Ramos, and Doucet (2008) employ abstracting as a means of assessing student's information literacy skills. These three areas of research; conceptual role, specific skills, and metadata context coincide with the participant perspectives included in the IL framework identified in the information literacy literature review.

In addition to pointing to skills and concepts that relate metadata use to learning and knowledge creation there is research which indicates a need for further investigation of the role of metadata use in information environments. For example, Denn, Haas, and Hert (2003) found (as reported in Hert et al.(2007)) eight themes related to user interaction with statistical metadata including participant knowledge, interpretation, information navigation, and information integration. They concluded that although domain knowledge and task knowledge are integral elements of effective use of metadata in specific contexts, creating metadata schema which contained this information would be difficult given the wide array of contexts of information needs and users

(Hert, et al., 2007, p. 1277). Hert et. al conclude that metadata is an important component of scaffolding and indicate effective use of statistical metadata involves metadata familiarity. Hert et al. (2007) conclude their analysis by focusing on Bloom's taxonomy and Anderson and Krathwohl's (2002) work.

Research addressing the role of digital texts in IL sometimes includes research on metadata. Borsheim, Merritt, and Reed (2008) for example examine the educational implications of a technology enriched learning process and consider the role of student technology literacy diversity when implementing technology rich environments. Their focus is on the concept of Multiliteracies which they view as being concerned with "the impact of communication technologies and multimedia on the evolving nature of texts, as well as the skills and dispositions associated with the consumption, production, evaluation, and distribution of those texts" (Borsheim, et al., 2008, p. 87). This view is in line with those posed in an aggregated book on "New Literacies" which are viewed as the literacies emerging from the use of ICT (Coiro, Knobel, Lankshear, & Leu, 2008). Another key publication in this area is the work by the National Research Council on Information Technology Fluency (1999). Their report includes examples of the extent to which information technology (IT) is integrated into society including jury duty, changes in job definitions, and understanding laws and ethics in an information society (National Research Council, 1999). The report analyzes the required literacies and includes metadata-rich concepts such as a concept of data structures, programming algorithms, and the ability to organize and structure information. Unlike other skill-based conceptions of technology literacies, their concept of Fluency with Information Technology (FIT) includes a focus on conceptual knowledge as well of skill knowledge (National Research Council, 1999). This report includes a substantially larger skill and conceptual set for the general population than does other literacies with regards to technology. In relation to the concept of metadata-literacy, the report includes information organization and metadata related competencies including the ability to manage complex systems, organize and navigate IT, collaborate and communicate, conceptualize digital documents, create organization structures, and engage in algorithmic thinking.

2.2 A working definition of metadata-literacy

Metadata-literacy can be defined as the ability to conceptualize, create, and work with metadata within information environments. This concept of metadata-literacy, has been developed through the reviews on information literacy, information organization and user-perspectives. Metadata-literacy is particularly important in digital and complex learning environments where metadata-rich digital resources, a focus on collaborative work, and interest in student-researcher models are require these skills. Although there is ample research discussing the use of complex digital environments to enhance learning environments (Bold, 2006; Bussert, Brown, & Armstrong, 2008; Richardson, 2006), there is little attention paid to the literacies required to work with the digital forms of data in these environments. Further, there has been little research that considers what required elements should exist in courses which employ these elements or that look at the resulting output of the class. Hert et al. (Hert, 2006; Hert, et al., 2007), asserts that the gap of knowledge about how to handle information and metadata on a conceptual level is a contributing factor in the success of the use of information technology. Without this understanding, technologies that emphasize individual/group ownership over the educational space and online collaboration (including wikis, blogs, and collaborative authoring applications) can be difficult to implement given a need for students and faculty to work with new document structures and new metadata concepts.

The definition of metadata-literacy as the ability to conceptualize, create, and work with metadata will be examined using the information literacy framework in the following sections. One element of this definition is the use of active verbs to describe how the user or participant interacts with and creates information. Rather than use the term ‘user’ to describe the individual engaged in these tasks or the concept of the ‘student’ from education literature, this literature review uses the term ‘participant’ to talk about the individual engaged in information tasks. Examples in the three participant areas of skill, concept, and context will be identified along with the teacher perspectives of pedagogy, information and learning theory, and environment.

3 Elements of metadata literacy

As discussed in the definition of metadata-literacy, one way in which literacies can be analyzed are in terms of specific skills, concepts, and contexts in which that literacy exitsts. These three elements are one part of the framework developed in the information literacy literature review and are grouped under the overarching concept of the participant perspective. By framing a discussion of these elements from the view of the information user, the discussion of elements focuses on what constitutes metadata literacy. The other section of the IL framework focuses on teacher perspectives including pedagogical approach and implications, information and learning theory elements, and the role of the information environment. By discussing these three elements (pedagogy, information theory, environment) from a teacher or librarian perspective, this framework allows the investigation of a literacy to be framed in terms of how a literacy can be taught. A further benefit of approaching the discussion of literacy using this framework is in its ability to easily map specific learning goals and competencies onto the revised Bloom's taxonomy (Krathwohl, 2002). In this section, each element of the IL framework will be discussed in relation to metadata literacy. After discussing literature related to each of these areas, the section concludes with the mapping of specific literacy skills onto a prevailing learning theory (Bloom's taxonomy) as an example of how to turn a metadata-literacy element into a actionable literacy.

3.1 Participant perspectives

The elements of the IL framework which focus on participant perspectives examines ideas related to specific literacy skills, conceptual knowledge, and contexts of use. The focus on participant or user perspectives in this section allows the definition in operational terms of metadata literacy. In each of these three areas, literature is discussed which informs the relevance of these categories to defining a holistic concept of literacy.

3.1.1 Skills

Information skills are a necessary element of literacy. The literature review on information literacy underscores the emphasis on skills in many IL models. In order to demonstrate examples of metadata skills, this review focuses on specific IL literature that addresses and helps define metadata literacy.

Although there is no a specific discussion of metadata-literacy in the literature reviewed, there are a number of skills related to metadata. Eshet (2002) for example investigated the idea of digital literacy and defined digital literacy skills as being able to read from digital interfaces, digital reproduction, knowledge construction, and information evaluation. Bawden (2001) reviews the concept of digital literacies and provides a summarized list of digital skills. This skill list includes several metadata concepts such as the ability to interact with a hypertext document structure, ability to collate and classify retrieved information, ability to employ information filters/agents, and awareness of the social context of information. Bawden's (2001) list is partially replicated in Table 1.

Table 1 Bawden's information literacy skills

Information Literacy elements
Skills of reading and understanding in a dynamic and non-sequential hypertext environment
Knowledge assembly skills; building a 'reliable information horde' from diverse sources, with 'the ability to collect and evaluate both fact and opinion, ideally without bias'
Searching skills, essentially based in Internet search engines
Managing the 'multimedia flow', using information filters and agents
Creating a 'personal information strategy', with selection of sources and delivery mechanisms
An awareness of other people and our expanded ability [through networks] to contact them to discuss issues and get help
Being able to understand a problem and develop a set of questions that will solve that information need
Understanding of backing up traditional forms of content with networked tools

Wariness in judging validity and completeness of material referenced by hypertext links

Although the concept of metadata-literacy is not commonly discussed in IL literature, there is discussion of it in librarian-centered literature. Sheila Inter for example lists a series of skills that librarians should have in order to become be metadata literate (Intner, 2007). Similarly, a discussion at an ALCTS session at ALA's 2008 conference discussed core competencies for metadata librarians as including knowledge of encoding systems (XML), data modeling, programming, as well as traditional cataloging skills (Martin, 2008). In a post in 2007, Christine Schwartz summarized a list of suggested cataloger skills (Schwartz, 2007). These skills are represented in Table 2.

Table 2 Schwartz's information literacy skills

Information Literacy elements
Learning systems analysis/theory
Learn new technologies
Learning to read code: XML, SQL, and CQL
Openness to play and experimentation with new technologies
Learn about what makes the web work
Talk to people who are making the Semantic Web work
Find a way to get your data onto the Semantic Web
Understanding more about how computers work, what they can do, what they can't do
Develop a fundamental understanding of computer systems and modern technology
A willingness to learn new technologies/standards and to experiment/play with them

The lists of skills from Bawden represented in Table 1and Schwartz represented in Table 2 includes both core metadata-literacy elements such as complex searching skills and metadata-informed elements including the ability to judge web based content by evaluating hypertext links. Other metadata specific skills based on the skills discussed in the metadata literature review which are not mentioned in these two tables include: (a) encoding of metadata, (b) assignment of

descriptive metadata to a document (c) using metadata in searching, (d) harvesting metadata for use in an information system, (e) connecting metadata from different systems together in a new information system, and (f) using metadata in information systems.

3.1.2 Concepts

Conceptual understanding is considered to be a key element of literacy. Oblinger and Hawkins (2006) comment on the understudied gap between student technology literacy and information literacy, citing a drop in familiarity as soon as students are asked about common but not core applications. Of particular concern to them is the issue of student avoidance of libraries and librarians for web-search and the impact that has on their IL skills (p. 12). They ask about the IL skills in a digital world and emphasize the skills of evaluation, and ethical use. Likewise, Wang and Artero (2005) point to the need for specialized IL skills for web-based searches and examine the concept that undergraduate students skills are not grounded in a larger understanding of information and research skills. Talja (2005, p. 18), discusses conceptual knowledge as a core component of IT literacy arguing that skill-based knowledge does not completely fill an IL need. In addition to finding a list of conceptual ideas surrounding IT literacy, Talja found that participants also viewed domain knowledge to be an important element of literacy. To make this point, Talja presents an enumerative list of conceptual competencies including: (a) IT language and terminology, (b) programming, (c) components of a computer, (e) how programs work, (f) operating systems and environments, and (g) the basic logic of a computer.

As with the skills section, metadata concepts are not directly represented in the literature. In addition to this list, metadata-specific skills such as: (a) the ability to create metadata, (b) use metadata to create a personal information system, (c) recognize metadata, (d) understand the concept of metadata interoperability, (d) recognize the role of metadata in digital information systems, and (e) understand the difference between structured and unstructured data are considered to be core conceptual understandings of metadata literacy. Despite a lack of representation in information literacy literature, metadata conceptual literacies are discussed in relation to librarian competencies (Hillmann, 2007; Library of Congress Working Group on the

Future of Bibliographic Control, 2008). The report of the Library of Congress working group on the future of bibliographic control recommended "core levels of knowledge for all information professionals in the fundamentals of knowledge organization theory and practice, including application not only in libraries, but also in the broader range of related communities and information activities" (Library of Congress Working Group on the Future of Bibliographic Control, 2008).

3.1.3 Context

The idea of context with regards to metadata-literacy is seen in Lotehrington's (2003) discussion of the relationship between digital devices and document structure. Lotherington approaches the idea of literacy by asking about the impact of digital devices on information structure and use "questioning how the borders of the encoded world have shifted now that encoding and decoding information has so surpassed the literal boundaries of alphabetic print from which the term literacy derives" (p. 306).

New contexts of information use have introduced the need for a new skill and conceptual elements for metadata literacy. One example of a new context is the digital information remixing application. Yahoo Pipes (Yahoo, 2008), for example, provides an graphical programming interface in which users can manipulate and recombine data. Users have the ability to use a number of different types of inputs (RSS, CSV, etc) and create multiple outputs. Similarly, Intel's MashMaker (Intel, 2009) allows users to take data from multiple websites and integrate them into a new dataset with new uses. One key feature of MashMaker is that it emphasizes the concept of date-repurposing. For example some suggested uses include showing contacts from an address book on Google Maps, aggregating historical pricing data onto a single chart, and creating new search interfaces for multiple websites. The Horizon 2009 report cites this style of web-based information work as the "Personal Web" (Educause, 2009, p. 19) and looks towards growing usage over the next two to three years. Another example is Chickenfoot which provides a scripting environment within the context of a browser client (MIT, 2008). Chickenfoot does this by providing a development environment which includes data harvesting

from web pages alongside a JavasScript based processing environment. The developers of Chickenfoot assert that customized views of the web aggregated from multiple pages, the ability to automate repetitive tasks, and changing website appearance are three examples of the sort of tasks that web-users will embrace with this technology (Bolin, Webber, Rha, Wilson, & Miller, 2005, p. 1). These are three examples of new tasks which require metadata skills to be accomplished.

3.2 Teacher perspectives

While user or participant perspectives focus on the set of skills, competencies, and context within which metadata literacies occur, teaching perspectives focus on the pedagogical methods, information theories, and environmental role which underwrites the teaching of these literacies. Addressing the concept of metadata-literacy from these three areas allows this literature review to consider both instructional and information theory in addition to contextualizing the relevance of these theories within a given environment.

3.2.1 Pedagogy

The review on information literacy introduced the constructivist pedagogical theory as a primary means by which teachers approach teaching. The constructivist perspective has been used extensively within the context of Bloom's taxonomy to describe levels of learning in students and discuss goals by which teachers can approach a topic. Bloom's taxonomy has also been used to both outline the process of knowledge acquisition and learning. Bloom's original taxonomy contained six levels: Knowledge, Understanding, Application, Analysis, Synthesis, Evaluation. These six levels are operationalized into teaching goals by asking questions related to each area to help assess student learning. For example, common questions for the knowledge level include recalling essential details of a thing such as who, what, where, when. As Bloom's levels of learning progress, questions become more abstract or evaluative. For example questions directed towards the process of synthesis include "What could you infer from," "How would you design a," "How would you solve" (Bloom, Engelhart, Furst, Hill, & Krathwohl, 1956).

In 2001 Anderson and Krathwohl (2002) revised Bloom's taxonomy with the goal of adapting it to the current information and learning environment. The new taxonomy still contains six levels but these levels have been referred to in an active tense such as remember or understand and have been re-grouped to reflect the new importance that creation of information plays. The six updated levels are: Remember, Understand, Apply, Analyze, Evaluate, and Create (Krathwohl, 2002, p. 216). The revised taxonomy also examines each of these levels with four categories of knowledge: Factual knowledge, Conceptual knowledge, Procedural knowledge, and Metacognitive knowledge (Krathwohl, 2002, p. 216). The resulting matrix allows the examination of a learning level using these four categories. The updated model also has had specific verbs associated for it to help assess student achievement at these levels. For example the level of "Analysing" is associated with the verbs organizing, comparing, deconstructing, and integrating while the new level of creating is associated with verbs such as designing, constructing, planning, directing, and producing (Churches, 2008b).

The implications of the new version have been discussed widely but only recently have researchers in the education field begun thinking about how the actions associated with Bloom's taxonomy mesh with ICT pedagogy (Churches, 2008a; Cochran & Conklin, 2007; Krathwohl, 2002). For example, the work of Churches (2008b) includes both high level conceptual references to ICT tasks which relate to each level and also specific technologies and techniques. In a 2008 article in Tech & Learning Churches (2008a), outlines his view of the roles of ICT related to Bloom's taxonomy. The four levels of knowledge presented by Krathwohl (factual, conceptual, procedural, and meta-cognitive) (Krathwohl, 2002, p. 214) offer the updated taxonomy the ability to talk more specifically about a given stage of learning. Krathwohl charts these four levels in order to offer more granular description. These four levels (Krathwohl, 2002, p. 214) have been adapted to table form and are listed in Table 3.

Table 3 Krathwol's knowledge levels

Knowledge Level	Examples
Factual Knowledge	Terminology, details, components

Conceptual Knowledge	Classification, categories, principles, geneneralizations, theories, models, and structures
Procedural Knowledge	Subject-specific skills and algorithms, techniques, methods, criteria for selecting specific procedures
Metacognitive Knowledge	Strategic knowledge, self-knowledge, knowledge about cognitive tasks including context

Pedagogical theory is too large of a subject to receive attention outside of this review of the role that Bloom's Taxonomy plays in helping teachers create a learning environment. The discussion of the role of Krathwohl's taxonomy in supporting teaching models contributes to the generation of a metadata-literacy model by recognizing the impact that pedagogical perspective has on creating learning environments.

3.2.2 Information and learning theory

The information theories investigated in the review on user-perspectives discussed three main groups of information theories; process based models, cognitive and affective models, and participation-centric theories. Process based models tend to focus on information seeking as a process to be followed such as berrypicking (Bates, 1989), SenseMaking (Dervin & Nilan, 1986), and information encountering (Erdelez, 1999; Erdelez, 2004). Cognitive and affective centered models include Kuhlthau's information seeking model (Kuhlthau, 1991), the holistic user (Chatman, 1999), and ecological theory (Williamson, 2006). Participation-centric theories emphasize the multiple roles of participants including use, creation, and analysis (Holland, 2006; Tuominen, Talja, & Savolainen, 2003), the social facet of information creation and use (Sundin, 2008), and the role of IT in information interaction (Clark & Chalmers, 1998).

As was discussed in the review on user perspectives there is a connection between information theory, which focuses on how participants engage with information, and learning theory, which focuses on how participants use information to learn and acquire knowledge. Two key theories that help illustrate the role of metadata in ICT enabled information environments were discussed

in the user perspectives review. The first theory is the extended mind theory (Clark & Chalmers, 1998). This theory focuses on the role of technology in extending human cognitive work including memory, and work with complex theoretical concepts. The second theory is the theory of constructivism first introduced in the review on information literacy and built upon with the concepts of social constructionism (Holland, 2006; Tuominen, et al., 2003) which focuses on the dialog between a document and participant, and how scaffolding supports influence learning (Jacob, 2001; Vygotsky, 1977). The concept of metadata-literacy pulls on each of these theories by using both the perspective of technology-assisted thought and the importance of both social elements and structural support in information use and creation.

The support of these theories comes both in grounding the relationship of metadata skills to learning an in informing the impact of teaching approaches on learning. Ju (2007) for example, discusses the ability to recognize and use a classification system in the context of an information system (p. 2008) and observes that domain knowledge enables greater learning. Jacob (2001) describes two similar perspectives in discussing categorization as scaffolding, as a fixed information system, and classification as infrastructure, as the organic combination of individual, social community, and technology components. Kling, McKim, and King (2003) cite two primary axioms of electronic scholarly communication forums (e-SCF) as "Actor behavior is motivated by and/or constrained by the Information Processing (IP) features of the technology of an e-SCF" and "Actors can most usefully be considered as individual users who can choose to, or not to, use a specific e-SCF" (2003, p. 49). They propose a socio-technical model which includes assumptions on the integrated nature of social and technical systems, the impact of social theory on technology design and use, and the complex relationships that participants are part of both as part of technology and non-technology uses (Kling, et al., 2003, p. 56). This observation makes the point that, unlike previous information systems which focused on simple, static document structures, socio-constructionist information systems are embedded with a larger series of information organization and metadata assumptions which result in a more constructed, albeit scaffolded, environment. This allows both new interactions and limits the scope of the interaction. It becomes apparent from a brief review of supporting theories that no single

information or learning theory completely informs metadata-literacy elements. The relevant theory or model to use is related to the concepts, skills, and environmental factors of a specific element.

3.2.3 Environmental role

The literature review on information organization and metadata demonstrated that the advance of the digital document has had a considerable impact on how people create and use information. The literature review went as far to assert that metadata, which served primarily supporting roles in print resources serves more central roles in digital documents. Given the widespread use of digital documents by undergraduate students finding theories and pedagogical approaches which are designed specifically for this digital environment is important. An Educause study (Katz, 2006) on undergraduate students and their use of technology which reports that both technology ownership and information use/interaction over technology is nearly ubiquitous with undergraduate students. The study found that over 97% owned a computer and that over 99% used electronic messaging technologies on a daily basis. The survey also found that, while 56% of students preferred only a moderate amount of information technology use in the classroom, 75% view IT as a positive influence. Further, Katz (2006) reports that, while most students (74%) have used course management tools and view them as useful tools, a significant portion view them and their use as either neutral or negative.

Not surprisingly given the statistics from the Pew Internet Trust, there is a growing trend of using collaborative software in classroom environments. Bryant (2006) for example, lists both the technologies (blogs, wikis, VoIP, social bookmarking, and social networking) and discusses possible uses in the classroom. These uses include journaling, collaborative authorship, content publishing, and the ability to use social networking software to make connections to experts outside of the classroom. Research detailing examples of these uses is common.

Despite the widespread use of ICT in educational settings, and the use of the processes of categorization, description, and surrogation in these environments, little research focuses on the skills and concepts required to understand these elements of literacy. Likewise there is little

research or applied practice which looks at the areas of information organization and knowledge construction. One example of research of this type is the use of abstracting to evaluate information literacy skills in college students (Pinto, et al., 2008). In the review of their research, Pinto et al. discuss how the process of abstracting causes students to develop skills in relation to resource selection, identification of text structure, organization of knowledge, and production of new knowledge (2008, p. 134). They identify three key components of evaluating information based on organization - information schema, sentence grouping, and visual organization (2008, p. 137). The general interest in ICT is also seen in the use of social software in educational environments. Both Richardson (2006) and Klobas and Beesley (2006) have written books which provide overviews of the topic. In addition, a number of journal articles and web resources exist on the topic. In an article on electronic learning, Downes (2005) observes that the combination of social software and emerging ideas around student-centered education are leading educators away from traditional learning management systems to experiment with new tools. Churches (Churches, 2008a) goes as far as suggesting how specific tools map onto levels of learning in Bloom's taxonomy. In both of these examples, the environment underpinning an educational or information setting has implications for both the skills and concepts employed.

Table 4 summarizes the examination of metadata literacy in this section by pulling together

Table 4 Metadata literacy framework

Teacher / **Participant**	**Pedagogical theory**	**Information and Learning theory**	**Environmental role**
Skills	Embedded instruction Librarian collaboration Embed IO tools within coursework	Extended Mind Socio-constructivist	Digital text use Knowledge assembly Metadata use/creation Community interaction Technology / technical
Conceptual knowledge	Conceptual knowledge taught through	Participants learn to think about how	Role of metadata in personal, social systems

	interaction with systems, discussion of issues	technology / metadata supports learning/cognition	Interoperability Information organization Digital text structure
Skill/concept context	Authentic digital environment required Focused use of learning taxonomy to guide instruction	Extended Mind and socio-constructivist theory are most relevant in collaborative digital environments using structured data	Digital documents make metadata and encoding of social information central to information processes

Table 4 takes the exploration of metadata literacy in this section and attempts to bring these elements into a consolidated form. By mapping elements of metadata literacy in this way, the influence of environment in the form of platform and underlying assumptions about the role of digital texts are shown in concert with supporting information theory. By using this framework to plan an IL instructional concept or element, instructors are able to cross check underlying assumptions, instructional objectives, and learning goals to ensure that these elements are focused on the same ideas. In Section 4, this review takes a specific literacy concept and investigates the elements of this literacy and how it can be taught using Bloom's Taxonomy.

4 Tagging as an example of metadata-literacy

Digital information and social networking services are requiring participants to engage with metadata both in using and creating it. Metadata literacy enables an examination of this interaction by identifying and assessing participant awareness and perspectives of these metadata rich tasks. In this section, a specific metadata task known as tagging will be examined within the IL framework and Bloom's revised taxonomy. Tagging, which is a form of description, is a fairly recent phenomenon of individually created metadata. It began within the context of social

bookmarking systems and has become a widespread organization approach for socially-created sites (Sen, et al., 2006). It has also been identified as an important concept/task in digital learning environments (Churches, 2008b). Tagging is an example of a metadata-literacy element which is informed by the three participant perspectives. First, tagging involves specific actions it includes a set of skills that need to be learned. Second, tagging systems include the ability for the participant to model their own information system, requiring a conceptual understanding of the role of representation and organization of information. Finally, tagging occurs within specific information contexts such as tagging-enabled websites, or applications.

In discussing tagging, it is valuable to consider supporting social-organization information theories. Sen et. al. (2006) for example discuss uses of tags including personal and social contexts, self-expression, organization, finding/re-finding, decision support, and intended use . The environment of tagging systems includes a number of facets. Marlow et. al. (2006) present a model for a tagging system which includes resources, tags, users, and relationships. The system attributes discussed by them include tagging rights, tagging support, aggregation, type of object, source of material, resource connectivity, social connectivity. They also discuss user incentives: future retrieval, contribution and sharing, attract attention, play and competition, self presentation, opinion expression (Marlow, et al., 2006). Golder and Huberman (2006) discuss uses of tags including identification of topics (aboutness), kind of thing (description), ownership, refinements (specificity/granularity), qualities/characteristics (categorization/classification), self reference (user metadata), and task organization (use metadata) (p. 204). Because of all of the concepts surrounding tagging, it is a good example of a metadata-literacy element which is both commonly used and involves a number of metadata-centric literacies.

The use of tagging in learning environments is supported by the constructivist learning theory and Blooms' updated taxonomy. In identifying knowledge surrounding tagging, the use of Krathwohl's chart (2002, p. 214) allows the analysis of different states of knowledge related to a literacy. For example, in the example of tagging, a factual level of knowledge includes understanding what a tag is and where it is created. Conceptual knowledge includes understanding types of tags and their uses, and understanding underlying theories surrounding

tag creation and use. Procedural knowledge includes how and where to create tags, be able to identify a method of tagging for a specific situation, and being able to use and re-use tags as needed. Metacognitive knowledge about tags includes being able to monitor tag creation and manage content, understand how tagging is filling a learning or information need, and being able to determine new ways in which tags could be used to solve those needs. In addition to helping understand learning levels of metadata literacy, breaking down the metadata-literacy of tagging into a cognitive map on Bloom's taxonomy allows the identification of specific pedagogical approaches and evaluative metrics to teaching this literacy. Table 4 examines the role of social bookmarking evaluation within the framework of Bloom's revised taxonomy. It indicates the extent to which this metadata-literacy element impacts learning and knowledge creation.

Table 5 Cognitive map for tagging

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual Knowledge	Identify tag, bookmark	Identify roles of tags, bookmarks	Use social bookmarks in system	Identify types and uses of tagging systems	Identify roles, quality, use of tags	Bookmark/tag an item
Conceptual Knowledge	Uses of tags	General role of tags in system	Role of encoding in specific system	Types of description/representation	Relationship of tags to similar systems (classification)	Role of tags
Procedural Knowledge	How to identify a tag	How to use tags to retrieve resources	Steps in tagging an item	Steps for managing authority control	Steps for identifying preferred tags	How to bookmark/tag, which system to

				within/without individual tags		use
Metacognitive Knowledge	Role tags play in storage/retrieval			Role of tagging in working within community	How to use tags to manage individual knowledge	Position of individual work in community space

Table 4 shows how complex the knowledge foundation of a relatively simple metadata task can be. By using this approach to enumerate levels and types of knowledge surrounding metadata literacies, instructors and librarians could better tune instruction to meet individual student needs. For example, designing instruction which helps students move from one level of knowledge to another adds depth of understanding to a deceptively simple task.

5 Conclusion

As this review of research on metadata-literacy has shown, there is a body of literature on which discusses forms of information literacy and digital literacy, studies which examine the use of metadata in information seeking and use are limited. This may be due in part to the lack of emphasis on metadata use in searching interfaces in general or the presence of assumptions regarding the use of these services. While it is clear from the reviewed literature that classification and categorization are elements of cognition, there is not agreement on specific metadata skills or competencies. Here again, as with cognition, while there is a strong relationship between the role of metadata and well structured online social networks, there is little research which suggests the skills that a participant should have to make effective use of these environments. For example, while tagging is commonly used as a means of community information work in online environments, there have been no explicit studies which examine the various views of tagging and metadata creation across a community. Further, issues the scope and granularity of the representations and surrogations created in community environments are

influenced by the understanding and views of how resources should be represented. Likewise, there has not been research into the role that these perspectives play in creating community information nor has there been research which examines the role that being literate in these concepts/skills plays in an individual's ability to participate in a community.

Metadata technologies are still fairly new and developing; and it is not surprising that their use includes implementation and evaluation challenges. Nickles (2006) suggests using process measures to evaluate student performance and use of course management systems, but recognizes that measuring system logs stops short of gathering intent and actual use. Masiello, Ramberg, and Lonka point to the lack of research underwriting the assumed effectiveness of these applications and assert that "we also need to persistently evaluate every new methodology from the point of view of educational effectiveness" (2005, p. 183). Like Morgan (2003), Masiello, Ramberg, and Lonka (2005) identify issues with use including need for technical support and training, need to focus on specific pedagogical goals, and need to involve faculty in selection and design of the system.

Given the presence of these barriers to implementation, and the continued enthusiasm for use of these technologies in the classroom, libraries and librarians may be in a position to provide the platforms and expertise required to make using these applications possible. In many institutions, librarians are bringing their expertise with information seeking and evaluation, information organization and management, and are providing pre-established platforms for learning and collaboration in the form of both traditional digital libraries and non-traditional social software applications. The consideration of Bloom's taxonomy as an evaluative instrument for metadata literacies has provided this review with a framework which can be used to assess the results of the research on these two literacies. Further, it provides any instructor of an IL concept to identify in advance the relationships between a task, concept, and the related elements of learning that will successfully communicate that concept and task to a student.

This review investigated the concept of metadata-literacy within the context of the information literacy and information organization reviews conducted as part of this work. It found that while there are connections between IL, IO, metadata, and metadata-literacy, that there are also gaps in

the literature addressing this issue. As the IL review found, IL models can prove to be difficult to unify and an initial attempt to construct a model of metadata-literacy by reviewing literature on the subject may not prove to be particularly useful. This review has found that many theories can be used to investigate the concept of metadata literacy. The theory of Extended Mind reviews in previous literature reviews underscores the relationship between metadata and extended cognition. Likewise, Bloom's taxonomy and the work done to map specific skills and concepts onto learning levels demonstrate how metadata supports learning. The next literature review investigates research methods that have been used to investigate literacy, information, and metadata issues. This methodological literature review follows the topics covered in this metadata literacy review; and it provides insight into the methods that can be used to study metadata literacy, as defined in this current review.

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