METADATA LITERACY: AN ANALYSIS OF METADATA AWARENESS IN

COLLEGE STUDENTS

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Abstract

ERIK T. MITCHELL: Metadata literacy: An analysis of metadata awareness in college students

(Under the direction of Dr. Jane Greenberg)

CONTEXT: This dissertation examines the role of metadata in undergraduate students' information environments. It uses a constructivist world view and an Information Literacy (IL) perspective to evaluate student metadata literacy (ML).   Fifty undergraduate students formed the study population in an online mixed-methods study.

OBJECTIVE: To understand how students use metadata and to evaluate competency using metrics informed by IL models. Key research questions examined participant awareness of metadata, impact of instruction on levels of ML and use of metadata in information environments.

APPROACH: This study employed a mixed-methods approach which included survey, experimental, and observational elements.

ANALYSIS: Participant responses were grouped for analysis based on survey data and included education level, awareness of IL concepts, and extent of digital information use. Quantitative data was analyzed to detect differences among groups using

measures of task proficiency and self-efficacy. Qualitative data was analyzed to identify student attitudes towards and use of metadata.

RESULTS: Participants indicated a good base level of ML evidenced by high self-efficacy and reasonable task completion scores. Participants were found to be using metadata in complex ways for social networking purposes.   The study also found that academic level, major, and prior IL instruction were not related to ML levels in the study population. Significant differences were found among participants who had prior experience working with digital information ($p < .044$), in Self-Efficacy ratings among participants with prior IL instruction ($p < .015$), and among all participants in self-efficacy levels with regards to different ML concepts (e.g. ability to identify as opposed to create metadata). Qualitative analysis indicated that participants recognized the value of metadata in social networking software and were able to identify various uses of metadata including social connections and relationships and metadata re-use by others.

CONCLUSION: While students possess a base level of ability and confidence with regards to ML, they are not as confident about advanced concepts. Further, student creation of metadata tends to focus on social uses as opposed to personal uses.

This dissertation is dedicated to my parents Judy and Charles Mitchell for their encouragement, guidance, and support. Without them neither this dissertation nor any of the steps along the way would have been possible.

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Chapter 1   Introduction

The information age has seen a convergence of traditional literacy skills, social creation of information, and organization of this information in digital contexts. This dissertation investigates the role metadata plays for students engaged in these activities and how students use metadata to support their use of information systems. While research questions the added value of metadata in search (Hawking & Zobel, 2007; Hunter, 2003), and the sustainability of traditional metadata practices (Calhoun, 2006), other studies point to the centrality of metadata in learning environments and digital libraries (Shreve & Zeng, 2004; Zeng & Smith, 2003). This dissertation examines metadata use from the perspective of education and learning by using the supporting concept of literacy to investigate student competency levels for metadata use in participant driven information environments.   The work presented addresses this by examining metadata awareness from the two perspectives of user ability to complete metadata tasks and their level of self-efficacy with regards to these abilities.

Research has demonstrated that students are using metadata-rich digital information systems (Bussert, Brown, & Armstrong, 2008; Skågeby, 2009). Social communities such as Facebook, SecondLife and Flickr use varying levels of metadata both at system and user assigned levels. Reflective of this

development, the research communities addressing emerging information environments, metadata creation/use, and information literacy are very active. Despite this activity, there has been little research investigating the extent to which the awareness of metadata and document models impact the user experience in these information environments. This awareness is discussed in this dissertation as metadata literacy.

Understanding the various roles of metadata in digital documents requires an active view of the information user. Use of technology and digital documents includes roles of seeking, retrieving, creating and processing, all of which are tasks which have new implications in digital contexts. In their 2004 study, the Pew Internet Trust found that 87% of American teenagers and 66% of American adults use the Internet (Lenhart, Madden, & Hitlin, 2005, p. 2). Another Pew Trust survey from 2005 showed continued growth, with 72% of adults online ("Demographics of internet users,"). The 2005 survey of Internet Activities also indicated that 90% of these users used Internet search engines in information seeking. The only more popular activity indicated was e-mail (91%) ("Internet activities," 2005). The Statistical Abstract of the United States indicates similar usage numbers and patterns in their study from 2004, showing 62% of adults with Internet access at home (*Statistical abstract of the united states*, 2006, p. 751). The 2009 ECAR study found that information technology use in undergraduate students was nearly ubiquitous with strong inroads being made in the use of the Internet on mobile technology (S.D. Smith, Salaway, & Caruso,

2009). Despite the widespread use of technology however, many studies are also finding a gap between technology familiarity and actual information literacy with regards to that technology (Rowlands, et al., 2008; Yan, 2008). This dissertation investigates this gap for metadata awareness and use among college students.

The purpose of this study is to investigate how undergraduate students view metadata and to what extent they are comfortable engaging with it. Using a mixed-methods approach, this dissertation approached the question of how undergraduate students perceive metadata and what impact they see it having on their information environment. It also investigated how participants perceive authorship roles by asking them about their familiarity with and attitude towards metadata creation through the use of a tag creation exercise. This work focused specifically on digital environments and asked participants to think generally about their role in document creation and use. It was anticipated that while participants may not have formulated clear concepts of the role of metadata in their digital information environments and would not have a generalized understanding of metadata, they would both be able to think specifically about metadata tasks and grasp of the impact of metadata in their information experience.

The organization of the remainder of this document is as follows. Chapter 2 contains a review of relevant literature. Chapter 3 contains a discussion of

methods and study procedures. Chapter 4 contains the results of the descriptive

analysis of quantitative data. Chapter 5 contains the results of the inferential

analysis of quantitative data. Chapter 6 contains the results of the analysis of

qualitative data. Chapter 7 contains a discussion of findings and implications for

metadata instruction, research and theory. Finally, Chapter 8 contains

concluding observations on the findings and a discussion of research limitations

and next steps.

Chapter 2   Literature review and background

2.1   Overview

This literature review documents the research surrounding the concepts of metadata, information literacy (IL), and metadata literacy (ML). The emphasis of this literature review is on understanding the relationship between metadata use and IL. Further, this literature review seeks to understand how IL models inform our understanding of metadata creation and use in information systems. This examination of the concepts of metadata and IL creates a framework from which IL elements can be evaluated and concludes with a summary of the gaps in the literature surrounding these concepts.

2.2   Literature quality and representative works

A majority of the literature reviewed centered on one of three themes, metadata, literacy, or education. It proved difficult to find literature that included a focus on both metadata research and on literacy/education research techniques.   With regard to IL research, very little of the literature attempted to pull in perspectives from other disciplines. For example, the similar concepts of multi-literacies in the education field and meta-literacy in the Information Science field were not discussed interchangeably outside of their respective fields. Likewise, IL models tended to focus on a specific context such as digital

environment, business, or discipline and contain IL elements focused on that area. In contrast, educational models such as constructivism were discussed across the literature as an approach for teaching IL practices.

The following sections of this chapter investigate the concepts of metadata and literacy in relation to their relevance in digital information environments. Topics covered include how metadata is used in information systems, and how individuals use metadata to accomplish an information task. The literature review begins with an examination of the context of information use relevant to this dissertation, and continues by examining the role of metadata in this context. From this perspective, the review examines the utility of IL theory in understanding the impact of this use and proposes an evaluative framework which is used to investigate ML.

2.3   Defining the context of digital information

Early pioneers of digital information include Turing, Licklider, Bush, and Taylor. Detailed histories of the evolution of computers and digital information environments have been written by Markoff (2005) and Wright (2007) which discuss the roles of key individuals, technologies, and movements. One idea apparent in these histories is the notion of a change in the nature of the document as information systems have evolved. An overriding theme in these histories is an interest in how these documents are created, organized, and used. For example, reviews of the history of research in digital libraries shows an early

interest in community based collaboration (Borgman, 1999; Marchionini & Maurer, 1995). These systems have helped to create new types of digital documents which include structures unique to digital environments. These systems have also enabled users to engage in the representation and surrogation of resources as part of the document creation process.

This change in how documents are created and organized has implications not only for library and information science professionals, but also for any information consumer in that there is a new set of skills, concepts and contexts of use that coincide with the use of digital documents. As such, the information context in which this research is situated is not limited to new ways of accessing information or a change in the scope or pervasiveness of information in our everyday lives, but also includes the development of new information structures, conceptual foundations for those structures, and skills required to interact with them.

2.3.1 A document-centric view of information systems

The evolution of the digital document has coincided with changes in metadata systems, information use theories and technological advances. Buckland's (1997) article provides an overview of the origin of document theory in including perspectives from Briet, Otlet, Duyvis, and Ranganathan. Buckland compares their theories to the continuing evolution of documents in the digital realm,

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pointing out that "documentationalists increasingly emphasized whatever functioned as a document rather than traditional physical forms of documents" (p. 808). His claim that the "shift to digital technology would make this distinction more important" (p. 808) indicates a change in perspective from document as physical instance to document as instance of intellectual content, which is now the widely held view. Buckland's definition includes both text-based physical objects including books and letters and less concrete examples, including an antelope, or a model of a ship. While he does not explicitly include electronic formats in his 1991 work, he includes events as a different type of information. Lagoze (2000) extends this idea, citing the relevance of event-awareness for information objects. Likewise, Greenberg (2003) expands the definition of the document by defining objects as "any entity, form, or mode for which contextual data can be recorded" (p. 1876).

Just as the documentationalist movement of the early 20th century attempted to re-cast librarianship into 'knowledge management' (Buckland, 1997; Wright, 2007, p. 180), current trends in information science emphasize the relationship of information, document structure, and knowledge (Berners-Lee, 2006; Borland, 2007; Eriksson, 2007). The concept of the document as encoded knowledge is represented in the literature. Bruce (1997), for example, positions information technology in relation to the interaction between the individual and information. Likewise, Oostendorp, Breure and Dillon (2005) propose that information is also

medium dependant, suggesting that digital documents miss some of the interface characteristics inherent in physical documents.

Wright's (2007) history of information draws direct connections between the evolution of information facets such as accuracy, timeliness and ubiquitousness to the development of the technology, citing, in particular, the role that the codex and movable type printing press played in raising the role of information in the world. Holland (2006) goes further, observing that language itself is a technological innovation stating that "language, both verbal and written, provides tools for humans to alter and enhance their cognitive activities" (p. 95). These examples point to a symbiotic relationship in which the nature of information drives the technological encoding and also in which the resulting document structure guides the concept and representation process. These examples point to the idea that a document cannot be defined without considering the facets of platform, content, structure, and the role that the user plays in the representation of content in the encoded resource.

In relation to this changing concept of the document, social constructionism asserts that the view of information as an 'information brick' or as a noun-based state ignores the dynamics of user-centric information theory (Holland, 2006; Tuominen, Talja, & Savolainen, 2003, p. 563). This view asserts that neither the document nor the classification systems which represent it are objective, and that there is value in recognizing multiple perspectives in description and in

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recognizing the power in relationships between documents and users (M.J. Bates, 1998; Bowker & Star, 1999).

Literature in this area points to changes in publication, use, and ownership, and asserts that a shift from printed text to digital media will have a significant impact on how information is thought about. Wright (2007, p. 234) for example, asserts that the concept of the document is grounded in a literacy tradition that focuses on the construct of authorship and authority and asks, instead, if web-based mediums are beginning to create documents based on oral communication patterns rather than written patterns. Wright observes this change based on an observation that electronic texts such as instant messaging, blogs, and email are used in 'conversational' ways, allow a de-construction of authorship and authority, and utilize oral structures rather than written structures.

The shift in document authorship has been paralleled with a shift in the content of digital documents to non-text media. This view of authorship focuses less on primary authors and more on collaborative and iterative authors. As such, the idea of authorship is less of a static role and more of a type of action that the user engages in during use of a document. As Wright points out, the dominance of text in the document may have had significant ramifications on other communication traditions including oral and symbolic traditions (2007, p. 39). The implications for this shift both in how documents are created and how they are encoded is discussed by Ware and Warschauer (2005). They point to

the ability to create "interactive written communication," blurring traditional distinctions between author and reader. They also observe that electronic environments enable hypertext, challenging both the linearity of printed texts and creating contextual classification structures. As Crook (2005, p. 511) observes, the use of contextual document structures is also a key element of creating an 'active' reader through decisions and choices in text interaction.

As information architecture literature asserts, the growth in use of contextual data, or metadata, in these documents is changing the way users interact with these documents (Morville, 2005). The differences noted above in viewing documents as complex objects (Ware & Warschauer, 2005), as evidence of knowledge (Borland, 2007), and as process of social discourse (Tuominen, et al., 2003) underscores changing conceptions of what a document is, how it is used and what authorship of the document means. These ideas are important to this dissertation for two reasons. The first is the notion that, along with the change in documents, metadata is becoming more central to the idea of a document and how it is created and used. Second, there exists the idea that distributed authorship not only of the document but also of the metadata surrounding the document, including categorization and contextualization of that document, is becoming more common. These changes in the creation, storage and access of documents have resulted in a re-evaluation of traditional processes and roles, including the role of classification structures in encoding information, the role of creators and consumers of metadata, and the impact of

the increase of scale and automation in creating and using these structures. The
implication of this change for users is that a new set of literacies are required in
order to understand how to interact with and create these documents. In order to
understand the role of metadata in these documents and the implications for
users, this literature review examines these two topics in the following sections.
It concludes with a discussion of ML as a unified model for examining the use of
metadata in digital information environments.

2.3.2 Understanding the role of metadata

The definition of Metadata as understood in this dissertation research is defined
as a form of structured or contextualized data that adds context to an information
object. This definition is similar in scope to that of Greenberg who views
metadata as "structured data about an object that supports functions associated
with the designated object" (Greenberg, 2003).

Metadata is less central to the use and structure of traditional information
artifacts such as books, paintings or stories. While certain elements such as
descriptive metadata (e.g. author, title, publication information) and categorical
metadata (e.g. topics, dates, relationships) have played an important role in print
resources, the role of metadata in information systems is changing in the digital
environment. These roles include resource organization, discovery and
management, personal information management, and discovery of new

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information. Although metadata serves important roles in the structure and context of documents, research does not always agree on the utility of metadata in some areas. Studies show, for example, that full-text indexing provides sufficient retrieval at lower indexing costs than manual indexing (Hawking & Zobel, 2007; Hemminger, Saelim, Sullivan, & Vision, 2007). Other research has shown that metadata is/can be of significant value for evaluating and using documents (Liddy, 2005; Reamy, 2004; Yee, Swearingen, Li, & Hearst, 2003).

Despite these differing views, there is ample evidence of the relevance of metadata in electronic documents. The use of metadata to support various functions has expanded greatly in recent years, and metadata is increasingly used in common information environments as opposed to 'back-end' system work. This has had major implications for how we view metadata. First, and perhaps most notably, the focus on a single type of use is diminishing. Information artifacts are increasingly generated to be re-used and transformed. Second, notions of authorship are changing. Informal modes of collaborative and community authorship are beginning to re-emerge as the technological platforms to enable them are becoming more widespread. Finally, the digital document enables new types of metadata to be recorded, often automatically, and integrated into documents. This means that new ways of managing and using these documents are possible.

Metadata serves these changing roles by providing models and encoding systems to store this new information. This means that new documents are being created in which a key element is the presence of metadata. As a result, it is important to understand the extent to which users are aware of and understand the role of metadata in these information artifacts and the role that they (the users) play in creating, using and storing this metadata.

2.3.3 Research on metadata creation and use

In the area of metadata research, few articles focused on how individuals use metadata and what impact it had on their learning, knowledge level or information experience. Metadata research includes management approaches (Chapman, 2007; Halamka, 2008; LeBlanc & Kurth, 2008), innovative uses (Min-Yen & Yee Fan, 2008), metadata quality (T. Bruce & Hillman, 2004), metadata generation (Greenberg, Pattuelli, Parsia, & Robertson, 2001) and metadata interoperability and standardization (Greenberg, 2005; Zeng & Chan, 2006). Other literature on metadata focuses on its impact on certain information tasks such as retrieval (Hawking & Zobel, 2007), personal information management (Barreau & Nardi, 1995; Jones, 2007), and use in complex information environments (D.G. Campbell & Fast, 2005; Dongwon, Peter Hoh, Fran, Young-Gab, & Doo-Kwon, 2005). In contrast, work done by Greenberg (Greenberg, et al., 2001) studied the impact of author created metadata, while Guy and Tonkin (2006) and MacGregor and McCulloch (Macgregor & McCulloch, 2006) both included

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participant-perspectives when discussing the role that folksonomies play in information environments.

Research on metadata creation and use by general users has focused on a number of issues including quality of metadata, impact of metadata, and user attitudes towards metadata creation. Metadata is also discussed as supporting the interaction between information organization and system design (Morville & Rosenfeld, 2006; Rosenfeld, 2002). For example, significant design issues in Internet applications include search and retrieval (Kwasnik, Crowston, Nilan, & Roussinov, 2001), navigation tools (English, Hearst, Rashmi, Swearingen, & Yee, 2002), accessibility (Harper & Bechhofer, 2007), and participant cognitive load (Furnas, 1997; Hert, et al., 2007). The primary area of metadata research focused on in this dissertation is user metadata creation and use.

Both Poore (1999) and Hert et al. (2007) conducted research on metadata use. Their research focused on ways that metadata influenced information system use. For both Poore (1999) and Hert et al (2007), the concept of scaffolding and how metadata supports cognitive work is a central idea. Hert et al. (2007) found that metadata scaffolds learning and work through its ability to "enhance retrieval processes, improve information organization and navigation, and support management and preservation of digital objects" (2007, p. 1268). They use Jacob's (2001, p. 89) definition of scaffolding which emphasizes a minimization of cognitive load through the provision of technology tools,

knowledge, strategies or processes. The concept of scaffolding has strong

connections both to constructivist learning theories and in social constructionist

information interaction theories.

The review of research in this section shows that the issues related to

metadata use differ from those of other metadata research areas. Investigating

how metadata is used involves considering a holistic information environment

that includes elements of individual/social contexts, information need/task

context, and system/technical contexts. The next section examines specific

examples of how metadata is used in the creation of digital documents.

2.3.4 Metadata in digital documents

As web-based information systems and classification methodologies have

evolved, the gap between metadata creation and the use of it by the end user

has begun to close. Likewise, the role of metadata in system design is being re-

examined as information systems begin to use on a mix of expert assigned,

automatically harvested, and user-supplied metadata. The movement

surrounding this development is commonly referred to as Web 2.0 or the

read/write web (O'Reilly, 2005). This movement is comprised of three

complimentary concepts. First, the technological foundation of Web 2.0 is

grounded in web scripting languages, XML, readily exposed data-management

applications, and service oriented architecture. Second, many Web 2.0

applications share fundamental philosophical assumptions about the value of

user-driven information, open-source data, open source software and the value

of community. Third, Web 2.0 applications are grounded in the concept of the

'data' web and as such create services that allow users to find, reuse and remix

metadata in their own sites. These concepts grounding Web 2.0 inform the

environment in which digital documents are created.

Lawrence Lessig (2004) refers to this movement as the remix culture which is

concerned with the recombination of intellectual content to create new

information objects. A key component of mashups and remix culture is the idea

of data and metadata re-use and recombination. This is an emerging topic of

research in metadata literature (Dushay & Hillman, 2003; Zeng & Chan, 2004,

2006). Systems which employ these approaches include Facebook (Facebook,

2008), Amazon web services (Amazon, 2008), and Flickr web services (Flickr,

2008).

Technology that serves as the foundation of these applications include Ajax

(Garrett, 2005), web services (Berners-Lee, 2002) and linked data (Berners-Lee,

2006). These technologies are helping developers and users dissolve the barrier

between information consumer and producer by creating technically simpler and

more seamless methods of information interaction.   XML-based encoding

standards are feeding these technologies and enabling the interoperability

required to facilitate user contributed metadata models. The 2008 Horizon report

in particular, focused on metadata rich technologies. The report pointed to four types of metadata-rich services: collaboration webs, data mashups, collective intelligence systems and social operating systems (Educause, 2008). Metadata presence in these types of services is not merely descriptive in nature. Gilliand (2000) defines a taxonomy of different metadata types including administrative, descriptive, preservation, technical and use metadata. Other types of metadata that have been defined include event-based (Lagoze, 2000), rights (Brand, Daly, & Meyers, 2003), and geospatial (FGDC, 2008).   The diverse approach to defining metadata types underscores the general agreement that metadata includes a number of different types and use purposes.

A key area of interest that has emerged relating to social creation and use of metadata is the role that these tasks play in supporting learning. Liccardi, et al. (2007) discuss the potential positive impacts of metadata tasks such as tagging, collective intelligence/recommender systems and digital library/personal information management (PIM) systems on learning experiences. Specific tasks that are enabled in metadata rich information systems include item storage, tagging, rating, evaluating, managing, and preserving. Although they claim that information communication technology (ICT) and social networks possess this potential, they also caution that these approaches also increase the impact of issues of student efficacy with technology (2007, p. 230).

In each of the examples above, specific information organization related tasks can be identified, such as tagging, user-publishing, mashups/rich site summary (RSS), and collective filtering/context creation. By investigating the relationship between the user, the information system and the metadata and document model, this dissertation seeks to understand how concepts of literacy relate to user ability to effectively use these systems. With this understanding of the use of metadata in digital documents, this literature review continues by examining information seeking models and their relevance to digital documents.

2.4   Understanding the role of the user

The growth of user-centered information theory with Dervin and Nilan's article (1986) helped shift the profession from a focus on the document to a focus on the user. The shift coincided with developments in technology which have created converging pressures between information organization and use applications. As Dervin's work continued (1998, 1999; Dervin, Reinhard, & Shen, 2006), the focus has evolved from being centered on the rather static idea of the user to the concepts of communication and discourse surrounding the interaction between individuals, social groups and information.

As information science research has evolved from a 'system' orientation to a 'user' orientation to a 'discourse' orientation, technological tools have evolved to

help support these new conceptions of documents, users and the context of their

interaction. These technological developments allowed an increase in both the

amount of information produced and its availability, complicating the process of

information retrieval. This trend was noted by Bush (1945, p. 1) and is regularly

repeated in information science literature today. Taylor's comments also pointed

towards this change, stating that libraries must change from "passive

warehouses to dynamic communication centers" (1968, p. 179). In their work on

creation and use of digital information, Van Oostendorp, Breure and Dillon (2005)

echo this sentiment claiming that access to information "has become a necessary

condition for participating in economic, cultural, and societal processes, both for

individuals and for organizations" (p. 1).

The view of the user as active information seeker reacting against a system is

grounded in foundational views of information science theory.   Taylor's theory of

information needs which includes visceral, conscious, formalized, and

compromise states (1968, p. 182) is widely regarded as a beginning point for

discussing user-perspectives. Early models of users and information interaction

include Belkin's anomalous states of knowledge (ASK) in which users address

the gap between their concept of a problem and their voicing of that problem

(1980), and Dervin and Nilan's Sense-Making model of information seeking. As

with Belkin, the Sense-Making approach recognizes the iterative process of

information seeking.

2.4.1 Process based models

Early models of information seeking focused on linear or circular models. As these models developed, they began examining information seeking as an exploratory and non-linear process. Bates' (1989) theory of berrypicking, for example, emphasizes the user's tendency to retrieve only selected relevant documents from each attempt at interaction. "In other words, the query is satisfied not by a single final retrieved set, but a series of selections of individual references and bits of information at each stage of the ever-modifying search" (p. 3). Toms (2002) builds on the berrypicking model in her 2002 article on information interaction. She points to a shift from viewing people as "general-purpose computational systems" to viewing them as "adaptive and adapted organisms whose whole computational mechanisms are specialized and contextualized" (p. 856) and echoes Bates' emphasis on browsing. "When a cue is noted, the user stops to examine the text, and may or may not extract and integrate the information. Toms' suggestion, that information has become so ingrained in daily life that it is an invisible and required component to existence, has continued to be emphasized in recent works including Morville's book Ambient Findability (2005). Morville discusses the ramifications of ubiquitous information in his chapter on "Graffiti theory," in which he suggests that "all information that flows through our senses continuously and unconsciously

shapes our memories, beliefs, predictions, decisions, and behaviors" (2005, p. 169).

The research of information seeking within the context of the web has had an impact on information problem solving based literacy models. Several models and studies detail processes such as starting, chaining, browsing, differentiating, monitoring, and extracting (Choo, Deltor, & Turnbull, 1999), initiating, selecting, exploring, forming, collecting, and presenting (Carol C. Kuhlthau, 1991, p. 367) and recognizing, defining, selecting, formulating, executing, examining, extracting and reflecting (Marchionini, 1995, p. 50). Other models take a meta-view of the process approach and define the elements of interaction (problem, setting, task, system, domain) (Marchionini, 1995, p. 48) or define facets of specific types of searching such as exploratory search (lookup tasks, learning, and serendipitous browsing) (Marchionini, 2006, p. 42). Understanding the role of these models is important when considering how IL plays a role in the information seeking process.

Within the context of IL, these process-based approaches map onto discussions of the research process and can be used to inform many of the skills-based elements of IL instruction (identify question, formulate search strategies, determine material availability) (ACRL, 2006). These models can also be used to inform how specific system elements should be designed or used. Marchionini (2006), for example, defines search features which aid in exploratory

search, including hypertext links, relevance feedback, dynamic query interfaces (sliders, quick limits), and faceted metadata which may impact a user's search experience (p. 44).

2.4.2 Cognitive and affective models

In addition to the process-based approach to defining an information user, several models define cognitive and affective states of the user. Kuhlthau (1993, 1999), in particular, maps cognitive and affective states of information seeking processes and observes that facets of these states including redundancy, mood, prediction, complexity and interest (1999), have a significant impact on the user's information experience.

Kuhlthau (1993) takes a second significant step in relating her concepts of information seeking to the constructivist philosophies of Dewey, Bruner, Kelley and Vygotsky. She suggests that Dewey's five phases of reflection (suggestion, intellectualization, guiding idea, reasoning and testing) map onto both the process of information seeking and the cognitive state of the user in the process. She further observes that Kelley's phases recognize the impact of new information and uncertainty on the user and asserts that Bruner (1968), like Dewey (1924), emphasizes the importance of interpretation and internalization to the information seeking process (C. C. Kuhlthau, 1993, p. 341). Kuhlthau continues creating connections between constructivist philosophy and

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information seeking, arguing that Vygotsky's (1977) zone of proximal development, which describes the area of influence around a student's ability to learn independently and their ability to learn with assistance, maps onto her concept of zone of intervention (C. C. Kuhlthau, 1996).

Expanding on the impact that environment and personal/social contexts have on the information seeking process, Chatman (1996) discusses information seeking from the perspective of vulnerable populations and the impact that views of social connectivity and power have on an individual's pursuit and acceptance of information. Some of the affective states that Chatman (1999) documents include alienation, hope/hopelessness and avoidance. Nahl and Tenopir (1996) observe that affective response in information seeking experiments help inform research results. Research in this area has continued to investigate elements of cognitive and affective states that impact information seeking. Nahl (2004) uses a taxonomy of concepts including need, preference, attitude, motivation, expected effort, uncertainty, optimism, satisfaction and relevance.

Wilson (1997; 2000; T.D. Wilson, Ford, Ellis, Foster, & Spink, 2002) discusses the connection between information seeking processes and affective and cognitive states within the context of an information need, and views uncertainty as a measurable element which is reduced through information seeking. Williamson (2006) builds on several of these models to create an ecological theory of information behavior. She begins by discussing

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complimentary perspectives on information behavior, including Bates's (2002) integrated theory, which balances active and passive information seeking, and Erdelez's (1999) 'information encountering' theory.

Williamson continues her work by contrasting 'ecological theory' with those of Dervin (1986), who focuses on SenseMaking, Kulthau (1993), who focuses on uncertainty reduction and Belkin (1980), who focuses on states of knowledge, stating that "while these are appropriate for the study of purposeful information seeking, not all information-related behavior is purposeful" (2006, p. 128). Williamson's view of the user, not as sole individual nor as sole social being, but as 'self-created' also includes "biological and social circumstances and constraints" (2006, p. 130). Williamson's ecological theory is intriguing in part because it serves as a bridge between the information seeking theories of Dervin, Belkin and Bates to the social constructionist theories discussed in the next section. Williamson asserts that 'ecological' elements including "biological factors, age, ethnicity, stage of disease and affective issues" played a role in the seeking habits of the users on a breast cancer website. She observes that metadata can play a key role in creating information systems that are responsive to the user ecology.

2.4.3 The active user

Current research in information seeking is informed by the perspective that information interaction habits of digital information users are dramatically different from information behaviors of pre-Internet users. This discussion is often characterized as a gap between young and old or between digital and analog users. Net-generation age information seekers are often cited as having different information seeking habits from previous generations. Some research goes further to claim that these users are cognitively different, given their experience with digital media. "This research points to the possibility that N-Gen students are literally wired differently from previous generations, their brains shaped by a lifelong immersion in virtual spaces" (Mabrito & Medley, 2008). These models suggest that, because students are less familiar with traditional texts such as books and journal articles, they appear to lack core IL skills. In contrast, Mabrito and Medley (2008) claim that N-Gen students already possess independent critical thinking skills, exceptional collaboration skills, and are exceedingly familiar with the fluid nature of documents on the web.

There has been a shift in information seeking and literacy models to accommodate digital information seeking processes. Tom's (2002) berrypicking model, for example, uses the idea of hyperlinks to discuss information seeking. Likewise, Bruce (1997) views information interaction as a relationship between a user, knowledge and an information technology platform. Other views of

information seeking and IL look at social facts. Sundin (2008) asserts that

information seeking is implicitly a socially based practice and points to Marcum's

(2002) observation that the social and domain contexts of information interaction

are essential to understanding the interaction.

   The assertion that Net-generation users seek and process information

differently from their predecessors has solicited some response, notably by

research which suggests that these perspectives are not looking closely enough

at the phenomenon. Rowlands, et. al. (2008) performed a cross-study evaluation

of previous work on the changes in information interaction with the goal of

confirming or debunking concepts about the generation that they call the

"Google Generation." Their findings confirmed some perspectives, such as the

predisposition towards digital objects and the familiarity with technology, but also

disagreed with other observations, such as the expectation that students

implicitly understood the nature and context of digital documents. Rowlands, et

al. (2008) further observed that, in contrast to the expectation that students were

experts in evaluating digital resources, they lacked essential critical selection and

evaluation skills. They further asserted that many of the changes attributed to

the "Google Generation" were also seen in anyone who had adopted the same

technological platforms, suggesting that, while change is occurring in the ways

people search for, select, evaluate and create information, there is not some

special pre-disposition that the most recent generation is experiencing.

The shift in users from passive searchers and consumers to creators and classifiers of information highlights a need to investigate the set of skills and concepts that users have when interacting in digital environments. This literature review is left asking what models help discuss these changes, particularly with regards to the use of metadata-rich documents and community created metadata. The following section examines the connection between information seeking and IL theories. In doing this, the literature review seeks to identify relevant theories which help us understand the role that metadata creation and use play in information seeking and learning theory.

2.5   The role of literacy in information systems

Literacy is an important concept for the discussion of learning in the information age. There are numerous works on the history of literacy and its role in shaping history (Stock, 1983; Wright, 2007). Wright (2007), for example, discusses the rise of literacy in western society in Medieval Europe arguing that literacy had a far reaching impact in the Middle Ages as documents became representative of contracts, agreements and social norms (p. 107). This fact, he asserts, meant that even those who could not read or write were affected by these documents. Wright claims that this growth was a form of stigmergy, in which the presence of documents had far-reaching impacts that laid the groundwork for an information revolution far before the moveable type printing press was invented. Both Wright and information use models including

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Chatman's (1996) and Dervin's (1986) include questions about the role and perspective of the participant in determining how information is sought, harvested, created and used. These tasks coincide with the common notions of literacy investigated in this dissertation.

IL is relevant here as a context within which student skills and conceptual understandings of metadata can be assessed. While IL is a large and widely researched field, the focus of this dissertation is on IL as a model from which these competencies can be described. In addition to investigating abilities using the field of IL, this dissertation borrows from learning theory in order to more specifically define levels of abilities with regards to specific metadata literacies. In order to understand the role of IL and learning theory, this review of literature investigates relevant theories and creates a model through which metadata literacies can be evaluated. The review includes a summary of relevant models, investigating how different fields such as education and library and information science approach IL and concludes by pulling together the concepts of literacy as a pedagogical approach and information theory.

2.5.1 Definitions and relationships

Literacy is widely defined and discussed in the library and information science and education fields. IL definitions tend to focus on the series of skills and concepts related to information seeking while educational definitions of literacy

tend to focus on the role of various literacies in learning. In general, IL definitions span three primary areas. First, many models discuss IL from the perspective of a foundational approach to teaching and learning. From this perspective, IL is seen as a lens that can be used to teach a number of topics and skills. Second, many models discuss IL from the perspective of a set of skills and concepts that form the foundation of an information literate individual. Third, some models view IL as less of a thing and more of a dialogue between individuals, documents and contexts. Still, many IL models do not fit neatly into one of these three areas, meaning that it is becoming increasingly difficult to discuss IL as a unified concept. This literature review explores these three perspectives and generates an IL framework that can be used to discuss the role of metadata and documents in IL. The review pays particular attention to the definition of skills, conceptual knowledge, and contexts of IL for creating this framework.

The concept of IL has come out of the work of many organizations. Paul Zurkowski is commonly attributed as the coiner of the term in 1974 and since then, IL has been widely investigated. Marcum (2002) credits Patricia Breivik with creating the first consolidated model of IL in the 1980s. Marcum observes that Breivik's framing of IL from within the context of lifelong learning expanded the concept of IL beyond library instruction and incorporated concepts such as skill-based learning and problem-based learning. One often cited definition from ACRL is based on the 1989 presidential committee report which identified three key components to IL: organization, discovery and use (Presidential Committee

on Information Literacy, 1989). This report also identifies a number of skills that have served as the foundation of IL programs for the last 19 years. These skills include recognition of information need and the ability to locate, evaluate, organize and use information. The report draws parallels between these skills and personal empowerment and points to the divides that impact IL including education levels and socio-economic status. Both the Association of College and Research Libraries (ACRL) and the American Association of School Librarians (AASL) use the definition of the ALA 1989 report as their foundation for IL. Other fields interested in this area include education (A.M. Johnson & Jent, 2005; Carol C. Kuhlthau, 1993) and business arenas (Carmel, 2002). While other disciplines are interested in IL research, it is noted that much of the active research in this area is in librarianship (Weetman, 2005).

Bawden's (2001) review of IL models points to a number of definitions as examples in these areas. Common themes from the definitions he emphasizes include: a) the ability to read and write, particularly in a specific language, b) the non-binary nature of literacy; literacy as a continuum, c) cultural knowledge, societal interaction, and d) possession of the skills needed to interact with society. These themes are often used as primary perspectives from which to discuss literacy. Crook (2005, p. 510), for example, cites the importance of the cultural foundation of literacy. Campbell (1990) discusses literacy from individual/social perspectives including intended use of literacy, social context, language, and domain expertise. Finally, Clifford (1984) discusses literacy from

the perspective of a continuum as opposed to a binary (literate/illiterate) perspective.

As can be seen in these definitions, there is a lack of agreement about the scope of IL. The reviewed literature points to a number of issues of discussion related to this. Snavely and Cooper (1997) cite inconsistencies surrounding the use of the term, including the use of ambiguous terminology. Foster (1993) discusses concerns about the substance of the field. Clifford (1984) focuses on the implications of taking a 'binary' approach to literacy and illiteracy. Hughes and Shapiro (1996) criticize the field for having a pre-occupation with 'skills' approach, and Grafstein (2002) discusses a need for discipline-specific literacy and observes that the field lacks emphasis on tangible evaluation. Conversely, Owusu-Ansah (2005) views these differences as pointing to facets of a unified concept. Owusu-Ansah's position that IL is perhaps too diverse and large of a concept to be represented by a single fixed definition is reflected in the work reviewed here. Many of the definitions of IL define it so broadly that it would be impossible to tie down the specifics without excluding major areas of interest (such as the role of pedagogy, the impact of social context, or the utility of specific skills).

IL theories which were evaluated for this dissertation are: Association of College and Research Libraries ACRL (2006), the Big6 (Eisenberg, 2006), the seven pillars model developed by the Society of College, National, and University

Libraries (SCONUL) (SCONUL Advisory Committee on Information Literacy, 1999), the Six Frames model (Lupton, 2006), and the United Nations Educational, Scientific, and Cultural Organization (UNESCO) model (Horton, 2007). In addition, three meta-models are reviewed, the Hughes and Shapiro (1996) model, the Socio-technical model (Tuominen, Savolainen, & Talja, 2005), and Sundin's (2008) perspectives of IL instruction. Finally, three education centric models were included, the International Society for Technology in Education (ISTE) National Education Technology Standards (NETS) (2008), the IEA SITES studies (R.E. Anderson, 2008) and the expanded Bloom's Taxonomy (Krathwohl, 2002). These models have been selected due to their prevalence in literature and to their relevance to this research.

2.5.2 The study of information literacy

Research in IL has been widespread. Comparative reviews of literature have been completed by Rader (2002), Bawden (2001), Snavely and Cooper (1997), Virkus (2003) and Sundin (2008), among others. Articles tend to fall into one of four areas: research (Edwards & Bruce, 2002; Miriam, 2007; Sundin, 2008), case studies (Bussert, et al., 2008; Corradini, 2007; Mackey & Jacobson, 2004), meta-analyses (Bawden, 2001; Koufagiannakis & Weibe, 2006; Rader, 2002; Snavely & Cooper, 1997; Virkus, 2003) and definition or foundation articles (Johnston & Webber, 2003; Owusu-Ansah, 2005; Tuominen, et al., 2005). While interest in IL is clear in the library realm, there is also significant work in education,

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psychology, technology and science (J. Smith & Oliver, 2005) and literacy in specific contexts (Carolan, 2007). While the library and information science field has primarily focused on theoretical and case study research in this area, the education field has completed a number of large scale literacy studies intended to identify the extent of use of specific literacy related technology and skills in schools (R.E. Anderson, 2008). Anderson's review included a number of studies such as the International Association for the Evaluation of Educational Assessment (IEA) Second Information Technology in Education (SITES) studies (2006), IEA's Computers in Education study, and the Minnesota Computer Literacy Assessment. In the literature several other large scale studies have been reported, including education focused assessments such as standards testing by Ontario's Education Quality and Accountability Office (EQAQ) (2007) and a skills proficiency test called iSkills offered by the Educational Testing Service (ETS) (2007).

   In her review of IL research from 1973-2002, Rader (2002, p. 242) reviews an active field of research, citing over 5000 articles in the span of time reviewed. Bawden's (2001) search of LISA for resources from 1980 to 1998 showed a continued growth in the ideas of literacy and a gradual emergence of related literacies such as digital literacy, media literacy and computer literacy. Rader (2002, p. 244) indicates that the majority of IL instruction is occurring in higher education and K-12 environments and asserts that instruction in special libraries, public libraries and the workplace has been minimal. She further points to limited

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integration with other coursework and questions the presence of a sufficient

foundation of assessment in IL curricula (2002, p. 244). Sundin (2008, p. 28), in

contrast, points to the work of Kuhlthau (1993; C. C. Kuhlthau & Todd, 2007) in

bridging the literacy research being done in the education and library fields.

Perhaps, given its wide body of research, it is not surprising to find

contrasting opinions with regards to IL. One such area is the difference between

IL and information technology literacy (ITL). Bruce (1997) distinguishes between

ITL and IL, but identifies the relationship of information technology to the IL

standard being addressed. For example, IT is seen as an outer shell in IL

processes, as a mitigating influence between information sources and use.

Likewise, ACRL (2000) views information technology as being skill based

learning as opposed to the "intellectual framework" learning associated with IL.

Just as there is a lack of consensus on what defines IL, there is no single way

of investigating IL. Much of the research addresses classroom environments,

while other research focuses on theoretical issues such as the role of knowledge

in IL processes.   Barzilai and Zohar (2008), for example, investigate whether or

not information technology has replaced the need for traditional IL skills by

interviewing expert researchers. They focus on issues of distributed cognition

and knowledge organization (Barzilai & Zohar, 2008, p. 37), arguing that domain

knowledge is a necessary pre-cursor of effective information retrieval and

extended learning. Likewise, Rowley and Urquhart (2007, p. 1164) observe that

IL behavior is tied to factors including domain knowledge and practices of everyday information seeking behavior. Kirkwood (2006) investigates the impact that Information Communication Technology Literacy has on IL. Other recent literature focuses on faculty/library collaboration and embedded curriculum approaches. Some of these approaches focus on research methods (Tenopir, Wang, Zhang, Simmons, & Pollard, 2008; Weisskirch & Silveria, 2005), while others focus on tasks specific to certain disciplines (Walczak & Jackson, 2007).

Given this wide body of research supporting IL, it is worth asking whether IL is still relevant to study in the information science discipline. In Owusu-Ansah's (2005, p. 373) view, the preponderance of foundational work in this field may not ultimately be working towards common ends and research in this area should focus on student achievement or the position of the library in the education process. Despite this recognition that the field has been heavily studied, recent articles also call for new research. Studies report the continued relevance of literacy within the context of lifelong learning (C. Bruce, 2004; Lau, 2006; Walczak & Jackson, 2007, p. 1390) and the need to further define IL from this perspective. Further, recent articles stress the importance of incorporating new perspectives into IL including socio-technical (Tuominen, et al., 2005), and social-software perspectives (Bussert, et al., 2008; S. Smith, Mitchell, & Numbers, 2007). These areas continue to have relevant questions to ask.

The proliferation of IL models and perspectives makes it difficult to examine IL from a holistic perspective, much less decide how to use IL as a model to investigate a new information area. Rather than addressing this gap by evaluating IL models, this dissertation investigates selected models which are relevant to the concept of ML. The following sections of this literature review examine how the literature approaches assessing IL in users, breaks down IL into the three categories of skills, conceptual knowledge, and context of use; and analyzes these three categories from pedagogical perspective, information use perspective and environmental role perspective. This major section concludes by proposing an IL evaluative framework that gives us a way to approach the discussion of ML.

2.5.3 Assessment of information literacy

A brief discussion of Bloom's taxonomy is included here, not because it is a specific IL model, but because it has been used as an analytical framework to relate IL skills and concepts with states of knowledge and understanding. Bloom's taxonomy was initially generated from the work of a group in the 1950's and resulted in a pyramid shaped model which demonstrated the role of different states of knowledge and understanding in the learning process. This pyramid places knowledge at the base level, and progressively moves through the states of comprehension, application, analysis, synthesis and evaluation (Bloom, Engelhart, Furst, Hill, & Krathwohl, 1956). This model has been used in

education to identify student achievement and define learning. In 2002, Anderson and Krathwhol updated Bloom's taxonomy to reflect the changes over time and to re-define the sub-components of each level. For example, in the original taxonomy, knowledge was discussed in terms of specifics which they refer to as facts, means (including methods, conventions and classifications), and abstractions (including theories, principles and generalizations). In the updated model, these areas are re-grouped into factual, conceptual and procedural categories, and a new category of metacognitive structures is added, which includes strategic, analytic and self-knowledge (Krathwohl, 2002, p. 214). The updated model changes the basic categories to remembering, understanding, applying, analyzing, evaluating and creating (Churches, 2008b). The impact of this change has been widely discussed in education literature. Some of the key points that have received attention are the switch from noun based descriptors to verb based descriptors (Churches, 2008a), the definition of four knowledge dimensions (factual, conceptual, procedural and metacognitive) (Cochran & Conklin, 2007), and the addition of the creating category at the top of the pyramid (Kash, 2008). An adapted table from Krathwohl (2002, p. 216) representing this matrix is included as Table 1.

Table 1. Krathwohl's Cognitive Process Matrix

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual Knowledge						
Conceptual Knowledge						
Procedural Knowledge						
Metacognitive Knowledge						

Anderson and Krathwhol's matrix maps the learning states of remember, understand, apply, analyze, evaluate and create with the four dimensions of factual, conceptual, procedural and metacognitive knowledge. The matrix represented in Table 1 provides a consistent way of representing observations about a participant's interaction with a task. While this matrix is more often used as an evaluative and guiding structure to help teachers frame questions and assess student learning, it is also descriptive of the emerging literacies discussed in this review including the ability to assemble and create knowledge, collaboration, and ethical use of information.

IL models often take a different approach to discussing the roles of skills, conceptual knowledge, and context of literacy. The models can be grouped by focus into three broad areas: a) information seeking process models, b)

participant behavior models, and c) meta-models which focus on overarching themes as opposed to specific skills and actions. Widespread adoption of process models such as the Big 6 model and the ACRL model have occurred in the US while the SCONUL and UNESCO models have been more widely implemented in international realms (Horton, 2007; Johnston & Webber, 2003; C. C. Kuhlthau & Todd, 2007). For example, American K-12 school systems have widely adopted a three tiered IL standards model based on ALA's IL model which focuses on literacy, independent learning, and responsibility. This model includes references to the access, evaluation, and use theories prevalent on their website today (American Association of School Librarians, 1998). In analyzing these different approaches, three main themes emerge. These three themes are the role of skills in literacy models, the role of conceptual learning in literacy, and the notion that literacy exists in a variety of contexts. One theme which did not emerge in this review was an overt discussion of the role of the digital document and metadata in these skills, concepts and contexts. There was, in fact, an absence of discussion of the impact of metadata and information organization in the digital environment in which these literacy models exist. The following three sections discuss each of these areas with the goal of identifying themes which emerged.

2.6   Self-efficacy in IL assessment

Two of the primary goals of the research were to identify participants comfort level and proficiency with regards to metadata. Self-efficacy (SE) is one method of assessing comfort level. Bandura defines SE as a self-measure of one's ability to complete a task (1982). He further refines the concept of SE by observing that is the outcome of a mix of social, cognitive, and behavioral skills and impacts not only whether or not an individual can do a task but more importantly if they will choose to take on a task and how much time they will spend with it (1982, p. 123).

Given the union of both task proficiency and comfort level measures, SE is a popular metric in the IL area. Marcolin et al. (2000) for example observe that SE tends to be viewed as an outcome of competence (p. 40). The idea of SE is also at the root of Talja's (2005) concept of the IT-self. These theories employ SE as a way of providing a holistic view of participant ability which combines competence and confidence measures.   Although SE may be a good measure of confidence level and likeliness to use specific literacies it is not a measure of actual task proficiency. By measuring SE levels in conjunction with actual task performance measures, this dissertation sought to create a holistic profile of ML levels in participants.

SE instruments tend to use a Likert scale and multiple questions to examine a SE concept. In order to strengthen the measure of self-efficacy, it is preferable to

use a validated IL self-efficacy tool. Use of a previously designed instrument can be difficult given the need to customize the instrument to examine a specific literacy concept or context. Two reviewed studies on self-efficacy focused on IL self-efficacy and the impact of self-efficacy on academic performance (Kurbanoglu, Akkoyunlu, & Umay, 2006; Tella, Ayeni, & Omoba, 2007). While several self-efficacy models exist, the IL centric model by Kurbanoglu, Akkoyunlu, and Umay provides a succinct, information interaction centric tool which can be easily implemented in a research environment. As Marcolin et al. (2000) observe, self-efficacy is but one approach to measuring IL/IT skills. In fact, self-efficacy is entirely based on participant perspective and as such could be criticized for not being a true 'evaluation' of literacy but rather identification of opinion. On the other hand, information and technology literacies are varied and difficult to evaluate using rigid evaluation instruments. Kurbanoglu et al. (2006) observe that self-efficacy is an important metric because it is a required element of an information literate person (p. 731).

Despite the value of self-efficacy research, it can also be claimed that participant confidence and self-efficacy is context dependent. This means that a self-efficacy needs to be appropriately tied to a context as closely as possible. For example, in Marcolin et al.'s (2000) work, specific self-efficacy methods were chosen which evaluated participants' feeling about being able to complete specific tasks. Likewise, Kurbanoglu et al. (2006) observe that a specific IL self-efficacy test is required. The self-efficacy test developed by Kurbanoglu et al.

focuses almost entirely on skills. Given this fact, it is necessary to develop a
self-efficacy test centered on the concept of metadata literacy. As noted above,
creating a context specific self-efficacy test is important in ensuring valid results.
Three models in particular may prove useful in this process. The first is the
results of the meta-analysis by Koufogiannakis and Wiebe (2006) in which they
present an updated model of Bloom's taxonomy created by Anderson and
Krathwohl (2002).   This model can serve as a framework for identifying specific
questions. The framework was adopted from Anderson and Krathwohl (2002) is
outlined in Table 1.

The areas discussed in Anderson and Krathwohl (2002) help describe
relevant actions and cognitive states that use of metadata can influence. Within
this framework, the self-efficacy test by Kurbanoglu et al. (2006) and their design
approach provides an appropriate framework for modeling an ML self-efficacy
test. The self-efficacy test which is included in Appendix 1 uses a similar
framework but different questions to assess participant levels of ability and
comfort levels regarding literacy.

2.6.1 Information literacy skills

IL skills are defined as specific tasks or procedures which serve information
need. In IL, there is a growing but still core set of skills that can be directly tied to

information seeking, use, management and preservation. The models which

included a granular focus on skills also focused on information problem solving

(IPS) style problems (e.g. modeling a research process, mapping the

advancement of states of knowledge). In other models, such as the updated

Bloom's Taxonomy, skills were abstracted from the core model as a way of

operationalizing broader concepts. Of the models reviewed, particularly ACRL,

AASL, SCONUL and UNESCO, the following skills were mentioned multiple

times. The skill elements in Table 2 were adapted from multiple models (ACRL,

2000; American Association of School Librarians, 2007; Horton, 2007; SCONUL

Advisory Committee on Information Literacy, 1999).

Table 2. Information Literacy skills

Information literacy element
Identify an information need
Define methods for solving that need
Identify possible sources of information
Identify and select information retrieval systems and methods
Access information
Select appropriate information
Employ appropriate search strategies
Compare found information
Extract and manage information from systems
Synthesize and evaluate information
Create, apply, and communicate information

While IPS focused models use skill definitions as a primary organizational

structure, meta-models such as Bloom's revised Taxonomy and Hughes-Shapiro

group IPS skills into a broader category. Bloom's Taxonomy tends to identify

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these skills as procedural knowledge, which is defined as "How to do something; methods of inquiry, and criteria for using skills, algorithms, techniques, and methods" (Krathwohl, 2002, p. 214).

2.6.2 Information literacy concepts

IL concepts in the context of this review are thought of as abstract knowledge (e.g. ethical use of information) which serves as a foundation for IL. The review of models found that there is a perceived usefulness, although often a lack of specificity, regarding the utility and relationship of conceptual and metacognitive knowledge in IL. In some cases, this is demonstrated as the difference between learning technology skills and being able to think analytically about found information, in the Seven Pillars model. In other cases, it is represented as the ability to think about different types of literacy (e.g. cultural, media, technology, and publishing) or to think metacognitively about an information process (e.g. administer, manage, plan). In particular, both Bloom's Taxonomy and the Hughes-Shapiro models include a metacognitive element.

The theme of social empowerment and responsibility is seen both in the ALA model and in more recent UNESCO publications on IL. The ALA report observes that "It allows people to verify or refute expert opinion and to become independent seekers of truth (Presidential Committee on Information Literacy, 1989)." Similarly, UNESCO connects IL and social impact, saying that IL

"empower[s] people in all walks of life to seek, evaluate, use and create information effectively to achieve their personal, social, occupational and educational goals" (Horton, 2007). Again, both ACRL and AASL suggest specific social and ethical concepts related to IL. The concepts represented in Table 3 are concepts that are common in the reviewed models. Concepts have been adapted from the ACRL (2000) model, AASL model (American Association of School Librarians, 2007), and UNESCO Models (Horton, 2007). Horton calls on the two concepts of self-empowering and self-actualizing to represent these ideas (2007, p. 3).   These metacognitive perspectives are good examples of the outcomes sought in the updated Bloom's Taxonomy metacognitive facet (Krathwohl, 2002).

Table 3. Information literacy concepts

Information literacy element
Recognizes the need for information for decision making
Employs IL as a mechanism for being an independent learner
Uses IL as a mechanism for creativity
Recognizes the importance of information in democracy
Respects intellectual freedom
Respects intellectual property
Uses information responsibly
Shares information with and respects others' ideas
Collaborates with others

2.6.3 Information literacy and learning context

IL has been analyzed in a wide range of contexts and learning environments. Snavely and Cooper detail 34 areas, including library literacy, mathematical literacy, political literacy, workplace literacy and environmental literacy (1997, p. 12). Bawden groups skill based literacies into specific contexts of media (interacting with mass media) and computer/IT literacy (2001, p. 10). Eshet discusses digital literacy from the context of photo-visual, reproduction (ability to copy and paste), lateral (ability to link between resources) and information (ability to critically evaluate) literacies (Eshet, 2002). In fact, this contextualization of types of literacies has also led to the disagreement about the meaning of IL.

Horton defines IL in terms of core literacy (reading, writing, arithmetic), computer literacy (both hardware and software), media literacy and cultural literacy (2007, p. 7). The 1989 ALA report discusses cultural, civic, computer and global literacy as specific incarnations of IL (Presidential Committee on Information Literacy, 1989). While it is possible to perform an analysis on the components of each type of literacy, it is obvious from a simple accounting of literacy forms that the core concepts of IL have propagated to many specific areas.

The fragmentation of IL into context dependent models (e.g. digital literacy, media literacy, environmental literacy) is based on the idea that IL is a teaching and learning methodology which focuses on the role of IPS in gaining domain knowledge. Other models including UNESCO (Horton, 2007) define these contexts as a way of compartmentalizing specific IL skill and conceptual knowledge. The idea of context is relevant to this dissertation in that the impact of the digital environment and digital documents are of key to understanding the role that metadata plays in the reviewed IL models. Section 2.6.4 discusses this role.

2.6.4 The role of metadata in literacy models

While many of the models include organizational elements such as awareness of information organization structures, document management, document representation and surrogation, the importance of these elements is rarely addressed with specific skills or concepts. Much in the way that the models that have evolved over time now include technology literacy, the models reviewed peripherally refer to but do not directly address the impact that the current information environment has on digital document structure. Nor do the models directly address the role of metadata. As the literature review on the role of metadata in digital environments demonstrates, digital forms of information and interaction regularly employ elements of information organization at the level of the common information user. As such, the user is likely to hold a set of skills

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related to the categorization and classification, representation, and surrogation of information, an understanding of the role of document structures and metadata, and the changing focus from passive forms of literacy including knowing and understanding to active forms of literacy such as creating and sharing. A central focus of this dissertation is what roles metadata plays in a user's level of literacy. For the purpose of this discussion, this phenomenon will be called metadata literacy (ML).

ML appears to be an emerging concept, given both the increasing complexity of information environments and the widening definition of documents and information user roles in document creation and use. The creation of new information spaces in online environments which emphasize collaborative authorship, creation of new types of documents, and personal management of information resources is placing information consumers/authors in the role of context-generator. The extent to which they utilize metadata and information organization techniques in these environments has a significant influence not only on their personal information space, but on the larger information environment.

2.6.5 Information seeking, pedagogy and learning theory

While not always explicitly defined, the IL models reviewed and of interest in the subsequent discussion are grounded in learning theories that emphasize

individual and social construction of knowledge through interaction with information resources. Although many of the skills defined in these models are based on process-based literacies such as the ability to locate a book on a shelf, there are elements of each model which focus on skills and processes in which users create knowledge and information. Some models focus on individual generation of knowledge (Lupton, 2006) while others focus on the role of social structures in this process (Tuominen, et al., 2005). Because the IL framework developed in this dissertation takes the perspective that users create information in a community-based digital environment, the constructivist perspective of information creation/use and the implications of social information use need to be considered. These two concepts are investigated here through the theories of constructivism, social constructivism and social constructionism.

A specific debate surrounding the meaning of the terms constructionism, cognitive theory, cognitivism and social constructivism is represented in Information Science literature (Hjorland, 2002; Ingwersen, 1992; Talja, Tuominen, & Savolainen, 2005; Tuominen, et al., 2005; Tuominen, et al., 2003). The importance of the constructivist/constructionist perspective to this work relates to the perspective that digital environments and, by extension, the literacy tools required to operate in them, are decreasingly individual in nature. Within the confines of this dissertation, constructivism and social constructivism are viewed primarily from an information science and education-centric perspective, which poses the idea that knowledge is personally developed in reaction to the

external world (Bruner, 1968). This perspective is informed by Vygotsky (1977), who observes that knowledge is directly tied to language, which is in essence a classification system of social norms. Social constructionism differentiates itself from social constructivism in placing the emphasis on relationships over things (verbs over nouns) and is reflected in the work of Dervin (1998) on verb-based information environments.

IL literature draws heavily on constructivist approaches, particularly in regards to its use in educational circles. While it can be argued that the dynamics of social constructionism are not adequately reflected in popular IL models (Tuominen, et al., 2005), both theoretical and practical literature reference the use of both constructivist and social constructivist approaches to IL. In the educational domain, constructivism is based on the idea that students learn best in environments where they are challenged to not only solve the problems that they are given but to also construct the problems in the first place.

Constructivism is based on the theories of Bruner (1968), Dewey (1924) and Vygotsky (1977) and is represented in recent works by Brooks and Brooks (2001), Lajoie and Azevedo (2006) and Siemens (2004). Lajoie and Azevedo define constructivist teaching as "the active construction of knowledge in the context of solving realistic problems where learners build knowledge and organize it in a personally meaningful form" (2006, p. 804). This is often referred to as problem-based or inquiry-based learning and typically includes both

cognitive and affective aspects. There are a number of studies that investigate the application of constructivist, and active research approaches to IL including aspects of collaboration and discipline based approaches (Fosmire & Macklin, 2002; Sharkey, 2006; Walczak & Jackson, 2007; Weisskirch & Silveria, 2005; Wopereis, Brand-Gruwel, & Vermetten, 2008)

In concluding this section, it is also important to point out Kuhlthau's (1993, p. 6) constructivist based approach to IL. In Kuhlthau's approach, the teacher serves scaffolding roles as opposed to lecturer roles. In this model, constructivism both informs the view of the participant as an active contributor and socially-embedded actor in the IL framework and serves as the foundation for discussing the role of metadata in supporting learning and cognition in the reviews on metadata and ML.

2.6.6 Environmental role in information literacy

As stated in the ACRL, AASL, and Seven Pillars models, information technology (IT) skills are essential components, but not the core components of IL. These models adopt the perspective that technology skills are descriptive in nature and do not influence the core skill sets of definition, refinement, synthesis and evaluation which represent the more conceptual elements of IL. In the traditional world of print-based information systems, a relatively static set of library research skills easily served the skill-need of an IL environment. In recent

years, Internet search engines, online catalogs, and social-software have all had significant impacts on how information is conceptualized, created, used and preserved.

While some IL models sought to abstract themselves from a specific environment, others viewed it as a central element. In the Big6 model, for example, Johnson and Eisenberg found that information and computer literacy work well together when they "(1) directly relate to the content area curriculum and to classroom assignments, and (2) are tied together in a logical and systematic information process model" (2006, p. 1). More significantly, the advent of digital information has also led to the creation of new environments. One example is the shift in the web environment from static HTML pages to collaborative authoring spaces. These resources are significantly different from the documents that they are replacing. As a result, it can be expected that the IL skills required to find, use, preserve and evaluate these documents must also be different.

The theme of the impact of environment on IL approaches is readily seen in technology focused models. Bruce's (1997) seven faces of IL, Tuominen, Savolainen and Talja's (2005) socio-technical model, and Hughes and Shaprio's (1996) model emphasize the relationship of technology to literacy. There is a strong connection between IL and learning theory. This connection is found in education practices which emphasize student interaction with technology during

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learning. Lotherington (2003) poses a postmodern model for IL based on digital documents, and Skarkey (2006) discusses a technology informed IL curriculum. The use of these approaches provides insight into how to employ IL models in classroom environments.

2.6.7 A theoretical framework for investigating literacy

This review has investigated both the background of IL research and identified ongoing areas of interest. It has probed connections between IL theories and learning, assessment, and information technology. Throughout this review, one major gap that was found was a lack of attention on how to think through a "new" element of or form of literacy. For example, a simple framework does not exist that allows the instructor to design material that includes both the subject matter and IL content.

In concluding this section it appears that despite the substantial research in this area, there are still gaps in IL research. First, there is an emphasis on expert opinions over user-defined perspective in defining IL models. While some studies created IL models from limited interviews, no studies took, as a foundation, the work done by studies which have investigated student perspectives in information use. Second, while the studies reviewed showed awareness of existing models, there was a lack of overall agreement on how to define skills versus concepts in the models. Whether or not a unified theory of IL

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or ML is attainable is unsure. Regardless, none of the models reviewed showed fundamental incompatibilities with each other, which would suggest that further research in this area may be fruitful. Finally, while there is a great interest in technology and the impact that technological tools have on IL, there is little research which focuses on the impact of technology informed core information practices. There are, for example, several models which mention the utility of information organization knowledge in IL frameworks, but there was little research which showed that these concepts had been introduced into practice. By addressing the need to more extensively define how information organization and metadata practices inform system design and use in IL environments, this dissertation seeks to identify an approach for thinking about the role of literacy which will be able to more completely inform the technology-enriched IL curricula that are popularly reported in the literature.

The themes identified in the review of models include the three facets of skills, concepts and context, and the broader elements of pedagogical roles, information and learning theories, and the impact of digital environments on IL models. By taking as its base the three elements of skills, concepts and context and viewing the roles of pedagogical style, information/learning theory and the impact of digital documents and their metadata structure, a simple framework can be designed which will help consider the elements of metadata with literacy concepts. This framework focuses on three teacher and three participant perspectives within the IL area. Teacher focuses tend to be on pedagogy,

information and learning theory, and the role that a learning environment plays. 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. Table 4 shows the relationship between these concepts by creating a matrix and posing questions at each intersection between the IL categories of skills, concepts and context and the information/learning categories of pedagogy, theory and environmental role.

Table 4. Information literacy framework

	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?

The framework works in conjunction with the revised Bloom's Taxonomy matrix as an evaluative instrument for participant responses to specific examples,

making it possible to both define a literacy element and evaluate levels of learning in the application of that element.

What appears clear from the research that has been completed to date is that, despite the wide interest in IL as a platform for thinking about how individuals interact with information and learn from that interaction, there is the absence of a single approach for this process. While few researchers emphasized traditional approaches to literacy, there was also a notable lack of unification of the concepts of digital environment, organizational structure and participant interaction. Further, there was a lack of integration between information theory, on the one hand, and learning theory, on the other. In order to move forward with IL research and fully develop existing models, it is crucial to study technology informed core information practices including the conception of metadata and information organization practices. The proposed framework addresses this gap by providing a context within which the elements of learning, information theory, and context are compared with a specific literacy. In the following section, this framework will be used to investigate ML elements.

2.7   *Metadata literacy*

This research casts a wide net across the current landscape of users and systems found in information-rich environments. It focuses specifically on metadata creation and use and asks to what extent undergraduate students

possess these skills. Literacy continues to be a widely researched topic in education and information science disciplines. While there are many literacy standards (IL, visual literacy, social literacy, foundational literacy), there is no focus on literacy skills associated specifically with the notion of data and metadata and its role in digital documents. While information organization has been considered to be the realm of either organization experts, such as catalogers and indexers, or individuals engaged in personal information management, emerging social-centric systems are creating an environment in which users are collaboratively creating/using/harvesting organization and data structures. One of the key changing concepts in relation to these emerging tasks is the role of the information consumer as author in an information process. ML adopts this view of the user and takes as its base the assertion that information organization and related document structures are central to information creation and use.

This section focuses on research supporting the concept of ML. It builds on the work of the IL section using the IL framework and the metadata tasks identified in this literature review. The interest in ML in this dissertation 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.

2.7.1 A gap in information literacy 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) 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 IL (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 section, some

research has focused on different types of literacy such as digital, media, socio-constructionist and cultural, 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. This work addresses these roles by examining literature which incorporates metadata use and literacy models, by defining ML using the IL framework from the previous section, and by investigating research methods with regards to ML.

2.7.2 Literature on metadata literacy

ML is not a well defined concept, and there is little evidence of this concept in the literature based on extensive searching in the ERIC database, Association for Computing Machinery (ACM) digital Library, IEEE digital library, Library Literature, or Library and Information Science Abstracts (LISA). Literature in the field 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

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use 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 IL skills. 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. 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. In relation to the concept of ML, 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.

The reviewed literature suggests some key ways in which metadata is important in supporting information use and learning. This work expands on this theme by examining the role of metadata in information use from a literacy perspective.

2.7.3 A working definition of metadata literacy

ML can be defined as the ability to conceptualize, create and work with metadata within information environments.   ML 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 require these skills. Although there is ample research discussing the use of complex digital environments to enhance learning (Bold, 2006; Bussert, et al., 2008; Richardson, 2006), attention paid to the literacies required to work with digital documents is limited. 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. Research (Hert, 2006; Hert, et al., 2007), assert 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 ML as the ability to conceptualize, create and work with metadata will be examined using the IL framework in the following paragraphs. Examples in the three participant areas of skill, concept and context will be examined, along with the teacher perspectives of pedagogy, information and learning theory, and environment.

2.7.4 Elements of metadata literacy

This definition of ML incorporates the IL framework developed in this dissertation. One 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). The following section contains the literacy framework created in this dissertation, adapted to fit the concept of metadata. Following the framework, the categories represented in the columns and rows are discussed.

2.7.5 Metadata literacy framework summary

Table 5 takes the exploration of ML in this section and attempts to bring its elements into a consolidated form. By mapping elements of ML 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.

Table 5. Metadata literacy framework

	Pedagogical theory	Information and Learning theory	Environmental role
Skills	Embedded instruction Librarian collaboration Embed tools within coursework	Extended Mind Socio-constructivist	Digital text use, knowledge assembly, metadata use/creation, community interaction
Conceptual knowledge	Conceptual knowledge taught through interaction with systems, discussion of issues	Users learn to think about how technology and metadata supports learning/cognition	Role of metadata in personal, social systems. Information use/re-use, information structure
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

The remainder of this section examines each of these areas in more detail.

User perspectives

The elements of the IL framework which focus on user 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 ML. In each of these three areas, literature is discussed which informs the relevance of these categories to defining a holistic concept of literacy.

Skills

Information skills are a necessary element of literacy. The section on IL underscores the emphasis on skills in many IL models. Although there is no specific discussion of ML 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 6.

Table 6. 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 ML is not commonly discussed in IL literature, there

is discussion of it in librarian-centered literature. Sheila Intner for example lists a

series of skills that librarians should have in order to become 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 7.

Table 7. Schwartz's information literacy skills

Information literacy elements
Learn systems analysis/theory
Learn new technologies
Learn 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
Understand 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 6) and Schwartz

(represented in Table 7) include both core ML 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.

Concepts

Conceptual understanding is considered to be a key element of literacy. Oblinger and Hawkins (2006) comment on the gap between student technology literacy and IL, 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 evaluation skills 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 users 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, d) how programs work, e) operating systems and environments, and f) the basic logic of a computer. In addition to this list, metadata-specific skills such as the ability to: a) create metadata, b) use metadata to create a personal information system, c) recognize metadata, d) understand the concept of metadata interoperability, e) recognize the role of metadata in digital information systems, and f) understand the difference between structured and unstructured data are considered to be core conceptual understandings of ML.

Despite a lack of representation in IL 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).

Context

The idea of context with regards to ML is seen in Lotherington'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 new skills and conceptual elements for ML. One example of a new context is the digital information remixing application. Yahoo Pipes (Yahoo, 2008), for example, provides a 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 it 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. These contexts not only require new skills and conceptual understandings but also make the use of metadata and structured digital documents more common for users.

Instructor perspectives

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

Pedagogy

The review of IL models 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 outline the

process of knowledge acquisition and learning. Bloom's original taxonomy

contained six levels: Knowledge, Understanding, Application, Analysis,

Synthesis, and 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 or 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," and "How would you solve"

(Bloom, et al., 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 updated model also has had specific verbs associated with it

to help assess student achievement at these levels. For example the level of

"Analyzing" 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. Churches (2008a), outlines his view of the roles of ICT related to Bloom's Taxonomy. The four levels of knowledge presented by Krathwohl (Krathwohl, 2002, p. 214) offer the updated taxonomy the ability to talk more specifically about a given stage of learning. Krathwohl's four levels (2002, p. 214) have been adapted to table form and are listed in Table 8.

Table 8. Krathwohl's knowledge levels

Knowledge Level	Examples
Factual Knowledge	Terminology, details, components
Conceptual Knowledge	Classification, categories, principles, geneneralizations, theories, models, 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

The discussion of the role of Krathwohl's taxonomy in supporting teaching

models contributes to the generation of a ML model by recognizing the impact

that pedagogical perspective has on creating learning environments.

Information and learning theory

The information theories investigated in this literature review fall into three

main groups; 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 (M. Bates,

1989) SenseMaking (Dervin & Nilan, 1986) or information encountering (S

Erdelez, 1999; Sandra Erdelez, 2004). Cognitive and affective centered models

include Kuhlthau's information seeking model (Carol C. Kuhlthau, 1991) which

also includes a process focus, the holistic user (Chatman, 1999), and ecological

theory (Williamson, 2006).   Participation-centric theories emphasize the multiple

roles of users including use, creation and analysis (Holland, 2006; Tuominen, et

al., 2003), the social facet of information creation and use (Sundin, 2008) and the

role of IT in information interaction (Clark & Chalmers, 1998).

There is a connection between information theory, which focuses on how

users engage with information, and learning theory, which focuses on how users

use information to learn and acquire knowledge. Two key theories that help

illustrate the role of metadata in ICT enabled information environments have

been explored in this literature review. The first 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 is the theory of constructivism first introduced

in the review on IL 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 ML uses 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 from these theories comes both in grounding the relationship of

metadata skills to learning and 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), "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 users 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 ML elements. The relevant theory or model to use is related to the concepts, skills and environmental factors of a specific element.

Environmental role

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 reports that both technology ownership and information use/interaction with 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

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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, many of them view the usefulness of the tools neutrally or negatively.

Given the statistics from the Pew Internet Trust, there is a growing trend of using collaborative software in classroom environments. Bryant (2006), for example, both lists 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 use of 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 IL 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 (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.

2.8   Literature review conclusion

This review of literature examined the theories of information use, metadata creation and use, and IL with the goal of better understanding the relationship between metadata awareness and information system use. It found that, while many studies examine these areas independently, few viewed ML as a central theme. Likewise, much of the qualitative research in this area takes as its foundation a constructivist worldview (MaKinster, Beghetto, & Plucker, 2002;

Nokelainen, Miettinen, Kurhila, Floreen, & Tirri, 2004; Ullrich, et al., 2008). In contrast, quantitative studies focused on creating valid and reliable information problems (Brand-Gruwel, Wopereis, & Vermetten, 2005; Walraven, Brand-gruwel, & Boshuizen, 2008). Other examples of research on the role of metadata in supporting learning include work completed by the researcher (Mitchell, 2007; Mitchell & Smith, 2008; S. Smith, et al., 2007). These studies argue that information problems must be created equitably and with the research users in mind to ensure that statistical results are valid.

Metadata research continues to focus on identifying new document models and metadata standards, investigating the utility of metadata (Hawking & Zobel, 2007), and investigating the role that social and participant centered metadata plays in information spaces (Brendan & Özsoyoglu, 2008). What this research shows us is a convergence between the research into metadata structures and uses and concepts of literacy.

2.8.1 Deficiencies in the studies

While many of the studies identify interesting examples and conduct qualitative comparisons, only a few of the studies take a quantitative approach in identifying which elements of these interactions, including use of digital libraries, use of information management techniques, and use of technical skills, are contributing to the success of the student experience. Further, few studies

investigate specific interactions between metadata centric tasks such as categorizing, managing and evaluating or how these tasks are enabled/enhanced through the use of these techniques. Finally, most research related to this topic focuses on traditional information creation and learning models such as student as information consumer, and librarian as facilitator, and tends to focus on librarian perspectives.

In addition to the emphasis on qualitative research and the lack of focus on metadata tasks, there is also a marked lack of uniformity in research and evaluative models. Much of the critical work in the IL field observes the lack of a unified model or approach for investigating IL concepts (Koufagiannakis & Weibe, 2006). One goal of this dissertation is to begin connecting the research in these areas by asking how the growing role of metadata in web-based information systems changes our notions of the literacy skills and concepts involved.   In doing this, a combination of evaluative models (skills based on Bloom's Taxonomy and Self-efficacy) will be used to investigate an information structure (metadata) from the context of the impact on participant learning (IL).

2.8.2 Methodological findings

As this literature reviewed has shown, there is a wide range of qualitative work in the area of literacy. Likewise, there are substantial mixed-methods approaches in the Information Problem Solving (IPS) area. The issues

surrounding literacy, learning and information use are difficult to quantify. Further, attempting to use quantitative data exclusively fails to get to detailed answers about the intervention being tested such as how information resources are used, and only documents the extent to which certain activities are engaged in.

In contrast, the mixed methods approaches reviewed may provide a more generalizable knowledge base by tracking specific interactions, while possibly expanding on that knowledge using qualitative analysis. Both simultaneous (gathering qualitative and quantitative data together) and emergent methods (gathering qualitative following quantitative data) have been employed in the literature and are appropriate for different purposes. For example, Walraven, et al. employed qualitative survey data, quantitative survey and task data, and qualitative focus group data in their research (Walraven, Brand-Gruwel, & Boshuizen, 2009). Walraven, et al. discuss techniques for creating an authentic information task, including making the task open-ended (not a yes/no or fact finding question), wording the question in such a way that does not prompt the student to find a preferred site and making the problem significant enough (Walraven, et al., 2009, p. 236). The aim of this study is to identify ways in which metadata is used by users in IPS situations.

2.8.3 Implications for research

As the review of literature has shown, IL research is forming a fragmented, but adequate, foundation for investigating the role of information structures in participant learning. While there is a lack of commonly accepted evaluative models in the IL community, the education field has well established models, which help in forming survey questions.

This review of research also demonstrated a growing interest in the role that metadata tasks play in learning environments. This interest is fueled, in part, by the growth of ICT tools and, in part, by a growing connection to education for the library and information science profession. Despite this growing connection, there was a substantially larger body of research which tended to focus on technical research (standards and models) and possible participant uses (new systems and new interaction methods). These research methods tended to not take a participant-centric approach in investigating how metadata supports users.

2.8.4 Contributions and summary

The literature reviewed included a wide range of methodologies from surveys to focus groups to talk-aloud protocols and interviews. In each of these cases, the research goal influenced the methodological choice. In this study, the use of Bloom's Taxonomy and Self-Efficacy models to assess participant learning guides the methodology towards electronic platforms. The use of Bloom's

Taxonomy to evaluate learning levels will be facilitated by the use of suggested actionable verbs in questions. There is substantial documentation of how to ask questions to assess the level of learning in users (*Bloom's taxonomy wheel*, 2003). This research uses questions developed from these models to help guide participant responses.

   This research contributes to the existing literature in three ways. First, it bridges the fields of education, library science and information science by using research from these fields to investigate a common area of interest. In doing so, it takes models commonly used in primary and secondary education (Bloom's Taxonomy) and extends them to higher education. Second, it uses a mixed-methods approach to build the foundation of knowledge in this area and extend prior case-study research. Finally, this research extends the work done in the metadata arena which focuses on the impact of metadata on users.

Chapter 3   Methods and limitations

3.1   Overview

This research report outlines an investigation of the concept of ML in undergraduate students. The chapter has five main sections: an overview of the research problem, a definition of research objectives, a discussion of study design, a review of study procedures, and an initial plan for data analysis. Each major section contains sub-sections which document the problem, approach, and study procedures in detail. The chapter concludes with an examination of study boundaries. This methods chapter is structured using an outline proposed for mixed-methods approaches (Creswell & Plano Clark, 2007).

3.2   Research problem

We are transitioning from a print based culture to a digital culture. Reflective of this transition is a change in the way documents are created, structured and used. This change in the nature of documents requires redefining the mechanisms for representing and encoding documents and the abilities required to work with them. Investigating this interaction is a new area of research which studies both how the documents use metadata (i.e. the elements of contextualized data in the document) and what skills/abilities (i.e. literacies - the

abilities, skills and concepts that surround information awareness and use) document creators/authors need.

There is research in the information science field that investigates how metadata is used in representing and structuring documents and enabling information services in relation to these documents. This research includes developing metadata models to describe information structures, investigating the perspectives of creators and users of metadata, and creating systems that make innovative use of metadata to serve specific information needs. Likewise, there is research in the literacy field which investigates the types of skills and concepts that document users must have to work with specific types of electronic resources.

The growth of the role of complex digital documents on everyday information interaction has required an increased focus in researching how these resources are used. This research often employs a particular view of the user in order to define outcomes of use. This dissertation chooses to use an active view of the user as both a consumer and creator of information. It further employs a literacy framework to discuss different influential factors and levels of user ability. There is little research which examines metadata using a user-centric perspective. Further, despite the widespread interest in both metadata and IL, there has been little cross-investigation to discover the role that metadata plays in IL and, conversely, the nature of IL required in order to be an information consumer in a

metadata-rich environment. The research that does exist in this area tends also to be qualitative in nature and typically focuses more on expert perspectives than information creator/consumer perspectives.

3.2.1 Study rationale

The following factors, indicative of the change in our information infrastructure and literacy behaviors, are rationales for this study:

- Production of digital information use has increased dramatically across all segments of the population ("Demographics of internet users," 2005; Mabrito & Medley, 2008; Rowlands, et al., 2008)
- Digital documents focus less on narrative text and more on structured metadata (Weinberger, 2007; Wright, 2007).
- An understanding of and ability to work with information objects is key to using information and learning (Churches, 2008a; S.D. Smith, et al., 2009).
- Given the presence of this research - Users of digital resources need to understand the nature of structured metadata and metadata concepts to make effective use of documents.

In order to understand how to best make use of metadata in digital documents, this dissertation seeks to understand how participants think about metadata and what impact it has on their level of literacy.

3.2.2 Study focus and purpose

Research that investigates the relationship between metadata and literacy is of particular importance, given the growth in the use of metadata in popular information resources and services. This chapter defines how this research identified and evaluated student literacy with regards to metadata. The study used a mixed-methods approach to gather both qualitative data about participants' perceptions and attitudes and quantitative data about their levels of metadata ability and self-efficacy. The study also measured the impact on quantitative variables from a short introduction to uses of metadata to describe images.

A mixed-methods approach was used to examine both the extent of awareness and the perceived impact of metadata related tasks on participants in an information environment. The study used survey, experimental, observational and content analysis approaches to examine participant use and understanding of metadata. Data gathered included observations about the scope and relevance of metadata in their information environment, self-efficacy ratings of their IL levels, and scores from metadata task activities.

The study population included college students from a medium-size university. This study focused on college students for two reasons. First, college students are perceived to be immersed in and natively fluent with information

communication technology (ICT). There is existing research on ICT use by undergraduate students to which this research can be compared (Mabrito & Medley, 2008). This study sought to determine the extent to which ICT fluency extends to metadata. Second, studies have questioned the relationship between generalized and specific knowledge on the part of students in ICT environments (Rowlands, et al., 2008). One of the goals of this study was to identify a base level of competency with respect to metadata and perceived utility of metadata skills and concepts. The following section discusses the importance of this research in more detail.

3.2.3 Inquiry framework

In a recent review of published literature related to e-learning, Shih, et.al.(2008) argue that much of the research being completed in the education field focuses on information processing, instruction, manipulation of the learning environment, and metacognition. Their review of research found that few articles used experimental research to evaluate these areas. Studies on this topic from the perspective of library and information science have analyzed the impact of various types of skills and expertise levels of users on their use of the web (Tabatabai & Shore, 2005), the impact of IL skill teaching (Eisenberg, Lowe, & Spitzer, 2004; Gross & Latham, 2007; Koufagiannakis & Weibe, 2006), and the use of metacognitive skills in research (D. Anderson & Nashon, 2007; Jaeger, 2007).

In information and library science, as well as education, there is extensive use of IL and information technology informed approaches to evaluating competency in users. Popularly used standards include the ACRL IL standards (2005) and the Big 6 (2006). Both of these models include specific foci on skills, content areas and core competencies, but, in each case, tend to fail to abstract information skills from specific tasks (search, retrieve, evaluate, etc). There are other models that examine competencies across multiple areas. These models are called meta-literacy models and include Hughes-Shapiro (1996), Socio-technical (Tuominen, et al., 2005), and Sundin's literacy framework (Sundin, 2008). Each of these meta-literacy focused models looks at literacy from broad themes, such as categories of information interaction, roles of the participant, or perspective of the instructor.

These literacy models often assess the impact of literacy on learning through the use of Bloom's Taxonomy (Bloom, et al., 1956) and Bloom's updated taxonomy (Krathwohl, 2002). Literacies have been mapped onto each level of the taxonomy such as knowledge, comprehension, evaluation and creation as specific skills and concepts. Studies have evaluated these literacies through a number of methods, including the methods of task proficiency and self-efficacy (Bandura, 1982; Kurbanoglu, Akkoyunlu, & Umay, 2006).

Despite the connection between IL and constructivist learning theory through a body of literature presenting case studies on information rich learning

environments, there has been little research that examines how the use of information organization and metadata techniques impacts IL. In particular, no research examines the utility of metadata concepts in relation to IL. In order to address this gap, this research investigated the area of ML with a specific focus on the use of metadata skills.

This investigation used the framework created during the literature review which was based on a merging of theoretical stances with regards to different types of knowledge.   This framework is represented in Table 9. The framework identifies the relationship between an IL skill/concept, and appropriate pedagogical and theoretical approaches. It also asks, in both directions, what roles the context of the IL element and the surrounding information environment play in this interaction.

The concept of ML and the theoretical model supporting it received in-depth attention in the literature review supporting this research. In short, the theoretical model informing this research is based on the connection of popular literacy models and metadata types and uses. This model uses three broad categories to discuss ML which were developed during the review of literature. Each of these categories are represented in Table 9.

   1.   Skills - In the intersection between literacy skills (know, access, evaluate, use, ethical, etc.) and the roles of metadata (identify, categorize, manage, preserve, discover), there are skills specific to metadata (such as

recognize context, harvest, transform, archive) that are descriptive of the tasks that are required to use electronic metadata-rich documents.

2. Concepts - In the world of electronic resources, theoretical concepts such as Extended Mind and Socio-technical interaction describe environments in which metadata serves purposes such as cognition support, community building, and information management. Bloom's Taxonomy tends to align these tasks with higher levels of learning. As generalized knowledge about metadata grows, participants will be able to discuss these strategies for metadata management in more detail.

3. Context - As has been discussed in the literature review, the contexts of information interaction (user goals/needs and technological platform) play a role in the use of skills. This study will use context as a means to investigate how/if participants generalize specific metadata skills with which they are familiar.

In addition to these three views of literacy, there are three perspectives from which literacy is viewed. These three perspectives are pedagogical theory, information/learning theory and environmental role. Table 9 shows the relationship between these types of literacy and perspectives. At the intersection of each skill/perspective, specific questions are asked to help ground the framework.

Table 9. Mitchell's Information literacy framework

	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?

By examining both a metadata task and overall participant self-efficacy, this research sought to understand the relationship between specific task literacies and a generalized understanding of metadata on the part of the participants. The use of this framework allowed this research to identify specific metadata tasks, such as identification and creation, and understand how these tasks were used in specific information environments.

3.3 Research objectives

The overarching research question of this project is: How do students use metadata, and what impact does it have on their information experience? This research project investigated the concept of ML by examining the familiarity with and use of metadata by undergraduate students. This research consisted of a multi-part instrument, including descriptive survey elements, information interaction elements, pre/post metadata interaction tests and pre/post-interaction efficacy ratings. By employing an online survey tool and examples from real-world environments, this study sought to engage participants in a context with which they should already be familiar.

3.3.1 Philosophical foundations

A constructivist perspective is useful for grounding this research, given that the aim was to identify the perceptions, elements and roles of metadata in participants' information environments. Constructivism as a worldview encourages definition of a phenomenon from multiple participant perspectives, allows the data gathered from participant interaction to inform the theoretical models being used in the research, and encourages the use of multiple data sources to provide a more holistic view of a phenomenon (Creswell & Plano Clark, 2007, p. 24).

While the constructivist perspective is valued in both metadata and literacy research, it is not always the dominant world view. For example, Wang and Artero's study on high school students' use of IL concepts is grounded in a positivist view of 'correct' literacy skills, but uses the constructivist approach to discover student perception of training needs (Wang & Artero, 2005). Conversely, the socio-technical perspective of IL emphasizes the concepts of multiple perspectives, participant-created IL practices, and fluid relationships between IL elements (relationships, tasks, interpersonal interactions) (Tuominen, et al., 2005).   A constructivist focused investigation into the concept of ML allowed this study to both suggest elements of ML and to discover from participants alternative views of the roles of metadata and its importance in information interactions.

3.3.2 Research questions

The specific research questions examined in this study are a) To what extent are participants aware of metadata and ML concepts, b) What impact on participants' level of literacy does a short instructional element on metadata have, and c) How do participants view metadata as fitting into their information environment?

Each of these questions are broken into sub-questions that were used to design the study. Each question and its sub-questions are listed below.

1. To what extent are participants aware of metadata and ML concepts?

    a. How do participants think about metadata?

    b. How/where do they use metadata?

    c. What role do they see metadata playing in their information environments?

    d. Is there a difference in how participant groups (e.g. number of years in school, major, students with IL instruction) use metadata?

2. What impact on participants' level of literacy does a short instructional element on metadata have?

    a. Is there a significant difference in literacy levels reported by participants or groups of participants (e.g. number of years in school, academic major, previous IL instruction) following the instructional component?

    b. Is there any correlation between the awareness of metadata and/or use of it and reported levels of self-efficacy with respect to literacy?

3. How do participants view metadata as fitting into their information environment?

    a. What roles do they see it playing in their teaching, learning, everyday, common interest, community, and complex knowledge?

    b. Do they exhibit any ML practices in their own personal information environment?

3.3.3 Study variables/factors

This study requires both quantitative variables and qualitative factors to answer the research questions. For both quantitative and qualitative aspects of

this study, the participant's knowledge about metadata is either an independent variable (quantitative) or orienting factor. This independent variable was controlled through a short learning object and metadata interaction whose purpose is to inform the participant about metadata, help them generalize specific skills, and identify and create metadata first hand.

The dependent variables for the quantitative study are the participants' ability to complete metadata tasks and their self-efficacy level. These variables measured how 'literate' participants are. The variables were measured using metadata identification and creation tasks and a self-efficacy instrument created within the context of Bloom's Taxonomy.

The qualitative aspect of this research gathered input from participants on how they view/use metadata in their own information environments, the roles that participants view metadata playing in information interactions, and the overall perceived value of ML as a part of the IL framework.

3.4   Research approach and study design

3.4.1 Overview

The study used a mixed-methods approach to investigate the research questions outlined in the previous section. The study included five elements a) an evaluation of participant background and use of information systems, b) a pre-

instruction assessment of ML, c) an instructional element on metadata, d) a post-interaction assessment of ML and e) qualitative questions about metadata uses. The gathered data was analyzed using both quantitative and qualitative methods. This resulted in a holistic view of how participants used metadata and what their attitudes towards metadata were.

Participant responses were analyzed to determine differences in participant self-efficacy ratings, task ability levels and pre/post instruction efficacy ratings. Qualitative responses were used to provide contextualizing perspectives on participant information use. Participant groups were formed based on responses to the initial set of questions regarding their academic background. The following sections discuss each of the research steps, including the beginning survey, interactions, instruction process and post-instruction evaluation.

3.4.2 Demographic/information use survey

Survey questions gathered information on academic major, number of years of post-secondary education and information on how participants use common digital information systems. These survey questions are in Appendix A and are comprised of questions one through seven. The primary purpose of the survey portion of the study was to provide categorizing information which could be used for comparative analysis following the study. This section of the study gathered

information on participant ability to define metadata and provided information on how they use metadata rich systems.

3.4.3 Metadata literacy initial assessment

Participant level of ML was assessed prior to instruction using two metadata tasks and a self-efficacy instrument. The two metadata tasks assessed participant ability to identify different types of metadata and are represented in Appendix A as questions nine and ten. The self-efficacy instrument is represented as question eight in Appendix A and is comprised of seventeen questions which were generated by the researcher. The seventeen questions were designed to map on to three of the seven levels of Bloom's updated taxonomy. This mapping is available in Appendix B. Questions were adapted from several sources including an IL self-efficacy instrument developed by Kurbanoglu et al. (2006), field experts, and the literature review of metadata and IL concepts. Following question identification and organization, information science professionals and members of the target population were asked to provide feedback on the instrument. These participants were excluded from the full study.

Following the self-efficacy instrument, two metadata tasks involved having participants identify metadata elements by clicking on a screen-shot taken from Flickr.com. Each metadata task had participants identify a single type of

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metadata. In the first interaction, participants were asked to identify descriptive metadata elements and, in the second, participants were asked to identify social metadata elements. Participants were asked to identify appropriate elements by clicking on sections of the screen-shot from Flickr. When participants clicked on an area, it turned green. A metadata identification score was calculated for each interaction by adding together the correctly selected and correctly unselected areas of the screen-shot and dividing by the total number of elements in the interaction. Participants were assessed with a single metadata identification task and a metadata creation task following instruction.

The initial assessment of ML allowed the researcher to gather information on actual participant abilities with regards to metadata tasks and participant view of level of literacy with regards to metadata.

3.4.4 Metadata instruction

Following the initial assessment of metadata ability, participants were asked to view two videos regarding digital information and metadata. The first instructional video was called "The Web is Us/ing Us" (Wesch, 2007). This resource was selected because it has a relatively short length (4:34) and because it covers many of the important elements of metadata and Web 2.0 applications. Instructional elements of the video included how metadata helps streamline web use, what different encodings of metadata look like, and some

ways of using metadata-rich documents. The second video

(http://www.screencast.com/t/QzjepD1R6) was created by the researcher and

focused specifically on defining metadata and how it is used in digital image

sharing sites. It was one minute and twenty-six seconds in length and included a

short description of what metadata is and a discussion of different types of

metadata (e.g. descriptive, social and technical). An example image along with

its metadata from Flickr (zyrcster, 2008) were used.

The purpose of these two videos was to provide the participants with a base

level of instruction that could help them generalize specific knowledge they had

regarding metadata from other environments such as IL instruction or information

system use.

3.4.5 Post-instruction metadata literacy assessment

Following the instructional videos, participants were again tested on metadata

using two tasks. The first was similar in nature to the pre-instruction task in that it

asked participants to identify descriptive metadata elements using a screen-shot

from digg.com. The screen-shot included descriptive entries for the website

change.gov.

The second task was a metadata creation task. In the second task,

participants were asked to create five metadata tags for a supplied image. This

task involved an image of Barack Obama being inaugurated. The image was

pulled from the open collection of USAToday on Flickr (USA Today, 2008) and was a readily recognizable image to the population. The metadata identification task was used to compare pre and post instruction task completion scores, while the metadata creation task was used to investigate how participants created metadata.

3.4.6 Dependent and independent variables

The dependent variables being evaluated in the study were participants task ability level and self-efficacy ratings. These elements were assessed again following the instruction portion of the study. The independent variable being manipulated in this study is the participant's awareness of ML concepts.

Qualitative data was analyzed to identify metadata use themes and participant view of metadata in general. In addition, data gathered during the metadata creation task was analyzed to understand more about what kind of metadata the participants create.

3.4.7 Testing and validation

The elements of this instrument have been validated in two ways. First, experts were selected via snowball sampling and were asked to evaluate the extent to which the questions assessed IL and ML. Second, the survey was administered to a small sample of participants (less than 10) to check for survey

flow and logic and to discover any unexpected issues. Participants were asked to complete the survey in addition to providing their impressions. The IL self-efficacy instrument developed by Kurbanoglu et al. (2006) was used as framework for the self-efficacy instrument. Actual self-efficacy questions relevant to the concept of ML were created by the researcher and other information science professionals.

3.5   Study procedures

3.5.1 Setting characteristics

This research was conducted entirely online. Participants were solicited via email and responded in a web-based environment using the Qualitrics™ platform. The study included survey elements, task elements and instructional elements arranged in a survey, test, instruct, test, survey pattern.

3.5.2 Participants

Students were recruited from the student population at a medium-size university. One thousand undergraduate students were randomly selected from the student population and were emailed invitations. The first fifty students to respond were included in the study. In order to be eligible for the study, participants had to be over 18 years of age and be enrolled in undergraduate

level courses. Reminder emails were sent on a weekly basis until the maximum number of participants was reached.

3.5.3 Sampling procedures

The literature reviewed suggested fairly large pools of participants for survey-style research. Creswell (2008, p. 156), for example, suggests sample size for accurate survey results should include approximately 350 responses.   Based on Creswell's method of estimating sample size, if this study assumes a p =.05, and power of .8, and effect size of .5 (lacking other substantiating results) then using the chart in Creswell adapted from Lipsey (Creswell, 2008, p. 632) an appropriate response size would be approximately 65 responses to have confidence that the research questions were accurately tested. While this number of participants was outside the budgetary resources of this proposed research, 50 participants were enrolled.

Assuming a response rate between 15% and 30% (Sheehan, 2001), between 216 and 433 participants should be selected to participate. To allow for below average response rate and bounced emails, 1000 students were randomly selected from a database of all undergraduate students. Random selection was accomplished using a randomly seeded program to extract email addresses for these students.

3.5.4 Use of controls or comparisons

Because this study is exploratory in nature, no control group was used. Student responses to initial questions regarding academic background, use of information technology, and metadata ability levels were used to form groups for comparison of dependent variables.

3.5.5 Elimination of alternative explanations

One of the difficulties of this study is researching a concept which is most likely not widely understood by the participants. In order to address this issue, this study focused on creating a common understanding of the phenomenon through the use of familiar examples and use of a short instructional piece. Following instruction which defined metadata, participants were directly asked to reflect on the role of metadata in their experience and its impact on their perception of literacy. As a result, this research avoided examining phenomena outside of its focus.

3.6 *Data analysis*

Data analysis in this research followed two approaches. First, quantitative data was gathered, tabulated and compared to answer the primary research questions. Second, qualitative responses were analyzed to identify themes, which inform the quantitative results.

In general, primary comparisons were made between participant groups and their levels of ML, within the groups and their change in ML between the pre/post instruction evaluations, and within the groups in the overall difference between self-efficacy levels. In the sub-sections below, specific analysis plans are discussed

3.6.1 Quantitative analysis

Quantitative analysis formed the bulk of analysis in this research. The data was analyzed along three axes which are listed below and represented in tabular form in Table 10. Analyses were examined for statistical differences among the following groups.

1. Is there an overall significant difference between information and ML self-efficacy ratings between student groups?

2. Within each group, is there a significant change in reported levels of ML based on the interaction?

3. Within each group, is there a significant difference between their reported levels of IL versus ML?

These questions are grouped in Table 10 into independent and dependent variables. For each variable comparison, a statistical test and rationale for the test are included. While these comparisons are the foundation for analyzing

quantitative data, other statistical tests are included in Chapter 6 which examines

the relationships between variables.

Table 10. Variable analysis

Categorical independent variable	Dependent variable	Statistical test	Rationale
Academic major, years of education, use of information technology, level of interaction with the web	Pre-test self-efficacy score (averaged overall score)	Two-sample t-test	To determine whether average baseline scores differ between these groups
Academic major, years of education, use of information technology, level of interaction with the web	Pre-test metadata interaction (descriptive and social metadata identification)	Two-sample t-test	To determine whether average baseline scores differ between these groups.
Academic major, years of education, use of information technology, level of interaction with the web	Compare average pre-instruction to post-instruction scores for self-efficacy and metadata task	Two sample t-test	To determine whether average score differences differ between these groups. This will indicate whether there is a change in ML among these two groups based on a brief instruction

This study also looked at the correlation between IL baseline scores with ML baseline scores. Baseline self-efficacy scores were compared to the change in task scores to determine if self-efficacy was related to changes in task scores. In order to do both of these, this study used the Pearson correlation test.

3.6.2 Qualitative analysis

The qualitative analysis in this research was limited to participant observations surrounding their metadata use. The background/informational survey and the metadata use survey contained questions designed to elicit information about how participants think of metadata, what types of metadata services they use, and what they feel are important elements of metadata use. The following thematic areas were explored using an open coding approach a) How do participants define metadata? Are there generally accepted definitions? b) When discussing metadata-use and usefulness, what tasks/purposes do they mention? c) When discussing metadata-use and usefulness, what outcomes do the participants mention?

3.7 Study boundaries

This research used a mixed-methods approach to examine the question, *"How do students use metadata and what impact does it have on their view of their IL?"* This allowed the research to take a quantitative view of the difference between participants on the issue of metadata and to examine the ability of

instruction on a specific technology to help participants generalize their knowledge of metadata. This research also used qualitative methods to provide contextual responses regarding participant definitions, views and attitudes on metadata. It employed simple descriptive statistics on open-ended responses to provide a picture of how participants use metadata in common information environments and asked them to reflect on these uses.

This research also took a constructivist approach in gathering data in that it encouraged participants to ground their responses in their own experience and perceptions. By using self-efficacy based instruments to allow participants to rate their levels of information and ML, this research remains grounded in participant perspective as opposed to system functionality.

3.7.1 Alternatives considered

A number of alternative approaches were considered during the design of this research. For example, objective analysis of participant work by experts was considered to provide an objective evaluation of skill. Likewise, a separation of participants into multiple instruments and uses was considered, including an iterative survey design which would have asked librarians to comment on the views of the students. In the end, a single instrument approach was selected to allow the best chance to compare participant groups and to compare the change in metadata and IL through the interaction.

3.7.2 Assumptions

While this research employed a constructivist approach in investigating the role that ML plays in information interactions, it did have a number of base assumptions that drove the research. First, the study assumed that metadata is a valuable element in information environments. Second, the instructional element was designed to evaluate participant responses and view of ML when informed about the role of metadata in a specific application. As such, while it identified student competencies for specific tasks such as identification and creation of metadata, it did not seek to evaluate metadata elements or specific uses (e.g. which elements participants find useful). Finally, this research proceeded on the assumption that metadata is a generally understandable tool and concept for participants.   While participants may not have had an in-depth understanding of the various roles and types of metadata or its terminology, it is assumed that there was a base level of understanding that allowed them to understand common examples. For example, the metadata exercises included the assumption that students would recognize the general structure and content of the screen-shots taken from Flickr and digg.com.

Chapter 4   Descriptive analysis

4.1 Overview

This chapter reports analysis of descriptive statistics gathered in the study. This data was gathered in both the survey and experimental portions of the research. It includes summary data about the population and grouping data formed through the analysis of the survey questions, in addition to descriptive statistics on the metadata tasks and self-efficacy measures. Participant groups documented in this chapter are used in Chapter 5 to compare differences among groups for task performance and self-efficacy levels. These groups included participant demographic (e.g. number of years in school) and researcher determined groupings (e.g. type of major). This chapter also includes descriptive statistics for the metadata tasks and self-efficacy instrument.

4.2 Study population overview

The population consisted of 50 participants. These participants responded to a study participation call that went out to 1000 randomly selected undergraduate students. All students were affiliated with a single university.   The first set of questions gathered information about the number of years they had been in college, their major, their level of IL instruction, their type of use of information

systems, their frequency of use of information systems, and their frequency of use of information technology.

4.2.1 Number of years in college

The study was limited to undergraduate students. The distribution of participants was weighted towards first (n=17) and second year (n=16) students more than third (n=9) and fourth (n=8) year. The mean of the number of years in college was 2.16. No values were reported over 4 years. While the study population tended towards first and second year students, the data analysis in chapter 5 shows no significant differences in the performance or self-efficacy measures based on the number of years in college.

4.2.2 Academic major

Students reported their major by selecting from a list of majors that was pulled from the university website. Table 11 shows the distribution of majors. Forty-six students selected a major from the drop-down menu. One student selected 'other' while three students selected dual major. In four cases, students provided text responses indicating their major(s). The most declared majors were Economics, English, and Health and Exercise Science.

Table 11. Academic major

	n	Percent
Accountancy	1	2
Art History	1	2
Biology	1	2
Business	2	4
Chemistry	3	6
Economics	4	8
Education	1	2
English	4	8
Finance	1	2
Health and Exercise Science	4	8
History	1	2
Political Science	2	4
Psychology	1	2
Russian	1	2
Sociology	1	2
Spanish	1	2
Theatre	1	2
Other	1	2
Undeclared	16	32
Dual Major (Please list)	3	6
Total	50	100

Given the high number of participants in their first or second year of college, it is not surprising to see that 32% of participants are undeclared in their major. Because this represents a grouping in itself and because no other contextualizing information is known about participant subject matter expertise, this was used as a category when grouping types of academic major.

4.2.3 Grouped majors

Based on student responses, the researcher coded the majors into broad categories of Arts and Humanities, Business and Social Sciences, Science and Engineering, and Undeclared. These categories were based on the broad similarities in the fields being studied and were created to allow comparison across disciplines for levels of ML. The categorization of majors was verified by two information science professionals. Students who declared a dual-major (e.g. English and Engineering) had the more technical of the majors used for grouping purposes.   Although three students selected dual majors, only two actually wrote in multiple majors. Of these two students, one was dual majoring in Social Science based majors, and the other was dual majoring in an Arts and a Science program. Table 12 shows the distribution of participants in each broad grouping.

Table 12. Grouped majors

	n	Percent
Business and Social Science	17	34.0
Arts and Humanities	9	18.0
Science and Engineering	8	16.0
Undeclared	16	32.0
Total	50	100

4.2.4 Information literacy instruction

Participants were asked what type of IL instruction they had received. Instruction types were broken down into four types: library tours, single-session library instruction, multiple-session library instruction, and a semester long IL course. Participants were also given the option of selecting "other." One participant used this field, but indicated that they had taken a half-semester long IL course. For the purpose of this study, this is equal to option 4, the semester long IL course. While some students selected multiple levels of instruction, for the purpose of analysis, students were grouped based on their most advanced level of instruction completed. Fifty-two percent of students (n=26) indicated that they had not received any IL instruction. Note that the numbers in Table 13 add up to more than 50 participants because students were allowed to select multiple class types.

Table 13. Information literacy instruction

	n	Percent
No instruction	26	52.0
Library tour	8	16.0
Single-session	13	26.0
Multi-session	4	8.0
IL Class	3	6.0

Participants were separated into two groups for statistical comparison, those with no IL instruction, and those with some IL instruction. Students were considered to have no IL instruction if they had never taken a class or had only taken a library tour. Students were considered to have had IL instruction if they had been in at least a single session IL instruction session. This separation resulted in 19 students who had had some IL instruction and 31 who had only library tours or no IL instruction.

4.2.5 Information system use

Information system use was deduced from three major questions, including type and extent of system use, frequency of information system use and frequency of information technology use. Table 14 shows what type of uses participants engaged in on different categories of web sites. The categories are modeled after Bloom's revised taxonomy (Krathwohl, 2002) which includes the levels remember, understand, apply, analyze, evaluate and create. Students could select multiple tasks for each site.

Participants indicated that they primarily created information on social networking sites, as opposed to other types of sites. Figure 1 shows the difference between participant responses regarding creating content and viewing content in online sites. As the figure shows, participant creation of information in sites other than social networking sites is low in comparison to student use of

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already published information.   The top line indicates participant responses regarding viewing of content, while the bottom line indicates participant responses regarding creating content.

Figure 1. Use of information systems
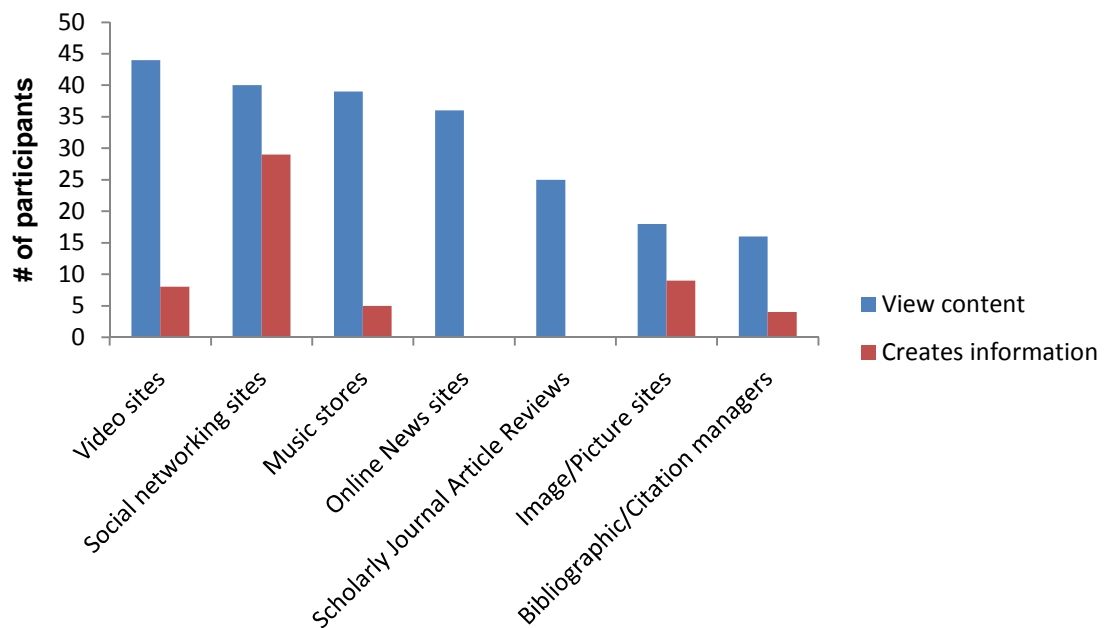
The data presented in Table 14 shows that, for every type of task (e.g. linking to content, adding comments or creating new content, participants are unlikely to be active outside of social networking sites. The table shows how many participants indicated that they engaged in each type of task for a given information system.

Table 14. Information system use

	Don't use	View content	Link to content on site	Add comments	Create new content
Social networking sites (e.g. Facebook, myspace)	2	40	19	39	29
Video sites (e.g. YouTube)	3	44	8	6	8
Image/Picture sites (e.g. Flickr, Picasa)	25	18	2	2	9
Bookmarking sites (e.g. Del.icio.us, digg)	44	3	3	0	1
Blogging sites (e.g. twitter, personal blogs)	36	12	1	3	4
Music stores (Itunes, Pandora, Rhapsody)	8	39	9	6	5
Bibliographic/Citation managers (Zotero, Endnote)	29	16	2	1	4
Scholarly Journal Article Review/Comment Systems (Connotea, Faculty of 1000, Publishers Journal sites, etc.)	24	25	2	1	0
Online News sites (New York Times, Huffington Post)	11	36	7	3	0

Participants were asked if, for each of the web site categories listed, they engaged in uses not covered by the categories. Table 15 contains the types of uses listed for each type of site which received responses. The participant who listed other uses for image sites also indicated that they create content online. Of the participants who listed additional uses for Facebook, the only participant who did not indicate that they create information in Facebook was the one who listed "keeping in touch" as an activity.

Table 15. Information system use open response

	n	Listed uses
Social networking sites (e.g. Facebook, myspace)	3	Hear/purchase music, keeping in touch, plan events
Image/Picture sites (e.g. Flickr, Picasa)	1	Upload pictures and edit
Music stores (Itunes, Pandora, Rhapsody)	3	Download content, download music, purchase media
Online News sites (New York Times, Huffington Post)	2	Cnn.com, Wall Street Journal

Table 16 shows how frequently participants use the sites discussed in the previous question. In this case, participants selected the closest matching time period of system use. Figure 2 shows which information systems participants said that they use daily. As was indicated with student type of use of information

systems, the most frequently used systems focused on social networking sites and entertainment sites.

Figure 2. Daily use of information systems
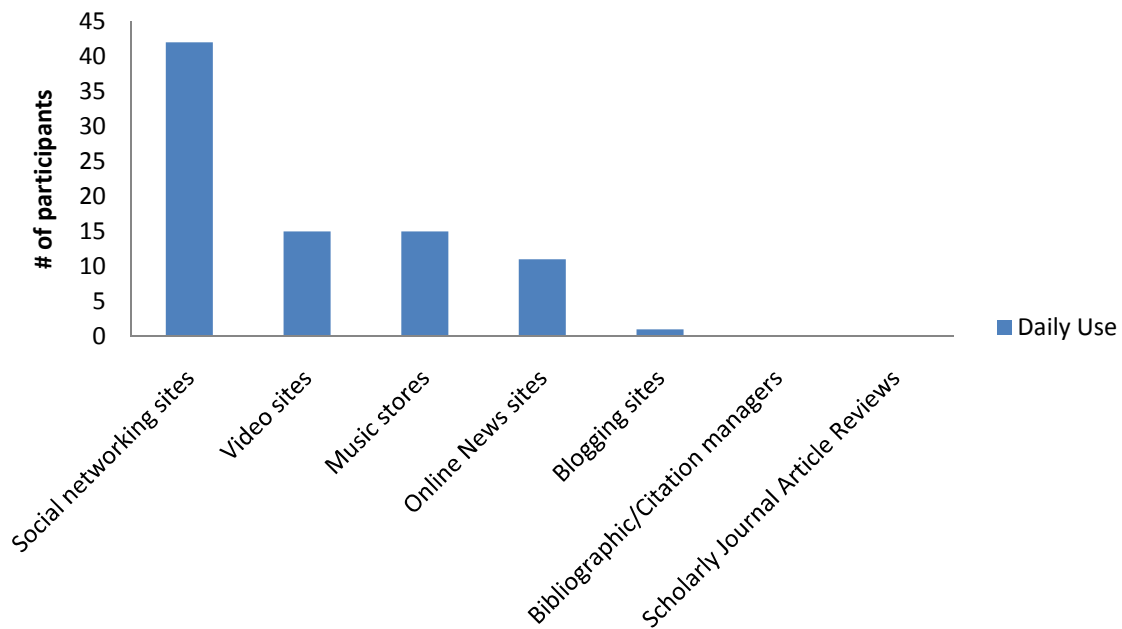
The data presented in Table 16 shows how frequently participants used each of the types of web sites. The results in this table reflect the predominating interest in entertainment and social networking sites among the population. As the table indicates, regular use of categories of sites diminished rapidly when not focused on social tasks.

Table 16. Frequency of information system use

	Never	Annual	Monthly	Weekly	Daily
Social networking sites (e.g. Facebook, myspace)	1	1	1	5	42
Video sites (e.g. YouTube)	3	1	4	27	15
Image/Picture sites (e.g. Flickr, Picasa)	23	5	14	7	0
Bookmarking sites (e.g. Del.icio.us, digg)	42	1	4	3	0
Blogging sites (e.g. twitter, personal blogs)	34	2	4	8	1
Music stores (Itunes, Pandora, Rhapsody)	5	1	12	17	15
Bibliographic/Citation managers (Zotero, Endnote)	26	4	16	3	0
Scholarly Journal Article Review/Comment Systems (Connotea, Faculty of 1000, Publishers Journal sites, etc.)	21	8	16	5	0
Online News sites (New York Times, Huffington Post)	11	0	12	16	11

Participants were also asked if there were other information systems that they use regularly. They were asked to indicate the system and frequency of use. Eleven participants answered this question. Five participants mentioned making daily use of Internet search engines, a category which was not included in the matrix. The other system type that was not examined in the information system use questions, but was mentioned by a participant was online shopping. A full listing of open-ended responses and the number of participants for each system and frequency of use are listed in Table 17.

Table 17. Frequency of information system use open response

Frequency of use	System category	n
Daily	Search engines (Google, Yahoo)	5
	Email	1
Monthly	Online shopping (Ebay)	1
	Pandora – online music	1
	Incomplete or N/A responses	4

In addition to asking about the type and frequency of use of information systems, participants were asked about the technology platforms on which they use information. Table 18 shows information technology platforms use and frequency of use. While all of the students reported using a laptop computer on a daily basis and all but one participant reported using a cell phone for talking or

texting on daily basis, just over half (n=26) reported accessing data on their cell-phone. This finding is in line with the 2009 ECAR study which found that 51% of participants owned an Internet-capable cell phone (S.D. Smith, et al., 2009, p. 7). Only one participant indicated that they use an ultra-portable computer (e.g. tablet or netbook).

Only one group was formed from the set of questions regarding information system use and information technology use. Based on Bloom's Taxonomy, participants were grouped by whether or not they create new content. While the definition of 'creating content online' is somewhat ambiguous, for the purpose of this grouping, only the highest level indicated in Table 14 were counted as creating content. Bloom's Taxonomy was used to create the values of the scale used in this question as well. Using this scale, participants indicated their familiarity with different levels of information system use including non-use, recognition of elements, analysis of elements and creation of new information. Participants were cross-checked against the open ended responses in Table 15 to ensure that, if tasks that included creating content were listed, they were included in the 'creates content online' category. Using this approach, 70% (n=35) of the 50 participants create content in one or more of the web site categories listed.

Table 18. Information technology use

	Never	Annual	Monthly	Weekly	Daily
Laptop or desktop computer	0	0	0	0	50
Cellular Phone - calls and texting only	0	0	0	0	49
Cellular Phone - Internet or email use	24	0	4	3	19
Portable music player (e.g. IPod or MP3 player)	3	0	8	12	27
Gaming consoles (e.g. Wii)	21	9	8	8	4
Automobile GPS device	20	8	10	11	1
Ultra-portable computer (e.g. netbook or tablet pc)	49	0	0	0	1

4.3 Self-efficacy ratings

Students were administered a seventeen element self-efficacy test both prior to and following metadata tasks and instruction. The instrument used a seven point scale with one equaling "Almost never true" and seven equaling "Almost always true." Average scores on both the pre and post instruction self-efficacy questions were above the midpoint of "occasionally true" (4). This midpoint was chosen to reflect the appropriate midpoint of the positively skewed responses. Table 19 shows both pre and post instruction self-efficacy score averages, along with skewness and kurtosis. The skewness data shows that participants had an overall positive bias in their self-efficacy responses and that, in general, their self-efficacy increased following instruction. The minimum self-efficacy score prior to instruction was 2.71, while the minimum self-efficacy score, post instruction, was 1.59. Conversely, the maximum self-efficacy score rose from 6.65, pre-instruction to 7.0, post-instruction.

Table 19. Self-efficacy scores

Self-efficacy question	N	Mean	Std.Deviation	Skewness	Kurtosis
Pre-instruction	50	4.8224	1.059	-.292	-.906
Post-instruction	50	5.0294	1.260	-.792	.483

A one-sample t-test was conducted on both pre and post instruction self-efficacy ratings to determine if student self-efficacy ratings are significantly different from the midpoint of 4 ("occasionally true"). Table 20 shows the results of the t-test on both pre and post self-efficacy scores. Both pre (p<.001) and post self-efficacy (p<.001) showed significant difference from the mid-point.

Table 20. One-sample t-test of self-efficacy scores

Self-efficacy	t	df	Mean difference	P <
Pre-instruction	5.489	49	.82235	.001
Post-instruction	5.776	49	1.02941	.001

Participants were grouped into high and low self-efficacy score groups for both the pre and post instruction scores. Participants with an average self-efficacy score above 4 were categorized as high, while participants with an average self-efficacy score below 4 were categorized as low. Table 21 shows the number of participants in each group for both pre and post self-efficacy scores.

Table 21. High/low self-efficacy groups

Self-efficacy	High self-efficacy	Low self-efficacy
Pre-instruction	39	11
Post-instruction	41	9

Self-efficacy scores were also broken down according to the levels of Bloom's Taxonomy. Rather than five different categories, however, the self-efficacy scores were grouped into the three categories of understand, analyze and create. The category assigned to each question can be found in Appendix B. Scores were then averaged in each of these three areas. The results of these averages can be found in Table 22. The analysis of categorized questions shows that, while participants had an overall positive view of their abilities, the analyze and create questions showed lower scores. Further, the analysis showed greater variance in participant ratings following instruction.

Table 22. Categorized self-efficacy scores

		n	Mean	Standard deviation	Skewness	Kurtosis
Understand	Pre	50	5.53	1.04	-.793	.590
	Post	50	5.43	1.22	-.986	.750
Analyze	Pre	50	4.86	1.19	-.602	-.354
	Post	50	5.23	1.35	-1.298	1.986
Create	Pre	50	4.08	1.31	-.072	-.969
	Post	50	4.46	1.50	-.467	-.253

4.4   *Descriptive metadata identification exercise*

In the descriptive tagging exercise, students were presented with a screen-shot from a metadata rich environment. In the initial interaction, participants had to successfully identify descriptive metadata items among 23 different tags on the screen-shot. In the post-instruction interaction, participants had to identify descriptive metadata items among 47 different tags. Both of these questions, along with the images, are located in Appendix A. The entire image from the web page was mapped so that any selection by the participant resulted in a selected area. Each area was labeled with what sort of information it contained (e.g. descriptive metadata, social metadata, page navigation, image). The categories of tags used to label the images in all three interactions are: a) descriptive metadata, b) technical metadata, c) social metadata, d) rights metadata, e) event metadata, f) digital image, g) page navigation element, h) search, and i) metadata tasks. Correctly completing the exercise included selecting the sections appropriate to the task (e.g. identifying descriptive metadata) and not selecting sections that were inappropriate to the task (e.g. page navigation).

For both exercises, a percentage score was calculated based on the percent of correctly selected or non-selected elements in the exercise. A 100% correct score meant that participants both selected all of the correct tags on the screen-shot (i.e. all sections with descriptive metadata) and did not select elements that

were not associated with the type of metadata that they were asked to select (i.e. social metadata, page navigation or search box). Table 23 presents the mean, standard deviation, skewness and kurtosis of the pre and post instruction description exercise. Both exercises were negatively skewed, indicating overall performance above the mid-point. The post-instruction task showed an overall lower score and greater variance.

Table 23. Description exercise performance

Description exercise	Mean score	Standard deviation	Skewness	Kurtosis
Pre-instruction	63.53%	.1363	-.026	-1.251
Post-instruction	61.23%	.1705	-.059	-.327

4.5   *Social metadata identification exercise*

A social metadata identification exercise was conducted prior to the instruction section. The social metadata identification exercise was similar in nature and scope to the descriptive exercise which preceded it. It contained twenty-three separate page elements, four of which contained social metadata. This task is represented as question 10 in Appendix A. Participants scored an average of 81.22% correct, with a standard deviation of .1452. A correct score in

this case is identical to the description tasks in that participants had to correctly identify social metadata elements while not incorrectly selecting other elements for a perfect score. This performance level is much higher than the descriptive metadata task performance levels discussed in Table 23. One reason for this difference may be in the number of selectable elements in the interaction. Both of the description tasks required the students to select a greater number of elements than the social metadata task. Skewness of the social metadata identification exercise was -1.327 while kurtosis was1.653. A one sample t-test indicated that scores were significantly different from the midpoint (50% correct). The exercise mean of .8122 (SD=.1452) was significantly different from .5, $t(49)=15.197, p<.001$. Figure 3 shows the distribution of scores for the social metadata identification task.

Figure 3. Social metadata identification exercise

Mean =0.81
Std. Dev. =0.145
N =50
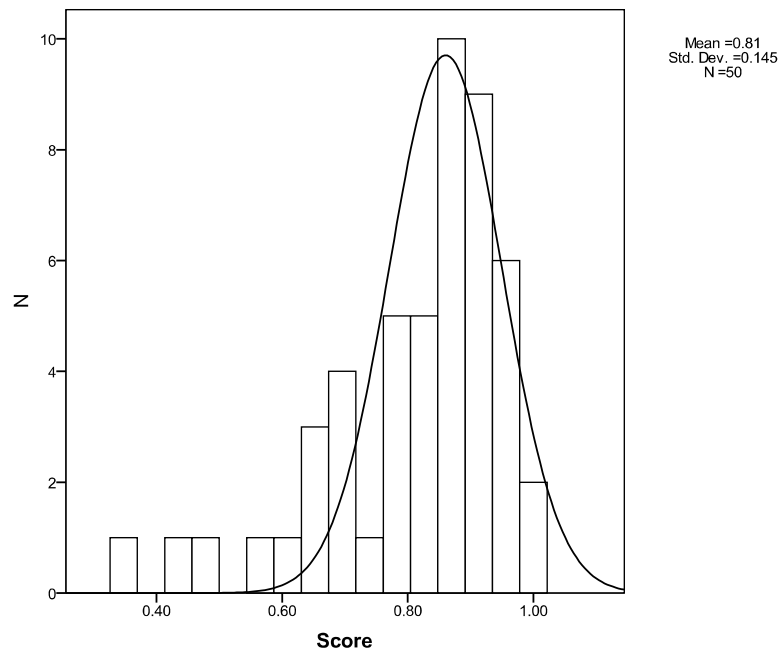
4.6   Summary

This chapter has documented the descriptive statistics from the study including raw scores for participant profile and performance and participant groups based on profile responses and performance levels. Subgroups were formed for data analysis purposes. The subgroups were formed based on the following data a) number of years of post-secondary education, b) type of major, c)level of IL instruction, d)level of use of information systems, and e) overall level of self-efficacy. These groups are represented in Table 24 along with their possible values.

Table 24. Grouped variables

Group	Scale
Number of years of post-secondary education	1, 2, 3, 4
Type of Major	Arts and Humanities Social Science Science and Engineering Undecided
Level of IL instruction	Some IL instruction No IL instruction
Level of use of information systems	Creates information in online information systems Does not create information in online information systems
Overall level of self-efficacy (both pre and post instruction)	High self-efficacy (average above 4) Low self-efficacy (average below 4)

In order to verify the coding of data for quantitative analysis, two information professionals were consulted. The first information professional aided in the coding of data and creation of groups. Following the grouping process, another information professional was asked to independently verify the group definitions and the assignment of individuals to groups. In the next chapter, these groups are used to perform comparative analysis on self-efficacy and task scores.

Chapter 5   Comparison of quantitative variables

5.1   Overview

This chapter contains comparisons between the dependent variables of self-efficacy and performance on metadata tasks and the independent variables a)number of years of post-secondary education, b)type of major, c)level of IL instruction, d)level of use of information systems, and e)overall level of self-efficacy. This chapter begins by presenting the results of the analysis to see if there was a significant change during the study. Part 2 of the chapter includes t-tests comparing independent and dependent variables. Part 3 includes correlational analyses of the dependent variables.

5.2   Change in dependent variables

5.2.1 Pre vs. post self-efficacy ratings

Paired-sample t-tests were conducted to see if there were any significant changes in dependent variables related to self-efficacy before and after instruction. A comparison between pre-instruction self-efficacy scores (M = 4.822, SD = 1.059) and post-instruction self-efficacy ratings (M = 5.029, SD = 1.260) did not show a significant difference in the results (M = -.207, SD = .8367, t(49) = -1.75, p =.086). The standardized effect size index d was equal to .247. Self-efficacy scores showed considerable overlap between pre-instruction and

post-instruction tests, as shown in Figure 4.   The 95% confidence interval for the mean difference between the two scores was -.445 to .031 The two means (pre-instruction mean 4.822 and post-instruction mean 5.0294) were significantly greater than the midpoint on the scale (4), indicating that students, overall, have a high self-efficacy rating with regards to IL and technology tasks on the scale.

Figure 4. Boxplots of self-efficacy scores
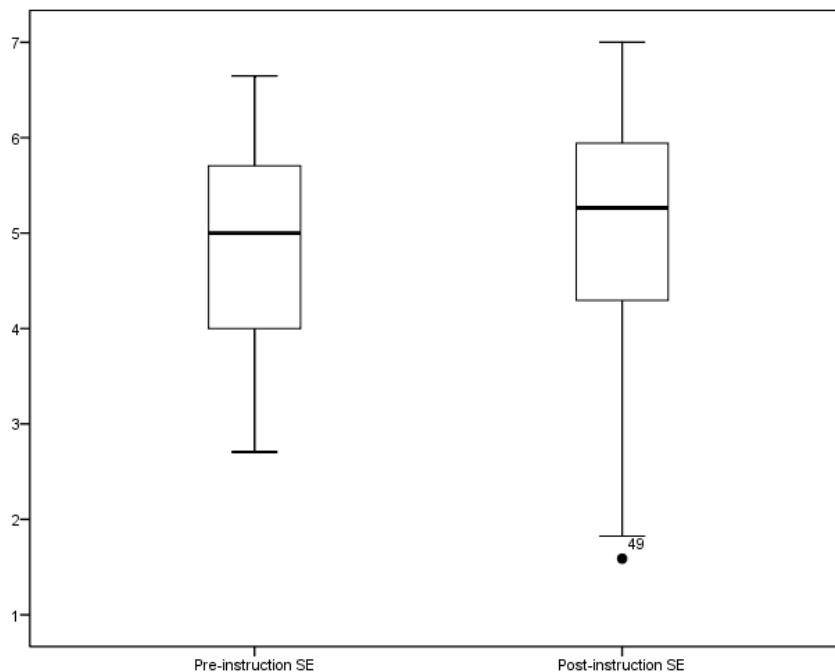
When self-efficacy scores were grouped into the three categories related to understanding, analyzing and creating information, significant variance was found. The more granular analysis of self-efficacy questions revealed differences in eight of the nine comparisons. The results of this analysis can be found in

Table 25. Table 22 contains the individual means for each of the categorized question sets. The one comparison which did not reveal significant difference is the change in the basic level of understanding following instruction (mean difference = .1, SD = .959, t(49) = .737, p < .465). Comparing change following instruction for the other two categories (analyze and create) revealed a small but significant fall in self-efficacy levels. These differences are in the right-most column of the table.

Table 25. Categorized paired-samples t-tests

Comparison		Mean difference	Standard deviation	t	p
Comparison	Category				
Pre vs. Post	Understand	.100	.959	.737	.465
	Analyze	-.37	.898	-2.929	.005
	Create	-.377	1.147	-2.323	.024
Understand vs. analyze	Pre-instruction	.670	.808	5.863	.001
	Post-instruction	.198	.691	2.027	.048
Analyze vs. create	Pre-instruction	.777	.828	6.636	.001
	Post-instruction	.770	.815	6.700	.001
Understand vs. create	Pre-instruction	1.445	1.060	9.648	.001
	Post-instruction	.970	1.099	6.243	.001

This comparison also revealed significant differences between participant levels of self-efficacy between the three categories of understand, analyze and create. For example, the widest gap in self-efficacy existed between participants self-efficacy level related to understanding information vs. their self-efficacy level related to creating new information prior to instruction (mean difference = 1.445, SD = 1.,060., t(49) = 9.648, p < .001). The greatest difference in self-efficacy levels following instruction also occurred between the category understanding and create (mean difference = .970, SD = .1099, t(49) = 6.243, p < .001).

5.2.2 Pre vs. Post instruction and metadata task

Paired-sample t-tests were conducted to see if there were any significant changes in the dependent variables related to task performance before and after instruction. A comparison between pre-instruction descriptive metadata identification scores (M = .636, SD = .136) versus post-instruction descriptive metadata identification scores (M = .612, SD = .171) did not show a significant difference in the results (M = .023, SD = .1755, t(49) = .939, p=.352). The standardized effect size index d was equal to 0.1328. Descriptive metadata identification scores were very similar between pre-instruction and post-instruction tests, as shown in Figure 5. The 95% confidence interval for the mean difference between the two scores was -.0265 to .0732. The two means

(pre-instruction mean .6356 and post-instruction mean .6123) were significantly greater than a 50% success rate, indicating that students achieved greater than average success on both description tasks.

Figure 5. Boxplots of descriptive metadata identification task
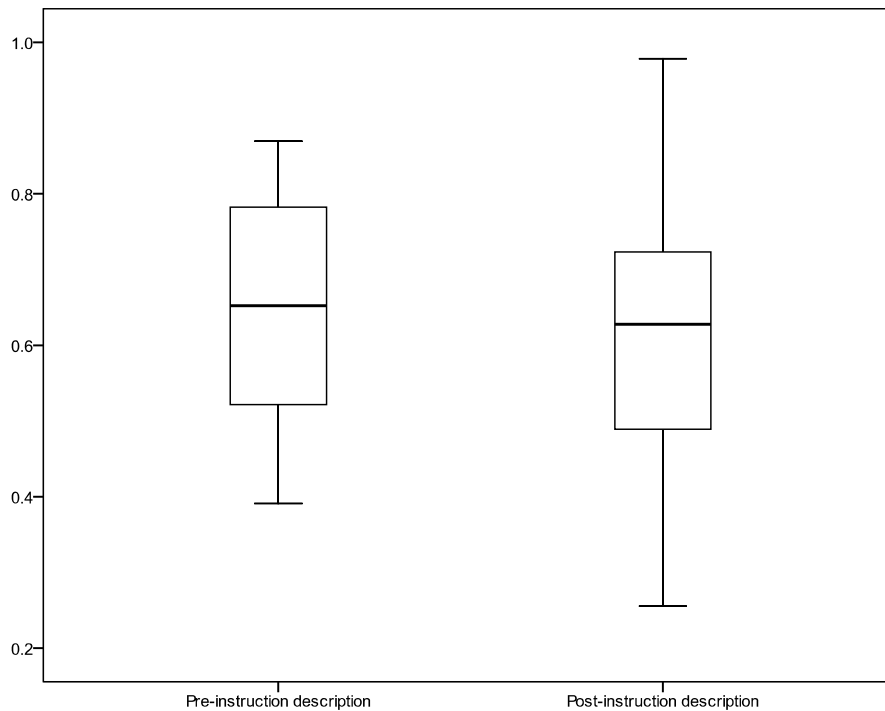
5.3   Comparison among groups

In order to see if there were any differences among the groups of students studied, independent and dependent variables were compared using ANOVAs. The dependent variables of self-efficacy levels and task performance and change in these variables were checked against the five participant groups identified in

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the previous chapter.   These groups are listed in Table 24 on page 131. The comparisons are organized by groups with analyses for self-efficacy scores, change in self-efficacy scores, task performance and change in task performance.

5.3.1 Years of post-secondary education and self-efficacy

One-way analysis of variance was conducted to examine the relationship between the number of years in college and participants' level of self-efficacy. The independent variable, years of post-secondary education, included levels of 1-4 years. The dependent variables were levels of self-efficacy prior to instruction, levels of self-efficacy following instruction, and the change in self-efficacy levels due to instruction. The ANOVA between the independent variable against participants' self-efficacy level prior to instruction did not show a significant relationship ($F(3, 46) = 1.881$, $p < .146$). Nor did the ANOVA between the independent variable and post-instruction self-efficacy level show a significant relationship ($F(3,46) = 1.654$, $p < .190$). Finally, there was no significant difference in the change in self-efficacy levels ($F(3, 46) = .795$, $p < .503$) with regards to the number of years that participants had been in school.

5.3.2 Years of post-secondary education and skill

One-way analysis of variance was conducted to examine the relationship between the number of years in college and participants' skill level in three

different exercises. The independent variable, years of post-secondary

education, included levels of 1-4 years. The dependent variables included the

pre-instruction descriptive metadata identification task score, the post-instruction

metadata identification task score, the pre-instruction social metadata

identification task, and the change in descriptive metadata identification task

scores in relation to instruction. The ANOVA between the pre-instruction

descriptive metadata identification score and the independent variable did not

show a significant relationship ($F(3, 46) = .433, p < .730$). The ANOVA between

the post-instruction descriptive metadata identification score and the independent

variable did not show a significant relationship ($F(3, 46) = .03, p < 1$). The

ANOVA between the pre-instruction social metadata identification exercise did

not show a significant relationship ($F(3, 46) = 1.997, p < .128$). Finally, there

was no significant difference in the change in skill levels for the descriptive

metadata identification task ($F(3, 46) = .274, p < .844$) with regards to the

number of years of post-secondary education.

5.3.3 Grouped majors and self-efficacy

One-way analysis of variance was conducted to examine the relationship

between the type of academic major and participants' level of self-efficacy. The

independent variable, grouped majors, included types of majors, a)arts and

humanities, b)social sciences, c)science and engineering, and d)undecided. The

dependent variable was level of self-efficacy prior to instruction, level of self-

efficacy following instruction, and the change in self-efficacy level due to instruction. The ANOVA between the independent variable and participant self-efficacy level prior to instruction did not show a significant relationship $(F(3, 46) = .361, p < .782)$. The ANOVA between the independent variable and post-instruction self-efficacy also did not show a significant relationship $(F(3,46) = .046, p < .987)$.

The ANOVA test to compare change in self-efficacy, as compared to the independent variable, was broken into two subsections. The first group of tests looked at students who had declared a major (n=32). There was no significant difference reported in the change in self-efficacy levels $(F(2, 31) = .444, p < .646)$ with regards to the type of major that the participant is pursuing. When an ANOVA was run on the larger group, which included undeclared students (n=50), similar results were found. There was no significant difference reported in the change in self-efficacy levels $(F(3, 46) = .268, p < .848)$ with regards to the type of major.

5.3.4 Grouped majors and skill

One-way analysis of variance was conducted to examine the relationship between type of academic major and participants' skill level in three different exercises. The independent variable, grouped major, included four types of majors, a)arts and humanities, b)social sciences, c)science and engineering, and

d)undecided. The dependent variables included the pre-instruction descriptive metadata identification task score, the post-instruction metadata identification task score, the pre-instruction social metadata identification task, and the change in descriptive metadata identification task scores in relation to instruction. The ANOVA between the independent variable and pre-instruction descriptive metadata identification score did not show a significant relationship ($F(3, 46) =$ .769, $p < .517$). The ANOVA between the independent variable and post-instruction descriptive metadata identification exercise did not show a significant relationship ($F(3, 46) = .538$, $p < .659$). The ANOVA between independent variable and pre-instruction social metadata identification score did not show a significant relationship ($F(3, 46) = 1.128$, $p < .348$).

The ANOVA test to compare change in self-efficacy, as compared to the independent variable, was broken into two subsections. The first group of tests looked at students who had declared a major ($n = 32$). There was no significant difference reported in the change in skill level ($F(3, 31) = 2.380$, $p < .109$) with regards to the type of major.

There was one participant who proved to be an outlier in the skill test with regards to the other participants. This participant scored highly in the initial tests and rated himself highly in self-efficacy both prior to and following instruction. While this participant performed on average with other participants in the pre-instruction descriptive metadata identification task ($M = .6522$ as compared to the

study population mean of .6356) he performed considerably worse in the post-instruction descriptive metadata identification task (M = .2553 as compared to the study population mean of .6123). If this single case is thrown out, for this ANOVA only, the change in skill level based on instruction for the descriptive metadata identification task is significant ($F_{(2, 30)} = 3.669$, $p < .038$).

When ANOVAs were run on the larger group, which included undeclared students, similar results were found.   There was no significant difference reported in the change in skill level ($F_{(3, 46)} = 1.352$, $p < .269$) with regards to the type of major that the participant is pursuing. In this case, removing the single problematic case does not result in a significant statistic ($F_{(3, 45)} = 1.920$, $p < .140$).

5.3.5 Information literacy instruction and level of self-efficacy

One-way analysis of variance was conducted to examine the difference between students who had had some library instruction and those who had had none, with regards to their level of self-efficacy. The independent variable, level of IL instruction, included two levels, a)some IL instruction, and b)no IL instruction. The dependent variable was level of self-efficacy prior to instruction, level of self-efficacy following instruction, and the change in self-efficacy level due to instruction.   The ANOVA between pre-instruction self-efficacy and these groups did not show a significant relationship ($F_{(1, 48)} = .666$, $p < .418$).

Similarly, the ANOVA between post-instruction self-efficacy and these groups did not show a significant relationship (F(1, 48) = .815, p < .371).

There was a significant difference reported in the change in self-efficacy levels (F(1, 48) = 6.388, p < .015) with regards to level of IL instruction. Students who had had some level of IL instruction, including single session, multi-session or semester long courses, had an average increase of .57 (8.1% increase) on a scale of 1-7 in their level of self-efficacy. Figure 6 shows the change in self-efficacy scores for students who had some IL, as compared to those with no IL instruction.

Figure 6. Change in self-efficacy with regards to instruction
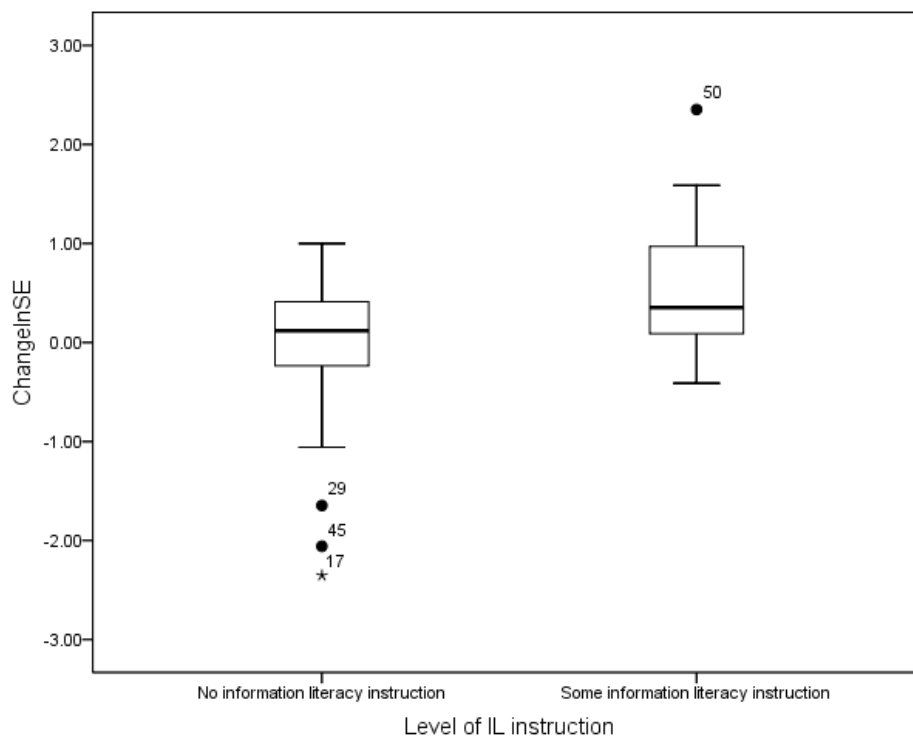
Additional analysis was done to further investigate this difference. ANOVAs were completed, comparing change in the three categorized types of self-efficacy questions against presence of IL instruction. The results of the comparisons are show in Table 26. The analysis found that participants with IL instruction increased in their confidence in creating information online more than students without IL instruction. The analysis did not find corresponding change in the understand and analyze categories.

Table 26. ANOVA comparing change in efficacy and literacy levels

	F	df	p
Understand	2.972	1, 48	.091
Analyze	2.878	1, 48	.096
Create	6.755	1, 48	.012

5.3.6 Information literacy instruction and metadata skill

ANOVA comparisons were done to compare IL instruction level and skill level in each of the three interactions (pre-descriptive, post-descriptive, pre-skill). The independent variable, level of IL instruction, included two levels, a) some IL instruction, and b) no IL instruction. The dependent variables included the pre-instruction descriptive metadata identification task score, the post-instruction metadata identification task score, the pre-instruction social metadata identification task, and the change in descriptive metadata identification task

scores in relation to instruction. The ANOVA between the independent variable

and pre-instruction descriptive metadata identification task did not show a

significant relationship ($F(1,48) = .194$, $p < .662$). The ANOVA between the

independent variable and post-instruction description skill also showed no

significant relationship ($F(1,48) = .134$, $p < .715$).   Removing the one outlier, as

discussed in the grouped major and skill section, failed to give significant results

($F(1, 48) = .632$, $p < .471$).   Finally, the ANOVA between the independent

variable and pre-instruction social metadata identification skill results did not

show a significant relationship ($F(1,48) = .006$, $p < .937$).

There was no significant relationship found in the ANOVA comparing level of

IL instruction with regards to the change in skill level ($F(1, 48) = .491$, $p < .487$).

As noted in the section comparing grouped majors and skill the single outlier

case was removed and another ANOVA was run. Despite the removal of this

case, the ANOVA did not indicate significant results ($F(1, 47) = 1.356$, $p < .250$).

5.3.7 Information system use and self-efficacy

ANOVA comparisons were completed to investigate the relationship between

information system use and level of self-efficacy. The independent variable, level

of information system use, was represented with two categories, a) creates new

online information in information systems and b) does not create new information

in online information systems. The dependent variables were levels of self-

efficacy prior to instruction, levels of self-efficacy following instruction, and the change in self-efficacy levels due to instruction.   The relationship between the independent variable and pre-instruction self-efficacy was not significant ($F(1,48)$ = 2.264, $p < .139$). Likewise, the relationship between the independent variable and post-instruction self-efficacy was not significant ($F(1,48) = .973$, $p < .329$.) There was no significant difference reported in the change in self-efficacy levels ($F(1, 48) = .153$, $p < .697$) with regards to the level of information system use of the participants.

5.3.8 Information system use and skill

ANOVA comparisons were completed to investigate the relationship between information system use and level of skill in metadata tasks. The independent variable, level of information system use, was represented with two categories, a) creates new online information in information systems and b) does not create new information in online information systems. The dependent variables included the pre-instruction descriptive metadata identification task score, the post-instruction metadata identification task score, the pre-instruction social metadata identification task, and the change in descriptive metadata identification task scores in relation to instruction.

The ANOVAs between the independent variable and metadata identification tasks were not significant a) pre-instruction descriptive metadata identification

task (F(1,48) = 1.028, p < .316), b) pre-instruction social metadata identification (F(1,48) = .886, p < .351) and c). post-instruction descriptive metadata identification (F(1, 48) = 3.088 , p < .085).   As was done in other comparisons which involved skill ratings, the one outlier case was removed and another ANOVA was run, comparing the independent variable and post-instruction descriptive metadata identification task. In this ANOVA, significant results were returned (F(1, 48) = 4.276, p < .044).

It makes sense that removing this case had an impact on the results, as the participant both scored outside of his expected performance level and was the lowest performer of the entire population on this task. This participant showed growing self-efficacy and on and above par performance in the first two skill tests (65% for pre-instruction descriptive identification and 100% for pre-instruction social identification), but showed very low performance on the post-instruction descriptive identification (26%). This participant did report creating new information online. Figure 7 shows the overlap between participants who reported creating new information online and those who did not report creating new information online with regards to their skill level with the post-instruction descriptive metadata identification task.   Figure 7 does not include the outlier case.

Figure 7. Boxplots of post-instruction metadata identification task
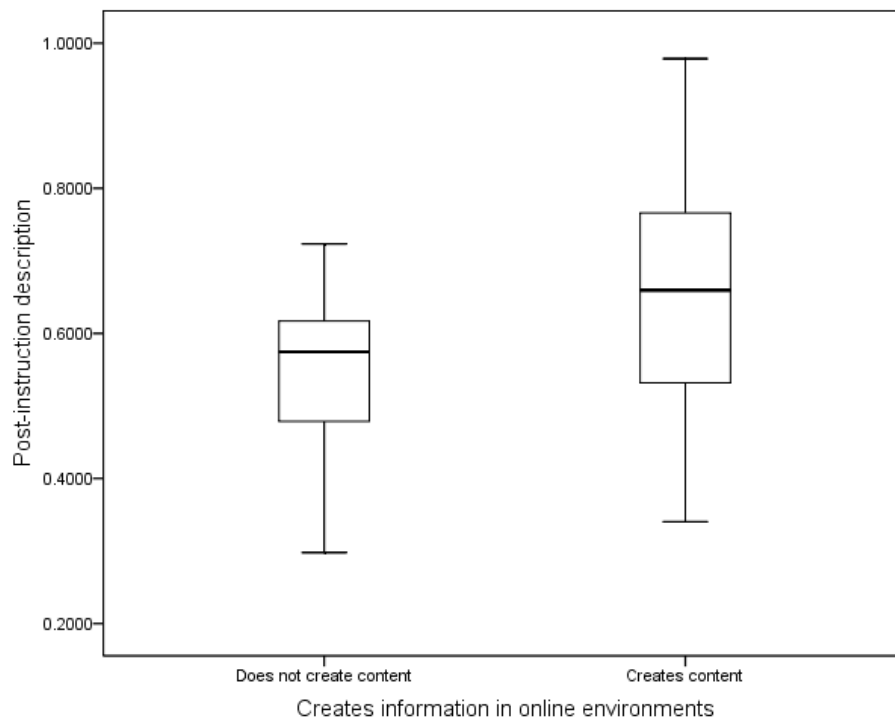
There was no significant difference reported in the change in skill level (F(1,48) = .779, p < .382) with regards to the independent variable. As was done in other comparisons which involved skill ratings, the one outlier case was removed and another ANOVA was run. When the one problematic case is removed, significant results are still not returned (F(1,47) = 1.295, p < .261).

5.3.9 General level of self-efficacy compared to skill level

Participants were grouped based on their response to the SE scale. Students rating an average of 4 or higher were classified as high in self-efficacy, while students with an average rating less than 4 were classified as low in self-efficacy. This process was completed for both pre and post instruction self-efficacy scores. Interestingly, although the population as a whole showed variation in their self-efficacy change (although this change did not prove to be significant), no students who were 4 or above prior to the instruction dropped below 4, and, conversely, no students who were below 4 prior to instruction raised their self-efficacy level to 4 or above.

The ANOVA comparing high/low level of self-efficacy and ability to perform the pre-instruction descriptive metadata identification task did not show a significant relationship ($F(1,48) = .170$, $p < .682$). Results were similar when comparing the independent variable against pre-instruction social metadata tasks ($F(1,48) = .579$, $p < .450$). Likewise, the comparison of post-instruction general self-efficacy levels and ability to perform the post-instruction descriptive metadata identification task did not show a significant relationship ($F(1,48) = .353$, $p < .555$).

5.3.10 Summary of ANOVA comparisons

ANOVA comparisons found significance in only one case, the change in self-efficacy with regards to level of IL instruction. In cases which examined certain grouping variables in relation to the dependent variable post-instruction descriptive metadata identification skill, significance was found when the one outlier case was excluded. Significant relationships were found between participants who reported creating new information online and their ability to complete the task. The outlier reported high initial and post-instruction self-efficacy and performed well on both the pre-instruction tasks, but performed poorly on the post-instruction description task. In addition to being well outside the expected range of performance for the post-instruction descriptive metadata identification task, this participant scored the lowest of the entire population.

5.4 Correlational analysis

5.4.1 Correlational analysis between self-efficacy and test scores

This section examines correlational relationships by comparing performance and self-efficacy scales and by comparison of these scales against population groups. This section includes analyses of correlation for performance and self-efficacy variables. Additional, analyses were completed for the two instances of significant findings in the previous section. These analyses used the Bonferroni method to control for Type I error. Correlation coefficients were computed

between the pre and post instruction self-efficacy and interaction scores. The results of the analyses show that there were no statistically significant correlations between pre-instruction self-efficacy and task performance. Similarly, there was no significant correlation between post-instruction self-efficacy level and task performance.

5.4.2 Correlation among performance and self-efficacy measures

Correlation coefficients were computed individually for the performance and self-efficacy measures. These measures included pre-instruction performance measures on descriptive metadata and social metadata identification, post-instruction performance measures on descriptive metadata identification, and pre and post instruction measures of self-efficacy. This analysis used the Bonferroni approach to control for Type I error. This means that correlations had to be significant at the .01 level (.05 X 5). Table 27 shows that two correlations were statistically significant. The comparison found that pre-instruction and post-instruction self-efficacy levels were strongly correlated. The comparison also found that pre-instruction and post-instruction descriptive metadata identification tasks were correlated. These findings mostly show that the two interactions measured similar abilities.

Table 27. Correlations among self-efficacy and performance measures

	Pre-SE	Post-SE	Pre-description	Pre-social	Post-description	Change in SE
Post-instruction SE	.753 **					
Pre-instruction descriptive task	.085	.129				
Pre-instruction social task	.264	.214	-.133			
Post-instruction descriptive task	.138	.146	.363 **	-.175		
Change in SE	-.132	.553 **	.087	-.11	.046	
Change in Performance	.068	.041	-.424 **	-.067	.690 **	-.024

** $p < .01$

Figure 8. Scatterplot of correlations of performance and self-efficacy
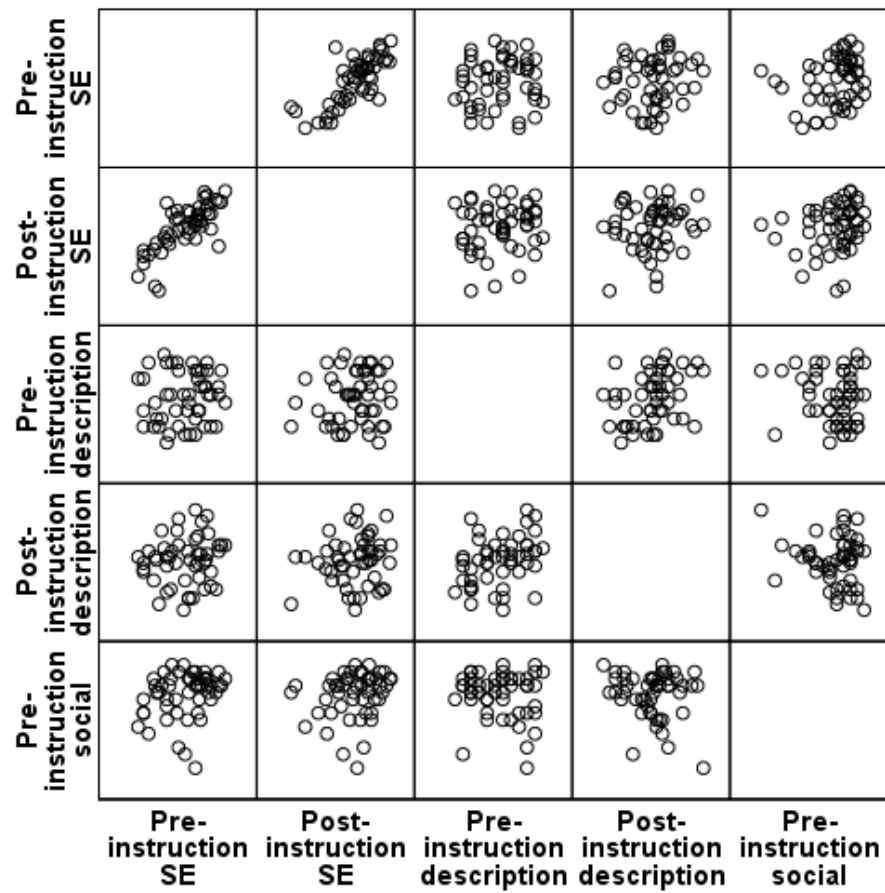
5.4.3 Correlation between self-efficacy measures and instruction

Because a significant relationship was found to exist between previous IL instruction and a participant's self-efficacy perception, correlational analyses were run between the independent variable presence of IL instruction and self-efficacy measures. The analysis found that presence of IL instruction was

positively correlated with a change in self-efficacy, and the correlation was greater than or equal to .34, p < .05. This correlation indicates that previous IL instruction helps participants feel more confident about their skill level after new ML instruction. There was no significant correlation found between presence of IL instruction and skill level. A positive correlation was found between post-instruction self-efficacy and the overall change in self-efficacy scores (r = .553, p < 0.01). This indicates that, the higher their post-instruction self-efficacy score is, the more they changed from their first test. Finally, there was a negative correlation found between pre-instruction descriptive metadata identification task and the overall change in descriptive metadata identification skill (r = -.424, p < .002). In general, results show that if you have a high level of self-efficacy prior to instruction you will have a high level of self-efficacy following instruction. Likewise, if you do well on the pre-instruction test you, will do well on the post – instruction test.   In both cases they were positively correlated, but with no significant improvement.

5.4.4 Correlation between performance and self-efficacy measures with regards to information system use

In the previous section, a significant relationship was found between the level of use of online information systems and performance level, when a single outlier case was excluded from data analysis. Correlational analyses were completed both including the outlier case and excluding it between the independent variable

"creates information online" and performance and self-efficacy measures. No

significant correlations were found between the independent variable and

performance measures with the outlier case included. When the outlier case was

excluded from testing, a positive correlation equal to or greater than .289, $p < .05$

was found between the independent variable and the post-instruction descriptive

metadata identification task. This indicates a small but positive relationship

between previous creation of information in online environments and the ability to

improve on tasks following instruction.

5.4.5 Correlation between change in self-efficacy and skill

There was no statistically significant difference found in the correlational

comparison between change in self-efficacy level and change in test scores.

5.4.6 Correlation between the pre-instruction metadata tasks

There was no statistically significant correlation found in the performance of

pre-instruction tasks. This test compared the scores between the descriptive

metadata and social metadata identification tasks.

5.5   Summary

This chapter compared the quantitative variables in the study. It included

comparison of the dependent variables, self-efficacy and performance measures,

against independent variables, including a) level of IL instruction, b) number of

years of post-secondary education, c) type of major, d) level of information system use, and e) grouped level of self-efficacy (high vs. low). The comparison found that participants who had had prior IL instruction experienced a greater positive change in self-efficacy levels following instruction than participants who had no prior IL instruction. Unfortunately, this difference was not mirrored with a significant difference in change of performance. A more granular analysis of self-efficacy instrument questions revealed that the significant difference among groups in the self-efficacy instrument was related to information tasks involving the creation of new information. It also found that there were significant differences in how participants felt about their ability to analyze and create information as compared to understanding how to access and use information.

This analysis also found a single outlier case which influenced the results of post-instruction skill analyses. This analysis found that, when the outlier case was removed, a significant difference was found between participants who create information online and those who do not with regards to the post-instruction descriptive metadata identification task. These findings suggests that students learn more about ML tasks from everyday information system use than they do from other measured sources, but may feel more confident about their abilities if they have been exposed to some level of IL instruction.

Correlational analyses were also completed between the dependent variables and independent variables, and between variables in those cases which yielded

significant results in the first portion of the chapter. Correlations were found

between the presence of IL and a positive increase in SE following instruction,

between an overall positive level of SE prior to instruction and an increase in SE

following instruction. This analysis also found a negative correlation between the

pre-instruction descriptive metadata identification task and the post-instruction

metadata identification task. This correlation was not related to any independent

variables. This finding indicates that, overall, participants did worse on the post-

instruction descriptive metadata identification task.

A correlational analysis was done between the level of use of information

systems and the metadata tasks. As in the ANOVA comparison, a significant

correlation was found between participants who create information online and

their ability to complete the post-instruction metadata task, only when the single

outlier case was removed. This correlation, when considered against the overall

negative correlation between pre and post instruction tasks, indicates that those

participants who regularly create information online were better prepared to

complete the second task.

Chapter 6   Qualitative findings

6.1   Overview

This chapter presents the results of qualitative analysis on data gathered during this study. Qualitative data was gathered alongside the quantitative data, often as a way for participants to add to or contextualize quantitative, data but was also a primary focus of the data gathered during the metadata creation task and post-study reflective questions on metadata use. Overall, there were five types of qualitative data gathered, a) participant profile data, b) participant understanding of metadata prior to instruction, c) participant assignment of metadata tags during a task, d) participant thoughts on non-academic metadata use following instruction and e) participant thoughts on academic metadata use following instruction. This chapter examines each of these sources of data.

6.2   Participant profile

It was expected that the participant profile would be rather homogenous in this study. As noted in the quantitative data chapter, all participants (n=50) were undergraduate students attending a single university. While there was no data collected on age/sex of the participants, information was collected about the type and frequency of information system use. This data found that the average participant uses social networking sites to create/add information on a daily basis

and that they rarely add information to other types of sites. Participants reported

frequently viewing information on video and music sites and to a lesser extent

image sharing sites. Most participants did not report using blogging or

bookmarking sites. Table 14 contains data on the type and frequency of use of

these systems.

The most frequently used information system types were social networking

sites, video sites and music sites. For example, 84% of participants reported

that, while they use social networking sites on a daily basis, they much less

frequently access other types of information sites. Fifty-Four percent of the

participants reported being weekly users of video viewing sites, while 28%

reported being monthly users of image sharing sites. In contrast, 84% of

participants reported never using bookmarking sites, and 68% reported never

using blogging sites.

Despite these central tendencies, there are outliers in the data. One

participant reported being a daily user of blogging sites, while 8 reported being

weekly users. Twenty three participants reported making some use of research

management programs on at least an annual basis, and twenty-nine reported

making use of scholarly content systems.

Information technology use was fairly consistent across the population. All

participants reported daily use of laptops and cell phones (calls and texting only).

38% of participants reported daily use of cell phones for some type of data

connection. This percentage is higher than the numbers reported by the Pew Internet report which found that 14% of Americans use their cell phone to access the Internet, and 8% access email (Rainie & Keeter).

6.3   Participant understanding of metadata

Prior to the self-efficacy and descriptive metadata identification exercises in the first part of the study, participants were asked if they a) could define metadata, and b) could list uses of metadata. Only six participants out of fifty said that they knew what metadata was. Of these six, five offered definitions and four listed uses of metadata. Only one participant defined metadata.

That participant defined metadata in general terms, using the textbook definition "data about data." Other participants seemed to confuse the concept of metadata with ideas of size, co-topicality or co-location of data. For instance, one participant defined metadata as "*a large number of data that is housed in one location and focuses on a specific topic.*" This definition includes these ideas which were separately reflected in other participants' definitions "*vast accumulation of data*" and "a *compilation of previously recorded data, ie metanalysis.*"

Proffered metadata uses included similar topics of helping to co-locate or accumulate data such as - "*to accumulate data into an inclusive segment, making it easier to access data.*" One participant, whose definition of metadata

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focused more on size/aggregation, suggested an appropriate use of metadata "*helps organize data, makes data easy to find,*" suggesting that they did understand the role of metadata but had a difficult time defining it. Finally, one participant felt that metadata serves as a "*learning tool.*" This idea was echoed by another participant, who viewed metadata as information derived from the meta-analysis of data and stated *"[it] serves to look at what we have already learned but in a different way so that we may learn more.*" This concept is central to elements of learning theory which assert that information organization and categorization play key roles in facilitating learning.

Overall, the responses prior to instruction indicated that very few students were familiar with the term metadata. Those who did offer definitions and uses tended to offer a set of disjointed ideas. While lack of specific metadata knowledge is not necessarily an issue, not having specific knowledge about the topic could have an impact on the participant's ability to work with metadata rich systems. The metadata interaction scores indicated that, given a specific environment and task, they could work with metadata, but, as is seen the participants' discussion of how they use metadata in academic and non-academic environments, they do not utilize it as a central part of their information systems.

6.4 Tag creation exercise

One of the post-instruction tasks was a tag assignment exercise. Participants were asked to assign five tags to a picture of the inauguration of Barack Obama. In total, 237 tags were created by the 50 participants. Forty-six participants assigned five tags, while three participants created less than five tags, and one participant skipped this exercise. The assigned tags are analyzed by structure, content and type in the following sections.

6.4.1 Tag structure and content

Participants, on average, used 1.8 words in their tags. Table 28 shows the distribution of tag lengths. The mean in this case is very close to the mode (2) of the variable. Multi-word tags tended to be constructed of words in abbreviated sentence form. A non alpha-numeric character was used in only one case; a portion of the tag was enclosed in quotes. Especially long tags tended to include connecting words such as "is," "and," and "of."

Sixteen of the 237 tags had misspelled words (6.7%). Fourteen of the sixteen misspelled words were "inauguration." Five of the 237 tags had factually incorrect information, all of which involved an incorrect date. Overall, there was consistency in the descriptive content of the tags. In order to get a sense of how participant tagging compared to real-world examples, the tags from this study

were compared against the tags for the same image in Flickr. The tags assigned

to the image in Flickr by the original image poster are contained in Table 29.

Table 28. Tag length

Tag Length (# of words)	Number of tags
0	13
1	87
2	111
3	22
4	10
5	6
6	1

Table 29. Tags assigned to the image in Flickr

Tags		
2009	inauguration	president-elect
america	jan. 20	republican
barack	january 20	u.s.
biden	michelle	united states
day	inauguration	usa
democrat	news	usa today
history	obama	vice-president
inaug09	politics	washington
inaugural	presidency	washington dc

While there were a number of terms that were included in the Flickr tag set that were not reported by participants, most of the concepts were represented. Table 30 lists the fifteen tags from the original image poster which were not represented verbatim by the study population. While many of the concepts in these tags were represented in other words, two that were not represented included "history," and "inaug09."

Table 30. Tags in Flickr but not study

Tag		
2009	usa	jan. 20
u.s.	vice-president	usa today
biden	republican	news
inaug09	day	president-elect
inaugural	barack	history

Although identical tags were not found, many of the same concepts, such as date, location, names, roles and historical context, were included. In contrast, there were 185 tags in the study population that were not represented in the Flickr tags. Of these 185 tags, 107 were unique in structure, often following different formats and spelling, but similar in content. Notable differences in the tags contributed by the study population included action-based tags like "*crowd observing*," "*wife by his side;*" multi-word tags like "*Presidential Election Result 2008*" and "*White House Administration;*" and subject tags including "*Major Events in U.S. History,*" and "*U.S. Presidents.*"

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Of the 237 tags, there were 118 unique tags entered. The tag with the

highest occurrence was "Obama" (20) followed by "inauguration" (15). If all of

the misspelled versions of the tag "inauguration" and tags which include

inauguration as a concept are counted together, there are a total of 38 which

include this concept. Only 14 participants failed to include the concept of

"Inauguration" in any of their 5 tags. Five of these participants used different

words, such as "sworn in" or "swearing." Of the 237 tags, only 15 contained

more than one concept. In each of these cases, the second concept was a

date/year indication.

These tagging habits are in line with those observed in the literature. For

example Mathes (2004) observes that tags are often created with different

browsing / searching goals than more structured organization systems. Similarly,

the data gathered in this study reflects the observations of Guy and Tonkin, who

found that many of the issues related to folksonomies such as misspellings,

ambiguous use of tagging, and inconsistent structure are common (2006).

6.4.2 Tag type

Tag contents were analyzed to determine the type of tag that the participant

assigned. This study assumes that tag type is related to the participant's

purpose in creating the tag. Tag types were initially based on the metadata types

defined in Gillian (2000). As the tags were analyzed, new categories were added

to more accurately represent tag content. Tag types of administrative,

descriptive, social, and technical are based on the definitions from the literature

review. The tag type "external meaning" refers to a tag whose content refers to a

place, person, or topic that is related to the photograph, but not contained within

it. For example, tags with content about the election, the presidency or United

States were tagged as having external meaning. The tag type "subjective

meaning" refers to tags with ideas that are either about the photograph or about

a concrete external object. For example, the tag "Major event in U.S. History"

was classified as a subjective meaning tag because it includes an interpretive

stance. Likewise, the tags "wife by his side" and "historic" are grouped under the

category subjective meaning. Table 31 contains a listing of tag categories and

the number of tags per category.

Table 31. Tag categories

Tag type	Number of tags
Administrative	2
Descriptive	187
Empty	13
External meaning	30
Social	1
Subjective meaning	15
Technical	2

For the most part, participants created descriptive tags based on image content. 75% of the tags created were descriptive tags. External and subjective meaning tags comprised the bulk of other tags, making up 6% and 12%, respectively. Table 32 lists each of the tag categories and the percent of tags related to these categories.

Table 32. Tag category percentage

Tag category	% of representative tags
Administrative	.8%
Descriptive	74.8%
External meaning	12%
Social	.4%
Subjective meaning	6%
Technical	.8%

The assignment of tags to the broad categories was assisted by two information professionals. The first professional aided in the definition of categories, and the second professional independently validated the assignment of tags to the specific categories.

6.4.3 Tag category and order of assignment

When grouped according to the first, second, third, fourth and fifth tag assigned, patterns of tag type emerge. While the first tag assigned was always descriptive of the image content, less than half of the fifth tag assigned were about image content. Table 33 lists tag categories by order of assignment.

6.4.4 Tag content type in relation to category

After grouping the tags into broad categories, sub-groups of tag content were assigned as a refinement to describe the tag contents. Group information was assigned using a "bubble-up" approach which allowed the researcher to specifically identify the type of content.

Table 34 lists each category, along with the type of content assigned for that category, and the number of tags that match the category/content mapping. As with tag grouping, information professionals were used to assist in the categorization and verification of specific content types to metadata tags.

Table 33. Tag category by order of assignment

Tag order	Tag category	Number of tags
First tag	Descriptive	49
Second tag	Descriptive	43
	External meaning	3
	Subjective meaning	2
	Social	1
Third tag	Descriptive	40
	External meaning	6
	Subjective meaning	2
	Technical	1
Fourth tag	Descriptive	33
	External meaning	10
	Subjective meaning	2
Fifth tag	Descriptive	23
	External meaning	11
	Subjective meaning	9
	Administrative	1
	Technical	1

Table 34. Tag category content

Category	Content	Number of tags
Administrative	Author	1
	Date/Time	1
Descriptive	Action	18
	Date/Time	6
	Event	44
	Group	30
	Person/Role	1
	Person Title	18
	Personal Name	54
	Place	15
	Topic	1
External Meaning	Event	2
	Fact	3
	Group	6
	Place	1
	Political perspective	1
	Related topic	13
	Topic	4
Social	Social	1
Subjective meaning	Emotional perspective	2
	Political perspective	8
	Related topic	1
	Social perspective	3
	Topic	1
Technical	Source	1
	Technical	1

As can be seen in Table 34 key areas of tag assignment included personal names, group names, events, and actions in the image. Where tags grouped under "external meaning" were used, they tended to relate to topics or concepts as opposed to specific people/objects. When tags grouped as "subjective meaning" were used, they tended to be grouped around a specific political perspective.   Tags of the "subjective meaning" type tended to describe concepts well outside the scope of the image or surrounding events. While some focused on a perspective on the significance of the occasion, other tags focused on social interpretations of the image (e.g. "wife by his side" or "verbal gaff"). One participant, in particular, used three of their five tags in this way, indicating a personal interpretation of larger political issues than were represented in the image. Many of the tag sets were documentary in nature, one person used all their tags to represent an action/perspective (e.g. "President being sworn in, ""two young daughters accompany them," and "Biden looking on.")

6.5   Student use of metadata in non-academic contexts

Forty-two of the fifty participants listed ways in which they use metadata in non-academic contexts. Five of the fifty participants did not provide a response, and three participants said that they could not think of an example.   The largest

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number of comments focused on social networking sites (n=14), with search

engines being second (n=10).

Table 35. Open-ended metadata use responses

Metadata use	Number of participants
blogging/microblogging	4
blogs	1
image sharing	1
none	10
online gaming	1
search engine	10
social networking	14
sports	2
ubiquitous	1
video sharing	6

Some students had in-depth concepts of non-academic metadata use, such

as the participant who viewed metadata as a ubiquitous concept in online

information system use.

> *Participant: Gathering information that doesn't relate to the academic setting is something that is a part of daily life now in the age of computer technology. Anything from directions to an unfamiliar location, lyrics to a song, current news updates, symptoms of suspected (sic) illnesses, etc. can be found in a*

matter of seconds. They are used to improve everyday life for everyone.

Other students listed specific uses of metadata.

Participant: Using Facebook and Myspace requires providing metadata in various ways. Metadata is utilized for commenting pictures, descriptions on profiles, and providing other useful information about the creator of the specific web link. Even when uploading documents (sic) or reading emails on your laptop or mobile device may require the use of metadata (sic).

Despite the positive view of metadata in these two comments, several students did not see a connection between metadata and non-academic information system use, indicating that the only use they could think of was for completing research for papers or observing that metadata seemed unrelated to their information system use.

6.5.1 Metadata uses

Participants reported a wide range of uses for metadata in non-academic environments. Several participants reported using generalized systems such as blogs search engines as their example of metadata use to serve very specific information needs. Finding information and resources was cited as a popular use of metadata. Some participants outlined the use of metadata to complete specific tasks such as finding new videos and videos related to a previous video.

Participant: I frequently use social metadata on youtube to see how many a views a video has, and from that I rationalize that a video either is or isn't really funny and worth watching. Then if I

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> *like the video I look to see who posted it. From that I explore A:*
> *wht (sic) other videos he was uploaded, and B: what videos he*
> *has favorited (sic), in the hopes of locating another gem.*

Similar comments discussed the use of tags in blogs to find articles and related concepts.

> *Participant: I read blogs and many of them use 'tags' to find*
> *related articles, pictures or comment threads. It's useful to click*
> *on tags to find something I'm particularly interested in.*

Another participant observed that they use metadata to find related articles after reading something of interest.

> *Participant: I frequently read article websites, mainly tutorial ones*
> *such as Wikihow.com. After reading an article I always check to*
> *see what other articles are filed under "Related wikiHows" and*
> *often chain from topic to topic.*

Participants who discussed search engine related tasks typically focused on finding and re-finding information. "*I often find sketches on google search that I like to copy. After I'm done, I like to find them again.*" Some participants noted specific goals such as finding music, information about specific individuals, and looking up brand names, while others viewed the role of metadata in search engines more generally as being relevant "*[w]henever I google anything for the purpose of gathering non-academic information.*" Some participants discussed creating metadata to forge social connections or add context to their posted images.

Three participants discussed using metadata to see statistics/performance information. In two cases, the participants referred to sport sites, but, in one, the participant commented on the use of metadata in online video games: "*Playing video games online. Seeing user tags, other gaming statistics (ie. Games played, experience).*"

6.5.2 Metadata awareness in participants

Although a number of students made the connection between uploading content to Facebook, Flicker and other sites, some did not. For example, one participant observed that they "*only use metadata for academic purposes.*" This participant, like many others, reported creating content in Facebook also adding comments to news, music and image sites. This same participant reported being a daily user of social networking sites, video sharing sites and music stores, and a weekly user of bookmarking and news sites. When asked about his academic use of metadata, this participant identified a specific type and location of metadata: "*I had to research a journal article on [the] library web page, and the journal article I found had an assortment of tags linking me to other similar articles.*"

Similarly, another participant saw metadata as unrelated to non-academic information system use, while seeing relevance for academic use "*through the use of tags it's easier to categorize and find info.*" Like the previous participant,

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this one reported creating content in Facebook and being a daily user of social networking sites and video sharing sites.

6.5.3 Facebook as a metadata rich system

Participants often reported Facebook as a key system in which they use metadata. Participant tasks in Facebook included tagging activities and photographs, assigning descriptive metadata to pictures and video. One student commented on assigning metadata onto digital objects as ""*tagging" individuals in Facebook pictures.*" Another student talked about the frequency of metadata use: "*I use Facebook on an almost daily basis to keep in touch with my friends, especially ones I don't see everyday. The use of metadata is apparent within the site, I believe. One can make photoalbums, post a link, etc.*" The theme of using metadata to assign context and create connections with other users was prevalent: "*Using Facebook and Myspace requires providing metadata in various ways. Metadata is utilized for commenting pictures, descriptions on profiles, and providing other useful information about the creator of the specific web link.*" In these cases, students had become very familiar with the process of creating metadata inside a structured system and adhering to a detailed schema without having a background in metadata or general expertise in working with structured data.

Another participant commented on their use of metadata in Facebook, but not to serve a description or connection purpose. "*Facebook is a good example of metadata. In order to navigate the website, you need to understand how to use the links and data given.*" This perspective focuses on use as opposed to creation, but hints at the idea that understanding data context and meaning is important to information system use. This is one of the base levels identified as ML in Bloom's revised taxonomy.

The idea that students readily engage in metadata tasks in order to create connections with others is an interesting facet of the impact of metadata in everyday information system use. Several students commented on how metadata creation facilitated the process of social interaction. Students independently recognized that Facebook is a metadata rich system and identified uses of metadata in that system (e.g. to create social connections, to describe events and images, to group similar objects, to effectively navigate the system, assigning tags for re-finding purposes). The use of metadata in this way has been previously researched (Wu, 2008), but with a focus on the use of descriptive metadata. In this case, participants are using metadata explicitly to create social connections (e.g. creating contextualized information with the purpose of sending messages or connecting with new people).

6.5.4 Non-academic metadata use summary

Participants tended to readily identify non-academic uses of metadata (n=42) when asked. Participant comments indicated that they use metadata for a variety of purposes, including finding/re-finding, social networking, contextualization of already found information, and documentation of personal digital objects. Likewise, they engaged in these tasks in a wide variety of systems, including social network systems, search engines, and video and image sharing systems. Comments from participants who use systems such as online gaming or sports statistics sites indicated that these participants have a grasp of metadata that is driven, in part, by the context of their system use. While anecdotal, this supports the theory presented in the literature review that casual or non-academic use of information systems can lay a foundation for sophisticated metadata use.

6.6   *Academic metadata use*

Participants were asked to reflect on their academic use of metadata. By far, the most common uses were search, typically in relation to completing a research paper, and writing a research paper. These two categories were distinguished because, in some cases, participants referred specifically to the search process and, in other cases, participants referred to the larger process of collecting, evaluating and citing resources as part of the research paper creation

process. Table 36 lists academic uses of metadata pulled from participant responses. Search was overwhelmingly the most popular use followed by research for a paper.

Table 36. Academic uses of metadata

Academic use	Number of participants
bibliographic management	2
citing resources	1
context discovery	4
evaluation	4
none	10
note taking	1
publishing	1
research paper	9
science lab	1
search	16
statistics	1

As with non-academic uses of metadata, some participants reported specific uses. One participant noted the role of metadata in helping them understand statistical information in research articles, while two others noted the role of metadata in bibliographic management systems.

Participants did not see themselves as taking an active role in metadata creation in academic contexts. Typically, participants reported using metadata to discover or help them contextualize information. One exception was the participant who viewed metadata as being key during the note-taking process in class. This was the only participant who indicated that they created metadata during an academic task. While there were slightly fewer participants overall who reported no academic use of metadata (n=7), all but one of these were simple non-responses. This is different from the responses on non-academic use of metadata which explicitly stated that metadata did not play a role in their information system use.

It is not surprising to see a more homogenous response set with regards to academic use of metadata. This study intentionally focused on a population which shares a common academic goal and background, so finding that most participants view themselves as passive consumers of metadata in academic environments is not unexpected.

The comments section did indicate that, at the end of the study, participants were successfully making the connection between everyday information system use and academic information system use, particularly with regards to metadata, but it is unclear to what extent participants have generalized this knowledge. The large percentage (n=24) of participants who said that they use metadata to

discover, contextualize or evaluate resources indicates that these participants are positioned perform research using metadata-rich research techniques.

6.7   Summary

The qualitative data portion of this research revealed that participants have specific thoughts on how they use metadata in both academic and non-academic environments. It is not surprising that metadata tasks focus more on using as opposed to creating in academic contexts and that participants view themselves as being more active metadata creators and users in non-academic contexts, given the typical academic role of this participant group.

What is unexpected is the sophistication with which some participants view their metadata use in information systems. In both academic and non-academic contexts, some participants documented ways of using metadata that indicate a firm understanding of the implications of metadata creation and an appreciation for the role that it plays in their larger information system use.

While it is not possible to draw connections between the ways participants said they used systems, their self-efficacy scores and their ability to create metadata statistically, the metadata tag assignment interaction demonstrated that participants had a rather consistent concept of tagging.   Participants with both high and low self-efficacy and performance scores had specific ideas about how to use metadata in academic and non-academic environments.

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While 74.8% of tags overall were descriptive of image content, several participants used their third, fourth and fifth tags to describe ideas, concepts and things external to the image being described. The high incidence of multi-word tags (over half had 2 or more words in each tag) is in line with the observations of Mathes (2004). It is curious that this approach is similar to pre-coordinate indexing approaches (as opposed to post-coordinate or faceted indexing approaches). With further investigation, it might be possible to understand what role these tags play in documenting how the participant thinks about the object in question and in helping to explain what descriptive tags participants are looking for in discovery systems.

Chapter 7   Discussion

7.1   Overview

This chapter discusses the results of the quantitative and qualitative analysis performed on the data gathered during the study. The first section (7.2) discusses the findings while the remaining sections of the chapter (7.3, 7.4, and 7.5) discuss implications for practice, research and theory given these findings. Section 7.3 examines implications for practice in metadata teaching and system creation. Section 7.4 examines implications for theory, with a focus on how the findings of this study change our understanding of what students know about metadata. Section 7.5 reports implications for research and discusses the utility of the methods used in this study.

7.2   Participant profile

This dissertation collected quantitative data on two dependent variables, self-efficacy and task completion competency, and qualitative data on student perceptions and use of metadata. The discussion of the data is presented here as a "participant profile" which shows the findings as they relate to the whole population.

The population studied consisted of fifty undergraduate students, over half of which were in their first or second year of post-secondary education. Many had

not yet declared a major (n=16). Distribution of subject matter expertise showed

an emphasis on business and social science disciplines (n=17), but other areas

were also represented. Participants reported a high level of ICT familiarity. All

participants used computers daily (n=50), and 49 used cell phones for voice and

texting daily. Fifty-two percent (n=26) used smart phones for Internet or email

and 94% (n=47) used some form of portable music player. Ninety-four (n=47)

percent used social networking software on a daily or weekly basis, while 84%

(n=42) used video sites on a daily or weekly basis. By comparison, only 6% of

participants (n=3) used bookmarking sites and 18% (n=9) used blogging sites on

a daily or weekly basis.

Some of these results match the results of other studies focused on

undergraduate students, notably the 2009 ECAR study (S.D. Smith, et al., 2009).

For example, both studies found similarly high levels of self-efficacy with regards

to IL. The ECAR SE score averaged between 3.43 – "fairly skilled" and 4.12

("very skilled") as compared to this study which averaged 4.8 (the high end of

"occasionally true") and 5.3 ("often true") (S.D. Smith, et al., 2009, p. 55). The

two studies diverge on topics of use of specific types of web-applications,

including the number of participants who contribute to video websites (ECAR

found 44.8% where this study found 16%), and to blogs (ECAR found 37.3%

where this study found 8%) (S.D. Smith, et al., 2009, p. 13). Finally, the ECAR

study found differences with regards to IT skill level between freshmen and

seniors and according to academic discipline (S.D. Smith, et al., 2009, p. 7).

This study did not find corresponding differences with regards to technology use or level of self-efficacy.

A broad theme found in both studies was the indication that students not only use the Internet for finding and using information, but also are active contributors to sites and creators of new information online. While the ECAR study focused on multiple themes of IT usage and the academic experience, this research focused in on the specific literacies related to metadata usage in these systems. In order to evaluate these literacies, this research measured the dependent variables prior to and following a short instructional element and asked students to reflect on their use of metadata at the end of the study. The quantitative data did not indicate significant differences among two of the five comparison groups (years of education and type of academic major), but did indicate small, but significant, differences for two groups, those participants who reported creating information online and those participants who had prior IL instruction. Students who reported creating information online showed a significant difference from other students in the metadata identification task following instruction. Students who had prior IL instruction reported a significantly greater increase in self-efficacy levels following instruction. By grouping the self-efficacy questions into the three categories of understand, analyze and create the study found that the significant change in SE ratings between students with IL instruction and those without IL instruction was on "create" level questions. Analysis of the data also

indicated a significant difference in self-efficacy levels for all participants between the three levels of understand, analyze and create.

These findings indicate that participants had a common base level of awareness of metadata. They also indicate, however, that there are some experiences, such as IL background and experience creating information online that influence participant metadata self-efficacy or ability. Unfortunately, this was not reflected across both dependent variables for a given group (e.g. increase in self-efficacy along with skill). If anything, these results indicate that current IL instruction is having little impact in student abilities with regards to metadata. This data points to the possibility that participants are obtaining metadata skills through their use of information systems in non-academic environments. This finding connects with both the socio-technical IL model and Hughes-Shapiro model which assert that literacies develop more through complex information interaction rather than through structured instruction.

In general, the study failed to find significant differences or changes in SE and task proficiency levels for participants. This may be attributable to one of a number of reasons. First, the metadata tasks were focused on basic 'understanding' level skills which proved to be too easy for participants. Given the high level of self-efficacy at the 'understand' level of participants a more complex task might show differences among participants. Second, although efforts were made to make the pre and post instruction tasks similar in difficulty,

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there were a greater number of elements to choose from in the post instruction task. Differences in scores between the two tasks were not found to be significant which indicates that although task similarity is an issue, overall task complexity is more important. Finally, the instructional videos were designed to help participants achieve an 'understand' level of metadata literacy. Given the advanced level of participants in the study the instructional videos could have focused on more complex concepts. Future research which focuses on measuring the change in ML due to instruction may be better served by using more complex or longer duration instructional methods.

The failure to find significant changes in SE levels among participants across the entire instrument appeared to be related to the high level of "understand" level literacies among participants. As the more granular analysis of SE questions showed, participants indicated a small but measurable change in SE levels for advanced 'analyze' and 'create' level literacies. Future research may benefit from using these SE measures in conjunction with more complex tasks and instructional elements to see if participant ability is in sync with confidence level.

A key finding of the self-efficacy instrument was that students had very similar levels of self-efficacy with regards to their ability to recognize and understand metadata, but had different levels of self-efficacy with regards to analyzing and creation skills. As could be expected, the greatest difference was found

between "understand" levels of self-efficacy and "create" levels of self-efficacy. This indicates that while all participants possessed a base level of literacy with regards to metadata, participants had very different levels of advanced metadata skills. While this finding was expected, it is interesting to note that this difference was connected with IL instruction, meaning that, at the very least, IL instruction provides students with the ability to more readily understand new information concepts. This finding presents an opportunity for teachers, who can leverage this base level of literacy to create more complex learning environments, and for system designers, who can incorporate more complex metadata models into systems based on participant background.

The goal of using SE and task performance measures in this study was to create a holistic profile of the participant and to better understand the gap that may exist between confidence levels and performance levels. In order for this approach to work better, the literacy (e.g. skill or conceptual understanding) being measured needs to be equally assessed in both the SE and task instruments. This dissertation focused on basic 'understand' level literacies for task evaluation. It found that participants were both rather confident and proficient with these types of tasks. While this supports the goal of this research to create a holistic profile of participants it did not succeed in identifying a task that was difficult to measure differences among participants. The findings of SE levels are in-line with other studies on IL. The positive bias that is common in SE studies indicates that combining other measures to balance out the SE measure

is appropriate. This research did attempt to do this but would have benefitted from more closely pairing self-efficacy and task instruments to ensure a more consistent result.

The qualitative analysis of tagging results and student responses on metadata use revealed two interesting trends in participant responses. First, the diversity of tag structure and usage by participants indicates that tag creation serves a wide range of purposes. For example, participants varied in their use of tag type, tag purpose and tag length. While they overwhelmingly described concrete elements of the image in the first and second tags assigned, there were also other uses of tags, including documenting some technical and administrative information, and describing content either external to the image or completely subjective in nature. Further, the prevalence of multi-word tags (n=150 out of 250) and the use of phrasing in longer tags (e.g. "wife by his side") indicated a tendency to structure tags in a way that conveyed meaning primarily to the participant.

The second trend noted in qualitative data analysis was the tendency of participants to comment on the use of metadata to serve social purposes. Not only did they tend to create information on social sites more frequently, they also identified several uses of metadata that were related to core features of social networking sites. Further, participant comments on the usage of metadata on these sites spanned the three categories of understand, analyze and create. For

example, participants commented on assigning metadata to keep in touch with friends, add descriptive data to digital objects, post links, and tag individuals in pictures. This finding suggests that students are much more engaged in social uses of metadata than resource description or advanced uses of metadata and that this familiarity can be used to help students generalize some advanced but specific, metadata skills.

This finding also suggests that participants had advanced understanding of metadata concepts even without an understanding of specific terminology. While only one participant could offer an accurate definition of metadata in the initial part of the study, forty-one participants could identify previous uses of metadata following instruction. Of these participants, several mentioned complex social uses of metadata in social software applications. The presence of metadata literacies in participants indicates an un-tapped opportunity for teachers and information system designers to create systems which capitalize on participant understanding of metadata. This finding also has implications for how instructional elements should be designed. By approaching students from a perspective with which they are familiar (e.g. social networking sites) complex ML skills and concepts can be explained with familiar examples. This would not only allow participants to build on previously held knowledge but opens new opportunities to implement higher level analyze and create strategies in instructional settings. In this research, using this approach would have enabled the creation of a more complex instructional video and advanced ML tasks.

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This participant profile shows a student body that has incorporated metadata creation and use into their everyday information system interactions. It shows a growing tendency to access these systems on multiple platforms and an ability on the part of the students to generalize advanced metadata skills when prompted. The profile also shows a confident attitude towards information and metadata literacies, although this confidence is not always reflected in actual ability. Overall, these findings are in line with other studies, although specific differences may be attributable to the limited population of this study. In order to better understand the implications on metadata theory, practice and research for this population, the following sections examine these findings with a focus on the implications for these three areas.

7.3   Implications for metadata literacy practice

7.3.1 Investigating metadata literacy through tagging

As the participant profile has shown, participants are engaging with metadata both by using and creating it. The study of ML enables an examination of this interaction by identifying and assessing participant awareness and perspectives of these metadata rich tasks. In this research, a specific metadata task known as tagging was used to examine participant competency levels within the IL framework and Bloom's revised taxonomy. This study found that students used tags in social networking sites, as suggested in other research (Sen, et al.,

2006). Tagging has also been identified as an important concept/task in digital

learning environments (Churches, 2008b), and this research found supporting

evidence that experience with tagging lays the groundwork for advanced

learning.

By understanding that previous experience with tagging can be used to

bolster learning and information system use, teachers, librarians and system

designers can design systems and instruction which take advantage of this

knowledge. In order to do this, the roles and outcomes of tagging need to be

enumerated. Sen et. al. (2006) discuss, for example, uses of tags including

personal and social contexts, self-expression, organization, finding/re-finding,

decision support and intended use. Likewise, Marlow, et. al., (2006) present a

model for a tagging system which includes resources, tags, users and

relationships. They also discuss user incentives: future retrieval, contribution

and sharing, attracting attention, self presentation, opinion expression, play and

competition (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 (metadata reflective of the user),

and task organization (metadata about how the resource will be used) (p. 204).

These perspectives on the role of tagging in an individual's information state

have been mapped onto Bloom's revised taxonomy in Table 37. In identifying

knowledge surrounding tagging, the use of Anderson and Krathwohl's chart (2002, p. 214) in Table 37 allows the analysis of different states of knowledge and the subsequent framing of learning experiences. 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, the ability 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, understanding 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 us understand learning levels of ML, breaking down the ML of tagging into a cognitive map on Bloom's revised taxonomy allows the identification of specific pedagogical approaches to and evaluative metrics for teaching this literacy.   Table 37 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.

Table 37. Cognitive map for tagging adapted from Krathwohl

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

7.3.2 Measurement of metadata literacy

This study attempted to measure ML via two means, self-efficacy scores and metadata interaction scores. It used a newly designed self-efficacy instrument based on the work of Kurbanoglu, et. al., (2006) updated to include ICT and metadata centered tasks. The self-efficacy portion of the study found that participants had an overall positive view of their self-efficacy level.   However, a comparison of self-efficacy scores against performance scores found that there was not a direct correlation between level of self-efficacy and ability to complete the metadata tasks. This may be due to a limited population size or the need to tune the task to more accurately detect student ML level. These findings do indicate that self-efficacy alone is not an adequate measure of literacy, but is a good indicator of the participant's literacy level when used in conjunction with specific evaluative tasks.

The study did find that there was a relationship between change in self-efficacy levels and prior IL instruction. This study also found that while, overall, students had a positive self-efficacy level, those who rated themselves below the mid-point on the self-efficacy scale prior to instruction rated themselves lower following instruction. This suggests that, at the very least, students who had had prior exposure to research concepts were better positioned to recognize new IL

or ML concepts and feel more confident about their abilities than their counterparts.

This research evaluated ML by focusing on the completion of a single type of task with which students were already familiar. As such, it built on the idea that categorization is commonly understood by participants but did not investigate more complex metadata tasks such re-use or structured metadata creation. By using the self-efficacy instrument in conjunction with this task, the research allowed a more complex understanding of student literacy levels than the task alone would have provided.

7.4   *Implications for metadata theory*

7.4.1 The role of metadata in supporting knowledge

The information space with which this dissertation is concerned is described in the Horizon 2009 reports as the "Personal Web" (Educause, 2009, p. 19). The Personal Web, as described by this report, is composed of aggregated and customized information that is controlled by the user interacting in community-created online environments. These types of tools add additional dynamics to the interaction between users and information, in that they require the users of these services to form a conception of the digital documents with which they are

interacting and creating. Further, because these sites are often social in nature, containing their own language, standards and conventions, it becomes increasingly important to consider what impact working in these environments has on participants. This study found that participants used the web for personal and social goals. Participant responses with regards to their use of social networking sites indicated that they used the sites as a way to encode and store information about their relationships and friendship networks. This type of usage is not explained by previously examined information seeking or literacy models which focus on resource identification and use.

The theory of the extended mind (Clark & Chalmers, 1998) asserts that humans use technology to support and extend cognition. These information seeking processes include initiation, selection, evaluation and remembering, which correspond to digital tasks such as bookmarking, tagging, recommending, reviewing, saving and collaborating. Clark and Chalmers' work on the extended mind is documented in Jacobs discussion of the role of classification in context (2001, p. 82). Jacob builds on the idea of embodied cognition in which the cognitive act is grounded in internal and external factors and incorporates Clark's system of external structures which support the extended mind. Jacob discusses this as 'cognitive scaffolding' in which "technology, knowledge structures or methodologies" provide the individual the opportunity to extend their knowledge based on interaction with the scaffolding structure. The concept of scaffolding which grew from Vygotsky's work (Jacob, 2001; Vygotsky, 1977) often employs

categorization and classifications systems to create supporting structures for the learner.   Clark and Chalmers (1998) discuss this as "situated cognition," in which the work of the mind is located not only in an individual's interior state, but also an external state which involves external environmental factors including social, political and technological factors (p. 11).

Three concepts related to the Extended Mind theory, that individuals use technology to create enduring structures embedded with social context, that scaffolding structures are used to provide cues to this context, and that the role of social influence on these structures is of primary importance in these systems, were found to be supporting theories, explaining both student familiarity with metadata and discussion of use of metadata.   This research found that students used metadata to define or create social relationships, connect with friends and discover or assign contextualizing information to digital objects. The fact that students more commonly commented on social rather than personal uses of metadata indicates how important these types of systems are to the population and the value that metadata brings to the use of these systems.

7.4.2 Metadata's role in information seeking

One of the perspectives of this research is that "information consumer," and "user" are not appropriate terms to describe people who use and create information online. This research took the stance that users are active

participants in an information environment. This perspective is supported by the theories of social constructivism (Holland, 2006; Tuominen, et al., 2003) and Extended Mind (Clark, 2001), which assert that users create and process information in conjunction with external systems to form a hybrid form/location of information.

This research found that participants readily create information in online environments to support a variety of roles. It also found that participants primarily create information online to serve social goals. It was surprising to find the large number of participants who view metadata as being integral to creating and maintaining social connections in these sites. This suggests that participants think of metadata as less a concept about resource description and more a concept surrounding relationship and community building. Further, it suggests that participants who use metadata in information systems use it for relatively sophisticated purposes. While this research did not delve into the fine points surrounding this idea by pursuing what participants did and how they thought of metadata in these systems, the results suggested that metadata understanding enabled participants to be more sophisticated information system users.

This research also found that students used metadata as a tool for sense making in information systems. Their assignment of tags in the tagging exercise extended beyond descriptive elements and included related topics, social and political perspectives, and subjective ideas. Dervin discusses how information

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systems are used to help participants bridge an information gap (Dervin, 1999). The idea that metadata serves a gap-bridging purpose in enabling participants to classify new knowledge into their information environment is seen in common metadata-informed information system tasks such as tagging.

7.4.3 Implications for metadata instruction

This research found that, at least at the base level, participants did not need instruction on the idea of metadata. It raises the question of how much instruction undergraduate students need in basic IL skills, such as searching, browsing, logic and evaluation. While many studies have found student deficiencies in these areas, these studies have also failed to evaluate ultimate success in pursuing specific information tasks.

The role of metadata as a way of helping participants acquire and preserve knowledge was initially explored in the literature review which found that metadata and information organization tasks are used to help students learn new knowledge (Shreve & Zeng, 2004; Zeng & Smith, 2003). This research found that many students readily understood how to use metadata in categorization contexts and that they could identify different types and roles of metadata without instruction. This finding suggests that ML is embedded in the ways students approach information problems. Further, it suggests that teaching participants about metadata does not need to focus on the mechanics of metadata use (e.g.

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assigning tags), but instead, can focus on best practices (e.g. understanding the role of tagging in an information system).

7.4.4 Implications for information systems

It was clear from the research that students are comfortable being active participants in online information spaces. Further, it was clear that they were also comfortable using metadata to accomplish specific information goals, such as community building, description, sense-making, searching and resource evaluation. The participant profile related these findings to the ECAR study and noted similarities and differences in the ways the two study populations used information technology. Despite the differences in these studies, both found overall positive views of participation in online information systems, a relatively high level of self-efficacy with regards to IT and IL skills, and a tendency in undergraduate students to use information systems to serve social information needs. What was not clear from the research in this dissertation is how successful and independent students could be without well structured information systems supporting their information interactions. For example, while many students referenced Facebook as supporting specific metadata tasks, none referred to system-independent structures which they had created on their own.

The tagging exercise found that students more readily engaged in pre-coordinate than post-coordinate indexing. This indicates that students view

metadata from a very personal perspective. Further, it indicates that they do not

consider constructs such as authority control or single facet topicality when

assigning tags. While not surprising, it means that information systems may

need to include additional rules or post-processing algorithms to enable users to

create and use metadata effectively.

Despite these issues, the level of student familiarity with general metadata

concepts and the enthusiasm with which they use metadata, when it serves a

socially connecting purpose, shows that information systems can make use of

complex metadata structures and concepts and that users will take advantage of

these structures when appropriately structured and presented.

7.5   Implications for research

This study found three major implications for research. First, it found that

self-efficacy can be a valuable, but not necessarily stand-alone, method for

evaluating competency. The overall high level of self-efficacy reported by the

participants has also been found in other studies which examined student self-

efficacy in relation to IL. The 2009 ECAR study, for example, found that 80% of

students surveyed were confident in their Internet search skills (S.D. Smith, et al.,

2009, p. 55).

Combining a participant's self-perception of ability with actual tasks related to

those perceptions allows the research to better understand the context within

which the participant approaches an information problem. One issue encountered was that it can be difficult to select a task which appropriately measures a skill or concept against a participant's view of their ability to accomplish it. While this dissertation did not find a significant relationship between self-efficacy and performance, it is possible that a more revealing task would have better illustrated such a relationship.

Second, this dissertation found that matching the research environment to the research question provides a window for understanding ICT competencies of participants. This study was conducted entirely online with image-informed interactions, video-based instruction, and questions on a topic that the participants did not have specific knowledge about. The high completion rate and few negative comments on study experience indicates that, overall, participants felt comfortable enough with ICT to engage in this research in a highly technical environment. Further, the efficiency of the interaction enabled the researcher to get to the population more easily and allowed a streamlined data collection procedure.

Third, this study would have benefitted from enrolling additional subjects with regards to forming larger groups for comparison. Although fifty participants provided adequate base-line qualitative and quantitative data, once the study began comparing participants based on self-selected categories the number of participants in each group became much smaller (Between 15-25 participants).

As suggested in the methodology, this study would benefit from enrolling enough students to ensure large groups for comparison and adequate power for statistical tests. It is possible that the small differences detected among groups are the primary issue and that additional participants would not help to show significant differences.   Future studies would benefit from creating instruments which show greater differences among participants.

While post-hoc power analyses were considered to assess the statistical power of the instruments, the results of this study indicated that the instruments needed to be refined to detect a greater difference among subjects. Significance findings indicated that while the tests showed difference in some cases, those differences were often very small.   At the very least, the instruments should be improved to show a greater difference among participants.

Finally, this study found that conducting research on metadata using a literacy framework reveals information about participant perspective and system use. While this data could have been gathered from other approaches, including use surveys, observation, or analysis of large data sets, using an observe/instruct/reflect research stance allowed the participants to engage in the research from their own perspective, first, and discuss their thoughts in relation to the researcher's perspective second. The resulting qualitative data that was gathered during the reflection portion of the research proved to be as revealing

as the quantitative data regarding student achievement and understanding of

core metadata concepts.

Chapter 8   Conclusion

8.1   Overview

This dissertation investigated the use of metadata in digital information environments by undergraduate students. It used an interdisciplinary approach to identify measures of metadata ability and to understand the role of metadata in common information environments. The study used, as a foundation, the qualitative studies conducted by the researcher and the research community to identify areas in which metadata is commonly used by the participant population and employed a mixed-methods approach in order to construct a holistic profile of participant awareness and use of metadata. The intent of the research was to better understand metadata awareness and use by the study population. By identifying these literacies (e.g. awareness and use), this study contributed to the research being conducted in education, information science and library science by better defining the role of metadata in information systems   This conclusion summarizes the research methods, questions and findings, discusses study limitations and proposes future research.

8.2   Research methods

This study employed a mixed-methods approach to examine undergraduate student use of metadata. Using a constructivist worldview to create a holistic

view of student use of metadata, the study gathered multiple forms of data including survey, instructional, experimental and observational elements. Data on participant information system use, self-efficacy level and task ability was gathered via survey and experimental elements. Qualitative data about student definition and use of metadata in academic and non-academic environments was gathered during an initial survey and post-instruction reflective questions. Responses were grouped for the purpose of comparative analysis based on survey data and included level of education, awareness of IL concepts, and type and extent of use of digital information systems. Quantitative data was analyzed to detect differences among these groups for the measures of task proficiency and self-efficacy. Qualitative data was analyzed to identify student attitudes towards and use of metadata in academic and non-academic environments. As a whole, study data was analyzed with the goal of creating a profile of student awareness of and proficiency with metadata.

8.3   Research findings

This dissertation asked three key questions: a) how familiar are participants with the concept of metadata, b) what impact would a short instructional element have on levels of ML, and c) how do participants use metadata in their own academic and non-academic environments. The answers were synthesized to form a profile of participant use of metadata in information systems. The following section summarizes the findings for each of these three questions.

8.3.1 Initial view of metadata

The study first sought to understand student familiarity with the concept of metadata. The study examined this question through the use of a participant profile survey and initial assessment of ML using a metadata identification task and metadata self-efficacy instrument. The initial survey of student use of metadata found that, while they did not have a specific understanding of metadata they were proficient in using metadata rich systems. Participant responses indicated a high level of self-efficacy with regards to metadata use (5.49 out of 7 average score) and performed reasonably well on metadata identification tasks (61% average correct for descriptive metadata identification task). The survey of information system use findings were in line with findings of other device and Internet use studies (Rainie & Keeter, 2006; S.D. Smith, et al., 2009).

The initial survey found that, while a majority of the participants used social networking software, very few participants created information on individual platforms such as bookmarking systems (n=1) or blogs (n=4). Further, there was only one participant who correctly defined metadata prior to instruction. The initial participant profile also found that, while participants had a common base level of self-efficacy with regards to metadata, they had varying levels of higher-level ML (e.g. analyze and create). The research found that participants scored reasonably well on metadata identification and assignment tasks. Further, when

asked to reflect on their use of metadata, they discussed using tagging in different ways and for different purposes. These findings suggest that at least these metadata tasks are readily familiar to undergraduate students and can be used as a supporting technique for learning other skills. This idea coincides with the theories of Rosch (1978) whose research indicates that categorization is a key part of individual and social cognitive structures.

8.3.2 Instruction and change in literacy

The study sought to find out what impact a short instructional piece on metadata would have on participant metadata ability. The study found that the instruction had little impact on either self-efficacy levels or task completion ability. There were three exceptions to this finding. First, the study found that participants who had prior experience creating information in digital environments did better on the metadata identification task following instruction than other participants. Second, the study found that students who had prior IL instruction had higher levels of self-efficacy following instruction than their counterparts. Third, significant differences were found between participants across different levels of ML.   This difference is seen in Table 25 which shows significant differences for three levels of ML (understand, analyze, and create) in the pre and post instruction scores. These comparisons show that participants experienced a small significant change in confidence across all groups following instruction for advanced literacy levels. These differences included an increase

of 5% for the analyze and create levels.   By breaking the self-efficacy questions down into their respective taxonomy levels of understand, analyze, and create this study found that there was only significant difference with non-IL instruction participants in the increase in confidence to create metadata ($F = 6.755$, $p < .012$).

The study did find that, overall, participants had a good base level of ML as evidenced by their ability to complete the basic tasks outlined in Table 37.   The lack of significant differences for most groups of comparison when considered with the overall high level of success with the metadata identification task, indicates three things. First, the data indicates that undergraduate students feel confident using metadata in online information systems, but may not feel as confident analyzing or creating new information in these environments. Second, the data suggests that use of information technology and metadata rich information systems positions participants to be more effective users and creators of metadata. Finally, the findings indicate that, while IL has a positive impact on self-efficacy, relevant metadata skills are more likely to be learned through everyday information system use than through current IL instruction approaches.

8.3.3 Overall use of metadata

The research sought to understand how participants use metadata in their own academic and non-academic environments. By having participants create their own metadata and reflect on how they use metadata in information systems, this study revealed that, while participants created metadata using a number of different approaches, their methods were in line with the approaches outlined in other studies (Guy & Tonkin, 2006; Macgregor & McCulloch, 2006). One key finding in this area is that students recognize and use metadata to support specific social networking goals, such as connecting with others and identifying digital objects for use by others. This support the idea that participants value metadata as an element of both their academic and non-academic use of information and that metadata serves a role in these systems for the participants.

The research found that participants had a surprisingly complex general understanding of what metadata is and how it is used, but did not have specific knowledge about metadata as a phenomenon. Once students were given definitions and examples of metadata, they were able to talk about their use of metadata for social networking and object identification purposes.   No significant differences in performance among groups of students with regards to number of years of education, academic major or level of IL instruction were found. The lack of significant difference in achievement among groups indicates that these skills are not necessarily related to discipline focus, are not a part of the

advanced learning that happens in a post-secondary educational environment, and are not related to IL instruction. This finding supports the theories of Tuominen, Talja and Savolainen (2003), who observe that IL skills are better understood in a social and technical context as opposed to traditional academic contexts. The implications are that participants may be gaining greater IL and ML skills through everyday information use than they are in traditional learning environments. While this does not necessarily mean that IL and ML instruction is irrelevant, it suggests that students are prepared to think about these concepts at a higher level or from a different perspective.   The findings of this research also suggest that metadata is positioned to be a valuable scaffolding tool in learning. By incorporating metadata and information organization techniques in information environments, system designers and teachers can create systems which position the users to become more sophisticated users of the system.

8.4   Limitations

While this study was designed to identify the role of ML and its impact on participants, it had to do so in a limited environment. The study focused on participants engaged in the academic process and familiar with electronic documents. This allowed the research to proceed without having to question the basic literacy knowledge of participants, but may have limited the generalizability of findings. A second limitation with this research was that it used tasks limited in scope to investigate abilities of the participants. In relying on participant self-

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rating of their literacy level and tasks focused on a single type of literacy, it did not address complex types of ML. Further, in researching a concept with which the participants had little knowledge, it faced the challenge of gathering data from participants without influencing participant responses.

While the research was successful in adding understanding to the field of metadata research, its findings were not conclusive with regards to student engagement with metadata. For example, while this dissertation offers two initial measures of ML, measures which could be extrapolated to other forms of literacy, it does not result in the development of a complete understanding of metadata literacy. Perhaps, by expanding the tasks required, an instrument could give a more complete picture of a participant's ML level. While the self-efficacy instrument's design was based on previous successful instruments and found results similar in scope to other current studies, it was not tested for reliability, nor was enough data gathered during the study to complete such a test.

Further, while the metadata tasks were designed to be related to specific elements of the instruction and self-efficacy instrument, student performance on the tasks did not improve following instruction. This suggests either that the tasks were too different to allow direct comparison or that they measured such a basic level of literacy that the instruction did not add to the basic ability to complete the tasks.   This study focused on a very specific population in a single

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university environment. In order to be able to make generalize these results outside of this population, different types of participants would have to be recruited. While this study focused on undergraduate students, this research could prove to be relevant for other classes of academics and general information users as well.

Despite these limitations, the research found that participants had at least a general, if not a specific, understanding of metadata prior to instruction. Further, it found that, following instruction, most participants were able to think generally about their use of metadata in other systems. This indicates that participants do know what metadata is and have some ML skills even if they do not think specifically about them.

8.5   Contributions and next steps

This research contributed to the field of metadata and IL research in two ways. First, it created a framework by which specific literacy elements can be evaluated and taught. This framework is represented in Table 9 and examines relationships between elements of instruction, information theory and IL.   This framework can be used in conjunction with Bloom's revised taxonomy to operationalize the instruction on specific IL elements. This study mapped the task of tagging on to Bloom's revised taxonomy as a demonstration of this in Table 37. Second, this research found that undergraduate students possess

both a basic level of ML and an overall high level of self-efficacy with regards to metadata use. In doing this, it validated other research on users of digital information environments and helped define a beginning point from which the role of metadata in information system use can be researched.

In order to build on this research, further investigation should be done on the role that learning theory and information organization theory play in the use of information systems. This study is not alone in wondering what impact the changing nature of information and information systems is having on users, but is unique in that it looks more at users understanding and use of metadata as opposed to their use of technology or specific information systems.

This research also found that practical changes can be made to instruction regarding the use of metadata-rich information systems in learning environments. For example, this research found that participants had general background knowledge of complex metadata concepts and could think reflectively about their use of metadata, once they were given instruction on what metadata is. This indicates that instruction can move quickly past the basics of information organization and metadata use in information systems and begin to allow students to use metadata and information organization techniques as learning tools.

The lack of relationship between participant self-efficacy level and performance on metadata tasks suggests that a positive self-perception

overrides actual performance level. In other words, participants may not "know what they don't know." Further research is required to understand the extent to which this is true, but the lack of correlation between self-efficacy and task performance measures and between pre and post instruction measures indicates that the two elements are not necessarily connected.

Finally, this research contributes to the growing interdisciplinary nature of information science research by examining the related fields of information science, library science and education with regards to metadata. While combining theories and research from these fields required the identification of similar concepts from different disciplines it allowed the examination of the value of metadata from a more holistic perspective.

Appendix A.   Study instrument

1. How many years have you been enrolled in college?

    a. 1, 2, 3, 4,5

2. What is your academic major?

    a. Answers pulled from university catalog, optional/dual majors given text
       box to respond

3. Have you ever taken any of the following classes or instructional sessions?
   (check all that apply)

    a. Library tours, single-session library instruction, multi-session library
       instruction, semester-long course on IL (e.g. Lib100), other, none of
       the above

4. Information system use. Select all the ways you use the following types of
   web applications. (check all that apply)

Information system use					
	Don't use	View content	Link to content on site	Add comments	Create new content
Social networking sites (e.g. Facebook, Myspace)					
Video sites (e.g. YouTube)					
Image/Picture sites (e.g. Flickr, Picasa)					
Bookmarking sites (e.g. Del.icio.us, Digg)					
Blogging sites (e.g. Twitter, personal blogs)					

Music stores (Itunes, Pandora, Rhapsody)					
Bibliographic/Citation managers (Zotero, Endnote)					
Scholarly Journal Article Review/Comment Systems (Connotea, Faculty of 1000, Publishers Journal sites, etc)					
Online News sites (New York Times, Huffington Post)					

     a. Are there ways in which you use systems which are not covered above? (indicate system and use)

5. Information system use: Rate the extent of your use of the following web-site functions: (check all that apply)

Information system use frequency					
	Never	Annual	Monthly	Weekly	Daily
Social networking sites (e.g. Facebook, MySpace)					
Video sites (e.g. YouTube)					
Image/Picture sites (e.g. Flickr, Picasa)					
Bookmarking sites (e.g. Del.icio.us, Digg)					
Blogging sites (e.g. Twitter, personal blogs)					
Music stores (Itunes,					

Pandora, Rhapsody)	
Bibliographic/Citation managers (Zotero, Endnote)	
Scholarly Journal Article Review/Comment Systems (Connotea, Faculty of 1000, Publishers Journal sites, etc)	
Online News sites (New York Times, Huffington Post)	

        a. Are there other information systems that you use regularly? (indicate system and frequency of use)

6. Information device use. Rate the extent to which you use the following devices (check all that apply)

Information device use frequency					
	Never	Annual	Monthly	Weekly	Daily
Laptop or desktop computer					
Cellular Phone - calls and texting only					
Cellular Phone - Internet or email use					
Portable music player (e.g. IPod or MP3 player)					
Gaming					

consoles (e.g. Wii)	
Automobile GPS device	
Ultra-portable computer (e.g. netbook or tablet pc)	

     a. Are there other information devices that you use regularly? (indicate device and frequency)

7. Are you familiar with the concept of metadata? (Participants do not see sub-questions if response is no)

     a. If you know what metadata means, please define it in your own words, otherwise leave this space blank

     b. In your opinion, what purposes does metadata serve?

8. Information use familiarity: In this part of the survey, please indicate your level of confidence in completing the following tasks. For each element, rate your level of comfort from "Almost never true" to "Almost always true." I feel capable in my abilities to:

Information Literacy Element	1 2 3 4 5 6 7
Find elements in a document (i.e. title, author, subject) that help answer your information need	
Select electronic documents to meet an information need	
Define the type and source of information needed	
Reference or cite electronic documents via links or citations (e.g. bookmarking, linking)	
Use the same document on different devices (e.g. computer, mobile device, phone, paper)	

Identify the creator(s) of a document (e.g. user-contributed, author-created)

Identify an appropriate website, search engine or database to meet an information need

Determine the purpose of elements of a document (such as user comments, descriptive tags, system tags)

Export data from a document to use in different software or applications (e.g. saving a citation into Endnote or RefWorks, using RSS feeds on profile page)

Interpret the structure of an electronic document (i.e. identify navigation, text, contextual elements)

Add tags, comments or other contextual information to a site (e.g. bookmarks, tagging, annotating)

Create records for different kinds of materials (i.e. books, articles, web pages) in a bibliographic management application (e.g. Zotero, EndNote, Refworks)

Evaluate the quality of content on a website

Use electronic systems to enhance your learning and memory (e.g. online diary, digital notebooks)

Synthesize newly gathered information with previous information

Create documents that use links, tags, or other types of contextual information

Create an electronic document using a specific format (e.g. a Podcast, RSS feed, or webpage)
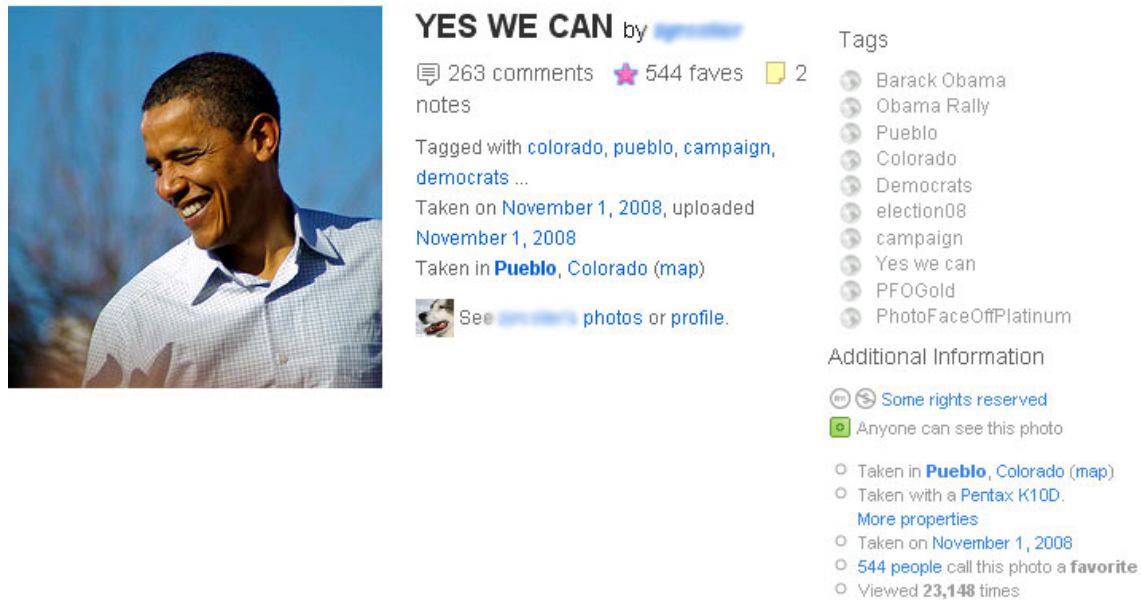
1 = Almost never true, 2 = Usually not true, 3 = Infrequently true, 4 = Occasionally true, 5 = Often true, 6 = Usually true, 7 = Almost always true

9. Tagging Exercise.   Seventeen second video showing how to select and deselect elements on the next two interactions.
http://content.screencast.com/users/mitcheet/folders/Default/media/81728dbb-fe1a-44fb-b654-ab94b95da884. In the screen-capture below, select all of the elements of the page that describe the image content. You can select an

area by clicking on it once. You can unselect it by clicking on it a second time.   Please note that you can make multiple selections

10. In the screen-capture below, select all of the elements that show who is using this image and how they are using it. You can select an area by clicking on it once. You can unselect it by clicking on it a second time. Please note that you can make multiple selections
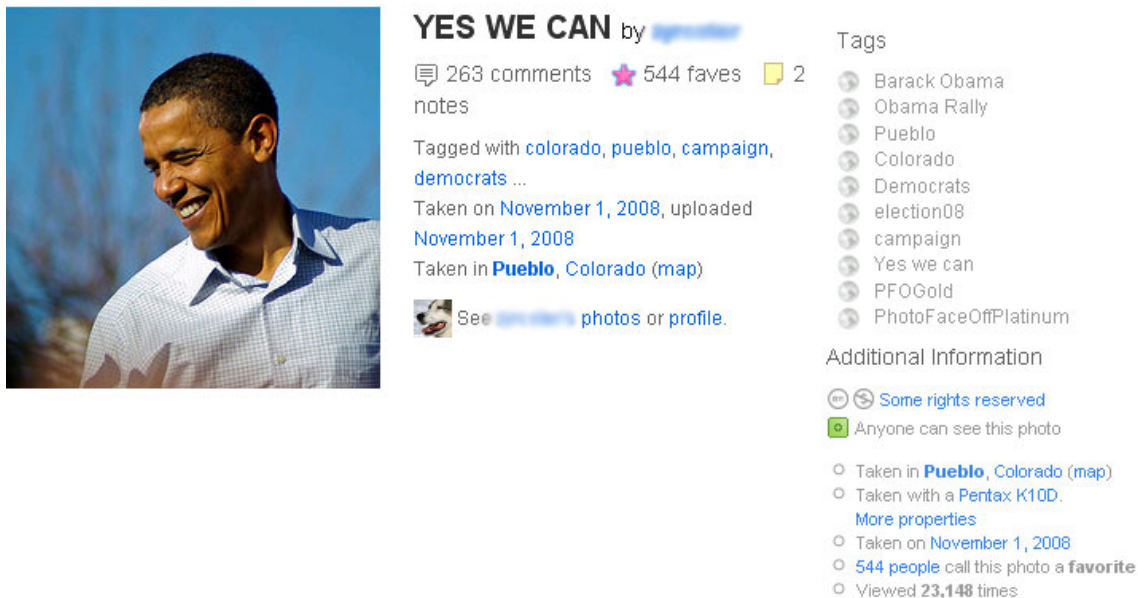
11. Metadata instruction. In this portion of the study you will view a short video about electronic documents that investigates the idea of metadata. The video is 4:33 long. Click the center of the video to start it. Once this video is complete, press the continue button at the bottom right hand corner of the page. If the video does not load, use this link The Machine is Us/ing us and then close the pop-up window to resume the study. (http://www.youtube.com/v/NLlGopyXT_g&hl=en&fs=1&)

12. Let's view another video. This one explains the different types of metadata. Please enable your audio system to listen to this video. Once you have viewed the video, proceed to the next screen. If the video fails to load follow this link Metadata instruction. Close the new window when done to continue with the study. http://content.screencast.com/users/mitcheet/folders/Default/media/83cde7cc-e559-437e-8e67-30d715356b75/bootstrap.swf

13. Tagging exercise. In the screen-capture below, select all of the elements that describe the site content. You can select an area by clicking on it once.

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You can unselect it by clicking on it a second time.   Please note that you can make multiple selections.

14. Description exercise. Here is another exercise. Look at the image below. Please write up to five metadata tags. Write one tag per text box.

15. Can you relate an experience that includes non-academic use of metadata? For example is there something that you do on a regular basis that relies on metadata?

16. Can you relate an experience about your academic use of metadata?

17. Please feel free to share any comments or questions about the survey, videos or tagging exercises

18. Would you be willing to be contacted to discuss your participation in this study?

19. Thank you for completing this study. If you would like to receive $15 for participating in this study, please enter your email address below.

Appendix B.   Self-efficacy instrument

Table 38. Mapping of self-efficacy questions onto Bloom's taxonomy

Category of Bloom's Taxonomy	Self-efficacy element
Understand	Find elements in a document (i.e. title, author, subject) that helps answer your information need
Understand	Select electronic documents to meet an information need
Understand	Define the type and source of information needed
Understand	Reference or cite electronic documents via links or citations (e.g. bookmarking, linking)
Understand	Use the same document on different devices (e.g. computer, mobile device, phone)
Understand	Identify the creator(s) of a document (e.g. user-contributed, author-created)
Understand	Determine the purpose of elements of a document (such as user comments, descriptive tags, system tags)
Analyze	Interpret the structure of an electronic document (i.e. identify navigation, text, contextual elements)
Analyze	Identify an appropriate website, search engine, or database to meet an information need
Analyze	Evaluate the quality of content on a website
Analyze	Use electronic systems to enhance your learning and memory (e.g. online diary, digital notebooks)
Create	Add tags, comments, or other contextual information to a site (e.g. bookmarks, tagging, annotating)
Create	Create records for different kinds of materials (i.e. books, articles, web pages) in a bibliographic management application (e.g. Zotero, EndNote, Refworks)

Create	Export data from a document to use in different software or applications (e.g. saving a citation into Endnote or RefWorks, using RSS feeds on your profile page)
Create	Synthesize newly gathered information with previous information
Create	Create documents that use links, tags, or other types of contextual information
Create	Create an electronic document using a specific format (e.g. a Podcast, RSS feed, or webpage)

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