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Determining the Extent to Which Information Literacy Online Learning Objects Follow Best Practices for Teaching and Assessing Critical Thinking

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DETERMINING THE EXTENT TO WHICH INFORMATION LITERACY ONLINE

LEARNING OBJECTS FOLLOW BEST PRACTICES FOR TEACHING AND

ASSESSING CRITICAL THINKING

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ABSTRACT

Critical thinking is widely accepted as a primary goal of higher education. The skills and dispositions of critical thinking have much in common with those of information literacy, and instruction librarians could improve their information literacy instruction by integrating critical thinking. However, it is not currently clear to what extent instruction librarians encourage critical thinking in their teaching. Moreover, rather than credit-bearing courses, much of library instruction currently consists of either "one-shot" (single class period) sessions or online learning objects which students complete asynchronously. This study focuses on online learning objects, which are often created with great effort, have long-lasting value, and may serve as a substitute for classroom learning for distance students.

This study attempts to determine the ways and extent to which online information literacy learning objects follow best practices for teaching and assessing critical thinking. To accomplish this, the researcher examined a sample of information literacy online learning objects archived in the Academic and Research Library Association's (ACRL's) repository of peer-reviewed information literacy online instruction materials, PRIMO (Peer-Reviewed Instructional Materials Online). A representative sample of PRIMO online learning objects from the five years preceding this study was assessed against a

rubric of best practices for teaching and assessing critical thinking in online information literacy learning objects. The rubric was developed based on a thorough literature review.

The resulting analysis provides evidence of the extent to which information literacy online learning objects adhere to best practices for teaching and assessing critical thinking. While not all critical thinking instructional and assessment strategies were well-suited to asynchronous online learning object platforms, some strategies were used creatively and effectively in online learning objects from the sample. Some online learning objects incorporated critical thinking strategies especially successfully, showing that such incorporation is possible and providing examples of how critical thinking can be integrated into information literacy online learning objects.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

Arum and Roksa's (2011) book, *Academically Adrift: Limited Learning on College Campuses,* described a study which had disturbing implications for higher education institutions. They found that 45% of college students had made no significant improvement in their critical thinking skills within the first two years of college, and the percentage only dropped to 36% for students with four years of college (2011). Many would agree that critical thinking should be an essential outcome of a college education. However, even after spending years in classes which purport to teach students how to become better thinkers, many students are graduating with limited critical thinking skills.

The fact that students often graduate without gaining critical thinking skills has been corroborated by employers who hire recent graduates. A 2006 report made by a collection of United States organizations found that employers rate "critical thinking" as the most highly desired skill of recent graduates (Casner-Lotto & Barrington). At the same time, over 90% of the surveyed employers found college graduates to be "deficient" in critical thinking skills (Casner-Lotto & Barrington, 2006). While the importance of

critical thinking is very infrequently disputed, the evidence suggests that it is inadequately addressed in most college curricula.

While critical thinking theory and instruction have been a subject of study for decades (Abrami, et al., 2015; Davies & Barnett, 2015; Ennis, 1993; Norris, 1985), the emergence of information literacy instruction is more recent. Furthermore, academic librarians may have a significant role to play in helping to reinforce and/or introduce the critical thinking skills of college graduates. For the purposes of this study, critical thinking is defined as reason- and evidence-based skepticism that habitually challenges both internally- and externally-generated ideas as a means to guide decision-making, problem-solving, and action (an in-depth discussion of critical thinking's definition can be found in section 2.1). It is currently not clear to what extent instruction librarians encourage critical thinking in their teaching, but the Framework for Information Literacy for Higher Education, which was adopted by the Association of College and Research Libraries (ACRL) in 2015, places a much stronger emphasis on higher-order thinking skills than the superseded Standards for Information Literacy in Higher Education. The face-to-face classroom sessions, reference interactions, and online learning objects facilitated by instruction librarians frequently explore skills which bear a close resemblance to critical thinking, including the evaluation and analysis of information and its effective communication. However, the relationship between critical thinking and information literacy has been only minimally explored in the literature.

Students are increasingly pursuing their higher education online (Stedman & Adams, 2014). To reach this growing online student population, librarians have been creating and using online information literacy tutorials to promote information literacy

skills (McClennan, 2016). However, online instruction presents its own challenges to instructors who wish to effectively teach and assess critical thinking. Much of library instruction currently consists of either "one-shot" (single class period) sessions or online learning objects that students complete asynchronously, rather than credit-bearing courses. While measuring the critical thinking solicited in one-shot sessions is challenging due to logistical constraints, online learning objects seem more tractable for study and, potentially, could reap distinct rewards. Online learning objects are often created with great effort, have long-lasting value, and may serve as a substitute for classroom learning for distance students (McClennan, 2016). For all of these reasons, online information literacy learning objects have the potential to play a key role in promoting critical thinking.

1.1 Purpose and Objectives

The purpose of this study is to answer the following question: *In what ways and to what extent do online information literacy learning objects follow best practices for teaching and assessing critical thinking in higher education?* This question resulted in the following study objectives:

- Define critical thinking and its relationship to information literacy
- Guided by the literature, develop a set of best practices for teaching critical thinking in information literacy online learning objects
- Use these best practices to create a rubric against which the quality of online information literacy tutorials may be judged and compared
- Explore the extent to which online information literacy tutorials promote various critical thinking skills and dispositions using the aforementioned rubric

3

1.2 Definition of Terms

Authority – "a type of influence recognized or exerted within a community" (Association of College & Research Libraries, 2016)

Bloom's taxonomy - a model which organizes learning objectives into a hierarchy of complexity, with less cognitively-taxing objectives at the bottom (such as remembering) and more cognitively-taxing objectives at the top (such as evaluating) (Bloom, 1971).

Critical pedagogy - "the use of higher education to overcome and unlearn the social conditions that restrict and limit human freedom" (Davies & Barnett, 2015, p. 18)

Critical thinking - reason- and evidence-based skepticism that habitually challenges both internally- and externally-generated ideas as a means to guide decision-making, problem-solving, and action

Disposition - "a person's habitual ways of acting" (Facione, 2000, p. 63)

Ill-structured problems - problems which "cannot be described with a high degree of completeness; cannot be solved with a high degree of certainty; experts often disagree about the best solution, even when the problem can be considered solved" (King & Kitchener, 2004, p. 11)

Information literacy – "the set of integrated abilities encompassing the reflective discovery of information, the understanding of how information is produced and valued, and the use of information in creating new knowledge and participating ethically in communities of learning" (Association of College & Research Libraries, 2016).

Metacognition – thinking about one's thinking

Online learning object - a modular unit of interactive content designed to teach one to two learning objectives and that is accessible online

Online tutorial - a self-directed, online module of teaching content that can be accessed at the point-of-need

Threshold concepts - "those ideas in any discipline that are passageways or portals to enlarged understanding or ways of thinking and practicing within that discipline" (Association of College & Research Libraries, 2016)

1.3 Problem Statement

Librarians have long promoted the critical evaluation of information as an aspect of information literacy (Bodi, 1988; Gibson, 1995; McClellan, 2016). While it has not often been explicitly acknowledged, critical thinking skills are an important part of critically evaluating information (Halpern, 1999). As people are barraged with more and more information, much of it misinformation, educators realize the importance of critical thinking for everyday information searching and evaluating. While critical thinking teaching strategies could be relevant tools for librarians attempting to teach information literacy, there is little evidence that these strategies are being deliberately employed by librarians to improve instruction. This problem is compounded in the online environment (where a significant amount of library instruction is conducted), because students may need more guidance and encouragement to employ critical thinking skills (Mandernach, 2006). For these reasons, a study that explores how critical thinking teaching and assessment strategies could be used to improve library instruction may help to address the need for students to know how to identify and evaluate misinformation they encounter.

CHAPTER II

LITERATURE REVIEW

2.1 Defining Critical Thinking

There would seem to be a general consensus in the literature that critical thinking is an essential outcome of higher education. However, interpretations of what "critical thinking" means have varied significantly since the term's introduction in the 1960s. Defining the term has historically been difficult, in part because, as a higher education buzzword, it is often confused with concepts like "problem solving," "higher order thinking," and "reasoning" (Lewis & Smith, 1993), and sometimes is used to simply mean "thinking." Faculty may contribute to this confusion by claiming that their academic teaching strategies include critical thinking in order to leverage the acclaim associated with the term (Halonen, 1995). When a large sample of California faculty across 57 colleges and universities were surveyed, a high percentage of them (89%) claimed that critical thinking was a primary goal of their instruction, but relatively few faculty (19%) could adequately define critical thinking (Paul, Elder, & Bartell, 1997).

In 1990, the American Philosophical Association (APA) facilitated a Delphi study which attempted to define critical thinking and its component skills and dispositions. The

study defined critical thinking as "purposeful, self-regulatory judgement which results in interpretation, evaluation, and inference, as well as explanation of the evidential, conceptual, methodological, criteriological, or contextual considerations upon which that judgment is based" (Facione, 1990b, p. 3). This panel of critical thinking experts also defined the characteristics of a critical thinker as:

> habitually inquisitive, well-informed, trustful of reason, open-minded, flexible, fair-minded in evaluation, honest in facing personal biases, prudent in making judgments, willing to reconsider, clear about issues, orderly in complex matters, diligent in seeking relevant information, reasonable in the selection of criteria, focused in inquiry, and persistent in seeking results which are as precise as the subject and the circumstances of inquiry permit. (Facione, 1990b, p. 3)

This definition has served as the basis for many studies since its publication (Abrami, et al., 2014; Facione, 2000; King & Kitchener, 1994; Lai, 2011).

However, the APA definition has also been criticized by some for its excessive breadth and verbosity. The definition of critical thinking has been narrowed by several prominent critical thinking scholars who have since offered their own definitions. Richard Paul and Linda Elder, founders of the Foundation for Critical Thinking, defined critical thinking as "the art of analyzing and evaluating thinking with a view to improving it" (Paul & Elder, 2001). Peter Facione, a contributor to the California Critical Thinking Assessment, defined critical thinking as "judging in a reflective way what to do or what to believe" (Facione, 2000). McPeck, a philosopher and critical thinking scholar, defined critical thinking as "the propensity and skill to engage in an activity with reflective skepticism" (McPeck, 1984).

Perhaps the most well-cited definition comes from Robert Ennis: "Critical thinking is reflective and reasonable thinking that is focused on deciding what to believe

or do" (Ennis, 1985). Ennis' definition captures the dual nature of the critical thinking definitions mentioned above. Most of these definitions include 1) the use of rational criteria to judge the thoughts and ideas of others, and 2) the subjection of one's own thoughts to judgment by way of strong metacognitive and self-reflection skills. Therefore, critical thinking (these scholars seem to posit) should result in careful, reasoned skepticism of external ideas on the one hand, and open-minded self-examination of one's own thinking on the other. The skills and dispositions that result from these habits of mind are not enough in themselves to be considered critical thinking; they must follow from a purpose and result in problem-solving or decision-making by the critical thinker.

Recent scholarship in the area of critical thinking has begun to expand the traditional definition of critical thinking to include aspects of critical theory or critical pedagogy. Critical pedagogy as defined by Davies and Barnett is "the use of higher education to overcome and unlearn the social conditions that restrict and limit human freedom" (2015, p. 18). Unlike traditional scholars of critical thinking, critical pedagogy scholars think critical thinking should involve action (not just skills and dispositions) performed by institutions and society more broadly (not just individuals). Rather than taking the "critical" in critical thinking to mean "criticism," critical pedagogues interpret it to mean "critique" (Davies & Barnett, 2015, p. 19). These newcomers to the study of critical thinking advocate for education that does more than build the critical spirit of individuals; it should, instead, educate for large-scale transformation of the ideological hegemony of capitalism. Critical pedagogy posits that students, through critical thinking instruction, should be made aware of their own indoctrination and given the tools to

combat it and, therefore, free their thoughts. Some critical thinking scholars, however, disagree with this stance and the prejudgment of an inequitable society it makes, arguing that the critical pedagogy stance itself could be considered indoctrination (Davies & Barnett, 2015). While unresolved, the debate about the relationship of critical pedagogy and critical thinking provides productive insights into the potential role of critical thinking education in our societies.

In keeping with the general tendency by scholars to define critical thinking as consisting of the elements of criticism and self-regulation (Ennis, 1985; Facione, 2000; Paul & Elder, 2001), in this study I define critical thinking as "reason- and evidence-based skepticism that habitually challenges both internally- and externally-generated ideas as a means to guide decision-making, problem-solving, and action." This definition relies on metacognition, openmindedness, and the use and analysis of evidence in taking action.

2.1.1 Disciplinary perspectives on critical thinking. Ideas and scholarship about critical thinking come mostly from the fields of philosophy and psychology, two fields that reflect the sometimes conflicting realms of humanities (philosophy) and science (psychology). Recent philosophers such as Richard Paul, Robert Ennis, Peter Facione, Gerald Nosich, and John McPeck have further developed the model of an ideal thinker. While philosophers have historically focused on the characteristics of a good thinker under the best circumstances, psychologists instead tend to focus on the observable behaviors of human thinkers (Sternberg, 1986). This dichotomy is evident in the definition of critical thinking developed by the American Philosophical Association (cited above), which focuses heavily on desired thinking skills and dispositions, not

observed behaviors. The downside to this approach is that it does not necessarily describe how humans think. In contrast, psychologists like Deanna Kuhn, Diane Halpern, and Patricia King and Karen Kitchener create developmental models which describe how humans behave and what this reveals about their capacity to think critically. In addition, psychologists tend to emphasize the problem-solving aspects of critical thinking over reflection and logic (Lewis & Smith, 1993). Education scholars have also contributed to the scholarship of critical thinking, and their theories related to the concept tend to be a mix of philosophical and psychological approaches (Sternberg, 1986). Despite the efforts of scholars in both of these disciplines, fundamental reforms in education to incorporate critical thinking have been less prevalent than was hoped (Arum & Roksa, 2011; Gibson, 1995).   Several noted philosophy scholars in the field of critical thinking study have developed models to describe both why critical thinking is necessary and what its results entail. For Paul and Elder (2001), the need for critical thinking stems from the biased, uninformed, and prejudiced nature of much of our thinking. Often, the result of this bad thinking is bad decisions and lower quality of life. A critical thinker, on the other hand, can raise important questions, gather and assess the appropriate information, think open-mindedly, self-regulate, and communicate well-reasoned conclusions effectively (Paul & Elder, 2001). Going beyond these general skills, Paul identified a distinction between two types of critical thinking: weak and strong. Weak critical thinking consists of thinking that is sophisticated, but puts the rhetorical tools of argument analysis and evaluation to use without care for values and fair-mindedness. Strong critical thinking, on the other hand, comprises a disciplined, self-assessing method of addressing issues that avoids self-deception (Paul, 1992). Ennis (2001), who has supplied one of the most well-cited

critical thinking definitions, clearly delineates it from the "higher order thinking skills" of Bloom's taxonomy, which he finds too vague. Bloom's taxonomy is a model which organizes learning objectives into a hierarchy of complexity, with less cognitively-taxing objectives at the bottom (such as remembering) and more cognitively-taxing objectives at the top (such as evaluating) (Bloom, 1971). Critical thinking skills must be more specific, Ennis argues, in order to be assessable. He defines critical thinking skills as the ability to do the following: judge the credibility of sources and the quality of arguments, identify the parts of an argument (including conclusions, reasons, and assumptions), develop and defend a position, ask appropriate questions, define terms, stay well-informed, and be open-minded (Ennis 2001). He later defines some critical thinking dispositions which must be cultivated, including the tendency to seek clear statements and reasons, to be alert for alternatives, to take the entire situation into account, and to change position when the evidence is sufficient (Davies & Barnett, 2015).

Nosich (2009), in a similar vein, describes a critical thinker as one who asks questions, uses thorough reasoning to attempt to answer the questions, and believes the results of the reasoning to the extent that he or she is willing to act on these conclusions. In his book *Learning to Think Things Through,* Nosich breaks down critical thinking into eight elements: purpose, question at issue, assumptions, implications and consequences, information, concepts, conclusions and interpretation, and point of view. He also provides the following standards for critical thinking: clearness, accuracy, importance or relevance, sufficiency, depth and breadth, and precision. Good critical thinkers will evaluate their own critical thinking against these standards, as well as the claims of others.

Facione (2013), a philosopher and educator who has been deeply involved in critical thinking efforts, such as the California Commission on Teacher Credentialing and the APA Delphi study cited earlier, describes why developing critical thinking skills is a worthwhile endeavor: "Becoming educated and practicing good judgment does not absolutely guarantee a life of happiness, virtue, or economic success, but it surely offers a better chance at those things" (p. 2). The critical thinking skills he considers essential are interpretation, analysis, evaluation, inference, explanation, and self-regulation (just as the APA Delphi study decided). For Facione (2013), the dispositions of critical thinking are essential to critical thinking instruction, and these habits of mind promote "civic engagement, concern for the common good, and social responsibility" (p. 14). To build these skills when approaching a problem or decision, Facione (2013) provides a five step process which creates the acrostic IDEAS: identify the problem, deepen understanding by gathering relevant information, enumerate options and anticipate consequences, assess the situation to make a decision, and scrutinize the process to self-correct if necessary (p. 25).

In contrast to philosophers, psychologists offer several developmental models of critical thinking. King and Kitchener's reflective judgment model describes the development of reflective thinking from adolescence to adulthood. The model outlines seven stages of development, grouped into three levels: pre-reflective thinking, quasi-reflective thinking, and reflective thinking (King & Kitchener, 2004, p. 6). In the pre-reflective thinking stage, knowledge can be known with certainty when it comes from authority figures. At this stage, evidence is not necessary to make strong claims. In quasi-reflective thinking, evidence becomes important to making claims, but the link between

the evidence and the conclusion may be flimsy. In reflective thinking, claims are understood in relation to their context and evaluated based on the consistency and quality of their evidence (King & Kitchener, 2004).

A similar model of cognitive development related to critical thinking was developed by Deanna Kuhn (1999). Her model builds on the idea of metacognitive knowing, a way of thinking that reflects one's ability to know about one's own knowing. Kuhn defines three states of metacognitive knowing (metacognitive knowing, metastrategic knowing, and epistemological meta-knowing), which she translates into four levels of epistemological understanding. At the first level is the realist, who sees reality as directly knowable and knowledge delivered by an external source as certain. Children of four or five years old typically exhibit behaviors consistent with this epistemological understanding. The next stage is the absolutist, who sees knowledge as coming from certain, external sources, but understands that assertions can be correct or incorrect. Individuals at this stage might use critical thinking to determine the truth or falsity of an assertion, but would generally fail to adopt a nuanced stance about a topic. Some people spend their entire lives within this level of epistemological understanding. At the next level is the multiplist, who has discovered that experts and authorities may disagree about a topic. Individuals at this stage see assertions as opinions, and each person's opinion as being as valid as the next person's. Critical thinking is not needed at this stage, because each person needs only to develop an opinion, and it should not be subject to criticism. The final stage of epistemological understanding is evaluative. At this stage, assertions are seen as judgments which, upon evaluation, can be understood to be more, or less, correct than other claims. Once again, critical thinking is necessary at

this stage, and is in fact central to developing knowledge and making assertions (Kuhn, 1999).

An important element of critical thinking promoted by philosophers and psychologists alike is metacognitive monitoring, or "thinking about one's thinking." This aspect of critical thinking is often reflected in the aspects of popular critical thinking definitions which emphasize self-examination, critical monitoring of one's own arguments and evidence, and open-mindedness. Metacognition is essential to the decision-making process that underlies a person's conclusion to use one thinking strategy over another. Metacognitive monitoring skills help students "monitor their thinking process, check whether progress is being made toward an appropriate goal, ensure accuracy, and make decisions about the use of time and mental effort" (Halpern, 1998, 454). Helping students build metacognitive skills might entail asking them to explicitly state which critical thinking skills might be necessary to solve a problem and how they will know they have reached their goal, then asking them again after a solution has been chosen which critical thinking skills they employed and how well the problem was solved (Halpern, 1998).

A table outlining the critical thinking focus emphasized by researchers in various disciplines can be found in Appendix A.

2.2 Critical Thinking and Information Literacy

Because this study explores the alignment of information literacy tutorials with critical thinking instructional best practices, it is useful to compare critical thinking and information literacy as concepts. Several scholars have noted the similarities between the

two ideas and observed that information literacy instruction could augment and incorporate critical thinking instruction (Bodi, 1988; Gibson, 1995; Weiner, 2011).

Information literacy, according to the Association of College & Research Libraries (ACRL), can be defined in this way:

> Information literacy is the set of integrated abilities encompassing the reflective discovery of information, the understanding of how information is produced and valued, and the use of information in creating new knowledge and participating ethically in communities of learning (Association of College & Research Libraries, 2016).

Just as with critical thinking, information literacy is understood to comprise both skill-like elements ("knowledge practices," the demonstrations of skill) and dispositions. The recently accepted Framework for Information Literacy in Higher Education of ACRL presents these skills and dispositions as elements within six "frames," which are loosely defined as the threshold concepts of information literacy (Association of College & Research Libraries, 2016).

The idea of threshold concepts comes from education scholars Meyer and Land (2003), and it consists of "those ideas in any discipline that are passageways or portals to enlarged understanding or ways of thinking and practicing within that discipline" (Association of College & Research Libraries, 2016). Threshold concepts are transformative (they change the way a student views the discipline), troublesome (they are often challenging or counterintuitive), irreversible (they are difficult to unlearn), integrative (they bring together ideas or concepts from a discipline), and bounded (they fit within a specific disciplinary realm) (Meyer & Land, 2003). Threshold concepts are often considered the "core concepts" of a discipline (Meyer & Land, 2003), and because it is not clear that "information literacy" is a discipline, there is some debate about

whether the Frames of the ACRL Framework can be considered threshold concepts (Wilkinson, 2014). The idea of threshold concepts is useful for exploring information literacy, but in this study the Frames will not be referred to as threshold concepts.

The Framework also relies heavily on metaliteracy, a concept which promotes students as self-aware consumers and producers of information. The Frames are not meant to be prescriptive or serve as learning outcomes for librarians who teach; rather, they serve as a flexible set of core concepts, or "big ideas," which students may begin to grasp over a long stretch of time, and which may or may not be assessable (Association of College & Research Libraries, 2016).

The Frames are as follows: Authority is Constructed and Contextual, Information Creation as a Process, Research as Inquiry, Scholarship as a Conversation, Searching as Strategic Exploration, and Information Has Value. Each Frame includes a short description, a list of "knowledge practices," or indicators of the development of information literate skills, and dispositions (Association of College & Research Libraries, 2016). None of the Frames mention critical thinking explicitly, although the concept is mentioned as an important component of metaliteracy. The role of critical thinking in the Framework is not made clear in the official document, so it is up to instruction librarians to determine how much and in what ways to promote critical thinking.

Scholars in the field of library science have attempted to explain critical thinking's role in library instruction for decades. Bodi (1988) wrote about her concern that there were some librarians who saw the role of "bibliographic instruction" (now typically referred to as library instruction) as merely to help students search for information, not to help them use the information once found. Gibson had similar

concerns about the perspective of librarians who see library instruction as tools-based and basic, and who "will consider critical thinking outside the scope of their responsibilities" (1995, p. 4). The attitude that librarians should focus solely on teaching how to use tools had its peak in the early 1990s in what was called the "back to basics movement" (Reece, 2005). In the following years, many librarians spoke out against this movement, and instead argued for the importance of higher-order thinking to information literacy (Reece, 2005). Clearly attitudes about library instruction have changed dramatically since that time, as demonstrated by the ACRL Framework and its promotion of higher order thinking in library instruction. Librarians will probably always need to "cover" the basic content involved in introducing students to catalogs and databases, but they are increasingly being encouraged by their colleagues and professional communities to incorporate higher order thinking concepts into their library instruction (Bodi, 1988; Gibson, 1995; McClellan, 2016).

In fact, Gibson argues (1995), basic skills and critical thinking cannot necessarily be separated, and both are important in real-world situations. Critical thinking skills should be taught in context anyway (according to Gibson), so the basic skills are used in service of conceptual goals and values. The tools and basic skills may change, thanks to rapid progress in technology and modifications to library tools, so focusing solely on skills creates dependency and non-transferability (Gibson, 1995). To apply critical thinking to information literacy instruction, therefore, library instruction must be more prominently embedded in departmental curricula (Gibson, 1995). Learning critical thinking skills takes time regardless of the context, and single 50-minute sessions may do little to promote growth in critical thinking information skills.

In describing the relationship between critical thinking and information literacy, Albitz (2007) argued that critical thinking skills are an important component of information literacy, but information literacy is not always necessary to critical thinking. She implies that information literacy is akin to a discipline, and critical thinking should be applied to it, as it is applied to other disciplines. Therefore, each element of information literacy (finding, evaluating, and using information) should be guided by critical thinking skills and dispositions. She also defines information literacy as made up of "concrete" skills and critical thinking as abstract, incorporating "not … skills but higher-level cognitive concepts" (Albitz, 2007, p. 101). Proponents of the ACRL Framework (and others) may not agree with this characterization of information literacy, but it serves to highlight information literacy as the content about which students must think critically.

Others in the library science literature have attempted to describe the relationship between information literacy and critical thinking. Daugherty and Russo (2010) presented critical thinking and information literacy as interdependent sets of skills that can be "meshed" in instruction (p. 26). Afino et al (2008) saw information literacy instruction as a method of enhancing critical thinking instruction, perhaps through the application of critical thinking skills to information literacy assignments and tasks. Many of these scholars promote library instruction that incorporates the higher order thinking skills and "big" concepts that are the foundation for the ACRL Framework. Critical thinking, while not explicitly explored in the ACRL Framework, clearly influenced its creation.

Allen (2008) compared each of the ACRL Standards for Information Literacy (the predecessor to the ACRL Framework) to critical thinking skills, implying that each

element of information literacy has its match in a critical thinking model. Weiner (2011) did something similar using a systematic review comparing uses of critical thinking and information literacy in the literature. He also created a map of terms linked to critical thinking, information literacy, or both. He found that critical thinking is a mental process, and therefore private and internal, while information literacy is more of a public process with observable techniques (Weiner, 2011). However, there was significant overlap between the attributes assigned to each concept in the literature, which suggests that they can be integrated in instruction for a stronger, more cohesive curriculum.

Both Allen (2008) and Weiner's (2011) evaluations of the similarities between critical thinking and information literacy work from an older conception of information literacy laid out in the ACRL Standards for Information Literacy, which were superseded by the ACRL Framework for Information Literacy in 2015. No equivalent pairing for each element of information literacy as re-explored by the ACRL Framework exists. However, these perspectives on the relationship between critical thinking and information literacy are useful for predicting which critical thinking skills will be promoted in information literacy online learning objects created both before and after 2015.

2.3 Teaching Critical Thinking

2.3.1 Divisions in the field. One conflict among scholars of critical thinking is whether or not critical thinking skills are general, or if they must be associated with a domain of study. Psychologists tend to side with the general skills view, seeing critical thinking as a set of discrete skills that can be applied in a variety of contexts (Abrami et al., 2014). Some philosophers (Paul, 1993; Ennis, 1989; Siegel, 1980) also see that, for the most part, critical thinking skills are general, rather than discipline-specific. Such

generic critical thinking skills might include analysis, interpretation, evaluation, and prediction, all of which might be taught on their own and adapted for work in a specific discipline.

The primary contender against the general skills view is McPeck (1984), who has memorably argued that "All thinking is about x. But, critical thinking is a kind of thinking. Therefore, critical thinking is about x" (pp. 4-5). Based on this argument, all critical thinking must be applied to content in a subject area, and there are no transferrable critical thinking skills. Furthermore, he argues that critical thinking necessarily requires some basic subject knowledge (McPeck, 1990). Critical thinking itself, he argues, is not a subject area, and therefore cannot be taught as if it was (McPeck, 1984). In response, some scholars have argued that some critical thinking skills may be appropriate across several subject areas, and that the existence of general skills does not imply that context-specific knowledge does not exist nor that it is not important (Abrami et al., 2014; Ennis, 1989). Critical thinking can be thought of as more than the content of thinking and, instead, as the framework or tool used to understand and use that content. That tool (habit or method of thinking) can then be transferred to new situations, resulting in better overall thinking and decision-making.

The implications of this scholarly debate are significant. During critical thinking's rise to prominence in the literature and educational programs of the 1980s and 1990s, programs and courses which specialized in teaching generic critical thinking skills became common. However, their effectiveness remains unclear, and the divorce of the content of these programs from disciplinary subject material may contribute to the ambiguity of their success (Abrami et al., 2014).

One method of assessing the effectiveness of contextual vs. generic critical

thinking education approaches was devised by Robert Ennis (1989). He identified four

"typologies" for critical thinking instruction: generic, infusion, immersion, and mixed

(Facione, 1990a). In generic critical thinking courses, critical thinking skills and

dispositions are the complete focus of the course without subject-specific content. In the

infusion critical thinking course, both subject matter and critical thinking skills are

introduced, and critical thinking is explicitly expressed as an objective of the course,

while an immersion course is also subject-specific, but does not explicitly state that

critical thinking is a goal of the course. A mixed critical thinking course is a subject-

specific one which treats critical thinking as an independent track within it (Ennis, 1989).

A meta-analysis conducted in 2015 showed that instruction with content-specific critical

thinking outcomes is associated with greater effects on critical thinking skills than

instruction with generic critical thinking outcomes. However, the study also found that

instruction which taught generic critical thinking skills did have an effect on critical

thinking skill acquisition, which suggests that generic skills exist, and that they can be

taught (Abrami et al., 2014).

Another core debate in the study of critical thinking is whether or not critical

thinking necessarily includes both thinking skills and the disposition to use the skills.

Facione (2000) described a disposition as a "person's habitual ways of acting" (p. 63),

and a disposition toward critical thinking as "the consistent internal motivation to engage

problems and make decisions by using critical thinking" (p. 65). Dewey (1933) described

a similar idea when he characterized the dispositional aspects of thinking as "personal

attributes" (p. 33). A notable characteristic of the landmark definition and report

developed by the American Philosophical Association (APA) panel was that the panelists decided that critical thinking skills and dispositions were different, but that one must have both critical thinking skills and dispositions to be a good critical thinker (Facione, 1990b, p. 20). Therefore, should someone demonstrate the ability to think critically without being inclined to use that skill, or find critical thinking to be very important but lack the requisite skills, that person would not be considered, under the APA's definition, to be a critical thinker.

A common way to describe the disposition of a critical thinker is as a "critical spirit." The APA study describes the critical thinking disposition as a "critical spirit, a probing inquisitiveness, a keenness of mind, a zealous dedication to reason, and a hunger or eagerness for reliable information" that is only possessed by a critical thinker (Facione, 1990b, p. 20). Siegel (1980), who first introduced the idea of a "critical spirit," described it as "certain attitudes, dispositions, habits, and character traits, which together may be labelled the *critical spirit* or *critical attitude*" (p. 9; italics in original). He emphasizes that a critical thinker must have more than the ability to subject judgment to principle; he or she must be willing to do so. Furthermore, a critical thinker must be habitually predisposed to search for reasons and evidence in appropriate situations (Siegel, 1980). Scholars have since argued about whether a definition of critical thinking must or could include the disposition necessary to habitually use the skills underlying the thinking, although most agree that a true critical thinker must be disposed to think critically.

The dispositional aspect of critical thinking education is vitally important, and should be the focus of instructors as much as critical thinking skills. Halpern (1998) points out that, from a cognitive psychology perspective, critical thinking requires

concerted mental work, and therefore is not likely to be used by those who do not see the value of exerting this cognitive effort, regardless of their ability to do so. The methods of teaching critical thinking dispositions are less well-understood, however. Facione & Facione (1997) found that students with a strong disposition to use critical thinking skills showed a greater development of critical thinking skills than those with a weaker disposition, although there was no one-to-one correlation between specific skills and dispositions. The literature suggests that the best way to teach critical thinking dispositions is to model the behavior for students (Facione, 2000). Helping students decide when to use particular critical thinking skills, and encouraging them to persist in the difficult mental task of critical thinking may also help (Halpern, 1998).

Perhaps the greatest barrier to learning critical thinking skills is the problem of transfer. Students may master critical thinking skills in one domain or setting, but most will fail to transfer those skills to a new situation. Lack of transfer can be traced to problems of memory; to recognize the need to use a particular critical thinking skill, one must be triggered to retrieve that knowledge from long-term memory (Halpern, 1998). Because new situations that require critical thinking skills may not have any clear connection to the example or situation in which they were learned, triggering this recall can be difficult. In essence, students must be able to recognize the structural aspects of situations that require a specific critical thinking skill in order to trigger the appropriate memory retrieval (Halpern, 1998). Studies show that the best way to combat this difficulty is to explicitly teach and practice transfer during critical thinking instruction (Halpern, 1998; Van Gelder, 2005). This instruction may involve helping students develop the disposition to recognize that critical thinking skills are necessary, choose the

correct skill, and apply it to the situation. Aiding students in recognizing the structure of problems or arguments beyond their surface-level content may also help (Halpern, 1998). One specific method for helping students make meaningful connections in their memories is through "elaboration," or encouraging students to make their own connections with related material which they already know. This strategy can be accomplished by asking thoughtful questions that students then answer by drawing on their own body of knowledge, which also encourages recall of this previous knowledge (Halpern, 1998).

    2.3.2 Critical thinking instruction methods. Scholarly disputes aside, the consensus among scholars and instructors alike is that critical thinking remains important to higher education instruction. Discussion continues, however, regarding how critical thinking skills and dispositions can be taught, and even whether they can be.

    After decades of research, a number of studies using a wide variety of evidence showed that appropriate instruction can lead to better student thinking (see Abrami et al., 2014). A recent meta-analysis provided encouraging evidence to support the idea that critical thinking can be taught (Abrami et al., 2014). The researchers examined 684 studies which assessed critical thinking skills and dispositions, ranging from K-12 instruction, to undergraduate and graduate education, to adult learning. For the purposes of this study, it is interesting to note that one category the researchers developed for instructional approaches was called "individual study" and included reading, watching, and listening to course content alone (all of which would encompass the type of instruction explored in this study). The results of the study found that it is possible to develop critical thinking skills and dispositions in students "at all educational levels and

24

across all disciplinary areas using a number of effective strategies" (Abrami et al., 2014, pp. 301-302). The activities which seemed to provide the highest levels of critical thinking improvement included discussion, both at the class level and the small group level, especially with teacher-developed questions; the use of authentic or situated problems and examples, especially problem-solving and role-play; and, to a lesser extent, mentorship, which usually consisted of one-on-one student-teacher interactions. Using all three of these instructional methods together produced the best results. However, the researchers acknowledged that teaching critical thinking is complicated and context-specific, and there is no "magic recipe" for successful critical thinking instruction, even while there are some methods which are especially promising (p. 303).

Halpern (1999) provided a four-part model for teaching critical thinking which draws heavily on the field of cognitive psychology. The first two parts of the model focus on teaching the skills and dispositions of critical thinking. The third part is a focus on "structure training," or instruction in how to recognize the underlying structure of a question or problem in order to better transfer the correct critical thinking response to the problem structure as it appears in various contexts (Halpern, 1999). Finally, the last part focuses on "metacognitive monitoring," or using what one knows about one's own thinking to improve learning (Halpern, 1999). This process can include checking progress toward a goal, monitoring thinking tools used and thinking accuracy, and deliberately choosing the amount of time and mental effort appropriate for a problem or situation (Halpern, 1999).

Another model for approaching critical thinking instruction was developed by educational psychologists King and Kitchener (2004). The reflective judgment model

(described earlier) builds on the idea of ill-structured problems, which are, as defined by King and Kitchener, problems that "cannot be described with a high degree of completeness; cannot be solved with a high degree of certainty; experts often disagree about the best solution, even when the problem can be considered solved" (p. 11). Jonassen (1997), who explored ill-structured problems in more depth, argued that ill-structured problems must consist of unknown or unfamiliar elements, have vaguely defined constraints, hold more than one reasonable solution or no solution at all, fail to invoke specific concepts or techniques necessary to address the problem, and require students to make their own judgments and defend them (p. 69). Well-structured problems, which have a single solution and engage specific, limited rules, are not like problems that students will likely encounter in everyday life, and their use is therefore not likely to encourage transfer of skills to novel situations (Jonassen, 1997). Ill-structured problems, on the other hand, ask students to draw on multiple content domains and to use skills which will be useful in everyday, complex problem-solving. Unlike factual or preference questions, ill-structured problems have answers which range on a scale from better to worse, and thus lend themselves to the reflective judgment model, as well as to critical thinking instruction (Jonassen, 1997).

Similar to the ill-structured problem model, the inquiry-based instruction model presented by Allison King (1995) asked students not just to find correct answers to questions posed by the instructor, but to create and answer their own questions. This instructional model promotes the metacognitive element of critical thinking by helping students identify their own knowledge gaps and misconceptions, and develop their own mechanisms for filling the gaps. If students are given guidance and examples for

26

generating their own questions, question-development is a skill that can be learned quickly and have swift, positive effects on learning (A. King, 1995). One manifestation of this inquiry-based model is an activity called "reciprocal peer questioning" (A. King, 1995, p. 14). First, students independently generate several questions based on the course material, then, in small groups, they question their peers using their generated inquiries. After some small group discussion, the entire class discusses some of the questions and responses that have been explored in the small groups. Students are held accountable for the responses they generate by their peers, and this hones the other side of critical thinking: reasoned skepticism.

A similar model for developing critical thinking skills was developed by Lynch and Wolcott (2001). Drawing from Fischer's dynamic skill theory (1980) and King and Kitchener's reflective judgement model (2004), Lynch and Wolcott (2001) created a graduated process for thinking about open-ended problems. Students move from problem-solving skills which involve low cognitive complexity, such as identifying the problem and interpreting evidence from several points of view, to skills which require a high level of cognitive complexity, such as communicating conclusions to an audience and acknowledging the limitations of the chosen solution. Breaking down tasks into these levels of problem-solving complexity may help students scaffold their learning. A key element of this approach is providing students with task prompts at the appropriate level and allowing them to explicitly use this process to guide their learning (Lynch & Walcott, 2001).

In keeping with the understanding that metacognition is a key element of critical thinking, instructional strategies that encourage students to reflect on their own thinking

can help to encourage better thinking habits. Some scholars define metacognition as both knowledge (knowing one's own thinking habits and cognitive processes) and regulation (the strategies used to control these cognitive processes) (Brown, 1987; Flavell 1979; Ku & Ho, 2010). Therefore, students must be taught about how cognitive activities occur and could be controlled, and then given opportunities to apply this knowledge to improve cognitive performance (Ku & Ho, 2010). Instructional techniques which ask students to explicitly develop both metacognitive knowledge and regulatory skills can help them plan their approach to critical thinking exercises more successfully (Ku & Ho, 2010). Simply asking students why they think they have been asked to accomplish an academic assignment or task may help them begin to habitually question their thinking endeavors (Kuhn & Dean, 2004). As discussed previously, discussion questions that ask students to defend their reasoning or provide evidence may also encourage them to examine the structure of their own arguments (Kuhn & Dean, 2004).

Van Gelder (2005) introduced an important aspect of critical thinking instruction: "quality practice" (p. 540). The "quality practice hypothesis" presumes that critical thinking skills can only improve through extensive, meaningful practice (Van Gelder, 2005, p. 540). This emphasis on practice is underscored by cognitive psychology; for students to successfully retrieve the critical thinking skills required in a variety of situations, they must draw meaningful connections to previous knowledge and practice recall frequently (Halpern, 1998). Practice can be more effective if it involves real-world examples and believable contexts (Halpern, 1998). Regardless of the practice methods used, the scholarly consensus is that gaining critical thinking skills is an effortful process that may take time. Instructors who explain that coming to a carefully-informed

conclusion will take more effort may find that students are better prepared for the additional mental effort required to think critically (Halpern, 1998).

2.3.3 Critical thinking assessment methods. Scholars tend to agree that critical thinking skills and dispositions are challenging to teach and learn (Abrami et al., 2015; Arum & Roksa, 2011; Behar-Horenstien & Niu, 2011; Ennis, 2001; Norris, 1985; Willingham, 2008). However, as discussed earlier, it is indeed possible to develop critical thinking skills through effective instructional strategies. Measuring that development, though, presents an additional hurdle. The assessment of critical thinking skills and dispositions is an obstacle which remains the subject of scholarly interest and discussion.

Ennis (2001) divided the assessment of critical thinking into seven categories: 1) assessment which determines the level of a student's critical thinking; 2) assessment that provides feedback to students about their critical thinking skills; 3) assessment which motivates students to become better critical thinkers; 4) assessment that helps the instructor determine if she or he was successful in teaching critical thinking; 5) assessment that helps in the process of research; 6) assessment to determine whether a student should enter an educational program; and 7) assessment to hold instructors accountable for their critical thinking teaching. All of these reasons for conducting assessment result in a variety of assessment tools, some of which include standardized tests. The primary standardized tests of critical thinking currently include the California Critical Thinking Skills Test (Facione, 1990a), the Cornell Critical Thinking Test (Ennis and Millman, 1985), and the Watson-Glaser Critical Thinking Appraisal (Watson & Glaser, 1980). These tests have been used in many studies and have been found to be

reliable and valid (Bers, 2016). However, a large-scale standardized test may not be practical for everyday instruction or assessment in online environments.

Assessment of critical thinking can be accomplished at a smaller scale. The well-known educational psychologist Thomas Angelo recommends monitoring student learning through the classroom assessment techniques he developed with his colleague, Patricia Cross (1995). These classroom assessment techniques (CATs) are often short, easy to implement, and useful for providing quick, informal data to an instructor. CATs also allow students to monitor their own learning, and give the instructor the opportunity to provide feedback either to the entire class or to individual students (Angelo, 1995). One of the most popular of Angelo and Cross's CATs is the "minute paper." In this short assessment, students are asked to share the most important thing they learned in class that day and any remaining questions about the content, an activity which should take no more than three to five minutes (Angelo, 1995). Many CATs both assess and promote critical thinking skills like problem solving, metacognition, and inference, among others.

Multiple-choice questions are a common assessment tool, thanks to the ease of their administration and analysis (Morrison & Free, 2001). However, debate about whether or not multiple-choice questions can effectively assess critical thinking skills continues. Several scholars have found that well-crafted multiple-choice questions can reliably and validly measure higher order thinking skills (Haladyna, Downing, & Rodriguez, 2002; Kerkman & Johnson, 2014; Morrison & Free, 2001). Morrison and Free describe four essential criteria for developing multiple-choice questions that promote (and therefore assess) critical thinking. First, students should be asked to rationalize or justify the multiple-choice answer they chose, describing in detail why they

selected one answer over the others (Ennis, 1993; Kerkman & Johnson, 2014; Morrison & Free, 2001). Second, questions should be written at or above the "application" cognitive level of Bloom's taxonomy; therefore, the questions should ask students to analyze, synthesize, or evaluate (Morrison & Free, 2001). Third, students should be required to know more than one concept to answer a single multiple-choice question (in other words, questions must require multilogical thinking). Finally, options provided in the multiple-choice question should all present plausible alternatives, with one option being a better fit than the others. For example, questions that ask students to decide which option is "best, most important, first, highest priority, and so forth" promote critical thinking by asking students to be highly discriminatory in their answer (Morrison & Free, 2001).

A method of assessment promoted by Broadbear (2012) is student self-assessment, as this helps to promote the metacognition that is so important to critical thinking. This kind of assessment may also help students overcome dispositional barriers to critical thinking by encouraging them to become self-critical and open-minded (Broadbear, 2012). Once work is assessed, either by the student or the professor, Broadbear argued that revisions are essential. For student thinking to improve, the student must have an opportunity to apply the arguments for changes he or she has made.

Whether used by students for peer- or self-assessment or by the instructor, rubrics can provide a useful tool for assessing critical thinking instruction techniques such as case studies, authentic investigations, and discussions (Terry, 2012). Rubrics are an especially useful assessment technique because they can be adapted to the specific instructional context or assessment goals of the instructor (Terry, 2012). When used

31

repeatedly, a rubric can provide a nuanced picture of student's critical thinking skill development over the course of a semester or across several semesters as instructional strategies are updated.

Reflection is often used to promote critical thinking, but assessing reflection can be difficult due to its subjective nature. Bourner (2003) recommended assessing reflections by looking beyond the content of the reflection (what the student said or did which is being reflected on) to how the student processed the experience. A good reflection, according to Bourner, should show evidence of the ability to "interrogate experience with searching questions" (p. 270). When teaching students to reflect, instructors should encourage them to move beyond recounting an experience to asking useful, relevant questions about the experience, such as "What happened that most surprised you?" and "What did you learn from that experience about how you react?" (Bourner, 2003, p. 270). A critical thinking reflective activity might ask students to consider what thinking strategies he or she used to solve a problem or make a decision. Examining the searching questions asked by students in their reflections is a successful way of assessing their critical thinking skills without judging their subjective experiences (Bourner, 2003, p. 270).

Assessment of critical thinking dispositions, while challenging, can also be accomplished. Critical thinking assessment is important because a low performance by a student could be explained as a result of poor critical thinking skills, or it could be the consequence of the student's lack of a critical thinking disposition (Giancarlo, Blohm, & Urdan, 2004). The California Measure of Mental Motivation (Giancarlo, 1998) is one standardized test which attempts to measure critical thinking dispositions rather than

skills, and it can be used in conjunction with a critical thinking skills assessment to better understand the cause of a student's performance (Giancarlo et al., 2004). Reflection and discussion can also provide evidence of students' critical thinking disposition, although more research in this area is necessary.

2.4 Teaching Critical Thinking Online

The higher education landscape has changed considerably in the last twenty years due to the increased demand for online delivery of instruction. The challenge of this transition has been to maintain the level of instructional quality in the online environment that can be achieved face-to-face. Critical thinking is clearly valued as an integral component of a successful higher education curriculum, but it is still unclear how critical thinking skills and dispositions can be encouraged in the online environment.

There are some benefits to incorporating critical thinking into online instruction, regardless of whether online integration is required. Online learning can be much more self-paced, allowing students to reflect more carefully on their interactions and assignments. Students are free from the time-constraints of a typical class discussion, and those with learning disabilities can sometimes more easily be accommodated (Mandernach, 2006). Of course, it is important not to use new technologies just for the sake of their novelty, but it is possible to go beyond simply attempting to recreate the face-to-face classroom online and, in addition, take advantage of asynchronous online learning's distinct benefits (Mandernach, 2006).

In their framework for teaching in online learning environments, Johnson and Aragon (2003) draw from behavioral, cognitive, and social learning theory. The principles for online instruction that resulted are as follows: encourage social interaction,

avoid information overload, provide hands-on activities, address individual differences, encourage student reflection, create a real-life context, and motivate the student (Johnson & Aragon, 2003, p. 34). To meet these online learning principles, Johnson and Aragon encouraged the use of multiple formats, engaging games, chunking of material, simulations or case studies, a personal connection with students, reflection, and active learning exercises. Like Mandernach (2006), Johnson and Aragon argued that online instruction need not be a direct instantiation of face-to-face instruction, and can, instead, promote instructional strategies which are most effective in an online environment.

Many studies which attempt to determine how best to teach critical thinking online focus on online discussions as a means of promoting critical inquiry. Socratic questioning, argument construction, collaborative problem-solving, and peer editing all can be accomplished in online discussion boards (MacKnight, 2000). Unfortunately, providing students with an online platform in which to discuss is not enough to ensure critical reflection; however, providing students with focused, provocative discussion questions and topics can help to promote this kind of thinking. Encouraging students to participate and periodically summarizing or contributing to a discussion (modeling) may be necessary to compel critical discussion and hold students accountable (MacKnight, 2000).

Online discussion does not necessarily need to consist of a series of questions that require responses from each student in the course. Discussions can be led in small groups; start in small groups and move to the larger class; be led by groups or single students; involve case studies, role-playing, group brainstorming; or even consist of debate teams which each take a side in an argument (Kalelioglu & Gülbahar, 2014;

MacKnight, 2000; Richardson & Ice, 2010). In a study comparing student preferences for online discussion format, open-ended discussion (using a topic question developed by the instructor) was the most popular method, followed by a debate-style discussion and a case-based discussion (Richardson & Ice, 2010). However, the authors noted that the questions used by the instructor have a significant effect on the success of a discussion hoping to promote critical thinking.

Another technique used in online instruction to promote critical thinking is practice-based simulation exercises. In this model, problem-based situations can be developed which reflect the kinds of problems students may encounter in real-world environments, and students can undergo virtual simulations on their own. Simulations can be followed by reflective debriefing that requires the students to consider the decisions they made and the cognitive strategies they employed (Park, et al., 2013). Peer debriefing can also be used.

Concept-mapping is a method for encouraging critical thinking that is used in face-to-face teaching but which can be easily transferred to an online environment. Concept maps can be used to help students expand their thinking about a topic, or they can be helpful in identifying previous knowledge (pre-concept mapping) and new knowledge gained by an experience (post-concept mapping) (Park, et. al, 2013). Variations on the concept-map include argument maps or trees that allow students to visually display or view relationships between arguments, evidence, and reasoning (Van Gelder, 2005). A wide variety of free or low-cost online concept mapping platforms currently exist which could be used in online critical thinking instruction (MindMup, Bubble.us, Mindomo, etc.).

Additional platforms for online learning that have emerged include blogs, wikis, podcasts, and many others (Mandernach, 2006). Some online learning is accomplished through online learning objects or digital learning objects. These online modules usually consist of discrete units of learning content delivered electronically, which may include videos, interactive tutorials, simulations, and instructional games, among other media. Just as with online discussion boards, concept mapping tools, and online group collaboration platforms, these tools can serve to augment the instructional activities that best accomplish critical thinking improvement. Of course, the focus should be on the best online instructional strategies, not the technology used.

2.5 Teaching Critical Thinking in Online Library Instruction

Even scholars outside of library science have noted that the changing landscape of information with the advent of the Internet increases the need for information literacy and critical thinking. Halpern, a psychologist and important scholar in the study of critical thinking, observed in the late 1990s, "The easy availability, with just a few keystrokes, of massive amounts of information has made the ability to evaluate and sort information more important than ever.… Thus the ability to judge the credibility of an information source has become an indispensable critical thinking skill that needs to be deliberately and repeatedly taught in college and earlier" (1999, p. 71). Librarians who teach information literacy will immediately see the connection between this call for critical thinking skills and the need for the information literacy skills that they promote on a regular basis. The importance of information literacy and critical thinking skills is nearly universally undisputed, and the proliferation of bad information available to students online increases support for both even further.

It could be argued that successful critical thinking instruction is even more important for online education that involves information literacy than in-person education because students may have more limited access to a librarian to help them evaluate and monitor understanding of information sources (Gibson & Scales, 2000). Librarians must find ways to instill these skills in students from a distance, and a variety of online library instruction efforts have attempted to accomplish just that.

The relationship between critical thinking and information literacy has already been explored, but how this intersection plays out in library instruction, especially online, can vary widely. While the literature is fairly scarce, several libraries have taken advantage of the need for a Quality Enhancement Plan (QEP) to meet accreditation requirements. At the University of Louisville, librarians created online library instruction modules that attempted to help students grasp "the deeper purpose of the library instruction session: the critical thinking skills required for information evaluation" (McClellan, 2016). These instruction modules use Paul and Elder's Elements of Thought Framework (2006) to teach students about Wikipedia, Google, and scholarly journal articles as sources. Importantly, the librarians expressly indicate to students that the modules attempt to teach critical thinking (falling into Ennis's "infusion" category of critical thinking instruction). Overall, the librarians received positive feedback from students regarding the modules, and they hope to expand them in the future (McClellan, 2016). The University of Louisville's successful integration of critical thinking and information literacy instruction bodes well for the potential future integration of these approaches.

Librarians at the City University of New York (CUNY) were also compelled to develop online critical thinking and information literacy content, in this case by a grant to develop e-learning opportunities for students to gain skills in "information literacy, digital fluency, and critical thinking" (Gashurov & Matsuuchi, 2013, p. 39). The result of this effort was an online, credit-bearing course which emphasized both information literacy and critical thinking. The content of the course focused on searching in and evaluating Internet sources, the politics of information access, the future of journalism, Wikipedia, and intellectual property, among other topics (Gashurov & Matsuuchi, 2013). The methods of instruction used were not explored at length in the article, but the authors mentioned the use of videos, readings, and discussion posts. In the end, the course was discontinued due to new general education requirements in the university system, although the authors hoped to use the experience to develop similar future projects (Gashurov & Matsuuchi, 2013).

Many examples of online information literacy instruction involve the use of online tutorials, although very few mentions of critical-thinking-specific library tutorials exist in the literature. For the purposes of this study, the definition of an online tutorial is a self-directed, online module of content that can be accessed at the point-of-need.

One of the most important methods of promoting critical thinking in information literacy instruction is to, as an instructor, improve one's own critical thinking and reflective practice (Gibson, 1995). Modeling this behavior can be a potent motivator for students to adopt critical thinking skills and dispositions. Facilitating this change requires new habits and new approaches to information literacy instruction (Gibson, 1995), especially in the online environment. Unfortunately, including critical thinking in

information literacy instruction may require more preparation, allow for less control in the classroom, and demand close examination of the librarian's own skills, all of which requires more effort and commitment (Atton, 1994).

2.6 Best Practices for Teaching and Assessing Critical Thinking in Information Literacy Online Learning Objects

Van Gelder (2005) identifies five characteristics of successful online critical thinking instruction: 1) motivating (encouraging students to deliberately practice), 2) guided (including clear instructions about what students should be doing when), 3) scaffolded (preventing students from attempting content which is beyond their skill level), 4) graduated (using gradually more complex activities), and 5) providing feedback. Additional best practices for online tutorials described in the literature include the ability for students to direct the learning experience themselves and access the content at the point-of-need (Reece, 2005). Online tutorials should also be interactive, engaging the student throughout the module. The author defined interactivity as consisting of the following elements, roughly from least to most engaging: navigational elements (which allow students to direct themselves to specific areas of the tutorial), assessment (such as quizzes and knowledge checks), interactive design elements (such as drop-down, drag-and-drop, and other features which require students to manipulate the interface in the process of learning), games, and simulation (which require the student to accomplish the task that the tutorial attempts to teach within the tutorial itself) (Goodsett, 2014).

Johnson and Aragon have also developed a framework for online instruction which consists of principles like "encourage student reflection" and "provide hands-on activities" (2003, p. 34). Their recommendations overlap somewhat with Van Gelder's,

but Johnson and Aragon also call for the content of online learning to be limited and divided into smaller segments, for the instructor to create a personal connection with students, and for students to reflect on their learning through one-minute papers, journals, or other methods (2003). They also encourage the use of multiple formats in the online environment to better address the individual differences of students.

In examining the best practices for teaching online information literacy tutorials that promote critical thinking, Reece (2005) developed some additional recommendations. She encouraged the use of controversial topics that draw from relevant, real-world examples, the inclusion of concept-based content (not just skills- or tools-based) that addresses necessary lower-order and higher-order thinking skills, and the maintenance of high expectations for students completing the tutorial (2005). The content should be kept challenging enough to drive and engage students without confusing or frustrating them (by, for example, limiting the use of library-specific jargon) (Reece, 2005).

In an effort to evaluate the best practices in the design of online modules for the health sciences, Foster and Pepper (2014) underwent a similar process to the one being set forth in this study. The researchers first used a literature review to identify the best practices for creating online modules that attempted to teach evidenced-based practice. Then, they located freely available online modules which met their criteria and evaluated them against the best practices they had developed. While the evaluation criteria that they developed were broader than is appropriate for this study (they were judging the overall quality of online modules, not just their match to best practices for teaching critical thinking), some of their criteria have been adopted for this study. Their focus on Bloom's

taxonomy levels and their judgement of interactivity in particular are useful for developing a best practices rubric.

Su and Kuo (2010), while not focusing on critical thinking in particular, also attempted to assess the design of online information literacy tutorials found in the Peer Reviewed Instructional Materials Online Database (PRIMO), as is explored in this study. They focused on the general content of the tutorials and their adherence to general best practices for online learning. They found that many of the tutorials focused on academic tools or skills, while fewer focused on information literacy concepts like information ethics and intellectual property. They also found that most of the tutorials (76%) used some visual engagement such as graphics, Flash animation, and voice-over narration. The scholars also assessed how many clicks away from the library homepage each tutorial was, and found that most libraries made the tutorial available within only one or two clicks. As described in Su and Kuo's study, issues about interactivity in particular were taken into consideration in the development of best practices for this study.

While similar to best practices for teaching critical thinking in online information literacy tutorials, the best practices for assessing critical thinking require the incorporation of several more elements to the rubric. When using multiple-choice questions, which are often ideal for online tutorials for their ease of creation and analysis, librarians should take care to craft questions which require higher-order thinking skills (Reece, 2005). As described earlier, Morrison advised instructors to create critical thinking multiple-choice assessments that ask students to justify their answers, are written for high cognitive levels in Bloom's taxonomy, require knowledge of more than one concept, and present multiple plausible alternatives from which to choose (2001). To

41

develop the skills of transfer, any assessments in the tutorial should require the student to apply skills developed in the tutorial to new situations. In addition, assessments in the tutorial should provide immediate feedback to students and, if necessary, review content that, as revealed by the assessment, is not yet understood (Reece, 2005).

The best practices rubric developed for this study based on the preceding review of the relevant literature can be found in Appendix B, and the scoring scale can be found in Appendix C.

CHAPTER III

METHODS

3.1 Population and Sample

This study attempts to determine the ways and extent to which online information literacy learning objects follow best practices for teaching and assessing critical thinking. To accomplish this analysis, the researcher examined a sample of information literacy online learning objects archived in the Academic and Research Library Association's (ACRL's) repository of peer-reviewed information literacy online instruction materials, PRIMO (Peer-Reviewed Instructional Materials Online). The PRIMO database was chosen for this study because it consists of the online learning objects which the profession has designated of highest quality through a peer-review process.

PRIMO consists of 313 learning objects that have been reviewed by instruction librarians and have met a rigorous set of standards. The PRIMO standards (used by the PRIMO Committee members, who make selections for the database) consist of criteria such as the instructional design of the submission, the innovative use of technology, the accuracy and organization of the content, and the submission's potential to be used as a model for other institutions (ACRL PRIMO). While none of the criteria require the online

learning object to teach critical thinking, the committee does look for submissions that

"offer opportunities to utilize higher order thinking skills (think, reflect, discuss,

hypothesize, compare, classify, etc.)" (ACRL PRIMO). However, each submission is

scored as a whole, and learning objects that reach a designated score are added to the

database, regardless of whether each criterion was met. This study provides useful data

about how many and which submissions meet the criterion about higher-order thinking

and, more specifically, which may solicit critical thinking.

  While the ACRL PRIMO Committee does not define "online learning object" or

what kinds of formats are accepted into their database, for the purposes of this study, the

researcher defines online learning object (OLO) as a modular unit of interactive content

designed to teach one to two learning objectives and that is accessible online. PDF

documents, static content, and entire online courses would not qualify as online learning

objects under this definition. Any OLO that was not accessible to the researcher at the

time of the study (whether through technology errors or log-in barriers) was not included

in the sample.

  Due to the prevalence of broken links and obsolete technology in PRIMO tutorials

created before 2012, the learning objects reviewed for this study consisted only of

PRIMO materials created in the last five years (2013-2017) as indicated by the PRIMO

metadata. This reduced the sample to 71, although some PRIMO submissions consist of a

collection of tutorials rather than a single learning object. When each tutorial was counted

individually, the total number of tutorials was 261. To extract a meaningful sample from

this collection, the researcher numbered each learning object, including the individual

learning objects within a single PRIMO submission. Then, she used a random number

generator to select online learning objects to be included in a representative sample. The sample consisted of 158 OLOs, which results in a 95% confidence level and a confidence interval of 5 (National Statistical Service of Australia, n.d.).

3.2 Scoring and Analysis

For each learning object in the sample, the researcher used the previously referenced, literature-based rubric of best practices for critical thinking instruction and assessment in information literacy learning objects (see Appendices B and C) to determine a score in each of three major categories, as well as an overall score. The major categories of the rubric are critical thinking instructional strategies (CTIS), critical thinking assessment strategies (CTAS), and online learning elements (OLE). Each OLO then underwent comparative analysis, as well as a statistical mechanism called data envelopment analysis. Data envelopment analysis is a statistical method of producing an overall score for individual units which have been scored across many factors. The production of a comparable overall score for each OLO allows the researcher to more easily compare the tutorials and identify overall trends. The score in each of the three categories for each OLO were determined, and the analysis process resulted in an overall score for each object. OLOs were compared against one another, and the analysis process produced a high-performing frontier among all analyzed learning objects. Learning objects with a particularly high and low score were revealed through the data envelopment analysis process, allowing for further review and study.

The content of the tutorials was also mapped against a list of Frames from the ACRL Framework for Information Literacy (ACRL, 2015) and the list of critical thinking skills developed by the American Philosophical Association (Facione, 1990). This

mapping process did not contribute to the scores of each online learning object, but it did produce data about the prevalence of online information literacy instruction that targets particular Frames and critical thinking skills.

3.3 Value of Study

The value of the results is twofold: the instruction librarian community can gain a better sense of the current success of librarians in eliciting critical thinking in their assignments, and the librarian community is able to use the best practices rubric to assess their own information literacy online learning objects. Online learning objects with a particularly high critical thinking best practices score were also identified, so they can serve as a model for librarians hoping to develop critical thinking online learning objects for teaching information literacy.

CHAPTER IV

RESULTS

Most educators agree that critical thinking is important to higher education
curricula, and librarians have already explored the relationship between information
literacy and critical thinking. Determining the performance rating of library online
learning objects (OLOs) in promoting critical thinking can help the librarian community
gauge how much instruction librarians are relying on critical thinking instructional
strategies. It also allows librarians to identify areas for improvement in promoting critical
thinking via information literacy OLOs.

4.1 Highest Overall Scores

Overall scores for each online learning object (OLO) were calculated in three
ways: by adding all of the scores for each element (raw score, RS), by counting the
number of elements present (element score, ES), and by conducting data envelopment
analysis (DEA). Together, these overall scores provide information about the number of
elements used in the sample OLOs, and how well the strategies were employed.

According to William C. Cooper (n.d.), pioneer in the development of DEA, this
statistical process is "a linear programming based technique for measuring the relative
performance of organisational units where the presence of multiple inputs and outputs

makes comparisons difficult" (Cooper, n.d.). This method is often used to measure efficiency across heterogenous units within an organization using the same parameters. It can be difficult to compare units against one another when their inputs, outputs, and priorities vary. The DEA method allows units to be compared against one another, and it allows the user to prioritize some parameters of comparison more than others. This statistical method was chosen to evaluate the data generated by this study because 1) it allowed the OLO scores to be compared against one another to generate a frontier, and 2) it provided a consistent overall score for objects measured across varying criteria. The frontier consists of the most efficient units after DEA has been conducted. In the context of this study, "efficiency" is defined as robust use of a wide variety of critical thinking instructional strategies, critical thinking assessment strategies, and online learning elements.

Out of the 261 PRIMO OLOs that met the criteria for inclusion (see Chapter 3), 158 were scored using the rubric. The overall raw score (RS) mean for the sample was 9.19, and the overall element score (ES) mean was 4.37. The maximum number of points possible for an RS was 42 and for an ES was 14, but a very high score would not necessarily indicate an OLO was better at following best practices, as it would be perhaps overwhelming and detrimental to include every single critical thinking instructional and assessment strategy in one OLO.

The OLOs with the highest RS (20) were "My Learning Essentials Online: Finding a job: Writing an effective CV" and "Research Success Tutorial Suite: Identifying Keywords." The OLOs with an RS of 16 or more were also examined on their own; this score cut-off was chosen because it made up approximately the top 10% of the

sample in regard to RS. Sixteen OLOs had an RS of 16 or more (out of 158). There were three OLOs that received the highest element score, or ES (9). In addition to the two OLOs that had the highest RS, OLOs with the top ES included the OLO titled, "Exploring Academic Integrity Tutorial." There were 12 OLOs that had an ES of eight or more (out of 158, 8%), a segment of the overall sample that, again, made up approximately the top 10% of the sample.

The DEA process produces a "frontier" of high performing study subjects. The OLOs that form the frontier performed best, taking into account their scores across the various rubric categories. In this case, the DEA process found 41 OLOs that made up the frontier line (receiving an efficiency score of 1), which was 26% of the sample. The frontier included the three OLOs that received top ES or RS scores. An additional 65 OLOs received an efficiency score above 0.5, while the remaining 52 received a 0.5 or below.

4.1.1 Highest overall scores, ACRL frames, and critical thinking skills. Each OLO was assigned up to three ACRL Frames and critical thinking skills. Assignment of ACRL Frames and critical thinking skills was not exclusive (each OLO could have up to three assigned in each category). Twenty-five OLOs were not assigned any ACRL Frames, and 36 were not assigned any critical thinking skills. Overall, the ACRL Frame "Searching as Strategic Exploration" was assigned most often (75 times), followed by "Information Creation as a Process" (31 times).
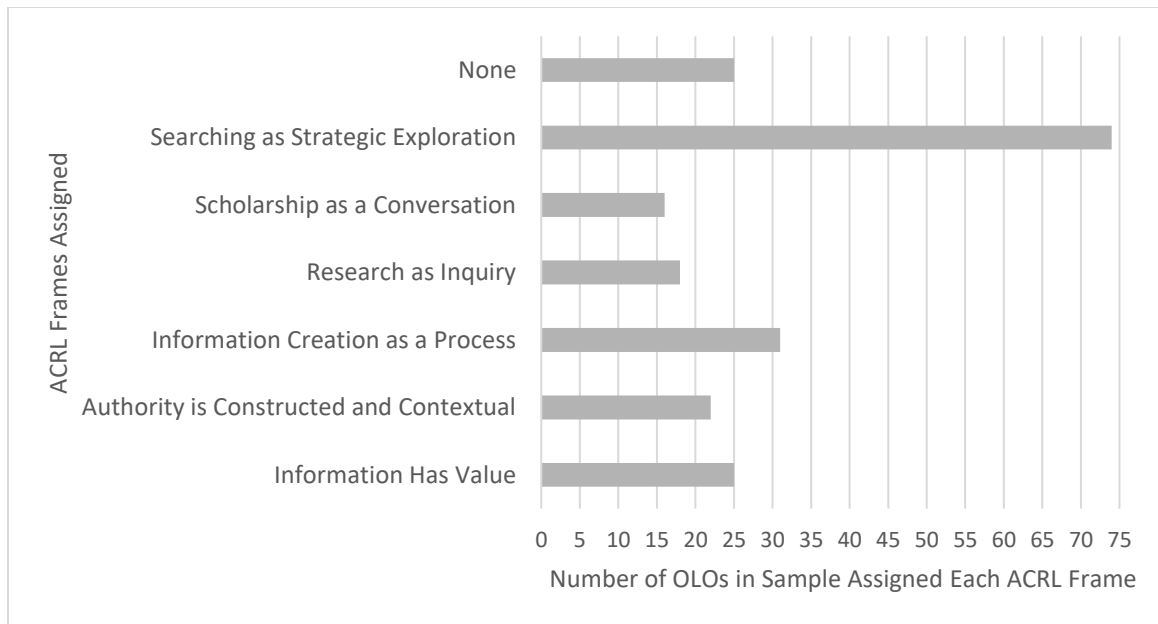
Figure 1. ACRL Frame Designation for Entire Sample (n=158)

Among the critical thinking skills, "Querying Evidence" was assigned most often (61 times), followed by "Examining Ideas" (38 times). "Analyzing Arguments" was only assigned once, and "Conjecturing Alternatives" twice.

Figure 2. Critical Thinking Skills Designation for Entire Sample

Of the top 10% (RS) of OLOs, the ACRL Frame most often assigned (8 times)

was "Searching as Strategic Exploration," and other ACRL Frames designated included

"Information Creation as a Process" (6), "Research is Inquiry" (4), "Authority is

Constructed and Contextual" (3), and "Scholarship is a Conversation" (2). Three of the

top-RS OLOs were not assigned any Frames. Among the top 10% (RS) of OLOs, 11

addressed the critical thinking skill "Examining Ideas," six addressed "Querying

Evidence," and six other skills were present at least twice. Examining ideas includes

skills like identifying issues and their relationships to one another, and defining terms.

Querying evidence involves judging the appropriateness of information to a question or

issue and developing strategies to acquire necessary information (Facione, 1989). All of

the top 10% (RS) of OLOs were assigned at least one critical thinking skill.

Figure 3. ACRL Frame Designation for Top 10% (RS) of OLOs
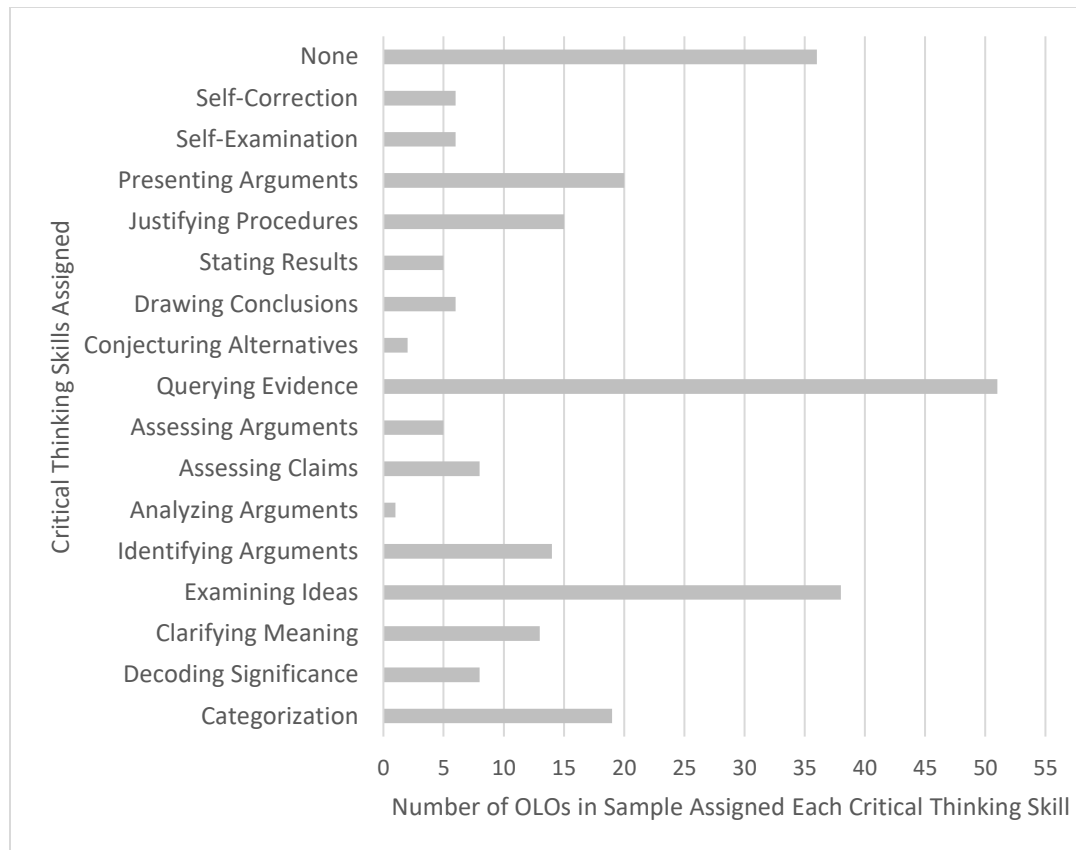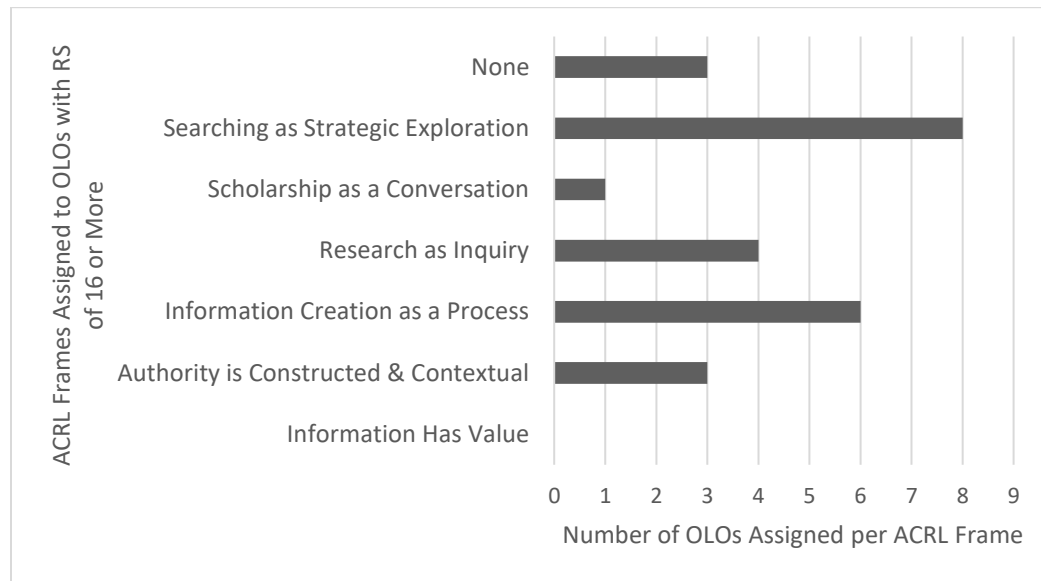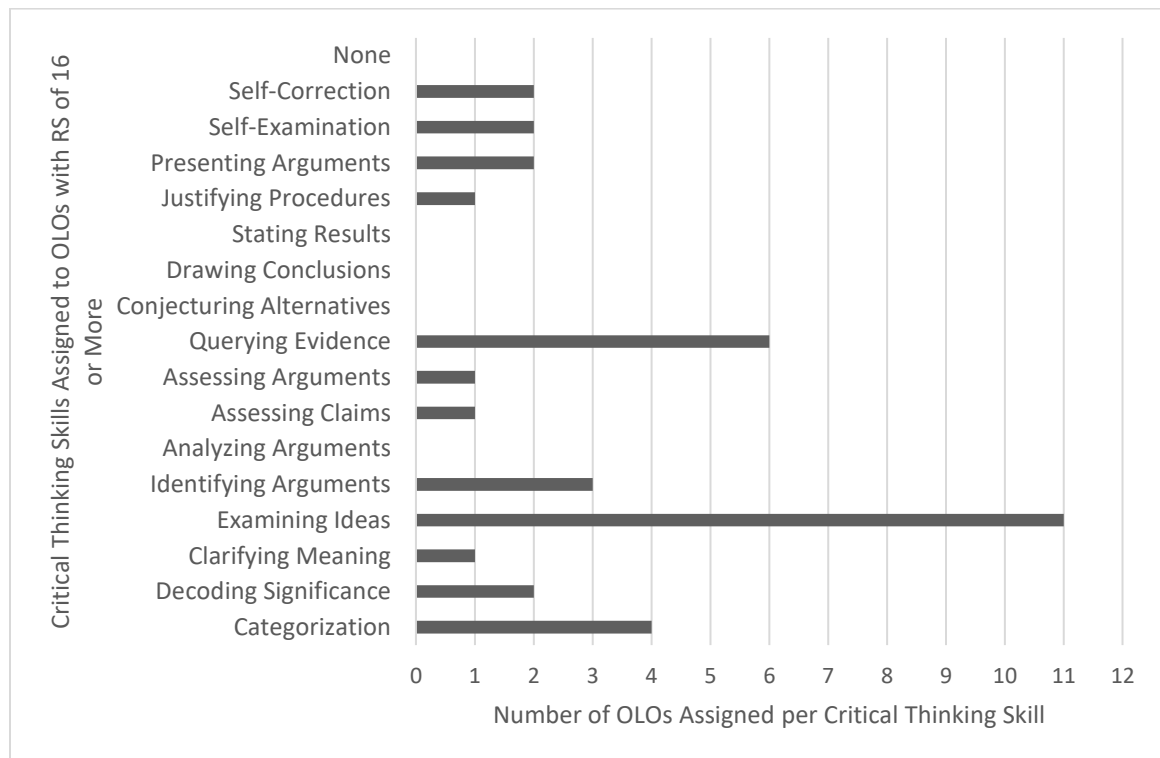

Figure 4. Critical Thinking Skills Designation for Top 10% (RS) of OLOs

Of the top 10% (ES) of OLOs, the ACRL Frame most often assigned (5 times) was also "Searching as Strategic Exploration," and all other Frames were assigned at least once, except "Information Has Value." Among the critical thinking skills that could be assigned, the top 10% (ES) of OLOs also were assigned "Examining Ideas" most often (5), and all other critical thinking skills at least once, except "Analyzing Arguments," "Conjecturing Alternatives," and "Stating Results." All of the top 10% (ES) of OLOs were assigned at least one critical thinking skill.

4.1.2 Highest overall scores and categories. Each OLO was evaluated against criteria in three categories: critical thinking instructional strategies (CTIS), critical thinking assessment strategies (CTAS), and online learning elements (OLE). For each criterion, OLOs could be scored up to three points (see Appendix C). Of the sixteen OLOs that made up top 10% (RS), the mean CTIS score was 6.81 (as compared to the overall mean in that category, 1.73), the mean CTAS score was 4.50 (as compared to the overall mean in that category, 2.17), and the mean OLE score was 11.56 (as compared to the overall mean in that category, 5.28). Of the 12 OLOs that made up the top 10% (ES), the mean instructional strategies score was 2.67 (as compared to the overall mean in that category, 0.91), the mean assessment strategies score was 2.17 (as compared to the overall mean in that category, 1.18), and the mean online learning strategies score was 3.42 (as compared to the overall mean in that category, 2.28).

4.1.3 Highest overall scores in each category. The critical thinking instructional strategies (CTIS) category included six strategies. The OLO with the highest RS in the CTIS category (8) was titled "My Learning Essentials Online: The big picture: achieving your academic goals." This OLO used the strategies "Authentic/Real World Problems"

(score of 2) "Graphic Organizer" (score of 3), and "Reflection" (score of 3). Twelve OLOs tied for the highest ES in the CTIS category (3), although their RS ranged for each from 3 to 8, suggesting that the effectiveness of CTIS element use ranged widely.

There were three strategies for the critical thinking assessment strategies (CTAS) category. Three OLOs had the highest RS for the CTAS category (7): "Y Search: Critical Reading," "Analyze Your Research Strategy," and "Developing a Research Question." All three OLOs received a score of 3 for "Feedback," 1 for "Multiple-Choice Question Formation," and 3 for "Open-Ended Questioning." Fourteen OLOs tied for the highest ES in the CTAS category (3, the highest possible score, because the rubric included three strategies). There was also a wide range of RS scores for the highest ES OLOs in this category (from 2 to 7).

The online learning elements (OLE) category had five criteria. Two OLOs had the highest RS for the OLE category (11): "Access and Explore the Library's Business Databases" and "A Suite of Interactive, Foundational Information Literacy Tutorials: Anatomy of a Citation and Reference." Both OLOs received a score of 3 for "Instructor Help/Support," 3 for "Navigation," 3 for "Personalized Presence," and 2 for "Interactivity." Twenty-two OLOs tied for the highest ES in the OLE category (4). The range of RS for high ES OLOs in this category was much smaller, with scores ranging from 7 to 11.

4.2 Best Teaching and Assessment Strategy Scores

The CTIS and CTAS sections measured OLOs against best practices for specific methods. Some OLOs scored particularly well regarding these specific methods. The

number of OLOs that scored highly for use of each strategy, percent of OLOs that used it, and the mean score for OLOs that used the strategy were calculated for comparison.

4.2.1 Critical thinking instruction strategies scores.

Table 1

Critical Thinking Instructional Strategies

Strategy	Highest Score Assigned[a]	Number of OLOs with Highest Score	OLOs That Used Strategy		
			Number of OLOs[b]	Percentage of OLOs	Mean Score for OLOs[a]
Discussion	2	1	2	1.27%	1.5
Inquiry-Based Learning	3	4	26	16.46%	1.97
Authentic/ Real-World Problems	3	3	36	22.78%	1.8
Graphic Organizers	3	4	20	12.66%	1.75
Reflection	3	14	29	18.35%	2.31
Practice and Repetition	3	3	30	18.99%	1.65

Note. a=out of 3, b=out of 158

In the CTIS section, there were six strategies in the scoring rubric. All methods were present in at least one OLO, although no OLO received the highest rating (3) for the discussion method. Discussion, according to Abrami, et al. (2014), consists of critical dialogue between individuals about a problem or question. In the online environment, this would most likely consist of an online discussion forum, as it must have a back-and-forth component to qualify as a discussion. One OLO, "My Learning Essentials online: Study strategies for success," received a score of 2 for discussion. The OLO creators accomplished this by encouraging OLO users to continue the conversation about the OLO's topic online using Twitter and a specific hashtag. Only two (out of 158, 1.27%) of

the OLOs used discussion as a teaching strategy. The mean score for those OLOs that used discussion was 1.5.

Inquiry-based learning, as described by Alison King (1995), emphasizes developing students' habits of inquiry so they can ask thoughtful questions in real-world contexts. Questioning activities could include students answering questions, developing their own questions, or questioning their peers (King, 1995). Four OLOs received the highest score (3) for inquiry-based learning methodology: "A Suite of Interactive, Foundational Information Literacy Tutorials: Creating a Thesis Statement," "Life Sciences Library Tutorial," "Navigate: UWF Libraries Research Tutorials: Formulating a Good Research Question," and "PICO: Research Questions for Health Sciences." These OLOs provided guidance in creating strong research questions and asked users to create their own questions. Often, many example questions were provided. The "Life Sciences Library Tutorial" OLO focused on generating questions during the source evaluation process. The "PICO" OLO also encouraged reflection by encouraging students to "ask yourself" questions during the research process. Out of all OLOs evaluated (158), 26 used this strategy (16.46%). The mean inquiry-based learning score for these 26 OLOs was 1.97.

The use of ill-structured problems and real-world examples is an important strategy for promoting critical thinking transfer (King & Kitchener, 2004; Reece, 2007). Incorporating authentic problems that students often encounter outside of academia may also help to develop their disposition to think critically (Reece, 2007). Three OLOs employed the instructional strategy titled authentic/real world problems and received the highest score (3): "Bowman Library Research Skills Tutorial: Module 2 – Searching,"

"Being digital: Information Universe," and "Being Digital: Search Slips and Tips." These OLOs explored complex, authentic topics that were not simply academic. Although none of the examples followed the conventions for teaching with ill-structured problems, the issues introduced did not have easily-determined answers. Both the Bowman Library and the "Being Digital: Search Slips and Tips" OLOs discuss information literacy skills for use in the workplace using case studies or examples. The "Being Digital: Information Universe" OLO explores real-world information sources and the scenarios in which they might be useful. All of the OLOs ask the students to engage with the content and make decisions based on the scenarios. Thirty-six OLOs (out of 158) used this strategy (22.78%). The mean score for authentic/real world problems among the OLOs that used this strategy was 1.80.

Graphic organizers can consist of concept maps, argument trees, or any other visual organization of a complex topic (Park, et al, 2013; Van Gelder, 2001). Four OLOs scored 3 (the highest score) for the use of graphic organizers to teach critical thinking: "My Learning Essentials Online: Revision Strategies: Managing your revision successfully," "My Learning Essentials Online: The Big Picture: Achieving your academic goals," "InfoRhode Tutorials: Start," and "InfoRhode Tutorials: Identify." These OLOs asked participants to create or add content to charts, forms, or maps that graphically organized the information. The content of these organizers varied from note-taking and goal-setting templates and study schedules, to concept maps and other research topic exploratory graphics. Examples were often provided. In all the high-scoring OLOs, students were asked to actively organize information in a graphic way within the context of the platform. In addition, the "My Learning Essentials" OLOs

allowed participants to save and print their completed graphic organizers for future reference. Twenty (out of 158) OLOs used this instructional strategy (12.66%). Of these, the mean score was 1.75.

An important critical thinking instructional strategy that encourages metacognition is reflection (Halpern, 1998). Questions that encourage students to consider why and how they undertake problem-solving tasks may help develop critical thinking dispositions and encourage them to self-interrogate in the future (Kuhn & Dean, 2004). Many OLOs scored highly on the use of reflection as an instructional strategy; 14 OLOs received the highest score (3). The use of reflection in these OLOs often involved asking participants to consider their own learning process or decisions, and to record these observations in open-response question blanks. The OLOs that did especially well promoting reflection were part of the "Being Digital" and the "My Learning Essentials" series; both provided OLOs framed as self-assessments, meant to help students deliberately examine their own study and learning habits and make plans to improve them. Out of all of the OLOs evaluated (158), 29 used reflection (18.35%). The mean score for reflection among OLOs that used the strategy was 2.31.

Another important critical thinking instructional strategy is to offer opportunities for students to practice transfer (Van Gelder, 2005). Van Gelder calls this deliberate repetition "quality practice" (Van Gelder, 2005), and it often involves multiple exposures to important concepts and repetition when a student has not successfully demonstrated mastery of a concept. Three OLOs received the highest score (3) in the category of practice and repetition: "My Learning Essentials Online: Knowing Where to Look: Your search toolkit," "My Learning Essentials Online: Planning Ahead: Making your search

work," and "Access and Explore the Library's Business Databases." These OLOs did more than allow students to repeat parts of the OLO content; they encouraged repetition and helped students understand when more practice was necessary. Thirty out of 158 (18.99%) OLOs used practice and repetition as an instructional strategy. The mean score for practice and repetition (among OLOs that used the strategy) was 1.65.

4.2.2 Critical thinking assessment strategies scores. There were three strategies evaluated in the CTAS category, and many OLOs received the highest score for each of these strategies. Twenty-three OLOs received a score of 3 for the use of feedback. This score was only given if feedback was immediately given and tailored to the user response (Van Gelder, 2005). About half of the OLOs (49.37%; 78 out of 158) used some kind of feedback as part of their assessment strategy. Of those OLOs that used feedback, the mean score was 2.29.

Table 2.

Critical Thinking Assessment Strategies

| Strategy | Highest Score Assigned[a] | Number of OLOs with Highest Score | OLOs That Used Strategy | | |
			Number of OLOs[b]	Percentage of OLOs	Mean Score[a]
Feedback	3	23	78	49.37%	2.29
Multiple-Choice Question Construction	2	18	75	47.47%	1.24
Open-Ended Questions	3	13	33	20.89%	2.15

Note. a = out of 3, b = out of 158

None of the OLOs scored above a 2 in the category of multiple-choice construction. A three would only have been awarded to an OLO that met three or more of the four criteria established by Morrison and Free (see section 2.3.3). Although many

OLOs used multiple-choice questioning, often not all of the alternatives given were

plausible and the questions did not require higher-order thinking to answer. None of the

OLOs asked students to justify or rationalize their choice. Overall, 47.47% (75 out of

158) of the OLOs in the sample used multiple-choice questioning and, of those, 18

received a score of 2. Of those OLOs that used multiple-choice questioning, the mean

score was 1.24, which is the lowest mean among all instructional and assessment

strategies.

Open-ended questioning is an assessment strategy that can help evaluate both

critical thinking skills and dispositions (Giancarlo, et al., 2009). Fewer OLOs used the

assessment strategy of open-ended questioning. Thirteen OLOs received the highest score

(3) in this category, and 33 (out of 158; 20.89%) used the strategy overall. OLOs that

asked students to use higher-order thinking when responding to open-ended questions

received the highest score. Of those OLOs that used open-ended questioning, the mean

score was 2.15.

CHAPTER V

DISCUSSION

This study attempted to answer the question "In what ways and to what extent do online information literacy learning objects follow best practices for teaching and assessing critical thinking in higher education?" There are limitations to this study that prevent the data from advancing a definite answer to this question, but the data do reveal some insights important to beginning to answer it.

5.1 Best Practices, the ACRL Framework, and Critical Thinking Skills

Because each OLO in the sample was assigned particular Association of College & Research Libraries (ACRL) Frames and critical thinking skills as described by the American Philosophical Association (APA) during the study's scoring process, it was possible to compare the assignment of the Frames and skills to use of best practices. Examining these matches is useful because they reveal correlations between focus on particular skills or Frames and the success of individual OLOs in following best practices for teaching and assessing critical thinking. In this case, examination showed that the highest scoring OLOs often correlated with Frames and critical thinking skills that emphasized search strategies.

Although all of the OLOs in the sample were accepted into the librarian-curated PRIMO database, not all objects were assigned an ACRL Frame in the course of this study. Some OLOs explored topics that are only tangentially related to information literacy, such as study habits, building a CV, and note-taking. However, of the OLOs that were assigned an ACRL Frame, the top-scoring OLOs (both RS and ES) were assigned "Searching as Strategic Exploration" most frequently, and this Frame was assigned most frequently by far across the sample (74 times). Many of the OLOs focused on the basic mechanisms of searching, such as database functionality, keyword development, and research question construction. The critical thinking skills most often used reflect a similar focus: "Querying Evidence" and "Examining Ideas." These skills involve the ability to find and evaluate evidence, and, as explored in the literature, information literacy and critical thinking seem to overlap most at this juncture. Skills like "Analyzing Arguments" were assigned much less frequently, perhaps because this close examination of content is often not emphasized in information literacy instruction.

While the researcher hypothesized that OLOs that explored "Authority is Constructed & Contextual" would score highest in best practices for critical thinking instructional strategies because of the topic's relationship with the "critical" part of critical thinking, this was not the case. Relatively few OLOs were assigned this Frame (22, 14%), and none of the top-scoring OLOs (both RS and ES) were assigned it. Regarding search strategies, which are within the wheelhouse of librarians, there appears to be plenty of opportunity to employ critical thinking instructional strategies, and to do so skillfully. At the same time, it may be useful to employ critical thinking strategies in

online tutorials with other aspects of information literacy where there may be overlap, such as with source evaluation.

5.2 Presence and Application of Best Practices

Score analysis of the OLOs in the sample reveal how much and in what ways librarians are employing critical thinking teaching and assessment strategies in their online learning objects. While more research must be done to fully understand how librarians and faculty use OLOs in the context of other, in-class instructional techniques, taken on their own, OLOs from this sample provide examples, correlational data, and insights into the use of critical thinking techniques by librarians.

Overall, examination of OLO scores showed that some OLOs did adhere to best practices in several ways, and their use of critical thinking instructional and assessment strategies was robust. However, the average OLO in the sample scored much lower than the highest-scoring OLOs, and even for those OLOs that used many strategies, they were not often robustly executed. OLOs tended to use real-world examples, practice and repetition, multiple-choice questioning, and feedback as strategies for instruction and assessment. Multiple-choice questioning especially showed room for improvement.

5.2.1 Mitigating factors. Before exploring the application of best practices for teaching critical thinking in this sample, it is important to recognize several mitigating factors. First, some of the OLO creators in this sample may not have been attempting to teach critical thinking. Ascertaining the intent of the OLO creator was not possible within the scope of this study, so all OLOs were assessed for the presence of critical thinking best practices. However, OLOs which teach basic skills provide an important foundation for learning critical thinking skills (Gibson, 1995). Unless students understand the

mechanisms by which to find information, they will not be able to evaluate and use it critically. Therefore, the OLOs that were assigned low scores in this study should not be undervalued. One implication of this study is that not every information literacy OLO teaches critical thinking, and perhaps not all should.

However, the overall mean RS of OLOs in the samples was fairly low (9.19) compared to the highest scoring OLOs (20), and the percentage of OLOs that used critical thinking instructional and assessment strategies was low for each strategy. As demonstrated by the literature, there is significant overlap between information literacy and critical thinking, so the overall number of OLOs generated to teach information literacy should, perhaps, use more of these strategies and use them in a more robust way. In addition, as Gibson (1995) points out, tools and technology may change, and focusing too heavily on them reduces transferability of skills. Concentrating on higher order thinking and underlying concepts improves the usefulness of the OLO and student retention of the material.

Another mitigating factor in the analysis of this data are limitations in the rubric. Via the rubric, non-interactive videos that only ask students to watch passively and don't include assessment score quite low. The low scoring of these OLOs may be a flaw in the rubric, as some videos may indeed encourage critical thinking by nature of the complexity and compelling presentation of their content. The rubric scoring still has merit, however, because, regardless of content and intentions, interactivity in online learning objects has been shown to improve student engagement with the content (Van Gelder, 2005). Determining the topic of each OLO and its appropriateness for teaching critical thinking skills was outside the scope of this study.

Finally, an additional consideration in this study is the absence of context for each OLO. Faculty or librarians may pair an OLO with in-class activities or with other homework. These additional exercises may promote critical thinking more effectively than the OLO alone. In fact, a simple OLO that does not engage higher order thinking may improve in-class instruction and provide better opportunities for critical thinking instructional strategies in the classroom. It was not, however, within the scope of this study to determine the context for each OLO's delivery.

5.2.2 Overall trends. Across the sample, there was a gap between the highest-scoring OLOs and the average OLO scores, both overall and within each major category. Scores for critical thinking instruction and assessment (as opposed to online learning elements) were especially low, on average, compared to the highest-scoring OLOs. Even those OLOs that used many instructional or assessment strategies often did not score highly on their use, indicating that their application within the context of the OLO could be improved.

The mean RS for all OLOs in the sample (9.19) was much lower than the RS for the highest scoring OLOs (20). While it is difficult to determine the extent to which information literacy OLOs follow best practices for teaching and assessing critical thinking without a control or standard for performance, internal score comparisons show that some OLOs performed very highly in contrast with most of the sample. It is possible to create an information literacy OLO that incorporates many instructional and assessment strategies for critical thinking, as demonstrated by the high-scoring OLOs. Understandably, barriers of time, money, or personnel may prevent librarians from

adding these elements; however, when this is not the case, the addition of critical thinking strategies could improve the impact of information literacy OLOs.

While OLO topics were not formally determined in this study, the subjects of the top-scoring OLOs did not seem to fall into a single category. In fact, of the two OLOs with the top RS, one addresses a topic that is not often considered relevant to library instruction (writing an effective CV). It did not seem that OLO subject correlated with high RS or ES scores.

Ennis (1989) established that there are several ways to approach critical thinking instruction, including generic critical thinking courses, subject-specific critical thinking training, and critical thinking instruction that is explicit or implicit. A later meta-analysis (Abrami et al., 2014) found that most effective critical thinking instruction explicitly alerts students that a learning outcome for the content is improved critical thinking skills. Ennis (1989) calls this approach to teaching critical thinking "infusion" (p. 5). Of the OLOs examined in this study, only two explicitly mentioned critical thinking. Direct mention of critical thinking in the context of the OLO could help prepare students to employ the high level of mental work required for critical thinking.

Because the sample was scored both in terms of quantity of strategies employed and quality of strategy usage, it was possible to determine if OLOs had both used many strategies and executed them well as compared to the rubric parameters. Overall, RS and ES scores overlapped, showing that the very highest scoring OLOs used many strategies well. This was not the case for OLOs within each major category (CTIS, CTAS, and OLE). The range of RS scores for top ES-scoring OLOs in CTIS and CTAS was wide,

indicating that some OLOs used many strategies, but did not score highly on the quality of their use.

Overall, more OLOs used the assessment strategies than the instructional strategies. Many of the OLOs also scored highly in the OLE category, both in the number of elements used and the raw score for use of each element. This may be because the PRIMO rubric itself lists good online learning instructional design as a criterion of acceptance into the database.

5.2.3 Category trends. When it comes to CTIS, the most commonly used strategy was real-world/authentic examples, followed by practice & repetition, and reflection. Very few OLOs used discussion, which is not surprising, given the difficult nature of including discussion in a non-synchronous online tutorial. In addition, discussion (1.5) had the lowest mean score among OLOs that used critical thinking instructional strategies, indicating that its use was generally weak. While the literature showed that some critical thinking strategies can be used online, and these strategies were therefore incorporated into the rubric for this study, much of the literature assumed these strategies could be employed in a learning management system in the context of a semester-long course. Because librarian-created OLOs are often used asynchronously by students, and rarely by all the students in a course, some of these strategies could prove challenging to employ. Discussion, examination of ill-structured problems with others, and group work, all of which are literature-supported critical thinking instructional strategies, cannot be easily incorporated into an OLO that is viewed once in isolation.

However, judging from the higher scores and more frequent use of some strategies among the OLOs in the sample, some strategies are indeed possible in an

asynchronous online environment, and can be executed skillfully. For example, reflection is often a solitary activity, and it can be completed by a student within the platform of an OLO fairly easily. The use of real-world problems as subject matter for an OLO is also possible and potentially valuable within the context of an OLO. Practice and repetition of content is, perhaps, even easier in an OLO than in the classroom, because student answers to assessments in an OLO can determine whether content or assessments should be immediately repeated. OLOs provide an important opportunity to help students begin to recognize the underlying structure of problems, employ the correct critical thinking strategy, and practice identifying problems and strategies for improved performance.

Among the OLOs that used CTIS and CTAS, reflection (2.31), feedback (2.29), and open-ended questioning (2.15) all had a relatively high mean score, indicating that their use was generally robust. Multiple-choice question formation (1.24) had the lowest mean scores among OLOs that used critical thinking assessment strategies, indicating its use was generally weak. Feedback was the most common CTAS (about half of OLOs employed the strategy), followed by multiple-choice questioning. Mean scores for OLOs that used feedback and open-ended questioning indicate they were used fairly robustly. However, multiple-choice questioning, while used often, had a low mean score, and no OLOs received the highest score. Overall, many OLOs used simplistic multiple-choice questions with answer choices that did not call for a high level of discrimination. Improving the use of multiple-choice questioning in OLOs is an important consideration, as this type of question is common in OLOs that may be completed by many students and need to be graded efficiently. The literature provides some guidance for how this kind of questioning can be improved to better measure critical thinking, and future information

literacy OLO creators might find these suggestions useful for improving OLO assessment.

5.2.4 Examples of successful use of best practices. Fortunately, for those librarians who are hoping to improve students' critical thinking skills, this study presents strong examples of literature-supported techniques and best practices in information literacy OLOs. The best practices that make up the study's rubric describe some strategies which are most consistently used in classroom teaching (rather than online). One value of this study is the demonstration by high-scoring OLOs of how these general strategies can be successfully applied to brief, fully online learning objects (for a list of OLOs referenced in this study, see Appendix E).

The OLOs with the highest RS were "My Learning Essentials Online: Finding a Job: Writing an effective CV" and "Research Success Tutorial Suite: Identifying Keywords." The online learning elements of the "Writing an Effective CV" OLO were very polished and the OLO received a 2 (moderate) for navigation, instructor help, and scaffolding/gradation, and a 3 (robust) for interactivity. The instructional strategies that were used included authentic problems (the subject was a real-world issue), reflection (users were asked to reflect on their note-taking by comparing it to feedback), and practice (the student was given multiple examples and opportunities to practice the same skill). The OLO also received a 3 (robust) for open-ended questioning and a 2 (moderate) for feedback. These scores were earned because the OLO encouraged students to observe examples of CVs, take notes within the browser, and compare notes to feedback provided in the OLO platform.

The "Identifying Keywords" OLO provided an extensive overview of the keyword development process. The OLO received a 2 (moderate) for both inquiry-based learning (students are presented with examples of good research questions and asked to input their own) and practice (students were asked to repeat activities with multiple examples). In the CTAS category, the OLO received a 2 (moderate) for all three strategies: feedback, multiple-choice question construction, and open-ended questioning. In the OLO, students must write their own research questions, break them down into keywords, and print out the resulting answers. The OLO also ends with a short multiple-choice quiz. In the OLE category, the OLO received a 2 (moderate) for instructor help and personalized presence and a 3 (robust) for navigation and interactivity. The OLO was visually engaging, easy to navigate, and diverse in its instructional strategies.

These two OLOs received the highest RS and ES, but one additional OLO tied for the highest ES as well: "Exploring Academic Integrity." This OLO only received a score of 1 (weak) for the instructional strategies discussion, authentic problems, and graphic organizers. These scores were awarded because the OLO provides examples of discussion by faculty via video, descriptions of and links to real-world cases of plagiarism, and opportunities for students to drag and drop information into a graphic organizer. The OLO did not use open-response questioning, but it did use multiple-choice questions (2, moderate) that had strong feedback (3, robust). The OLE scores were higher for this OLO: it received a 3 (robust) for instructor help and navigation, a 2 (moderate) for interactivity, and a 1 (weak) for personalized presence. The critical thinking strategies were often not robust, which was why the OLO did not have the highest RS (17), but it used a variety of instructional techniques within an engaging, easy-to-navigate platform.

These examples show that even a moderate use of several critical thinking instructional strategies, when paired with strong assessment and good online instructional design, can result in short, engaging OLOs that meet some best practices for teaching critical thinking while still exploring content that is important to information literacy. Creating OLOs that use best practices for teaching critical thinking may seem challenging, but the addition of real-world examples, open-ended questions, reflection opportunities, and graphic organizers for students does not require extensive technical complexity. Carefully considered activities, like the ones displayed in these high-scoring OLOs, require students to think more deeply about the content.

5.3 Recommendations for Application of Best Practices

Teaching critical thinking is challenging under any circumstances. Teaching it in an online environment is, perhaps, more challenging. Online learning objects may be limited in their ability to promote critical thinking because they are short, completed with no supervision, and restricted in their engagement. However, studying their potential to promote critical thinking has clear value and utility. OLOs may be viewed many times by many students, and are therefore efficient ways of imparting educational content; OLOs might be the only way distance students are introduced to new content; and OLOs can be paired with classroom instruction for greater impact. For these reasons, OLOs should remain a focus of critical thinking educational research.

It can be intimidating to create an OLO that requires students to think critically. Because this kind of thinking is more mental work, it may cause some users to disengage. If these tutorials are optional, the requirement to think critically may discourage users from continuing through the content. Even if the OLO is required, users will likely try to

find the easiest way to complete the content, which can reduce the impact of the critical thinking teaching and assessment strategies used. Therefore, only critical thinking activities that are rigorous and required are likely to have an impact, and they may lead to lower user satisfaction.

The PRIMO Committee that decides which OLOs will be added to the database of information literacy tutorials uses an extensive rubric. However, very few of the parameters in this study's literature-driven rubric are present in their evaluation rubric, with the exception of the online learning element criteria. It is likely for this reason that many of the OLOs had a high score in the online learning elements category in comparison with the critical thinking instructional and assessment strategies sections. Well-designed online learning elements are important for critical thinking instruction best practices, because without them students may be distracted, discouraged, or disappointed by the look and feel of the OLO, which may prevent them from imparting enough attention to gain any critical thinking skills. However, the PRIMO rubric may benefit from increased attention to critical thinking instruction and assessment strategies as well. Employing these strategies can be difficult and time-consuming for instruction librarians, but the result is OLOs that could have a higher level of impact and contribute value to academic programs that are attempting to promote critical thinking.

Both the literature and the OLOs in this sample provide guidance for librarians who hope to employ more critical thinking instruction and assessment strategies in their information literacy OLOs. Appendix D provides a listing of specific strategies that could be used for each element (discussion, graphic organizers, etc.). While critical thinking instructional strategies in OLOs may not always be appropriate or desirable, when they

can be incorporated into the design of OLOs they have the potential to improve learning,

increase impact, and better prepare students for everyday decision-making and problem-

solving.

CHAPTER V

CONCLUSION

5.1 Limitations

The generalizability of these results is limited, as the scores given to each learning object may have been subject to researcher bias. Additional studies conducted with multiple researchers using inter-rater reliability measures would result in more reliable data. In addition, the rubric used to score the learning objects did not undergo field testing to determine reliability or validity. Future studies could examine the rubric in more detail and test it under various conditions.

The results of this study are meant to be preliminary and provoke further exploration of the topic. Additional research has the potential to increase the generalizability of these findings and improve the testing instrument for future use.

5.2 Recommendations for Further Study and Application

The limitations of this study provide opportunities for future research. Field work which tests the rubric used for this study could result in a reliable, valid assessment tool for future measurement of critical thinking in online learning objects. The tool could then

be used by teams of researchers, who could test for inter-rater reliability before exploring their results.

There were no examples in the literature of studies that examined the potential of tutorials and videos such as the ones examined in this study for teaching critical thinking. Studies that measured student performance in terms of critical thinking skills and dispositions before and after using critical thinking OLOs would provide valuable information about the potential for OLOs to influence students' critical thinking skills. Examination of how specific critical thinking instruction and assessment methods can be successfully applied to this medium would also be valuable (for example, how can OLO creators best employ reflection or ill-structured problems?).

In addition, there are a number of opportunities for applying adult learning theory to these findings to explore how to more successfully teach adults critical thinking. For example, how do the instructional strategies explored here fit with Malcolm Knowles' six assumptions of andragogy (1973)? Are there some critical thinking instructional strategies that better take advantage of the motivations and skills of adult learners? Experiential learning, which is important to adult learning, could also be explored in relation to issues of transfer; for example, how can learning experiences be designed to reflect a variety of real world problems that develop the same underlying critical thinking skills?

For librarians and other adult educators looking to apply this rubric or the instructional and assessment strategies explored in this study to their teaching, considering these strategies during the planning phase would be most beneficial. Both in-person and online instructors could benefit from this pre-instruction preparation. Perhaps

as the instructor develops program goals and objectives (Caffarella & Daffron , 2013), specific critical thinking instructional strategies could be considered based on their appropriateness to the content and format. With that careful consideration underway, the instructor could then design instruction to incorporate critical thinking instructional strategies and assess students' critical thinking skills. While the rubric developed here is meant for online learning objects teaching information literacy, it could be easily modified to accommodate teaching in other fields and formats as well.

5.2 Summary

As is noted by Abrami et al (2014), there is no "magic recipe" for effective critical thinking instruction (p. 303). Many contextual factors influence what instructional strategies are most appropriate, including the students' needs, expectations, and motivations; whether the instruction is in person or online; the resources available to the instructor; and more. Teaching critical thinking is challenging, especially in an online environment, even if these contextual considerations can be met. However, this study demonstrates that incorporating best practices for teaching and assessing critical thinking in online learning objects is possible. In addition, the high-scoring OLOs from the sample establish methods of employing critical thinking instructional best practices for librarians teaching information literacy. Librarians have a noteworthy opportunity to acknowledge the relevance of critical thinking to their instructional content and goals, and to employ relevant instructional and assessment strategies to improve information literacy instruction. While more research is required, this study sheds light on potential ways forward for instructional librarians who value critical thinking in higher education.

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    with-threshold-concepts/

Appendix A

Critical Thinking Research by Discipline

Discipline	Critical Thinking Research Focus	Noted Scholars
Philosophy	- Ideal thinking processes - Defining critical thinking - Characteristics of critical thinking	- Richard Paul - Robert Ennis - Peter Facione - Gerald Nosich - John McPeck
Psychology	- Observable behavior and implications for thinking processes - Developmental models of critical thinking	- Deanna Kuhn - Diane Halpern - Patricia King - Karen Kitchener
Education*	- Methods and strategies for teaching critical thinking - Practical application of critical thinking theory - Assessing critical thinking	- Robert Sternberg - Martin Davies - Ronald Barnett

*Note: many scholars in philosophy and psychology have also contributed to the literature about teaching critical thinking.

Appendix B

Literature References for Rubric Factor Criteria

Standardized Criteria	References
Instructional Methods	
Discussion	The OLO* asks students to explore a subject through open-ended questioning (Abrami, et al., 2014; A. King, 1995). The OLO uses case studies, debates, or other engaging strategies to encourage student discussion (Kalelioglu & Gulbahar, 2014; MacKnight, 2000; Richardson & Ice, 2010). The OLO asks students to respond to one another about a complex or controversial topic (MacKnight, 2000; Reece, 2005).
Inquiry-Based Learning	The OLO explores methods of constructing or determining thoughtful questions in response to problems or decisions (A. King, 1995). The OLO asks students to develop one or more relevant questions about research sources or as a research focus (A. King, 1995).
Authentic/Real-World Problems	The OLO uses ill-structured problems to encourage discussion (P. King & Kitchener, 2014; Jonassen, 1997). The OLO uses complex authentic or real-world examples (Reece, 2005). The OLO asks students to undergo a simulation of a real-world problem that requires higher order thinking skills (Reece, 2005).
Graphic Organizers	The OLO asks students to organize information graphically to illustrate or explore a concept, argument, or scholarly conversation (Park, et. al, 2013; Van Gelder, 2005).
Reflection	The OLO asks students to reflect on their own decision-making, problem-solving, or thinking processes (Halpern, 1999; Johnson & Aragon, 2003; Kuhn & Dean, 2004).
Practice & Repetition	The OLO requires or encourages students to repeat parts or the entire module when reinforcement is necessary (Van Gelder, 2005). The OLO exposes students to critical thinking concepts multiple times (Van Gelder, 2005). The OLO explicitly demonstrates or explains the underlying structure of a complex question beyond the surface details (Halpern, 1998).
Assessment Methods	
Feedback	The OLO gives students feedback immediately (Reece, 2005; Van Gelder, 2005).

	The OLO feedback is customized to the student's response (Reece, 2005; Van Gelder, 2005).
Multiple-Choice Question Construction	The OLO uses multiple-choice questions that are accompanied by an option or requirement for students to justify their answers (Ennis, 1993; Kerkman & Johnson, 2014: Morrison & Free, 2001). The OLO uses multiple-choice questions that require understanding of two or more concepts to be answered correctly (Morrison & Free, 2001). The OLO uses multiple-choice questions that have options which are plausible enough to require students to discriminate among them (Morrison & Free, 2001).
Open-Ended Questions	The OLO asks students to provide open-ended responses to questions that require higher-order thinking (Giancarlo et al., 2004).
Online Learning Elements	
Instructor Help/Support	The OLO interface clearly indicates how students may get more help (Su & Kuo, 2010). The help features of the OLO are available throughout the module (Su & Kuo, 2010).
Navigation	Students are able to control the pacing and order of material in the OLO (Reece, 2005). Students are able to find and access specific, labeled sections of the OLO (Reece, 2005; Van Gelder, 2005).
Personalized Presence	There is a clear indication of who created the OLO or who is responsible for the content (Johnson & Aragon, 2003). A named avatar or narrator with a personality guides the student through OLO content (Johnson & Aragon, 2003).
Scaffolding/Graduation	The contents of the OLO are scaffolded such that the material becomes more difficult as the student progresses (Van Gelder, 2005). Students can choose or test into a level of difficulty in the OLO appropriate to their skills and experience with the content (Van Gelder, 2005).
Interactivity	The OLO consists of a game with clear goals, an artificial conflict, and distinct rules (Johnson & Aragon, 2003). The OLO includes meaningful interactive design elements, such as drop-downs, scroll-overs, and drag-and-drop features (Su & Kuo, 2010). Students are asked to demonstrate the skills or activities that they are attempting to learn through a simulation or role-playing exercise within the OLO (Johnson & Aragon, 2003).

OLO = Online Learning Object

Appendix C

Best Practices Rubric for Teaching and Assessing Critical Thinking in Information

Literacy Online Learning Objects

Area	Factor	Rating
Critical Thinking Teaching Strategies	Discussion	0=Strategy not used 1=Use of strategy was weak 2=Use of strategy was moderate 3=Use of strategy was robust, showing evidence of critical thinking theory
	Inquiry-Based Learning	0=Strategy not used 1=Use of strategy was weak 2=Use of strategy was moderate 3=Use of strategy was robust, showing evidence of critical thinking theory
	Authentic/Real-World Problems	0=Strategy not used 1=Use of strategy was weak 2=Use of strategy was moderate 3=Use of strategy was robust, showing evidence of critical thinking theory
	Graphic Organizers	0=Strategy not used 1=Use of strategy was weak 2=Use of strategy was moderate 3=Use of strategy was robust, showing evidence of critical thinking theory
	Reflection	0=Strategy not used 1=Use of strategy was weak 2=Use of strategy was moderate 3=Use of strategy was robust, showing evidence of critical thinking theory
	Practice and Repetition	0=Strategy not used 1=Use of strategy was weak 2=Use of strategy was moderate 3=Use of strategy was robust, showing evidence of critical thinking theory
Critical Thinking Assessment Strategies	Feedback	0=Strategy not used 1=Use of strategy was weak 2=Use of strategy was moderate

		3=Use of strategy was robust, showing evidence of critical thinking theory
	Multiple-Choice Question Construction	0=Strategy not used 1=Use of strategy was weak 2=Use of strategy was moderate 3=Use of strategy was robust, showing evidence of critical thinking theory
	Open-Ended Questions	0=Strategy not used 1=Use of strategy was weak 2=Use of strategy was moderate 3=Use of strategy was robust, showing evidence of critical thinking theory
Online Learning Elements	Instructor Help/Support	0=Element not addressed 1=Evidence of element was weak 2=Evidence of element was moderate 3=Evidence of element was robust
	Navigation	0=Element not addressed 1=Evidence of element was weak 2=Evidence of element was moderate 3=Evidence of element was robust
	Personalized Presence	0=Element not addressed 1=Evidence of element was weak 2=Evidence of element was moderate 3=Evidence of element was robust
	Scaffolding/Graduation	0=Element not addressed 1=Evidence of element was weak 2=Evidence of element was moderate 3=Evidence of element was robust
	Interactivity	0=Element not addressed 1=Evidence of element was weak 2=Evidence of element was moderate 3=Evidence of element was robust

Appendix D

Recommended Applications of Critical Thinking Instructional Strategies in Information

Literacy Online Learning Objects

Critical Thinking Instructional Strategies	Applications from Sample	Other Applications Possible
Discussion	• Use social media and a hashtag to continue the conversation	• Use an application like Padlet to encourage students to answer queries publicly and respond to other answers. • Ask students to provide a one-word response to a query and use the responses to create a word cloud. • Ask students to respond to discussion posts asynchronously in the LMS in conjunction with the OLO.
Inquiry-Based Learning	• Provide many examples of well-developed research questions. • Demonstrate the process for developing a good research question. • Ask students to develop an appropriate research question. • Encourage students to ask certain questions when evaluating a source.	• Ask students to consider all of the possible relevant questions to ask about a source when evaluating it. • Ask students to develop their own questions about a source and then answer them. • Ask students to brainstorm several good research questions for the same research topic.
Authentic/Real-World Problems	• Ask students to develop questions, keywords, or responses to a real-world problem (work-related, purchase, health decision, etc.). • Give students examples of information problems from outside academia (i.e. cases of celebrities and politicians committing plagiarism).	• Ask students to consider, find, or evaluate evidence both for and against a contentious issue. • Ask students to identify scenarios or experiences from their own lives that are relevant to the OLO topic. • Use recent news stories as examples.

Graphic Organizers	• Ask students to practice organizing their notes graphically. • Ask students to develop a research topic using a concept map.	• Ask students to use a concept map for other purposes (i.e. track scholarly influence, prioritize source types, etc.). • Ask students to create a research plan using a graphic organizer. • Ask students to document their research using a graphic organizer. • Ask students to create an argument map.
Reflection	• Give students a self-assessment to identify specific strategies for improving thinking. • Ask students to reflect on a decision, problem, or scenario.	• Allow students to reflect on their own stake in the research claim or question. • Encourage students to reflect on their biases and change their position on a research topic after examining evidence. • Give students a self-assessment to identify specific strengths or weaknesses in research skills.
Practice & Repetition	• Give students multiple assessments for the same skill. • If a student performs poorly on an assessment ask or require him/her to repeat content.	• Give students multiple assessments for the same skill, changing the overlaid context significantly to test for transfer. • If a student performs poorly on an assessment task, require the student to repeat it two or three times in a row successfully.

Appendix E

Online Learning Objects from the Sample Referenced in the Text

OLO Title	OLO URL	Page Referenced
My Learning Essentials Online: Finding a Job: Writing an Effective CV	http://www.library.manchester.ac.uk/using-the-library/students/training-and-skills-support/my-learning-essentials/	48, 68
Research Success Tutorial Suite: Identifying Keywords	http://researchguides.austincc.edu/researchsuccesstutorials	48, 68
Exploring Academic Integrity Tutorial	http://libraries.claremont.edu/achontutorial/pages/index.html	49, 69
My Learning Essentials Online: The Big Picture: Achieving Your Academic Goals	http://www.library.manchester.ac.uk/using-the-library/students/training-and-skills-support/my-learning-essentials/	54
Y Search: Critical Reading	https://ysearch.lib.byu.edu/	54
Analyze Your Research Strategy	https://portlandstate.qualtrics.com/SE/?SID=SV_dco40rNn31xNlBP	54
Developing a Research Question	http://library.wlu.ca/help/tutorials/developing-research-question	54
Access and Explore the Library's Business Databases	https://my.berkeleycollege.edu/bbcswebdav/xid-98680789_3	54, 59
A Suite of Interactive, Foundational Information Literacy Tutorials: Anatomy of a Citation and Reference	http://www.library.ualberta.ca/tutorials/	54
My Learning Essentials Online: Study Strategies for Success	http://www.library.manchester.ac.uk/using-the-library/students/training-and-skills-support/my-learning-essentials/	55
A Suite of Interactive, Foundational Information Literacy	https://www.library.ualberta.ca/tutorials/	56

Tutorials: Creating a Thesis Statement		
Life Sciences Library Tutorial	http://net.lib.byu.edu/tutorial/lifescience/story_html5.html	56
Navigate: UWF Libraries Research Tutorials: Formulating a Good Research Question	http://uwf.edu/library/research_help/tutorials/	56
PICO: Research Questions for Health Sciences	http://www.asu.edu/lib/tutorials/storyline/pico/	56
Bowman Library Research Skills Tutorial: Module 2 – Searching	http://www.menlo.edu/library/research/tutorial/	57
Being Digital: Information Universe	http://www.open.ac.uk/libraryservices/beingdigital/	57
Being Digital: Search Slips and Tips	http://www.open.ac.uk/libraryservices/beingdigital/	57
My Learning Essentials Online: Revision Strategies: Managing Your Revision Successfully	http://www.library.manchester.ac.uk/using-the-library/students/training-and-skills-support/my-learning-essentials/	57
InfoRhode Tutorials: Start	http://goo.gl/XliUKK	57
InfoRhode Tutorials: Identify	http://goo.gl/XliUKK	57
My Learning Essentials Online: Knowing Where to Look: Your Search Toolkit	http://www.library.manchester.ac.uk/using-the-library/students/training-and-skills-support/my-learning-essentials/	58
My Learning Essentials Online: Planning Ahead: Making Your Search Work	http://www.library.manchester.ac.uk/using-the-library/students/training-and-skills-support/my-learning-essentials/	59