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Using the taxonomy of cognitive learning to model online searching

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ABSTRACT

In this research, we investigated whether a learning process has unique information searching characteristics. The results of this research show that information searching is a learning process with unique searching characteristics specific to particular learning levels. In a laboratory experiment, we studied the searching characteristics of 72 participants engaged in 426 searching tasks. We classified the searching tasks according to Anderson and Krathwohl's taxonomy of the cognitive learning domain. Research results indicate that *applying* and *analyzing*, the middle two of the six categories, generally take the most searching effort in terms of queries per session, topics searched per session, and total time searching. Interestingly, the lowest two learning categories, *remembering* and *understanding,* exhibit searching characteristics similar to the highest order learning categories of *evaluating* and *creating*. Our results suggest the view of Web searchers having simple information needs may be incorrect. Instead, we discovered that users applied simple searching expressions to support their higher-level information needs. It appears that searchers rely primarily on their internal knowledge for evaluating and creating information needs, using search primarily for fact checking and verification. Overall, results indicate that a learning theory may better describe the information searching process than more commonly used paradigms of decision making or problem solving. The learning style of the searcher does have some moderating effect on exhibited searching characteristics. The implication of this research is that rather than solely addressing a searcher's expressed information need, searching systems can also address the underlying learning need of the user.

1. Introduction

In this research, we investigate learning theory for understanding information searching. Specifically, we aim to discover an inferential framework based on learning theory for indentifying the cognitive category of a searcher's need based on characteristics of the information searching process. By information searching, we mean "the 'micro-level' of behavior employed by the searcher in interacting with an information system" (Wilson, 2000, p. 49). While many have studied individual differences in information searching (c.f., Saracevic, 1991), no one has proposed a model that relates individual differences to information searching. Saracevic comments, "We are still lacking a theoretical framework and/or explanation for all these findings (concerning individual differences). Without such a framework, the work on individual differences in (information retrieval) will continue to proceed as in the past, using a shotgun approach." (Saracevic, 1991, p. 85). Ford, Miller, and Moss (2003) make similar assertions concerning the need for such a conceptual model.

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There has been prior work on classifying individual searching tasks rather than the specific need that generates these tasks. Several researchers have investigated individual searching tasks classifications. For example, MacMullin and Taylor (1984) present a classification of information seeking tasks. Byström and Järvelin (1995) explore the relationship between task and complexity in a work environment. Rose and Levinson (2004) present a classification of Web searching tasks based on the type of content desired. The research presented here is related to these prior efforts (and many others in the searching task research stream); however, our focus is in discovering a framework for classifying the underlying need that leads to a specific searching task.

The most commonly presented frameworks for understanding information searching needs are problem solving and decision making. Donohew and Tipton (1973) comment on the close relationship between information seeking (of which information searching is a component) and decision making (p. 251). March (1994) distinguishes between decision making and problem solving, commenting that searching relates directly to making decisions. Many other researchers have investigated aspects of information searching from a decision making or problem solving perspective (c.f., Belkin, 1988; Kraft, 1973; Lopatovska, 2007), and Case (2007) provides a review of decision making research for information seeking research.

However, the recognition of problem solving as a conceptual framework for information searching is not universally accepted. Sperber and Wilson (1995) argue that problem solving does not apply to all information searching situations. More importantly, there is a notable lack of empirical data to support the relationship between information searching and problem solving. Most of the published works that discuss the relationship between decision making and searching are descriptive in nature (i.e., the proposed decision making model is not predictive). Few laboratory studies linking information searching behaviors with decision making currently exist.

Some researchers have questioned whether decision making and searching are actually related. For example, in investigating the relationship between decision making and information searching, Jansen and McNeese (2005) administered the Problem Solving Inventory (PSI) survey instrument to approximately 40 participants of an information searching study. The PSI consists of a 35-item self-report measured in a 6-point Likert-style format (strongly agree to strongly disagree). The PSI instrument assesses an individual's perceptions of his or her problem solving capabilities (i.e., a person's level of efficacy as a problem solver). A person's self-efficacy in a given domain is correlated to actual performance in that area (Bandura, 1994). Jansen and McNeese (2005) showed no statistically significant relationship between problem solving self-efficacy and searching performance or between perceptions of problem solving ability and searching characteristics. If prior work on information searching as a problem solving activity is correct, one would expect some relationship between problem solving and information searching behavior (Bandura, 1994). Bandura (1996) reports that self-efficacy in a particular task influences choice of activities, effort expended, and duration of effort. Jansen and McNeese (2005) failed to show a relationship, and we have found no studies that reveal a statistically significant correlation between decision making and information searching. Based on these findings, we sought potential approaches other than problem solving or decision making to describe accurately the information searching process.

One likely potential approach is that searching is a learning process. Schmeck (1988), p. 3 defines learning as "an interpretative process aimed at understanding reality". Davis and Palladino (1995) p. 194 state that learning is "a relatively permanent change in behavior potential that occurs as a result of experience". Bloom, Englehard, Furst, and Krathwohl (1956) state that learning occurs at the cognitive, affective, and psychomotor domains.

Prior work has often linked information searching, albeit anecdotally, as a learning activity. For example, Dewey's "learning-by-doing" (1916) is often used to provide the pedagogical underpinning for interactive learning environments. Wittrock (1974) describes the process of knowledge construction in which the learner relates new information to old, building enhanced knowledge structures. Yankelovich, Meyrowitz, and van Dam (1985) draw an analogy between education and hypermedia information as seeing connections and following links. Marchionini (1995) states that information searching is closely related to both problem solving and learning (p. 5–6). Budhu and Coleman (2002) consider information processing as a fundamental cognitive activity underlying the process of learning.

Are there specific searching behaviors that one can map to a particular learning model? If so, what are these mappings? What does this insight tell us about the underlying need of the searcher? These questions motivate our research. In the following sections, we present a literature review of learning as a model for understanding information searching, followed by our research questions, research results. We conclude discussion of implications for online searching systems and future research aims.

2. Review of literature

Information need is a core concept of information science (Wilson, 1981) and typically refers to the underlying motivation of the user to seek specific types of content. In this research, we replace 'information need' with just 'need, as research has shown searching is motivated by needs other than just information (Jansen, Booth, & Spink, 2008). Users select search strategies based, at least in part, on how they conceptualize the need. Moreover, need also influences a variety of factors concerning the evaluation of the usefulness, relevance, and authority of retrieved content in searching. As such, a better understanding of and a methodology for classifying needs is central to adequately addressing the variety of motivations that cause individuals to engage in searching.

2.1. Searching as learning

The information science literature contains some hints of learning as a vehicle for understanding people's needs (Lehmann, 1999; Zhang, Jansen, & Spink, 2006), although many times the learning element is subsumed within other frameworks, including sense making and searching in online environments.

In a sense-making paradigm, Dervin (1992) defines information need as something constructed internally to address a gap or discontinuity. One can view information searching as a learning progress to address this gap. Case (2002) states that sense-making is theoretically grounded in the constructivist learning theories of Dewey (1933). Dewey argued that learning can only occur through problem solving. Similarly, Kuhlthau's information seeking process (1993) includes a significant learning component, the beginning of which is uncertainty. In fact, part of the basis of Kuhlthau's information seeking process is Kelly's Theory of Learning (Kelly, 1963). According to Kuhlthau (1993), uncertainty in the earlier stages of information seeking is caused by the introduction of new information that conflicts with previously held constructs. Kuhlthau does not view this uncertainty as a negative, but rather, as the beginning of innovating and creating, which are part of a learning process.

Defining learning as the development of new knowledge, Marchionini (2006) elaborates on the learning elements inherent in information searching by describing searching in order to learn as increasingly viable in a content rich, online environment. Marchionini (2006) conjectures that searching can be a learning process requiring multiple iterations and cognitive evaluation of retrieved results. The researcher specifically employs terminology from Bloom's categorization to describe attributes of learning while searching for information.

Some researchers have investigated elements of learning within a searching framework using empirical methods. Hill and Hannafin (1997) attempt to identify strategies that adult learners employ when using a hypermedia information system. The researchers report that learners use a variety of strategies and that self-reported knowledge of both system and topic appear to affect the strategies employed. Budhu and Coleman (2002) propose that Web technologies allow for interactive learning environments that in turn can foster an increased understanding of science and engineering concepts.

Continuing this empirical line of research, Tang (2002) analyzed the searching behaviors of 41 public library patrons and categorized them into two groups based on their exhibited searching strategies, either resource-oriented or query-oriented. The resource-oriented searchers made only minor changes to their initial queries. The query-oriented users exhibited a lot of query reformulation. Halttunen (2003) studied whether there were relationships between learning style, academic domain, and teaching information retrieval techniques. The researcher reported that learning styles generated differences in conceptions of information retrieval understanding. The students who were primarily concrete learners reported computer skills and information retrieval methods as important. Students who were reflective learners viewed information retrieval as the knowledge of information needs analysis, methods, and assessment.

Tsai and Tsai (2003) explored the relationship among students' information searching strategies in Web-based science learning activities and the influence of students' Internet self-efficacy. The researchers reported that students with high self-efficacy employed better searching strategies and learned better relative to those students with low self-efficacy. Noting the similarity between the features of the Web and those characterizing creative individuals, Shoshani and Hazi (2007) postulate that the Web encourages creativity, a higher order of learning, by providing content access in a variety of disciplines.

Focusing on query construction as a learning process, Zhang et al. (2006) discuss the similarities between the linguistic characteristics of query formulation and learning to formulate words in a spoken language. Most queries are lists of one or more noun terms (Jansen, Spink, & Pfaff, 2000; Wang, Berry, & Yang, 2003). Gentner (1982) reports that "children learn nouns before predicate terms" (1982, p. 327) and "in early-production vocabularies, nouns greatly outnumber verbs" (p. 327). Nouns are "object-reference terms" (Gentner, 1982, p. 328) and have "fewer psychological constraints on their possible conflationary patterns" (Gentner, 1982, p.328) than verbs have. Thus, every time searchers seek 'new' information, they use nouns to articulate their needs. Researchers in cognitive science also pointed out that, in many languages, nouns have prototypical functions in discourses" (Lakoff, 1987, p. 64).

Related to learning, Ford et al. (2003) have investigated the influence of study habits, building from a series of previous investigations in this area (c.f., Ford, Miller, & Moss, 2001; Ford, Wood, & Walsh, 1994; Wood, Ford, Miller, Sobczyk, & Duffin, 1996). Ford et al. (1994) analyzed the relationship between study habits and searching strategies in an electronic environment. The researchers reported that comprehension learners used broader search strategies while operational learners used narrower strategies. In a subsequent study on the relationship between preferred study habits and searching strategy, Wood et al. (1996) found that comprehension learners used a greater number of searches, more new terms, and more unique terms. These students were also more aware of search techniques for broadening or narrowing the query. Ford et al. (2001) investigated the association between individual differences at the cognitive level on searching outcome. Ford et al. (2003) investigated to what extent the selection of search strategies is influenced by study approaches. Using factor analysis, the researchers found correlations with the use of Boolean searching by actively interested but anxious individuals. Students who were effective time managers used either Boolean or best match.

Previous research has postulated the relationship between searching and learning; however, limited prior empirical research exists to show how or even if learning explicitly manifests itself in the information searching process. By analyzing exhibited information searching behavior, we can understand the nature of the underlying information need (Allen, 1996), and importantly, we can posit a learning process as an appropriate model to view information searching. To accomplish this we employed an established taxonomy of cognitive learning and a survey of individual learning styles as a possible moderating effect.

2.2. Anderson and Krathwohl's refine to Bloom's taxonomy

One of the most widely accepted cognitive learning frameworks is Bloom's taxonomy. In 1956, a team of educational theorists led by Benjamin Bloom developed a series of learning categories that categorized questions by level of abstraction, and Bloom's taxonomy is now a well known classification of learning in the cognitive domain (Bloom et al., 1956). Bloom's taxonomy is based on difficulty of abstraction, ranging from recognition of facts to development of creative concepts. Since its initial publication, a number of investigations have examined the theoretical validity of Bloom's taxonomy with mixed results. For comprehensive reviews of the studies, see (c.f., Furst, 1981; Seddon, 1978). However, Bloom's taxonomy is widely accepted in a variety of research fields and has had substantial impact in the field of learning. Given its wide acceptance and use, the taxonomy is regarded as a functional and, therefore, successful tool (Seddon, 1978).

One of the governing principles of the taxonomy is its descriptive scheme in which every type of learning goal can be represented in a relatively context free manner (Bloom et al., 1956, p. 14). In this respect, one can use the taxonomy to determine the level of existing questions. However, one can also use the taxonomy to develop appropriate questions for each level. There are several articles on how to develop questions based on Bloom's taxonomy (c.f., Lord & Baviskar, 2007). Anderson and Krathwohl's taxonomy is an updated and redefinition of Bloom's original classification (Anderson & Krathwohl, 2001), which is the specific taxonomy that we employed in this research.

2.3. Individual learning styles

It is widely acknowledged that people have a variety of preferences when they learn and process information, and there are many learning style systems to describe and categorize such preferences (c.f., Felder & Silverman, 1988; McCarthy, 1980). Therefore, we believed that we had to assess the learning styles of the individuals in some way. For this research, we desired a survey instrument that would identify a searcher's general learning style, so we selected a simplified test (Al-Mahmood, McLean, Powell, & Ryan, 1998) based on Kolb's experiential learning theory model (Kolb, 1985). A similar learning style approach was used by (Halttunen, 2003), so we this provides some comparison among findings.

Kolb's learning theory articulates four distinct learning preferences and is based on a four-stage learning cycle. For the first stage, *concrete experience* (CE), the learner actively experiences an activity. In the second stage, *reflective observation* (RO), the learner consciously reflects on that experience. For the third stage, *abstract conceptualization* (AC), the learner attempts to conceptualize a theory or model of what they observed. Finally, in the fourth stage, *active experimentation* (AE), the learner tries to plan how to test the model, validate the theory, or plan for a forthcoming experience. Therefore, Kolb's model offers both a way to understand individuals' different learning styles and an explanation of a cycle of experiential learning. In this cycle of learning, immediate or concrete experiences provide a basis for observations and reflections. These observations and reflections are assimilated and distilled into abstract concepts producing new implications for action which can be actively tested, creating new experiences (Kolb, 1985).

The simplified test (Al-Mahmood et al., 1998) identifies one's preferred processing and perception styles and is adapted from (Carter, Bishop, & Kravits, 1998). The survey instrument classifies one's learning styles into four types across two spectrums. The active/reflective spectrum refers to how the person processes information, and the abstract/concrete spectrum refers to how the person perceives information. Each category's learning traits are summarized in Table 1, adapted from Carter et al. (1998), p. 58 and Al-Mahmood et al. (1998).

We selected Kolb's experiential learning theory model because the four-stage learning model fits nicely with the concept of information searching and the data-information-knowledge-wisdom (Ackoff, 1989) classification. Additionally, Kolb's experiential learning theory model is aimed specifically at adult learners, which fit the demographic population from which we would draw our sample. We selected a simplified version of instrument, as assessment of learning styles was not our main research focus but a moderating component.

Table 1
Explanation of learning styles.

Learning spectrums	
Active learners • Are flexible • Are creative • Are dynamic and fast paced	Reflective learners • Always want to help others • Have good communication skills • Like sharing ideas with others
Abstract learners • Have good analytical skills • Deal well with complex problemsare thorough and precise	Concrete learners • Manage heavy work loads • Have leadership qualities

3. Research questions and hypotheses

A variety of information science models address the concept of individual differences and interaction with information searching (c.f., Choo, Detlor, & Turnbull, 1998; Ingwersen, 1996; Marchionini, 1995; Saracevic, 1996; Wilson, 1999). However, such models are primarily descriptive. Our aim in this research is develop inference constructs based on search tactics and infer the learning context underlying the information need. As such, this research will significantly inform aspects of various models of information searching, including search tactics and cognitive aspects of the searcher.

To these aims, we specifically address two research questions.

3.1. Research question I: are searching episodes learning events?

If searching episodes are learning events, then one would expect differences in behaviors from different learning levels. In order to analyze this question, we used Anderson and Krathwohl's (2001) redesign of Bloom's taxonomy of learning in the cognitive domain to develop searching tasks for each of the six categories within the taxonomy. In a user study, we then analyzed the exhibited searching characteristics of each searching category with established online searching parameters to detect if there were differences in exhibited searching behavior.

Prior to design the research study, we had to operationalize this research question. During the normal interaction between a searcher and Web search engine during information searching, there are a limited number of measures that occur (e.g., submit query, view results, refine query, etc.). Based on a ethogram of Web searching behaviors (Hargittai, 2004; Jansen, Taksa, & Spink, 2008), we investigate seven hypotheses addressing this research question, which are:

Hypothesis 1. There will be a significant difference in the number of queries per session among the classifications in Anderson and Krathwohl's taxonomy.

Hypothesis 2. There will be a significant difference in the average query length per session among the classifications in Anderson and Krathwohl's taxonomy.

Hypothesis 3. There will be a significant difference in the number of unique terms per session among the classifications in Anderson and Krathwohl's taxonomy.

Our first three hypotheses focus on the query. Although an acknowledged imprecise representation of the underlying information need (Croft & Thompson, 1987), the query is the central aspect of information searching and information retrieval (Robertson, 1977; van Rijsbergen, 1975). Numerous empirical studies have focused on the various aspects of the query as surrogates for the expression of need, including session length (Park, Bae, & Lee, 2005), number of terms (Wang et al., 2003), and use of keywords (Wolfram, 1999). Therefore, we believe the number of queries per session, query length, and number of unique terms used in the session are appropriate searching characteristics for this study. We define a session as the series of interactions between the searcher and information system(s) while addressing one of the given searching scenarios.

Hypothesis 4. There will be a significant difference in the number of topics per session among the classifications in Anderson and Krathwohl's taxonomy.

For simple information needs, a one-to-one correlation usually exists between need and topic. For complex information needs, one or more topics may comprise the overall need. Due to the dynamics and complexity of the Web information environment, people are becoming more involved in coordinating multiple searching behaviors (Waller, 1997). Studies also indicate that users' searches may have multiple goals, topics, or problems in information seeking and retrieval contexts (Miwa, 2001; Spink, 2004). Therefore, this hypothesis examines the number of topics searched in a given session.

Hypothesis 5. There will be a significant difference in the duration of sessions among the classifications in Anderson and Krathwohl's taxonomy.

Time on a system has been a consistent measure of information searching and retrieval studies as one of a variety of indictors of task difficulty (c.f., Hsieh-Yee, 1993; Kelly & Belkin, 2001; Kelly & Belkin, 2004; Su, 2003; Wang, Hawk, & Tenopir, 2000).

Hypothesis 6. There will be a significant difference in the number of result pages viewed per session among the classifications in Anderson and Krathwohl's taxonomy.

The number of result pages viewed is one aspect of implicit feedback used to determine the level of difficulty of a searching task or how well a searching system is satisfying a user's information need. Researchers have explored various aspects of interactions as measurements of implicit feedback. For example, Goecks and Shivalik (2000) used hyperlinks clicked, scrolling performed, and processor cycles consumed. Seo and Zhang (2000) studied reading time, scrolling, link selection, and bookmarking as potential implicit feedbacks and found that bookmarking had the strongest relationship with interesting documents, but scrolling had no relationship. Claypool and colleagues (Claypool, Le, Waseda, & Brown, 2001) measured mouse clicks, mouse movement, scrolling, and elapsed time as the implicit feedback metrics. Kelly and Belkin (2001) studied reading time, scrolling, and interaction. Kelly and Belkin (2004) also examined the display time as the implicit feedback and found no direct relationship between the display time and the usefulness of documents. Shen, Tan, and Zhai (2005) employed previous queries and clickthrough information as the implicit feedback measures.

Hypothesis 7. There will be a significant difference in the number of search systems used among the classifications in Anderson and Krathwohl's taxonomy.

Anderson and Krathwohl (2001), p. 85 state that the higher order learning processes are multiple phases and that the student draws upon elements from many sources, piecing them together, crafting a novel structure or pattern relative to prior knowledge. As such, we are interested in the number of information systems used, expecting that higher order classification will require more systems than the lower order classifications require. We define an information system as a mechanism for acquiring, storing. Indexing, and retrieving an organized body of data, information, or knowledge (e.g., Wikipedia, WebMD, HowStuffWork). We also include search engines in this definition (e.g., Ask, Googe, MSN Live, Yahoo!).

3.2. Research question II: Are searching characteristics within Anderson and Krathwohl's taxonomy affected by the searcher's learning style?

While research question one is the major focus of the paper, research question two addresses possible moderating effects of individual learning styles. Other researchers have worked to integrate learning levels and styles (Howard, Carver, & Lane, 1996). In order to analyze this question, each participant in the study completed a learning style assessment survey. We then analyzed the same seven searching characteristics from research question one (i.e., *number of queries, number of topics, duration of sessions,* average *query length, number of unique terms, number of result pages viewed, number of search systems used*), controlling for learning styles.

Hypothesis 8. There will be a difference in exhibited searching characteristics based on learning styles.

One would expect some difference among learning styles in exhibited searching behaviors, although there would be benefits for search engine designers if there were no differences. A learning style is a somewhat fixed characteristic of an individual, and it refers to an individual's preferred and habitual approach to processing information (Riding & Rayner, 1998). A strategy is a well-planned series of actions that may be used to cope with situations and tasks (Riding & Cheema, 1991), such as an information searching scenario. Halttunen (2003) reports that learning styles generate differences in information retrieval self-efficacy. Therefore, we would expect some differences in searching characteristics among searchers with difference learning styles. Some other information searching and seeking studies have highlighted that individual learning styles may affect aspects of the searching process (Ford et al., 1994; Wood et al., 1996). For this hypothesis, we investigate the information searching characteristics of queries per session, topics per session, duration of session, query length, number of unique terms, number of result pages, and number of search systems used.

4. Methods

As the foundational elements for our research, we draw on constructs of learning levels in the cognitive domain and preferred learning styles of individuals, specifically a variation of Bloom's taxonomy of the learning domains (Bloom et al., 1956) and Kolb's learning styles (Kolb, 1985).

4.1. Anderson and Krathwohl's Taxonomy

For this research, we devised two searching scenarios for each of the six-levels of Anderson and Krathwohl's taxonomy, with each scenario correlated to one of the six classifications. We selected four domains (entertainment, health, ecommerce, and travel) to provide a common grounding for the participants as they moved through the searching scenarios.

We pilot-tested the scenarios twice before using them in a laboratory study. Similar to Bloom's, Anderson and Krathwohl's taxonomy is a six-tiered model for classifying learning according to cognitive levels of complexity. The six classifications with definitions (Anderson & Krathwohl, 2001, p. 67–68) and sample searching scenarios are shown in Table 2, with the complete list of searching scenarios presented in Appendix A.

Table 2
Anderson and Krathwohl's taxonomy with searching scenarios.

Classification	Definition	Example scenario
Remembering	Retrieving, recognizing, and recalling relevant knowledge from long-term memory	List 5 movies directed by Steven Spielberg
Understanding	Constructing meaning from oral, written, and graphic messages through interpreting, exemplifying, classifying, summarizing, inferring, comparing, and explaining	Give a brief plot summary of the TV show, *Veronica Mars*
Applying	Carrying out or using a procedure through executing, or implementing	What are some possible characteristics of a person who would enjoy hip-hop music?
Analyzing	Breaking material into constituent parts, determining how the parts relate to one another and to an overall structure or purpose through differentiating, organizing, and attributing	A certain television show contains intense violence and coarse language. Which rating should it receive?
Evaluating	Making judgments based on criteria and standards through checking and critiquing	Create a list of pros and cons for the new iPod shuffle. Based on this list, would you purchase it (assuming you had the money to do so)? Why or why not?
Creating	Putting elements together to form a coherent or functional whole; reorganizing elements into a new pattern or structure through generating, planning, or producing	Which do you think will have better overall sales – the XBox 360, the Nintendo Wii, or the Playstation 3? Why?

Table 3
Development characteristics of searching scenarios.

Anderson and Krathwohl's taxonomy classification	Key element(s) for developing the searching scenarios
Remembering	Scenario must have participant describe, list, or name factual information
Understanding	Scenario must have participant translate, construe, interpret, or extrapolate information
Applying	Scenario must have participant exploit information and put the resulting knowledge into action
Analyzing	Scenario must have participant deduce, scrutinize, or survey information
Evaluating	Scenario must have participant appraise or relate information to the real world
Creating	Scenario must have participant formulate, generate, restructure, or combine information in a novel way

Budhu and Coleman (2002) suggest that information use behaviors for learning can be indentified using educational theories. We take the opposite approach, namely deducing levels of learning based on online searching behaviors.

We use the phrase *searching scenarios* to be consistent with user study literature calling for information searching research to situational place laboratory participants (Borlund & Ingwersen, 1997). These scenarios have inherent information needs and information tasks. Defining what is an information need or task has been the subject of much debate and with multiple definitions (Wilson, 1981). Given this, for this research, a search scenario for each level of Anderson and Krathwohl's taxonomy was the most appropriate approach.

Developing questions based on Anderson and Krathwohl's taxonomy is not straightforward. Although the categories reflect distinctions among the behavior of learners, Bloom acknowledges that classifications may not be sharp and rigid (Bloom et al., 1956, p. 15). We also concede that the scenarios we developed may not be exclusive of each other. However, there are prior works on developing such questions and objectives (c.f., Ferguson, 2002; Lord & Baviskar, 2007), and we leveraged these literature in the development of our searching scenarios. Table 3 highlights the key elements of the scenario development process for each level.

Our scenario development went through several rounds of redesign before we arrived at a set that we were happy with implementing in a study. After two rounds of pilot testing, we were comfortable that our scenarios were in line with the learning levels for our target demographic of traditional college age students. There are several guides for writing objectives using Bloom's and Anderson and Krathwohl's learning taxonomies. In addition to published works, we utilized the guidelines from the Center for Teaching and Learning at the University of North Caroline – Charlotte.[1] Most of the guidelines for implementing Bloom's and Anderson and Krathwohl's learning taxonomies take similar approaches, namely a linkage from the learning level – to keywords – to questions or objectives. We followed this approach for our scenario generation.

4.2. Kolb's learning styles

To identify a searcher's general learning style for this study, we used simplified test (Al-Mahmood et al., 1998) based on Kolb's experiential learning theory model (Kolb, 1985). The survey identifies the searcher's preferred processing and percep-

[1] http://teaching.uncc.edu/resources/best-practice-articles/goals-objectives/objectives-using-bloom.

tion styles and classifies one's learning styles into four types across two spectrums. To complete the survey instrument, we gave the participants a series of questions with a set of responses arranged in a row for each question. Participants ranked each of the responses for each question from 'most like me' (5), to 'least like me' (1) in the manner that suited them best. We then totaled the columns, providing preferences for each of the learning styles. See Appendix B for the complete survey instrument.

4.3. User study procedure

To investigate our research questions, we conducted a quantitative study using a laboratory experimental design. A controlled laboratory approach gave us the advantage of being able to control for external variables in order to gauge the effect of learning levels. As with all approaches, there are limitations to adopting such a course of action, namely the lack of realism that is present in naturalistic studies. However, given that we sought to investigate quantifiable hypotheses as the basis for further investigation in more naturalistic settings, we considered a laboratory experiment a valid choice for this research. Several studies have taken similar approaches (c.f., Armitage & Enser, 1997; Barry, 1994; Hargittai, 2002; Kellar, Watters, & Shepherd, 2007; Meadow, 1982; Toms, Dufour, & Hesemeier, 2004).

Over the course of two weeks, 72 participants engaged in a laboratory study (59 males and 13 females; mean age 20 years with a standard deviation of 1.9 years). Concerning, the imbalance of gender, Hupfer and Detlor (2006) found no gender difference in exhibited searching characteristics. The participants were all undergraduates attending a major US university and enrolled in one of several information technology courses. The participants had high self-efficacy of their searching ability, self-rating their searching expertise a mean 4.1 on a five-point scale (standard deviation 0.5).

A moderator first had each participant complete administrative and demographic paperwork. Then, the moderator presented each participant with six searching scenarios and instructed them to answer the questions and verify their answers. The six searching scenarios were each on an individual sheet of paper with blank spaces on the sheet for answers or notes. We imposed no time limit on searching sessions. We counterbalanced the searching scenarios among the participants using a Graeco-Latin square approach. At the conclusion of the searching session, the moderator administered the learning style inventory to the participants.

During the study, participants recorded their answers to the searching scenarios on the worksheets. Each participant had access to an individual computer with Internet access. All user interactions with the computer were logged using a non-invasive logging software package developed for use in information searching studies (Jansen, Ramadoss, Zhang, & Zang, 2006).

Once all participants had completed the study, we analyzed participant interactions in accordance with standard characteristics of information searching using transaction log analysis as the methodological approach and ANOVA for the statistical evaluation. We analyzed the data using SPSS version 15. We employed the parametric tests, ANOVA, rather than non-parametric tests, such as the Wilcoxon signed test, because the parametric tests are more stringent in their analysis. The main advantage of using non-parametric tests is they do not need data in normal distribution. However, Hull (1993) has shown that the parametric tests performed extremely well with skewed and non-parametric data, recommends that they be used whenever possible, and are well-suited for the use in studies such as this one.

5. Results

In the following sections, we report our results and examine if there is any differences in searching characteristics among the six classifications of cognitive learning. We present our results using terminology similar to that used in other user studies (c.f., Wang et al., 2000). A *query* is string of terms submitted by a searcher in a given instance. A *session* is a series of queries submitted by a user during one interaction with the Web search engine. A *topic* is the information focus of a series of one or more queries. A single session may have several topics. The *session duration* is the temporal length. Earlier and partial results were reported in a workshop submission (Jansen, Smith, & Booth, 2007a) and two conference posters (Jansen, Smith, & Booth, 2007b; Jansen, Smith, & Booth, 2007c).

5.1. First research question

5.1.1. Queries per session

Hypothesis 1. There will be a significant difference in the number of queries per session among the classifications in Anderson and Krathwohl's taxonomy.

We used a one-way ANOVA statistical analysis to compare means and variance among the classifications. The one-way ANOVA tests whether two or more groups are significantly different. Our results indicate that there is a significant difference among the groups ($F(5) = 5.778$, $p < 0.01$). We ran a Tamhane's T2 Test comparing group means to identify specific differences. Tamhane's T2 Test does not assume equal variances among the samples.

Tamhane's T2 results indicate that the collection of learning tasks classified as *applying* was significantly different from the classifications of *remembering*, *understanding*, and *evaluating* ($p < 0.05$). *Applying* was not significantly different in number of queries per session from *analyzing* and *creating*. *Understanding* was also significantly different from *creating*, and *evaluating* was significantly different from *creating*. So, Hypothesis 1 is partially supported. By partially supported, we mean that at least one but less than all six of the classifications were statistically different from the others. All six classifications statistically different from the others would be a fully supported hypothesis. Fig. 1 shows the mean queries per sessions of the six classifications.

5.1.2. Average query length

Hypothesis 2. There will be a significant difference in the average query length per session among the classifications in Anderson and Krathwohl's taxonomy.

Using a one-way ANOVA, our results indicate that there is a significant difference among the groups ($F(5) = 2.86$, $p < 0.01$). Tamhane's T2 results indicate that the classification *analyzing* was significantly different from the classifications of *applying* and *creating*. Hypothesis 2, therefore, is partially supported. Fig. 2 shows the mean query length for each of the six classifications.

5.1.3. Unique terms per session

Hypothesis 3. There will be a significant difference in the number of unique terms per session among the classifications in Anderson and Krathwohl's taxonomy.

Again using a one-way ANOVA, our results indicate that there is a significant difference among the groups ($F(5) = 3.34$, $p < 0.01$). Tamhane's T2 results indicate that the classification *analyzing* was significantly different from the classifications of *remembering* and *evaluating*. Hypothesis 3, therefore, is partially supported. Fig. 3 shows the mean number of unique terms for each of the six classifications.

5.1.4. Topics per session

Hypothesis 4. There will be a significant difference in the number of topics per session among the classifications in Anderson and Krathwohl's taxonomy.

Using a one-way ANOVA, our results indicate that there is a significant difference among the groups ($F(5) = 8.613$, $p < 0.01$). Tamhane's T2 results again indicated significant differences among the classifications. *Applying* was significantly

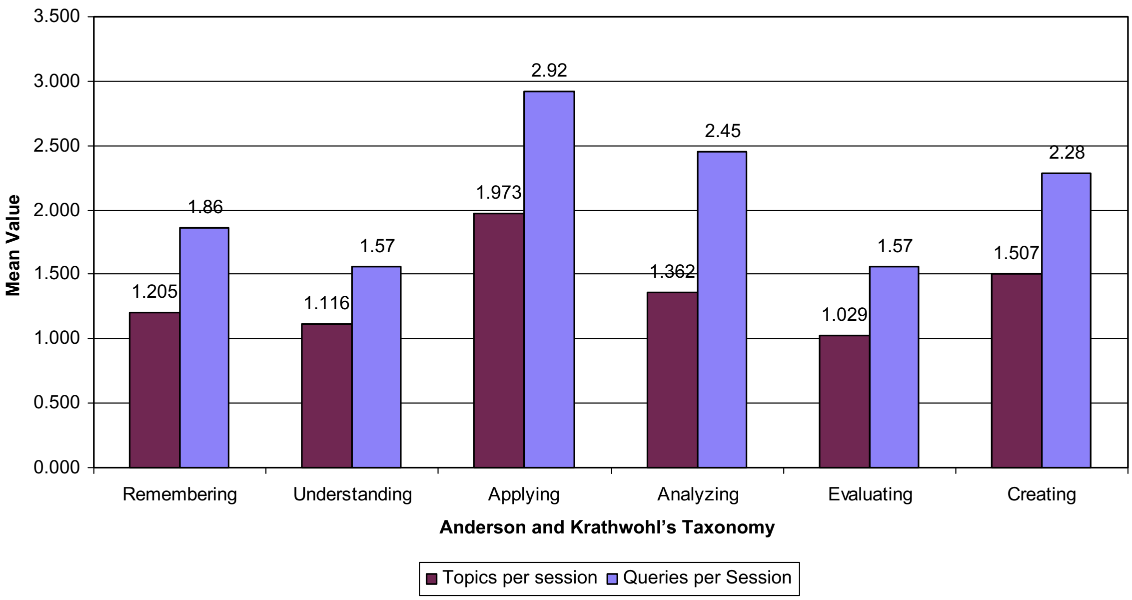

Fig. 1. Queries per session and topics per session.

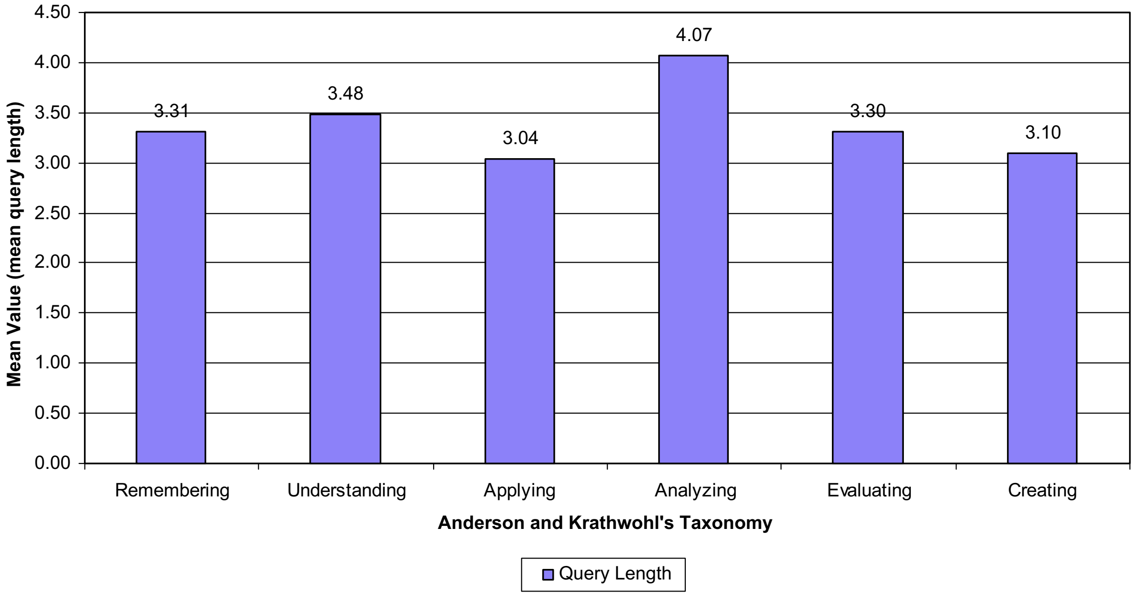

Fig. 2. Mean query length.

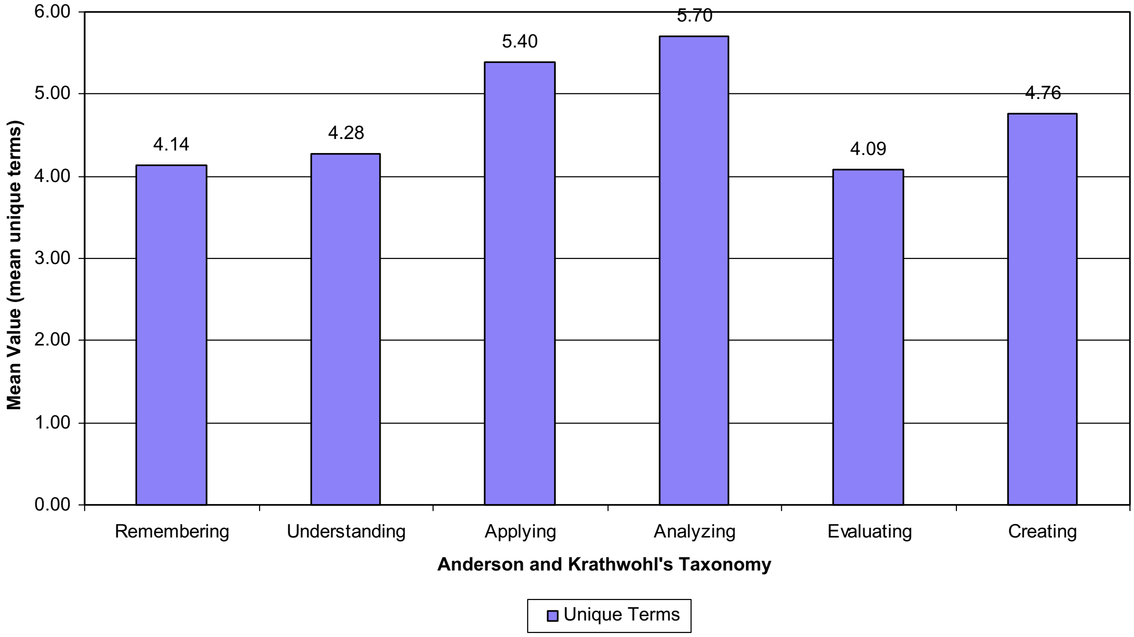

Fig. 3. Number of unique terms.

different from the classifications of *remembering*, *understanding*, and *evaluating* ($p < 0.05$). *Understanding* was significantly different from *creating*, and *evaluating* was significantly different from *creating*. Therefore, Hypothesis 4 is partially supported. Fig. 1 shows the mean topics per sessions of the six classifications.

5.1.5. Duration of session

Hypothesis 5. There will be a significant difference in the duration of sessions among the classifications in Anderson and Krathwohl's taxonomy.

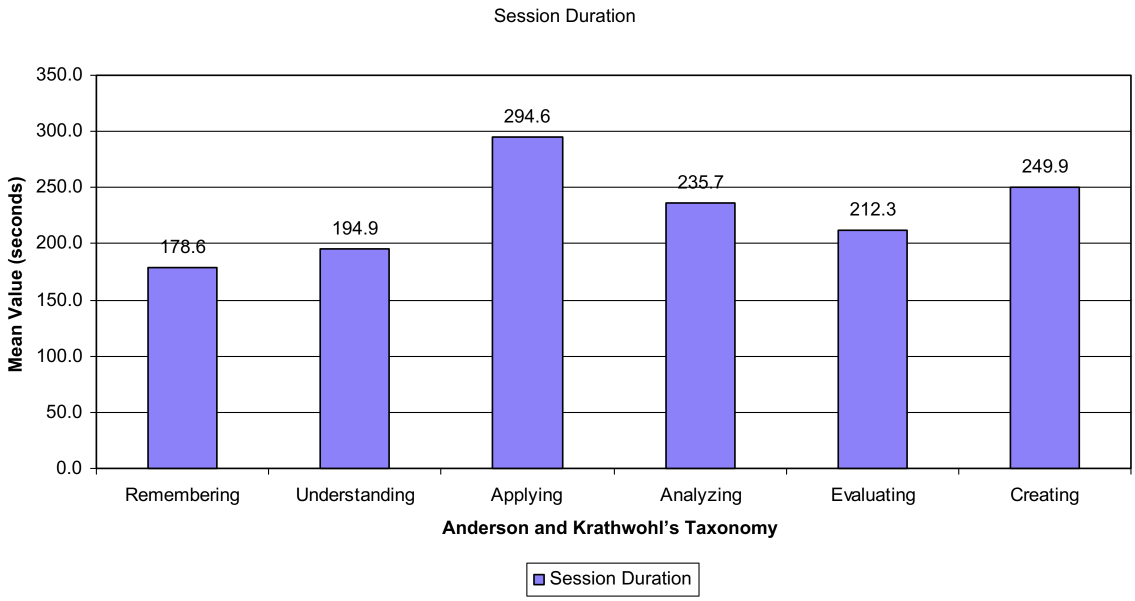

Fig. 4. Session duration in seconds.

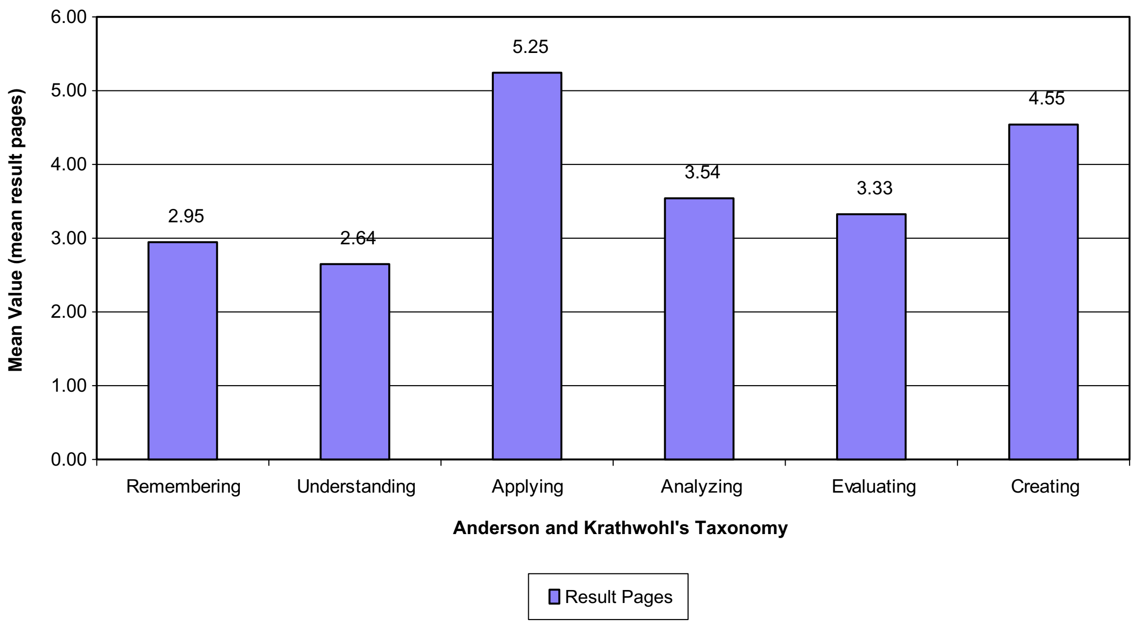

Fig. 5. Number of result pages viewed.

Again using a one-way ANOVA, our results indicate that there is a significant difference among the groups ($F(5) = 2.68$, $p < 0.05$). Tamhane's T2 results indicate that the classification *applying* was significantly different from the classification of *remembering*. Hypothesis 5, therefore, is partially supported. Fig. 4 shows the mean durations of sessions for each of the six classifications.

5.1.6. Result pages view per session

Hypothesis 6. There will be a significant difference in the number of result pages viewed per session among the classifications in Anderson and Krathwohl's taxonomy.

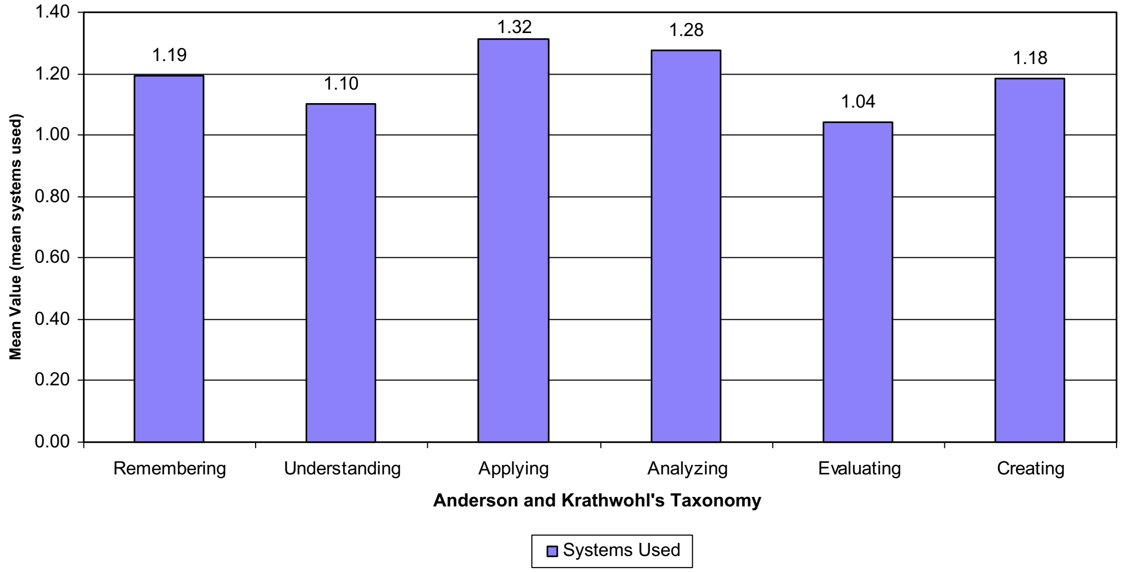

Fig. 6. Number of information systems used.

Table 4
Systems used by participants.

	Information system	Occurrences of use	Percentage (%)
1	Google	358	72.3
2	Wikipedia	40	8.1
3	MSN	16	3.2
4	Ask	12	2.4
5	Ebay	12	2.4
6	IMBD	12	2.4
7	Amazon	7	1.4
8	Yahoo!	7	1.4
9	Froogle	3	0.6
10	WebMD	3	0.6
11	Metacrawler	2	0.4
12	Orbitz	2	0.4
13	Other	21	4.20
	Total	495	100.0

Note: Used one times, the others were: about, Apple, Best Buy, CheapFlights, CheapTickets, Dictionary, Dogpile, FindArticles, Graduates Hotline, Greyhound, Hotwire, HowStuffWorks, Ikea, LinxBest, Mapquest, NetDoctor, Nielsen Media, Overstock, SortPrice, Target, Travelocity.

Again using a one-way ANOVA, our results indicate that there is a significant difference among the groups ($F(5) = 2.26$, $p < 0.05$). Tamhane's T2 results indicate that the classification *applying* was significantly different from the classifications of *remembering* and *evaluating*. Hypothesis 6, therefore, is partially supported. Fig. 5 shows the mean number of result pages viewed for each of six classifications.

5.1.7. Systems used per session

Hypothesis 7. There will be a significant difference in the number of search systems used among the classifications in Anderson and Krathwohl's taxonomy.

Again using a one-way ANOVA, our results indicate that there is a significant difference among the groups ($F(5) = 2.21$, $p < 0.05$). Tamhane's T2 results indicate that the classification *applying* was significantly different from the classifications of *remembering* and *evaluating*. Hypothesis 7, therefore, is partially supported. Fig. 6 shows the mean number of systems for each of six classifications.

The distribution of systems that the participants used is interesting because of the predominance of Google as the main information system and the fact that none of the participants directly accessed the university's library system in addressing the searching scenarios. Table 4 shows the use of systems for all searching scenarios for all participants in the study.

Table 5
learning styles of participants.

Learning style	Occurrences	Percentage (%)
Concrete	33	45.8
Reflective	13	18.1
Active	10	13.9
Abstract	9	12.5
Active, abstract	3	4.2
Concrete, reflective	2	2.8
Concrete, active	1	1.4
Concrete, active, reflective	1	1.4
Total	72	100.0

Table 6
ANOVA results of learning styles of participants and searching characteristics.

	ANOVA *F* value ($df = 5$)						
	Queries per session	Topics per session	Duration of sessions	Average query length	Unique terms	Result pages viewed	Search systems used
Abstract	3.73**	3.01*	2.53*			2.72*	
Active	2.51*						
Active, abstract					3.62*		
Concrete	2.74*	3.79**					
Concrete, reflective	5.39*	4.40*					7.20**
Reflective							

* $p < 0.05$.
** $p < 0.01$.

As shown in Table 4, there were 495 total instances of use of 33 systems. The general-purpose search engine, Google, represented more than 72% of all instances of use. Most participants used one information system to address the searching scenarios, along with some destination Website or page. However, more than 18% of the participants used two systems, with the remainder using between three and five information systems for a given scenario. Naturally, what is or is not an information system is a matter of discussion. Is Google an information system, an information portal, or a navigational aid? Is a personal Website an information system or just a 'document'? Based on our definition of information system, for this research, we have included the general-purpose search engines.

5.1.8. Second research question

Research Question 2: Are searching characteristics within Anderson and Krathwohl's taxonomy affected by the learning style of the searcher?

Table 5 shows the numbers of the participants in each learning style.

From Table 5, more than 45% of the participants were concrete learners, although there where sizable numbers of reflective, active, and abstract learners as well. Investigating whether or not learning style affects exhibited searching behaviors, we examined hypothesis 8 (*There will be a difference in exhibited searching characteristics based on learning styles.*) using a one-way ANOVA and Tamhane's T2 Test to compare group means to identify specific differences. Our results are reported in Table 6.

We did not perform post hoc tests for *concrete – active* and *concrete – active – reflective* due their low occurrences. From Table 6, it appears that learning does affect searching characteristics based on learning level. There were notable differences between those with an *abstract* learning preference and those with a *concrete* learning preference. These findings are in line with what one would expect if information searching were a learning process. Focusing primarily on groups with nine or more participants (Concrete, Reflective, Active, and Abstract), we see that Abstract learners exhibited the most unique searching behaviors, with significant differences in queries per session, topics per session duration of session, and result pages viewed. The implications are that in studies of searching systems, those users with Abstract learning styles probably should be control variables.

6. Discussion and implications

In this research, we conducted a laboratory study to investigate whether learning theory provides a basis for investigating online searching. The implications being that if searching needs could be classified into an appropriate learning model based

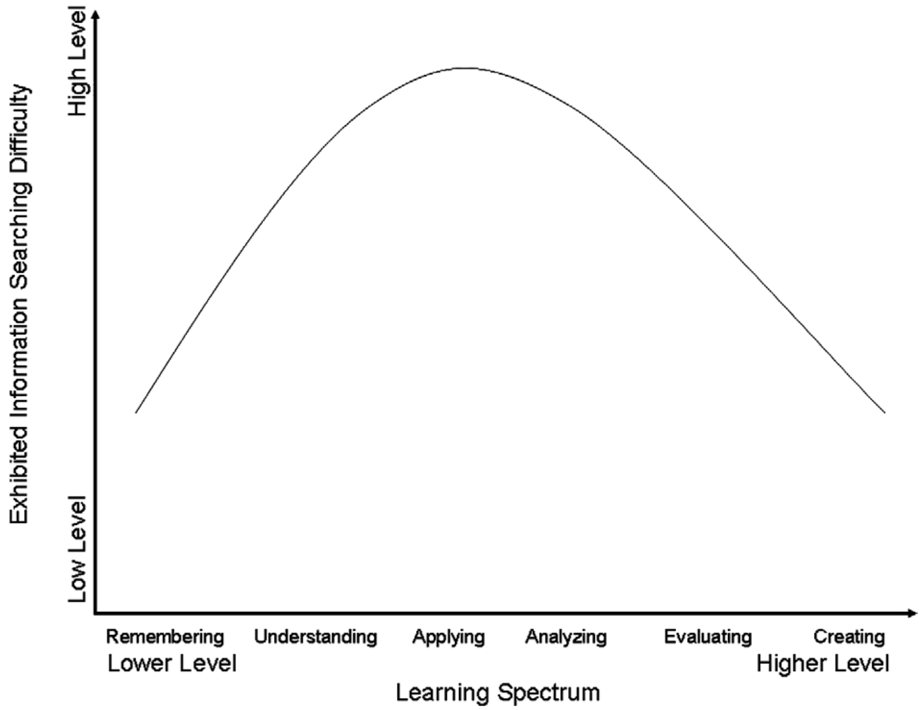

Fig. 7. Relationship between Anderson and Krathwohl's taxonomy levels and exhibition of searching difficulty.

on searcher behavior, information systems could provide results that are not just relevant to the query but also to the underlying learning need.

Utilizing Anderson and Krathwohl's taxonomy of the cognitive domain as the overall learning paradigm, we designed searching scenarios consistent with each classification of the six-levels of the taxonomy. We employed two searching scenarios for each classification, used a large number of participants, and logged their searching actions. We then measured searching characteristics of *number of queries*, *query length*, *unique terms*, *number of topics*, *session duration*, *number of result pages viewed*, and *number of search systems* for each classification. Research results indicate that learning appears to be an appropriate model through which to view searching. All hypotheses were partially support using these designated searching characteristics.

Primarily, the middle classification of *applying* was generally statistically different than *remembering* and sometimes *understanding* (i.e., number of queries, number of topics, session duration, number of result pages viewed, and number of systems used). *Analyzing* was also statistically different from *remembering* (i.e., unique terms). Searching tasks at these learning levels appear to be the most challenging for searchers, exhibiting more complex searching characteristics. In some ways, one would expect these findings given that *remembering* and *understanding* are relatively 'lower level' cognitive tasks relative to *applying* and *analyzing.* However, in many cases *applying* and/or *analyzing* were also different from the 'higher level' cognitive tasks of *evaluating* and *creating* (i.e., number of queries, unique terms, number of topics, number of result pages viewed, and number of systems used).

In examining the overall relationship between learning level in the cognitive domain and exhibited searching difficulty (i.e., lengthier, longer, higher, etc.) of the task, we get an inverted curve as shown in Fig. 7.

At the lower level of cognitive learning (*remembering* and *understanding*) and at the higher level (*evaluating* and *creating*), the exhibited searching characteristics are what one would deem indicative of relatively non-difficult searching tasks. At the lower levels, searchers seem to engage in fact checking and homepage-like finding activities (Kellar et al., 2007). Interestingly, they seem to engage in the same activities at the higher level, presumably just to verify facts and information they already possess. The implication is that the 'simple' task searching behaviors exhibited by Web searchers (c.f., Hölscher & Strube, 2000; Silverstein, Henzinger, Marais, & Moricz, 1999) may relate to more complex underlying learning needs. While the higher levels tasks are more difficult, especially in terms of searching time and result pages viewed, they appear to depend more on the users' creativity and viewpoints. The additional knowledge that searchers need to complete the task appear to be fact-finding tasks. Obviously, in these cases, searchers may be missing serendipitous findings and alternative viewpoints. This aspect would be a case for developing searching interfaces to facilitate exploratory searching. However, at the middle cognitive levels (*applying* and *analyzing*), the exhibited searching characteristics are characteristics of more complex searching needs.

Interestingly, these factors appear to be consistent across users with different learning styles, although there are some statistically significant differences in exhibited search behaviors. These differences are especially notable with Abstract learners, so there may have to be some allowance for these types of searchers. Concrete, reflective, and active learners appear to be relative homogenous in their searching behaviors. Therefore, it appears that learning style has limited effect on exhibited differences in searching characteristics, with the exception of Abstract learners.

Naturally, there are limitations with a controlled laboratory study; namely the lack of realism that is present in naturalistic studies. However, we believe that the methodology is consistent with our research aims of isolating to the degree possible the learning aspect that appear inherent in information searching tasks. Another limitation is, of course, the searching scenarios. Although we designed the scenarios to be consistent with each level of cognitive learning, there is no guarantee that each participants actually engaged in these cognitive processes. Certainly additional studies in this area with a variety of searching scenarios would be beneficial. However, given the study design, it appears that some unique process is occurring at the different levels. Also, while the cognitive learning process certainly appears to impact how users search, it seems reasonable that other cognitive, affective, and situational factors also influence the expression of the underlying information needs. A wide range of information science, computer science, and other domain literature well documents these factors. For example, Oliver and Oliver (1997) have commented that the amount of retained knowledge gained is influenced by the activity context and purpose. We also acknowledge that learning and decision making may be inter-related processes or embedded with each other, as noted by (Tang, 2002). Learning and problem solving activities may also be intertwined in the performance of a Web searching activity. Further research is necessary to tease apart these multiple and intertwined factors. Finally, there is the issue of gender imbalance (i.e., were more male than female participants). Some prior work (Large, Beheshti, & Rahman, 2002; Roy & Chi, 2003; Roy, Taylor, & Chi, 2003) has reported some gender differences within information searching. However, Hupfer and Detlor (2006) in their comprehensive study reported no such difference.

There are several strengths to this research. First, there is the grounding of the searching scenarios in a well established learning taxonomy, which anchors the study within both the learning and searching domains. Second, the use of a controlled

Table 7
Knowledge and cognitive dimensions of Anderson and Krathwohl's taxonomy.

The knowledge dimension	The cognitive process dimension					
	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual knowledge	List	Summarize	Classify	Order	Rank	Combine
Conceptual knowledge	Describe	Interpret	Experiment	Explain	Assess	Plan
Procedural knowledge	Tabulate	Predict	Calculate	Differentiate	Conclude	Compose
Meta-cognitive knowledge	Appropriate use	Execute	Construct	Achieve	Action	Actualize

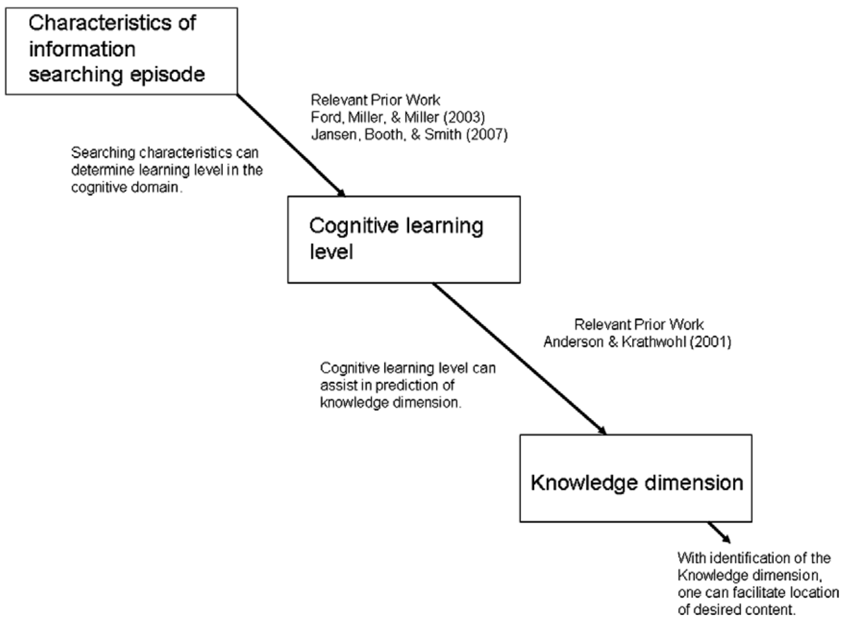

Fig. 8. Possible predictive relationship of cognitive need, exhibited searching, and desired content.

laboratory study to examine the relationship of individual variables highlighted the effect of the searching scenarios on exhibited searching characteristics. Third, we examined multiple searching characteristics for differences among the learning categories, which allowed for multiple dimensional examination of searching as learning.

There are several important implications of this study, including insights into searching needs, a learning model for information searching that is inferential, and possibly improved identification of needed content. First, the commonly held notion that Web searchers have simple information needs may not be correct. Some of these simple expressions may be indicative of higher-level information needs at the *evaluating* and *creating* levels of learning. While these tasks are more difficult, they depend more on the users' creativity or opinions; therefore, any additional information they need to complete the task is fact finding.

Second, learning theory may be a way of modeling online searching in a predictive manner. There are many paradigms for information searching (Dervin, 1992; Kuhlthau, 1993; Saracevic, 1996; Wang et al., 2000), many studies on information searching (Kellar et al., 2007; Wang et al., 2003), and many studies on information needs (Taylor, 1991; Wilson, 1981); however, linking these three areas of study in a meaningful way has been lacking. Formulation of need is an important and usually neglected part of searching and retrieval instruction. Some have argued that given the current state of the development of information retrieval systems, emphasis should be directed from query construction to analyzing search tasks, information needs, and problem formulation (c.f., Halttunen, 2003). The formulation of meaningful search has been considered within the context of information literacy instruction (Webber & Johnston, 2000). Based on the results of this research, framing these needs, tasks, and problems within the learning framework of *Anderson and Krathwohl's taxonomy* appears to be appropriate.

Finally, there are benefits of modeling searching as a cognitive learning process, namely that Anderson and Krathwohl's taxonomy also presents a second dimension concerning the information needed (the Knowledge Dimension), as shown in Table 7 (Forehand, 2005).

Anderson and Krathwohl's Taxonomy has a knowledge dimension that, when combined with the cognitive process dimension, results in a 24-cell matrix where one can link cognitive process to the type of knowledge required. These information needs follow nicely with information needs as noted in various information science and information retrieval literature (c.f., Detlor, 2003; Kellar et al., 2007; Taylor, 1991), although some searching needs common on the Web still need to be researched (c.f., Rose & Levinson, 2004). Although requiring more research, Fig. 8 illustrates the possible linkage between need and content by viewing information searching as a learning process.

The implications of this linkage between the cognitive processes, searching characteristics, and desired content are extremely beneficial. Several researchers have lamented the lack of real system impact on information searching user studies, the shotgun approach (c.f., Saracevic, 1991) to the identification of user characteristics, and the lack of granular searching models for the development of information searching systems. Marchionini (2006) speaks of building supporting information tools if we can define types of information-searching with associated strategies and tactics. What has been lacking is an inferential model that links the cognitive aspects of the user, searching characteristics, and type of content. From the results of this study, it appears that classifying information searching episodes by levels of the cognitive domain can possibly provide the linkage to content, as illustrated in Fig. 8. Again, this is an area that will need considerable future research but may lead to a real linkage between users, system features, and content.

7. Conclusion and future research

From the results of this research, it may be possible to model searching episodes as levels of learning in the cognitive domain. If so, then one can design search interfaces that facilitate different information seeking needs using the results of this study. For example, providing tools to collect and annotate findings might enhance *applying* tasks as searchers could develop their arguments during the search process. Similarly, we could present people with multiple perspectives on an argument (e.g., Budzik & Hammond, 2000; Sack, 1995) in order to enhance their viewpoints when engaged in *evaluating*. We envision search interfaces assuming various modes that correspond to searcher goals and intentions.

Although this research provides a solid basis, it is clear that more work is needed to highlight the relationship between learning level and exhibited searching characteristics, especially in terms of other moderating effects such as expertise and environment. People search for information for a variety of reasons, and this research investigated categorizing some of these reasons in terms of learning needs. The results from this research suggest one can categorize such searching intentions and that these intentions vary in terms of their cognitive demands. In addition to the future research outlined above in linking searching characteristic to learning level to type of content desired, an additional area of research would be isolate specific searching characteristics that actually link to some cognitive process such as *applying* or *creating*.

Appendix A. Questions for searching based on learning taxonomy

- Entertainment
  - Remembering

- List 5 movies directed by Steven Spielberg
- Who wrote the Macarena?

- Understanding
  - Give a brief plot summary of the TV show, Veronica Mars.
  - Briefly explain the meaning of the lyrics of "You are the Moon" by the Hush Sound.

- Applying
  - What are some possible characteristics of a person who would enjoy trip-hop music?
  - About how many songs can a 80G portable mp3 player hold?

- Analyzing
  - What are the main differences between techno and trance music?
  - A certain show has intense violence and coarse language. What television rating should it receive?

- Evaluating
  - Create a list of pros and cons for the new iPod Shuffle. Based off of this, would you purchase it (assuming you had the money to do so)? Why or why not?
  - Which of the new ipods would be most suitable for the average college student? Why?

- Creating
  - Design a radio ad for the movie, Fearless.
  - Which do you think will have better overall sales – the XBox 360, the Nintendo Wii, or the Playstation 3? Why?

- Health
  - Remembering
    - List 5 symptoms of a heart attack.
    - What is Klinefelter's Syndrome?

  - Understanding
    - What are the benefits of Vitamin K?
    - What are the differences between a cold and the flu?

  - Applying
    - Your friend has Chickenpox, but (for whatever reason) does not want to consult a doctor. Develop a list of instructions to aid in his or her recovery.
    - What are the characteristics of someone who would be highly susceptible to heat stroke?

  - Analyzing
    - What are the main things to look for when selecting a health care provider?
    - What is one problem with America's current health care system? What is a possible solution for this problem?

  - Evaluating
    - What are the current available methods for tattoo removal, and how effective are they? Which method do you think is the most practical? Why?
    - You just moved to a new town and are looking for a chiropractor. Prepare a list of criteria to judge the practices in your area and indicate priority.

  - Creating
    - Your friend just got back from studying abroad and suddenly developed a high fever. Dry cough, chills, and breathing difficulties soon followed. What could your friend have?
    - Given the current medical technology, when (if ever) do you think scientists will develop a cure for AIDS? Why?

- Ecommerce
  - Remembering
    - List 5 states in America that have a sales tax on clothing.
    - What is Pennsylvania's state sales tax, and which items are exempt?

- Understanding
  - Explain the steps you would have to take if you wanted to sell a lamp on Ebay.
  - Which websites would you check if you were looking for car listings online?
- Applying
  - You and a roommate are planning on refurnishing your living room. You want to get a new couch, recliner, television, and lamp. Considering the average budget of a college student, calculate an estimated cost for each of the items as well as a total estimated cost.
  - You want to sell one of your old pairs of boots on Ebay. Create a listing for your boots (include all relevant information you'd need to sell them).
- Analyzing
  - Explain how ecommerce has affected the retail industry.
  - You find a great deal online, but it's from a company that you have never heard of before. How do you determine of the website is legitimate or not before you make your purchase?
- Evaluating
  - Would you get better results if you listed an item for sale on Ebay or Amazon? Why?
  - Do you think it is more beneficial for clothing companies to sell their goods online or in a physical store? Why or why not?
- Creating
  - What do you think will be the next advancement in ecommerce? Give reasons for your choice.
  - You notice a recent charge on your credit card that you did not make, and you suspect that someone has stolen your credit card information. What steps would you take to correct the recent fraudulent charge and to prevent more fraudulent purchases on your card?

- Travel
  - Remembering
    - What are the top 10 US vacation spots?
    - In terms of aircrafts, what does the acronym CAT stand for?
  - Understanding
    - Terrorism and hijacking aside, what kind of things does the average traveler need to consider when traveling somewhere by plane?
    - Is it statistically safer to travel by car, boat, train, or airplane?
  - Applying
    - You are planning a trip to Africa with your travel agent. What questions would you ask with regard to health and safety?
    - You decide to spend your Spring Break in Orlando, Florida. You want to leave from Philadelphia March 5th and return on the 12th. Which website offers the cheapest airline ticket for your trip, and how much does it cost?
  - Analyzing
    - What problems do airlines face because of commuter response to terrorism in the media? How can they overcome these issues?
    - What are the benefits of planning a trip (researching destinations, purchasing tickets, and making reservations) online as opposed to using a travel agency?
  - Evaluating
    - Your friend is planning on studying abroad next year, but has no idea where to go. He is a business major and will be funding the trip himself. Recommend a country for him to visit and give reasons to support your recommendation.
    - You live in New York City and want to take a trip to Boston. Which method of transportation would be most effective? Why?
  - Creating
    - You and a friend are planning a trip to NYC. Both of you live in Philadelphia, have no car, and have $200 each to spend on the whole day. Create travel plans and a tentative itinerary for the day.
    - Considering current technology, how long do you think it take until cars running on alternative fuel (i.e. not fossil fuel) will become commonplace? Why?

Appendix B. Questionnaire on learning styles

Rank each of the items below across the columns from *most like you (5)*, to *least like you (1)*. Place the number next to each of the items that best suit you and add up each column at the end.

Rank each of the items below across the columns from **most like you (5)**, to **least like you (1)**. Place the number next to each of the items that best suit you and add up each column at the end.

1	2	3	4	5
least like me				most like me

1. I prefer lecturers/tutors/demonstrators who			
give me step-by-step instructions	provide active and stimulating learning	have a supportive classroom	provide challenging materials
2. I prefer materials that are			
well arranged	hands-on	about humanity and improving the world	intellectually challenging
3. Other people view me as			
loyal and reliable	creative and dynamic	caring and compassionate	intelligent and inventive
4. When I'm stressed I would prefer to			
take control of life	do something adventurous	talk to friends	reflect alone about my circumstances
5. I dislike people who are			
irresponsible	rigid and like routine	selfish and unsympathetic	illogical
6. One word that describes me is			
sensible	spontaneous	giving	analytical
7. My holidays can be described as			
traditional	adventurous	pleasing to others	new learning experiences
Total	**Total**	**Total**	**Total**

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