Broad Exploration or Precise Specificity: Two Basic Information Seeking Patterns Among Students

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This article investigates whether information seeking patterns can be related to discipline differences, study approaches, and personality traits. A quantitative study of 305 master's thesis students' information behavior found that their information seeking tended to be either exploratory or precise. Statistical analyses showed that inner traits seemed more influential than discipline characteristics on information behavior. Exploration or specificity was manifested in terms of both the level and scope of information students wished to retrieve and the way they searched for it.

Introduction

No matter how fast information technology evolves or how sophisticated search systems we learn to master, our basic human reactions remain as they have been through centuries. Our behavior, even in seemingly rational activities such as information seeking, is influenced by our holistic being as a creature of physiological, cognitive, and affective processes. This characteristic has important implications for the development of user-centered information services. The user can learn to adapt to search systems, but more importantly search systems should be adapted to users' natural ways of seeking information. The traditional approach in library and information science has been to support users to overcome their possible weaknesses in search ability. Equally important is to recognize particular strengths in the users' habitual ways of information seeking and adjust systems to support these tendencies.

An understanding of information behavior would account for the broad interaction of contextual, sociological, and psychological factors that influence information seeking in any given situation. If we find patterns in information behavior and gain insight in explaining underlying variables,

we are further on our journey toward an increased understanding of the user. A psychological perspective may reveal reasons behind habitual preferences for particular information seeking styles.

This article focuses on patterns of broadness versus specificity in students' information seeking by relating information behavior to students' academic discipline, study approach, and personality characteristic. Finding general styles of information seeking and relating them to explanatory variables would be highly beneficial for the further development of information services.

Students are important users of information services, as they need to retrieve information in order to expand their knowledge.

Extensive research has convincingly shown the influence of context and search task on information seeking (for an overview see Solomon, 2002). The academic field university students are working in forms an important context for their information seeking. Information seeking patterns are usually quite standardized within a certain discipline and the newcomer is trained in those patterns.

Drawing on previous research (Entwistle & Ramsden, 1983; Ford, Wilson, Foster, Ellis, & Spink, 2002; Julien, 1999; Kuhlthau, 1993, 2004; McDowell, 2003), the most common patterns in students' information seeking can be described along a dimension of broadness versus specificity. Broad exploration may indicate that students are exploring a new research topic and need a wide overview in order to get acquainted with the field. At times, a broad search pattern may also reflect the way students build their knowledge. Several models of cognitive processing point to two basic styles of cognition and problem solving, either a convergent rational, problem-focused style or a divergent intuitive, creative broad style (Edwards, 2003; Kolb, 1984). Typical for students with a divergent learning style would be to start their learning process through an overall understanding of a topic to which further pieces of information can be linked. This need induces a broad search pattern throughout project stages. A precise search approach may indicate that students

have found a focal point of particular interest after the initial exploration of a new topic. Controlled and systematic seeking with a precise goal may also be typical for students with a serialist learning style. Both broad exploration and specific searching have their particular benefits dependent on stage of the research process, or the preferred way of learning.

Students' personal interest and motivation for their study topic are reflected in the depth of their information need. They may pursue information either because they want to fill a specific knowledge gap or because they enjoy learning more about the topic. This reflects two motivational processes of either wanting or liking (Litman, 2005). Individual styles of seeking information in order to meet information needs could be related to a more pervasive influence on behavioral patterns, personality. Styles can be described as stable patterns that arise from the transaction between the individual and his/her environment (Kolb, 1984, pp. 95–98). Personality inclination is likely to form characteristic styles of information seeking preferences that interact with contextual factors in any given search situation.

This article links master's thesis students' information seeking to their disciplinary context, approaches to studying, and personality traits in order to analyze typical patterns in their information seeking.

The specific research questions were the following:

- Do information seeking features form patterns of broadness versus specificity?
- Can patterns of information behavior be explained by discipline differences?
- Can patterns of information behavior be explained by approaches to studying?
- Can patterns of information behavior be explained by personality?

Information seeking is studied here through three layers: from the contextual influence of discipline, through the motivational impact of study approach, to the inner inclination of personality disposition.

Information Seeking Patterns Related to Discipline Differences

Information seeking patterns within disciplines highlight the differences in knowledge creation among academic fields. The knowledge base in sciences is cumulative: New discoveries are grounded on former ones. This tends to induce a sequential knowledge creation pattern in which certain basic facts are needed as fundamentals in the creation of new insights. Information seeking, as a consequence, is commonly structured and focused on one specific aspect at a time (Becher, 1989, pp. 77–103; Brittain, 2000). In arts and social sciences, new understanding is built in a more holistic way, in which individual interpretations are less bound by laws of science. Accordingly, gathering of information within social sciences tends to be more investigative (Brittain, 2000). One way to describe the patterns of information need and seeking within academic fields is in terms of specificity and exploration.

Typical of hard sciences are clear-cut information searches concentrated on one specific aspect, a search pattern comparable to a problem-solving process (Palmer, 2005). Research in sciences is often focused on detailed analysis of a specialized problem in a laboratory experiment or fieldwork setting. In this environment, information is seen as a recipe and encyclopedia of facts. The most common and convenient way to meet a specific information need is to ask a colleague at the workplace or in the field (Noble & Coughlin, 1997; Rolinson, Al-Shanbari, & Meadows, 1995). The specificity of topic may also center the sources of information on specialized journals. As science is a rapidly evolving field, it becomes crucial to keep up to date with current developments (Becher, 1989, pp. 77–103). This need can be met, for instance, by monitoring core journals (Ellis, Cox, & Hall, 1993).

Compared to the problem-solving search attributes characteristic of sciences, the general search pattern within humanities tends to be a more extensive investigation around topical interests (Palmer, 2005). Naturally, at times a particular information source is also sought in order to fill a specific information gap within humanities, but the general tendency seems to be to gather information widely through consultation of a variety of sources (Steinwedel, 1999). A common search pattern for humanists and social scientists is to retrieve information through browsing (Ellis, Cox, & Hall, 1993). Science scholars, who often need a specific solution to their information need, are less likely to find browsing productive. The range of material available for social scientists is, furthermore, related to the lasting informativeness of documents compared to the fast-changing natural sciences. In humanities research, results are usually published in books, and in many arts fields it is often important to consult primary literature (Steinwedel, 1999).

Despite differences between these academic fields, patterns of information seeking among scientists are additionally formed through similarities. Ellis has described six basic information-seeking strategies of scientists: starting, chaining, browsing, differentiating, monitoring, and extracting (Ellis, 1993; Ellis, Cox, & Hall, 1993). Ellis's model has recently been confirmed with the addition of four information features—accessing, networking, verifying, and information managing—that combined with Ellis's model form four interrelated patterns of information seeking: searching, accessing, processing, and ending (Meho & Tibbo, 2003). The stages of the Ellis model correspond to the information-seeking process model developed by Kuhlthau (1993, 2004). These information seeking features typically occur at certain stages of a research process but may also flexibly arise in relation to momentary needs. The aspects of time and development of a research process must therefore be considered in the discovery of search patterns.

Previous studies have shown that students are socialized into the traditions of their discipline and adopt search patterns similar to those of established scholars (Delgadillo

& Lynch, 1999; Whitmire, 2002). It may consequently be assumed that master's thesis students, as the population of the present study, would have taken on information seeking patterns similar to those established in their field.

Information Seeking Patterns Related to Approach to Studying

Information seeking of students is likely influenced by the specific features of their academic field. Within the disciplinary framework, groups of students still vary in their information behavior. One explanation for this is their study motivation, which in turn is reflected in level of search engagement. Extrinsically motivated students tend to adopt a surface approach to studying characterized by reproduction of information through rote learning. Intrinsically involved students tend to employ a deep approach using information as a building block for their personal comprehension of the topic. Strategically oriented students adjust their study approach according to task demands in order to obtain good study results (Entwistle & Tait, 1996).

The way the students approach their studies relates to their own conception of learning and their desired outcome of the knowledge creation process. In order to satisfy the desired level of understanding, information material of a certain depth is needed. It has been shown that a wide search pattern with use of many kinds of material and many search paths is typical for students with a deep study approach. As these students use information as a means to reach a personal understanding of a phenomenon, they need to retrieve material for reflection and analysis. These students construct their knowledge by relating new information to previous topical understanding. Because it is particularly important for them to get an overall perspective of the phenomenon, they employ processes of broad information gathering (Ford, 1986).

The opposite search pattern can be characterized by use of minimal effort. Particular pieces of information are sought in order to fill a momentary gap of information, instead of being linked in a wider pattern of knowledge creation. This search approach has been shown to be typical for students who have a surface study approach, who conceptualize learning as memorization (Entwistle & Tait, 1996). For students who have a surface approach, fear of failure particularly seems to reduce the degree of search engagement (Ford, Miller, & Moss, 2001). Students who mainly study by rote learning and have a syllabus-bound approach to studying tend to consult information sources only because they are required to do so. Lack of personal interest is here reflected in low search engagement. This search pattern may create problems in the critical analysis of information and relevance judgment.

As approaches to studying are related to intention and motivation, they have a natural link to contextually generated incentives. It has, nevertheless, been found that certain personality traits often induce particular study approaches (De Raad & Schouwenburg, 1996; Diseth, 2002).

Deep-level information processing has been shown to have a basis in the combination of openness, conscientiousness, and stability (Schouwenburg & Kossowska, 1999). A surface study approach has been related to insecurity (Adema, 2000) and low conscientiousness (Sheppard & Gilbert, 1991), whereas a strategic study approach has been linked to thoroughness (Blickle, 1996; Schouwenburg & Kossowska, 1999). As this section has indicated, approaches to studying seem to have an impact on information behavior, which may imply an indirect influence of personality on information seeking. But does personality also directly influence information seeking habits?

Information Seeking Patterns Related to Personality

Students who are in the same discipline and have the same study approach are likely to share some common search characteristics. Their ways to retrieve information nevertheless also vary. One possible explanation for these differences lies in the very core of individuality, personality.

Each individual is distinguished by unique and consistent patterns of thoughts, feelings, and behavior, which reflect the inner personality core. Personality traits form dispositions and regularities in a person's behavior across situations and over time, but at times situations can temporarily modify or even reverse typical reactions (Allport, 1963). The profound base of personality has been supported in contemporary research that has shown that 50% of the central personality traits can be related to genes (Bouchard, 1997). Personality traits seem to center on five dimensions: sensitivity, extroversion, openness to experience, agreeableness, and conscientiousness (Costa & McCrae, 1992, pp. 14–16).

As personality is a stable characteristic that is reflected in behavior in various situations, personality differences can also form habitual information seeking preferences. Personality seems to be particularly influential on search engagement and activity. In the previous section energetic information seeking was related to deep motivation and personal interest in a task. Persistent and enthusiastic information seeking may also reflect inner characteristics such as responsibility and diligence (Kernan & Mojena, 1973). Use of effort in information seeking is here related to a generally hard-working and conscientious character with an ambition to excel through tedious work. Tenacious information seeking may also indicate insecurity (Kernan & Mojena, 1973), which creates a different frame of reference for the search pattern. In this case, diligent information seeking compensates lack of confidence. Methodical and engaged information seeking here reflects the need for control.

Interestingly, insecurity has also been linked to minimal search effort: Self-doubt occasionally triggers the opposite reaction to diligence—giving up the search. This can perhaps be related to the degree of insecurity. At manageable levels, the searcher still feels optimistic enough to try to compensate for low self-confidence by increased search

effort. At high levels of insecurity, self-doubt may turn into an information barrier. Searchers who believe they are likely to fail often abandon the search too soon, do not take notes, or type inaccurately (Nahl, 2001). Insecure persons tend to experience difficulties in coping with unpredictability, disorder, and ambiguity in Web searches (Finley & Finley, 1996). The less competence the searchers attribute to themselves, the less effort they are willing to use. Those who expect to be successful are more efficient and adaptive than those who doubt their search ability.

Another dimension of information seeking that has been linked to personality is systematic and focused searching as opposed to flexible gathering of information. This difference was particularly evident in a study by Palmer (1991), who compared information behavior of adapters and innovators. Adapters tend to be dogmatic, conscientious, introverted, and insecure to their personality (Kirton, 1989). These tendencies are reflected in a controlled, methodical, and systematic information seeking style (Palmer, 1991). Typical traits for innovators are openness, extroversion, and confidence (Kirton, 1989, p. 31). These characteristics often lead to spontaneous and creative ways of collecting information widely and enthusiastically through many different sources (Palmer, 1991).

Patterns of information content preference, particularly along the dimension of innovative or familiar content, have also been related to personality traits. It has been shown that confident persons are more accepting of new information and prepared for possible changes. They have a flexible cognitive structure and are more adjusted to a changing world. Insecure persons are less likely to change their views and accept new information (Miculincer, 1997).

Previous research has thus shown that information seeking patterns relate to personality traits, study approaches, and discipline differences. The present study combines these three perspectives to compare their contrasting and/or mutual influences on information seeking directly.

Method

The aim of the study was to find general patterns in information seeking that could be related to personality traits, study approaches, and/or discipline contexts. Data were collected by the use of three questionnaires: the NEO Five-Factor Inventory (Psychological Assessment Resources, Inc.), the Approaches and Study Skills Inventory for Students (Professor Noel Entwistle), and a questionnaire about information behavior developed for this study.

In order to account for the respondents' own preferred way to approach information it was vital that the participants currently were engaged in a task that would require extensive information seeking. It was furthermore significant that the participants were free to approach their searches independently, in their own natural way. Students in the process of writing a master's thesis were judged to fulfill these requirements and therefore chosen as the population of the study. In order to standardize the sample and preclude the influence of factors such as university culture, the population was limited to students of one university, Åbo Akademi University in Finland.

Respondents

The respondents represented all departments at Åbo Akademi University (Table 1). The departments accounted for the disciplines of humanities (arts, theology), social sciences (economics and social sciences, education, social and health sciences), engineering (chemical engineering), and sciences (mathematics and natural sciences). The final overall response rate was 67%.

The percentage of respondents in the Departments of Arts, Economics, and Social Sciences was comparatively high. This is an artifact of the data collection method. Whenever possible, data were collected through master's thesis seminars, which frequently are held in humanities departments. As seminars are not as commonly held in the science

TABLE 1. Participation in the study by students of various departments at Åbo Akademi University (ÅA).

Department	Students contacted		Respondents by department		ÅA students by official statistics
	(%)	n	(%)	n	(%)
Arts	31	140	33	101	22
Mathematics and natural sciences	15	67	11	34	18
Economics and social sciences	27	122	30	91	22
Chemical engineering	6	26	6	17	10
Theology	1	5	1	4	4
Education	16	72	13	40	17
Social and health sciences	5	22	6	18	7
Total population	100%	454	100%	305	100%

Note. The column of students at a particular department at ÅA is based on the brochure *Åbo Akademi in brief* (2000). The percentage of the total number of students at a particular department at ÅA (column 3) refers to all students at Åbo Akademi University, only to the students writing their master's thesis. That is why the percentage of the students contacted at the department (column 1) does not completely correspond to the percentage of students in the department.

departments, students in these departments were mainly mailed the questionnaires. The response rate of the questionnaires distributed by mail was only 60% compared to 100% at seminars. Consequently, there is a bias in this study toward students of humanities. This bias was accounted for in the statistical analyses.

The NEO Five-Factor Inventory

Personality dimensions were tested by the NEO Five-Factor Inventory (NEO FFI), a well-established personality test of five basic trait dimensions: sensitivity, extroversion, openness to experience, agreeableness, and conscientiousness (McCrae, 2000). The test consists of 60 statements with which the respondents can choose to disagree or agree on a 5-point scale. Each personality dimension is measured by 12 items, which are summed as a final trait score for each respondent. Reliability for the scales within the population of the present study was tested with Cronbach alpha and tielded the following results: neuroticism (.87), extroversion (.83), openness to experience (.70), agreeableness (.77), and conscientiousness (.81). The following are examples of statements measuring each dimension:

- I am not a worrier. (neuroticism)
- I usually prefer to do things alone. (extroversion)
- I have a lot of intellectual curiosity. (openness to experience)
- I would rather cooperate with others than compete with them. (agreeableness)
- I never seem to be able to get organized. (conscientiousness)

Approaches to Studying

The approaches to studying were examined by using the short version of the Approaches and Study Skills Inventory for Students (ASSIST), a reliable and widely used test (Tait, Entwistle, & McCune, 1998). Each of the three approaches to studying, deep, surface, or strategic, is measured by six test items on a 5-point scale, to yield a total of 18 statements. Each respondent obtains a final summarized score for each of the three study approaches. The ASSIST test has been validated in a Nordic context comparable to that of the present study (Diseth, 2001; Mårtenson, 1986). Reliability for the scales within the population of the present study was tested with Cronbach alpha and gave the following result: deep (.66), surface (.63), and strategic (.67). Examples of statements measuring each dimension are the following:

- Ideas in course books or articles often set me off on long chains of thought of my own. (deep)
- I concentrate on learning just those bits of information I have to know to pass. (surface)
- I look carefully at tutors' comments on coursework to see how to get higher marks next time. (strategic)

Questionnaire About Information-Seeking Behavior

The 70-item questionnaire that measured information seeking behavior was developed for this study. The questionnaire accounted for background variables such as discipline, grades and gender. The emphasis of the questionnaire was on information seeking aspects, such as critical evaluation of information, difficulties in relevance judgment, preference for recall or precision, document selection criteria, experience of time pressure as a barrier to information, and effort used. For a detailed description of the questionnaire, including the specific questions, the reader is referred to Heinström (2002).

The results were mainly analyzed by factor, correlation, regression, and variance analyses. Factor analysis was used in order to find clusters of variables that share an underlying relationship. Correlation analyses were employed to find possible relationships between the variables. Regression analyses were used to test whether the independent variables could predict the dependent variables. Analyses of variance were applied in order to test the influence of categorical variables on the dependent variables.

Results

The aim of the study was to investigate possible patterns of information seeking, particularly in relation to exploration and specificity. In order to join and separate the information seeking features into distinguishable clusters a factor analysis of the information variables was conducted. All the variables added to the factor analysis were normalized and transformed into interval scales. After testing out various factor solutions, a three-factor model was chosen on the basis of the properties of the eigenvalues for the various solutions. Loadings over .30 were regarded as significant (in line with Hair, Anderson, Tatham, & Black, 1998). A varimax rotated factor analysis showed that the information seeking variables tended to load on all three factors (Table 2). The three information seeking patterns found in the analysis were named *Fast surfing* (factor 1), *Broad scanning* (factor 2), and *Deep diving* (factor 3).

The factor analysis grouped the information variables, and not the respondents, into clusters. As can be seen in the factor analysis, the patterns were not exclusive, but overlapping on some features. The three factors can nevertheless be interpreted as representing patterns of information behavior, which may be characteristic for certain persons. The next stage of the process was to analyze possible explanations for the patterns by relating them to the independent variables of the study. The regression analyses were conducted by first connecting the three factors separately to each of the independent variables (discipline, study approach, and personality) and finally comparing their impact by inclusion of all independent variables in the same analyses. In the following, the separate analyses related to each of the three search patterns are accounted for; the interested reader can find the overall analyses in Heinström (2005).

Fast surfing was a search pattern dominated by use of minimal effort, in terms of both information seeking and content analysis. Information sources were chosen on the basis of easy access, and information seeking was seldom

TABLE 2. Factor analysis of the information seeking variables, three-factor solution.

	FS	BS	DD
Important that the document is clearly and plainly written	**.61***	.8	.16
Prefer certain types of documents, for instance, articles to books	**.49***	−.3	.4
Appearance of the document important	**.44***	−.9	−.20
Prefer overview material	**.40***	.11	.11
Difficulties in judging relevance	**.37***	.11	−.18
Experience time pressure	**.34***	.5	−.9
Language of the document important	**.33***	−.2	.4
If nothing is retrieved in a database search, assume nothing is written about the search topic	**.49***	**−.42***	−.11
Thorough information seeking	**−.53***	**.60***	.12
Want to get new ideas from information documents	−.26	.21	.3
Internet sources (journals on the Internet, other material on the Internet)	.1	**.56***	.4
Media sources (TV, radio, newspapers)	.5	**.49***	−.5
Group sources (conferences, lectures, associations, companies)	.10	**.48***	.9
Written sources (encyclopedias, journals, books, brochures)	.21	**.42***	.7
Accidental information discovery	.2	**.37***	−.20
Critical information judgment	−.23	**.32***	.12
Informal sources (teacher, supervisor, fellow students, friends)	.12	**.31***	−.1
Plan database searches	.6	**−.31***	.4
Prefer a precise search result instead of many slightly related documents	.26	**−.53***	.0
Put effort into information seeking	**−.32***	.15	**.41***
Important that the author of the documents is respected in field	−.4	−.7	**.72***
Important that the information source is acknowledged	.6	.1	**.69***
Important that the document is of high scientific quality	−.17	−.13	**.67***
Important that the document is thorough	.26	.11	**.47***
Variance explained by each factor	2.51	2.36	2.17

Note. Varimax rotation was used in the analysis. FS = Fast surfing, BS = Broad scanning, DD = Deep diving.
*Refers to significant loading.

particularly thorough. Fast surfing students preferred information content that was easily digestible, such as clearly written overviews, or documents that confirmed their previous understanding of the search topic. Overly deep and scientific content was experienced as too challenging. Fast surfing often gave rise to problems with relevance judgment and critical evaluation of information content. In order to test reasons behind this search style, fast surfing was related to the independent variables of the study (Table 3).

TABLE 3. Summary of the relation between the search patterns and independent variables.

		FS	BS	DD
Personality dimension	Neuroticism	+		
	Extroversion		+	
	Openness	−	+	+
	Agreeableness		−	
	Conscientiousness	−		+
Study approach	Deep			+
	Surface	+		
	Strategic			+
Discipline difference			+	

Note. The table shows significant connections (+ indicates a positive relation and −a negative one) based on the regression and correlation analyses accounted for in the article. FS = Fast surfing, BS = Broad scanning, DD = Deep diving.

A stepwise general linear model, which allows both categorical and interval data, was conducted in order to relate fast surfing to the influence of discipline differences. The results showed no significant connection between fast surfing and discipline, $R^2 = .009$, $F(5, 299) = .56$, $p = .73$.

Next, a stepwise general linear model was conducted in order to compare fast surfing to study approaches. The results of this analysis indicated that study approaches accounted for a significant amount of fast surfing, $R^2 = .14$, $F(3, 296) = 16$, $p = .0001$, and a surface study approach showed the strongest influence, $F(3, 296) = 46$, $p = .0001$.

A stepwise general linear model was then used to relate fast surfing to the influence of personality traits. Personality seemed to have a significant influence on fast surfing, $R^2 = .09$, $F(5, 292) = 6$, $p = .0001$. The personality trait that influenced fast surfing most was conscientiousness, $F(5, 292) = 12$, $p = .0005$. Conscientiousness was negatively correlated to fast surfing, $r = −.18$, $p = .001$, a finding that suggested that students who have low conscientiousness may be prone to this search style. Openness to experience also seemed to contribute to fast surfing, $F(5, 292) = 10$, $p = .002$. The relationship was negative, $r = −.15$, $p = .008$, revealing a connection between fast surfing and low openness. High sensitivity was the final personality trait that seemed related to fast surfing, $F(5, 292) = 5$, $p = .02$. The more sensitive the students were, the more prone to fast surfing they seemed, $r = .13$, $p = .03$. Persons who had low

conscientiousness tend to be easily distracted, impatient, and rather easyoing. These characteristics seem to be reflected in a hasty and unstructured information acquisition pattern. Adding the cautious nature of conservativeness and sensitivity enhances understanding of fast surfers' resistance to challenging information content. It is understandable that students who have these personality traits, who in addition lack motivation for their studies, may only be sparsely engaged in information seeking. Fast surfing showed a negative connection to good study results ($r = -.14$, $p = .02$).

Broad scanning was an exploratory search pattern characterized by wide searches in many types of information sources. The broad scanning searches were more spontaneous than planned, and it was common for these students to retrieve useful information incidentally in unexpected contexts. Broad scanners appreciated topical content that inspired thinking in new directions and had an aptitude for critical evaluation of information.

A stepwise general linear model revealed a significant connection between broad scanning and discipline differences, $R^2 = .05$, $F(5, 299) = .3$, $p = .01$. It was shown that students in the Department of Economics and Social Sciences had the highest level of broad scanning $F(5, 299) = 4$, $p = .01$. Broad scanning may have a link to the disciplines of social sciences, in which information can be found in a wide range of sources. In the larger analysis, it was found that typical personality traits of students of social sciences were extroversion, openness to experience, and competitiveness (Heinström, 2002).

A stepwise general linear model revealed no significant relation between broad scanning and study approaches, $R^2 = .01$, $F(3, 296) = 1$, $p = .36$. Personality traits, however, seemed to influence broad scanning, $R^2 = .10$, $F(5, 292) = 7$, $p = .0001$. Extroversion, $F(5, 292) = 14$, $p = .0002$, had the strongest influence on this search style, $r = .21$, $p = .0002$. Agreeableness, $F(5, 292) = 12$, $p = .0006$, was also related to broad scanning. This connection was negative, $r = -.15$, $p = .008$, which revealed that broad scanning seemed connected to low agreeableness. A final personality trait with an impact on broad scanning was openness to experience, $F(5, 292) = 5$, $p = .03$. The more open the students were, the more prone to broad scanning, $r = .12$, $p = .03$.

The typical nature of the broad scanning students was outgoing, curious, and competitive, characteristics that seemed to be reflected in active information seeking. The outgoing broad scanners used their social skills in order to acquire information, for instance, through informal discussions about their topics. Their open character could explain their preference for inspiring information content, and their confident and competitive character likely contributed to their ability to evaluate information critically.

If easy availability was the key feature of fast surfing, and unstructured exploration the typical pattern of broad scanning, *deep diving* was distinguished by search engagement. The deep diving students expended considerable effort on information seeking and preferred documents of high scientific quality. They seemed focused and structured in their searches and aimed for thorough understanding of their search topic.

A stepwise general linear model was conducted in order to relate deep diving to the influence of discipline differences, but no significant connection was found between these variables, $R^2 = .03$, $F(5, 299) = .2$, $p = .07$.

Next, a stepwise general linear model was conducted in order to compare deep diving to study approaches. The results of this analysis indicated that study approaches accounted for a significant amount of deep diving, $R^2 = .09$, $F(3, 296) = 10$, $p = .0001$. A deep study approach seemed to influence deep diving most, $F(3, 296) = 17$, $p = .0001$, followed by a strategic approach to studying, $F(3, 296) = 4$, $p = .05$.

A stepwise general linear model was used in order to relate deep diving to personality traits. The results of this analysis showed no significant influence of personality on deep diving, $R^2 = .03$, $F(5, 292) = 2$, $p = .13$. There was, however, a connection to openness $F(5, 292) = 5$, $p = .03$, and conscientiousness $F(5, 292) = 3$, $p = .09$. Both openness ($r = .12$, $p = .05$) and conscientiousness ($r = .8$, $p = .18$) were positively connected to deep diving.

The fuel for deep diving seemed to lie in the combination of an intrinsic motivation to expand topical knowledge and a strategic aim to excel in studies. These were aims that made the effort of information seeking worthwhile. It seemed that deep divers succeeded in their goals, as deep diving showed a positive connection to good study results ($r = .15$, $p = .02$).

Discussion

The information seeking styles found in the study were grounded in personality traits and could in addition be linked to the students' study approaches. It seems that search drive and intention were linked to motivation, and the way the search was actually conducted was related to personality characteristics. The styles were not found to be extensively influenced by discipline differences, which would represent contextual influence or presumably learned behavior. The information seeking styles and their typical information attributes are depicted in Table 4, which shows differences and similarities between the search patterns in terms of typical ways of retrieving information, preferred content and depth

TABLE 4. Typical information seeking attributes for Broad scanning, Fast surfing, and Deep diving.

		Broad scanning	Fast surfing	Deep diving
Information retrieval	Search		x	x
	Acquire	x		
Content preference	Inspirational	x		
	Specific		x	x
Scientific depth	High	x		x
	Low	x	x	
Study results	High	x		x
	Low	x	x	

of documents, as well as the way the search patterns related to study results.

Broad scanning was the only search style that could be related to discipline differences. Students of social sciences seemed particularly prone to this exploratory search pattern. This finding can be explained partly by the discipline characteristics of social science itself, and partly by personality characteristics of social science students. The combination of extroversion, competitiveness, and openness that distinguished the broad scanning students was found to be typical for social science students in general. People tend to be attracted to environments and work tasks in which they can express their skills and values and take on a role that fits their personality. As a consequence, characteristic vocational environments that have features that resemble the personality traits of members are created. Each discipline, moreover, has its own special fields of interest and special knowledge creation, which require and reinforce certain interests and intellectual abilities. Features of the field of study and knowledge structure of an academic discipline in turn influence the way information is structured and sought within the discipline. In this, the combination of certain personality traits, abilities, and interests forms a base for information behavior on both an individual and a discipline level. A person who had an outgoing, competitive, and energetic character could consequently be drawn to dynamic and people-oriented fields such as social sciences. Holistic comparison and interpretation are typical for soft sciences, in which consulting a broad range of documents is vital. If the broad scanning students find their natural search styles productive within their field, it is likely to be further reinforced and developed. This likelihood implies that personality traits, choice of study area, discipline characteristics, and information seeking behavior all form a pattern in which all parts are interrelated.

The relation between broad scanning and disciplines was the only significant finding related to discipline characteristics found in the study. This result would indicate that search style is a feature more strongly related to inner characteristics than to being purely learned behavior. Naturally, each person has to adapt her/his natural search style to contextual and task-related demands in a specific search. The level to which this adaptation occurs is likely to vary according to the matching of inner inclination to situational requirements. It may be assumed that inner inclination and aptitude for a certain way of searching will remain with the person, although certain tendencies may strengthen and others weaken, as he/she learns more information seeking skills.

Styles of Exploration and Specificity Reflected in Strategy

The exploratory search style of broad scanning was characterized by far-reaching journeys on the information sea. The broad scanning students consulted a wide range of information sources and seemed to scan their environment for useful information constantly. This broad information

seeking style seemed particularly characteristic of outgoing, competitive, and open persons. These are all traits that reflect enthusiasm, which in turn seems to be conveyed into energetic information seeking. Broad scanning was a thorough way to seek information, but the searches were seldom very structured or organized. Instead, information was acquired spontaneously, for instance, through the occasional discovery of useful information in an unexpected context. The open broad scanning students also seemed to have the ability to recognize potential usefulness of information when they found it accidentally, e.g., during their leisure activities.

In sharp contrast to the broad scanning students, the deep diving ones rarely encountered useful information unexpectedly. Although both search styles shared an open personality, this personality trait instigated different information behavior when combined with other typical traits. The outgoing and impulsive character of the broad scanners induced a more impulsive gathering of information, and the thorough and conscientious character of the deep divers generated a more systematic information seeking style. The broad scanning students appreciated a large coverage, as it fit their naturally wide search style. The deep divers who searched with structure and focus had an opposite goal in their search, as they preferred precision to recall. It seems that a broad and spontaneous scanning of a wide range of information sources invited incidental and creative information discoveries, and a focused and systematic search style efficiently retrieved what was aimed for but simultaneously shut out the unexpected revelations.

The fast surfing students who had a narrow search style may exhibit a particular vulnerability to feelings of information overload. A large recall may be disturbing and troublesome for fast surfing students as it does not comply with their more limited information seeking attitude. The contrasting personalities of broad scanners and fast surfers could explain this difference. Broad scanners were open, curious, and confident in their personality, a character combination that led to an exploratory information attitude. A cautious, conservative, and sensitive fast surfer is likely to feel more comfortable with a precise information scope, which encompasses less distraction.

At times, fast surfing seemed to be a reaction to experiences of stress and lack of time. Although time pressure often is a reality in our fast-paced society, people may also vary according to the extent of their preception of this stress and reaction to it. Fast surfing students tended to have a sensitive personality with a vulnerability to feelings of pressure. In stressful situations this characteristic may narrow information seeking by reducing the ability to focus and concentrate. Fast access to easily digestible information content may seem to be a temptingly quick solution to information retrieval, but in the long run fast surfing may in fact prolong the information seeking process. It was shown that the fast surfing students often encountered problems in judgment of relevance and in the critical evaluation of documents. Both these quality aspects are facilitated by a basic understanding of the search topic, which is difficult to obtain through a too hasty gathering of information.

Styles of Exploration and Specificity Reflected in Content Preferences

Typical for the exploratory search style was engagement in topical analysis of the retrieved information. Broad scanning students particularly welcomed documents that inspired new ideas and gave them new insights. This interest seems directly linked to their openness to experience, a characteristic particularly distinguished by inventiveness, creativity, and intellectual curiosity. The broad scanning students also found it fairly easy to evaluate documents critically. This trait may be partly related to their competitive character, as competitive persons have the confidence and skepticism that are prerequisites for critical evaluation. Their broad search style offers another key to their quality consciousness. As the competitive students scan through a broad range of sources they see examples of many viewpoints and ways of presenting findings as well as obtaining broad insight into the area. They gain the topical and qualitative awareness that further facilitate their critical thinking.

Particularly striking regarding fast surfing were limited scope and strategy. The way information was presented was often prioritized over its substance. These students favored easily accessible content in overviews and clearly written documents and shunned more academically challenging texts. The key explanation behind this search style seemed to be a lack of motivation and ambition. It seemed that fast surfing foremost was an extrinsically induced response to the required information seeking to complete the master's thesis, which tends to be the students' final assignment before they finish their studies. It therefore may be that the drive for hasty fast surfing was related to the prospect of completing the master's degree and obtaining a desired occupation. Motivation for a certain task is by character temporary and strongly dictated by the personal relevance of the task at hand. Motivational patterns also tend to be related to certain personality characteristics as shown in the present study (Heinström, 2002), as well as in previous research (e.g., De Raad & Schouwenburg, 1996). Personality traits may give rise to engagement across tasks, either through an open eagerness to try new things or a conscientious urge to strive. The general personality pattern for fast surfing students was an opposite combination of low openness to experience and low conscientiousness, which induce a general tendency toward cautiousness and easygoingness rather than engagement.

Low conscientiousness seem to be reflected in a relaxed and somewhat careless attitude toward information seeking in which neither thoroughness nor quality is a priority. This information attitude contains some risks in an educational context, and it was indeed shown that the fast surfing students tended to get low grades. It must be stressed strongly that there are no ideal personality characteristics; any trait may have its own particular benefits. The fast surfing students' low openness to experience would render them less eager for new experiences and more practical. This down-to-earth approach to life could produce a problem-solving

attitude to information seeking with an aim to complete searching as soon as possible. This information seeking style has its benefits, for example, in circumstances characterized by extreme time pressure.

The fast surfing students preferred to confine their information scope to the easiest available, and the deep diving students tended to concentrate their searches on sources of particularly distinguished academic quality. Both search styles seemed to have a narrow search focus, but with opposite intentions. What drove the deep diving students was what the fast surfing students lacked: topical interest and a strategic drive for success. Deep diving students had an intrinsic interest in their search topic, and their search motivation was fueled by their ambition. The deep diving students were highly quality conscious. They prioritized texts by the most distinguished authorities within their subject fields and preferred to consult authoritative journals. These students were willing to use considerable effort to retrieve the desired documents. Their ambition and hard work also seemed to pay off, as this was the group that obtained the highest study results.

Conclusions

The main contribution of the study was the discovery of three typical information seeking styles, which could be depicted along a dimension of exploration versus specificity. Broad scanning was a broad and intuitive search style, whereas fast surfing and deep diving shared a limited precision in their search styles, although their goals and the means to accomplish them were opposite. Explorative searching, with a preference for recall and inspirational information content, was typical for open, curious, and competitive persons. Precise searching that focused specifically on high-quality information seemed typical for conscientious students with a deep strategic study approach. Striving for a precise search outcome may also be induced by a need for quick answers, often related to low study motivation and time pressure. Broad exploration, topical engagement, and incidental information discovery are likely to occur in more relaxed settings.

Figure 1 shows the three information seeking styles, broad scanning, deep diving, and fast surfing, in relation to the dimensions of exploration and specificity. Exploration was typical for broad scanning, whereas fast surfing and deep diving were related to specificity. Characteristic personality traits for the three search styles, as well as features of their typical information seeking style, are shown in the figure.

It should also be noted that another dimension related to information seeking style seems to be the one pictured horizontally in the figure, moving from a fast surfing style characteristic for students with a surface, nonstrategic study approach to the deep diving style typical for students with a deep strategic study approach. Broad scanning showed no connection to study approaches and would therefore be more strongly related to personality traits.
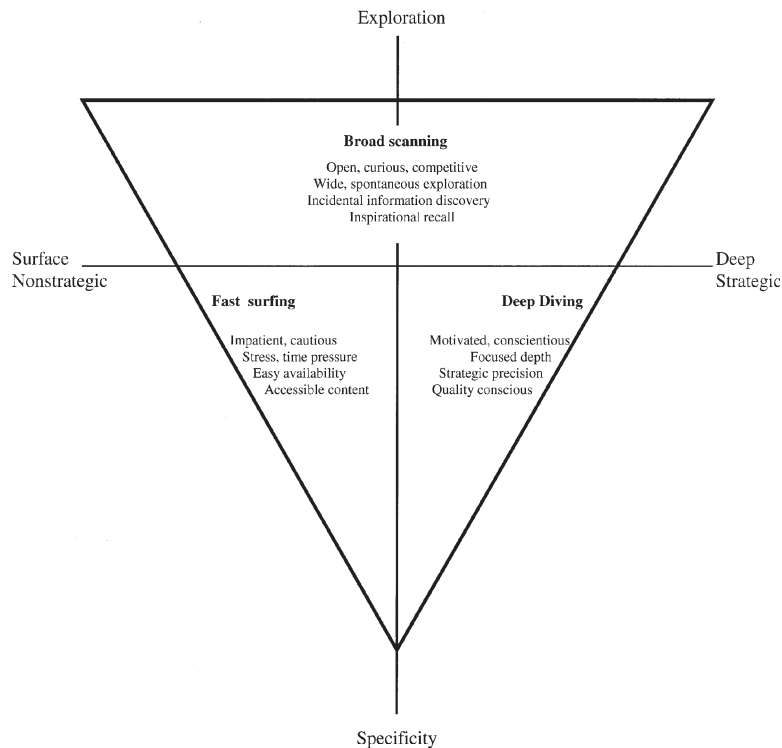
Exploration

Broad scanning

Open, curious, competitive
Wide, spontaneous exploration
Incidental information discovery
Inspirational recall

Surface
Nonstrategic

Deep
Strategic

Fast surfing

Impatient, cautious
Stress, time pressure
Easy availability
Accessible content

Deep Diving

Motivated, conscientious
Focused depth
Strategic precision
Quality conscious

Specificity

FIG. 1.   Dimension of exploration and specificity related to information seeking style, study approach, and personality.

The search dimension of either problem focused precision or broad intuitive exploration resembles similar conceptions found in neuroscience research (e.g., Edwards, 2003; Kolb, 1984; Litman, 2005). A precise search style would correspond to a cognitive dimension of left brain–dominated rational thinking and resemble the basic neural motivational process of temporary wanting. Explorative searching seems to correspond more to right brain–dominated intuitive thinking and the motivational trigger of ongoing liking.

As the information seeking styles could be linked to personality traits, it may be assumed that similar search styles related to the same personality characteristics could also be found in other contexts. Support for this notion was recently found among library and information science (LIS) students in the United States (Heinstrom, 2006). The search styles are likely to form an inclination toward certain information seeking behavior across contexts and search tasks. The natural search style may be reflected particularly in situations in which a person is free to approach information seeking in his/her own preferred way. Further research is, however, needed in a variety of contexts before final conclusions can be drawn. It would be particularly vital to explore the dimensions outside the academic context, e.g., those related to work tasks or everyday life information seeking.

There may also be possible combination of search styles. Fast surfing and deep diving seem to be somewhat opposite search styles and thus hardly compatible. Broad scanning may be combined with any of the others, for instance,

dependent on motivation for a certain task. Exploration of a routine task may, e.g., be quite superficial in times of pressing deadlines, while topics of strong personal relevance would inspire the broad scanner to use more effort in his/her investigations.

It seems that the user dimension traditionally depicted within LIS would be the horizontal dimension of Figure 1, fast surfing versus deep diving, with structured and planned deep diving the ideal. Deep diving does have benefits but it is doubtful that there is one single ideal search style. Time pressure may in fact require fast surfing, and there are clear advantages of creative and intuitive information exploration through broad scanning. The stylistic dimension depicted vertically in Figure 1, information exploration against a more limited focus, would be equally important. Conscientious and methodical persons may have an aptitude for planned and structured searching, and creative and spontaneous persons may gather information in a less controlled way. Both these styles would be important to acknowledge and encourage: Deep diving is an efficient way to retrieve the desired information; broad scanning gives birth to new insights.

Acknowledgments

References

Adema, J. (2000, July). Exploring the relationship between learning styles and personality. Paper presented at the 10th European Conference on Personality, Cracow, Poland.

Allport, G.W. (1963). Patterns and growth in personality. London: Holt, Rinehart & Winston.

Becher, T. (1989). Academic tribes and territories. Buckingham: Open University Press.

Blickle, G. (1996). Personality traits, learning strategies, and performance. European Journal of Personality, 10, 337–352.

Bouchard, T.J., Jr. (1997). Whenever the twain shall meet. The Sciences, 37(5), 52–57.

Brittain, M. (2000). Beyond information retrieval: Towards consensus. Proceedings of the Eighth International Congress on Medical Librarianship. Retrieved May 20, 2002, from http://www.icml.org/tuesday/future/brittain.htm

Costa, P.T., Jr., & McCrae, R.R. (1992). NEO PI-R. Professional manual. Odessa, TX: Psychological Assessment Resources, Inc.

De Raad, B., & Schouwenburg, H.C. (1996). Personality in learning and education: A review. European Journal of Personality, 10, 303–336.

Delgadillo, R., & Lynch, B. (1999, May). Future historians: Their quest for information. College and Research Libraries, pp. 245–259.

Diseth, Å. (2001). Validation of a Norwegian version of the Approaches and Study Skills Inventory for Students (ASSIST): Application of structural equation modelling. Scandinavian Journal of Educational Research, 45(4), 381–394.

Diseth, Å. (2002). Personality and approaches to learning as predictors of academic achievement. European Journal of Personality, 16, 1–13.

Edwards, J.A. (2003). The interactive effects of processing preference and motivation on information processing: Causal uncertainty and the MBTI in a persuasion context. Journal of Research in Personality, 37, 89–99.

Ellis, D. (1993). Modeling the information-seeking patterns of academic researchers: A grounded theory approach. The Library Quarterly, 63(4), 69–86.

Ellis, D., Cox, D., & Hall, K. (1993). A comparison of the information-seeking patterns of researchers in the physical and social sciences. Journal of Documentation, 49(5), 356–360.

Entwistle, N.J., & Ramsden, P. (1983). Understanding student learning. London: Croom Helm.

Entwistle, N.J., & Tait, H. (1996). Identifying students at risk through ineffective study strategies. Higher Education, 31, 99–118.

Finley, K., & Finley, T. (1996). The relative role of knowledge and innovativeness in determining librarians' attitudes toward and use of the Internet: A structural equation modelling approach. Library Quarterly, 66(1), 59–83.

Ford, N. (1986). Psychological determinants of information needs: A small-scale study of higher education students. Journal of Librarianship, 18(1), 47–61.

Ford, N., Miller, D., & Moss, N. (2001). The role of individual differences in Internet searching: An empirical study. Journal of the American Society for Information Science and Technology, 52(12), 1049–1066.

Ford, N., Wilson, T.D., Foster, A., Ellis, D., & Spink, A. (2002). Information seeking and mediated searching: Part 4. Cognitive styles in information seeking. Journal of the American Society for Information Science and Technology, 53(9), 728–735.

Hair, J., Jr., Anderson, R., Tatham, R., & Black, W. (1998). Multivariate data analysis (5th ed.). Englewood Cliffs, NJ: Prentice Hall.

Heinström, J. (2002). Fast surfers, broad scanners and deep divers—Personality and information seeking behavior. Åbo: Åbo Akademi University Press. Retrieved August 19, 2005, from http://www.abo.fi/~jheinstr/thesis.htm

Heinström, J. (2005). Fast surfing, broad scanning and deep diving: The influence of personality and study approach on students' information-seeking behaviour. Journal of Documentation, 61(2), 228–247.

Heinström, J. (2006, January). Detectives and treasure hunters—Information gathering habits of LIS students related to their personality and study approach. Paper presented at ALISE, Association for Library and Information Science Education, Annual Conference, San Antonio, TX.

Julien, H. (1999). Barriers to adolescents' information seeking for career decision making. Journal of the American Society for Information Science, 50(1), 38–48.

Kernan, J.B., & Mojena, R. (1973). Information utilization and personality. Journal of Communication, 23, 315–327.

Kirton, M.J. (1989). A theory of cognitive style. In M.J. Kirton (Ed.), Adaptors and innovators: Styles of creativity and problem-solving (pp. 1–36). London: Routledge.

Kolb, D.A. (1984). Experiential learning. London: Prentice Hall.

Kuhlthau, C.C. (1993). Seeking meaning: A process approach to library and information services. Norwood, NJ: Ablex.

Kuhlthau, C.C. (2004). Seeking meaning: A process approach to library and information services (2nd ed.). Westport, CT: Libraries Unlimited.

Litman, J.A. (2005). Curiosity and the pleasures of learning: Wanting and liking new information. Cognition and Emotion, 19, 793–814.

Mårtenson, D. (1986). Students' approaches to studying in four medical schools. Medical Education, 20, 532–534.

McCrae, R.R. (2000). Personality structure. Paper presented at the 10th European Conference on Personality, July 20, Cracow, Poland.

McDowell, L. (2003). Helping students along information literacy pathways. Paper presented at the Institute of Learning and Teaching in Higher Education (ILTHE) Fourth Librarians' Forum: Information Literacy, November 19, Durham, England.

Meho, L., & Tibbo, H. (2003). Modeling the information-seeking behavior of social scientists: Ellis's study revisited. Journal of the American Society for Information Science and Technology, 54(6), 570–587.

Miculincer, M. (1997). Adult attachment style and information processing: Individual differences in curiosity and cognitive closure. Journal of Personality and Social Psychology, 72(5), 1217–1230.

Nahl, D. (2001). A conceptual framework for explaining information behavior. Studies in Media and Information Literacy Education, 1(2). Retrieved May 10, 2006, from http://www.utpjournals.com/jour.ihtml?lp=simile/issue2/nahlfulltext.html

Noble, R., & Coughlin, C. (1997). Information-seeking practices of Canadian academic chemists: A study of information needs and use of resources in chemistry. Canadian Journal of Communications, 22(3–4). Retrieved August 19, 2005, from http://www.wlu.ca/~wwwpress/jrls/cjc/BackIssues/22.3-4/noble.html

Palmer, J. (1991). Scientists and information: 2. Personal factors in information behavior. Journal of Documentation, 47(3), 254–275.

Palmer, C. L. (2005). Scholarly work and the shaping of digital access. Journal of the American Society for Information Science and Technology, 56(11), 1140–1153.

Rolinson, J., Al-Shanbari, H., & Meadows, A.J. (1995). Information usage by biological researchers. Journal of Information Science, 22(1), 47–53.

Schouwenburg, H.C., & Kossowska, M. (1999). Learning styles: Differential effects of self control and deep-level information processing on academic achievement. In I. Mervielde, I. Deary, F. De Fruyt, & F. Ostendorf (Eds.), Personality psychology in Europe (Vol. 7, pp. 263–281). Tilburg: University Press.

Sheppard, C., & Gilbert, J. (1991). Course design, teaching method and student epistemology. Higher Education, 22, 229–249.

Solomon, P. (2002). Discovering information in context. Annual Review of Information Science and Technology, 36, 229–264.

Steinwedel, S. (1999). The information-seeking behaviour of theologians as humanists: A review. Retrieved May 17, 2002, from http://www.geocities.com/sjsteinwedel/theolog.htm

Tait, H., Entwistle, N.J., & McCune, V. (1998). ASSIST: A reconceptualisation of the Approaches to Studying Inventory. In C. Rust (Ed.), Improving students' learning: Improving students as learners. Oxford: Oxford Brookes University, the Oxford Centre for Staff and Learning Development.

Whitmire, E. (2002). Disciplinary differences and undergraduates' information-seeking behavior. Journal of the American Society for Information Science and Technology, 53(8), 631–638.