Critical Thinking, Information Use, and Decision-Making in GALILEO

Users: A Descriptive Study

Report submitted to the GALILEO Steering Committee

October, 1999

Dr. Mary Ann Fitzgerald, Principal Investigator
Assistant Professor
Department of Instructional Technology
University of Georgia
604 Aderhold Hall
Athens, GA   30602
mfitzger@coe.uga.edu

Chad Galloway, Research Assistant
Department of Instructional Technology
University of Georgia
607 Aderhold Hall
Athens, GA   30602
cgallowa@coe.uga.edu

Table of Contents

I. RESEARCH PROBLEM, PURPOSE, AND BACKGROUND

Today's educators at all levels bear the responsibility of preparing the information consumers of tomorrow (American Association of School Librarians & Association for Educational Communications and Technology, 1998; Peck, 1998). Worldwide, new information systems proliferate, and the amount of information that must be processed by individuals increases daily. Selected pieces of this information require scrutiny, or evaluation, according to the consumer's purpose for using the information. Evaluation is a critical thinking process that people use in making judgments of quality, truthfulness, and accuracy. Despite its importance in everyday life, evaluation as a process is poorly understood. The overall purpose of this study is to describe the cognitive processes involved in making critical judgments of information under naturalistic conditions.

One relatively new information system is GALILEO. While GALILEO has been formally assessed through opinion surveys (GALILEO Assessment Overview, 1998), little empirical data exist about its users' motivations, critical thinking, and decision making processes. Although assessment data show primarily positive results on variables ranging from reliability to cost benefit, there is no information about how GALILEO is used within the context of authentic research projects. A specific purpose of this study is to examine the critical thinking of GALILEO users within the context of authentic research projects.

Although GALILEO primarily contains core scholarly journals normally considered highly credible, it also includes popular publications from the mass media as well as links to public sites on the World Wide Web. The need to evaluate the relevance

and worth of individual articles remains a responsibility of each user according to personal information-use purposes. This evaluation process itself is little understood, and further descriptions of its nature are needed. GALILEO provides an excellent test-bed for this general investigative thrust. Because of the nature of qualitative inquiry, gathering data to satisfy the general purpose of this study revealed related information about the more specific purpose of describing user behavior within GALILEO. This information can supplement existing assessments of the information system. Research questions include:

- What cognitive processes do people use to evaluate information while using GALILEO?

- What parts of this evaluation process are specific to a digital environment?

- Are certain evaluative behaviors unique to GALILEO alone?

- How does the use of GALILEO fit into the authentic research processes of individuals?

- What misconceptions or problems occur as users use this particular system?

- In what ways can GALILEO be improved to facilitate critical thinking in users?

Procedures

Qualitative methods were chosen for this study because relevant variables were not yet well-isolated or defined in this problem area (Merriam, 1998). Because we were interested in finding out how people use GALILEO in authentic situations, efforts were made to observe users under conditions that were as close to authentic as possible. The primary means of attaining authenticity was requiring participants to pursue their own topics of interest during the research session.

Participants for this study were GALILEO users involved in personal information-usage tasks. Three types of participants were recruited: 10 undergraduate students involved in literature-based research projects for university classes, 5 private citizens using GALILEO in public libraries, and 10 high school students using GALILEO in their school media center. Undergraduate and public library participants were recruited through newspaper advertisements placed in the collegiate and city newspapers. Flyers were posted in prominent college locations. High school students were recruited through intensive negotiations between the research team, a local media specialist, and a classroom teacher. When these negotiations were complete, we appealed directly to the students and their parents. All proper procedures were followed to protect participants, according to the guidelines established by the University of Georgia Institutional Review Board (IRB). IRB approval and sample consent forms are provided in Appendices A through E.

In sessions lasting from one hour to ninety minutes, qualitative data about participants' system use and evaluative processes were gathered through four techniques: interview questions, retrospective accounts of previous GALILEO sessions, think-aloud protocols and observation concurrent with an online GALILEO session, and stimulated recall. In addition to audiotaped interviews and observation notes, electronic activities were captured through the recording package *ScreenCam*.

Each session followed a general pattern of pre-interview, think-aloud, stimulated recall, and post-interview (see Appendix F for protocols). The pre-interview included questions about the participant's past GALILEO use, demographic questions, opinions about GALILEO, the topic for the day's search, and any prior knowledge about that

topic. Next, a think-aloud procedure was conducted, in which participants genuinely sought information, describing their thoughts as they did so. Detailed instructions for performing think-alouds were given in addition to modeling by the interviewer. Because we tried to avoid interrupting the participant during the think-aloud process, this activity was followed by stimulated recall, in which we asked the participant to explain actions taken during the think-aloud or statements made that needed further clarification. The interview ended with questions about the participant's views on information quality and one or more questions designed to elicit the participant's epistemological stance. These questions helped to establish a framework of the participant's overall approach to evaluating information and seeking truth, and to position GALILEO within this overall framework.

Data were collected during the spring of 1999. Transcription proceeded as data were collected, using professional services to expedite the project. Analysis and writing occurred during the summer and fall of 1999.

Participants

The ten high school students were all part of an intact senior advanced placement calculus class. We collaboratively planned the research situation with the teacher of the class, who assigned research reports for the students to complete. The ten undergraduates were volunteers responding to an advertisement in the college newspaper or flyers, and the five public library users were volunteers responding to an advertisement in the local community newspaper. Each participant was paid $20.

Participants consisted of 11 males and 14 females. Ages ranged from 16 to 63, averaging 23.92. High schoolers averaged 17 years, undergraduates 21.5, and public library users 42.6. The high school group (HS) consisted of 9 seniors and 1 junior, while the undergraduate group (UG) contained 8 seniors, 1 junior, and 1 sophomore. Four of the public library users (PL) had master's degrees as their highest level of education, while one had recently received dual bachelor's degrees.

Table 1. General information about participants.

Partici-pant	Gender	Group	Age	Edu-cation	Content area or major	Typical access	Topic/project
Al	M	HS	18	12th gr.	NA	School library	History of computers: group research paper
Ann	F	UG	21	Senior	Psychology	UGA	Paraphilia; self-disclosure in romantic relationships: lit reviews
Apple	F	UG	22	Senior	International business and MIS	UGA	Production company or film festival: database creation
Ben	M	UG	22	Senior	Economics	UGA	Centralization vs. decentralization in organizational management: term paper
Bob	M	PL	30	M.Ed.	Technological studies	Work	Recent school shootings: personal interest
Chris	F	UG	19	Soph-omore	Cellular biology	UGA	Any psychology article: 2-page report on article
Cleopatra	F	UG	22	Senior	Psychology	UGA	Prejudice against light skin color in black communities: literature-based research project
Crusty	F	UG	21	Junior	Psychology	UGA	Validity of polygraph testing: group term project, presentation w/ bibliography
Edward	M	HS	17	12th gr.	NA	School library	Benjamen Banneker: report
Erin	F	UG	22	Senior	Real estate	UGA	Employee compensation, tied to DialAmerica interview: presentation
FG	M	PL	59	M.S.	Landscape architect	Home	Barrier-free landscape design and mixed-use land development: personal interest
Gidgit	F	HS	17	12th gr.	NA	School library	Women mathematicians: group report
Julie	F	HS	16	11th gr.	NA	School library	Women in mathematics: group report
Kathy	F	PL	24	BA, BA	Japanese and political science	[none since graduation; UGA]	Japanese yen crisis: in preparation for living in the country
Katie	F	HS	17	12th gr.	NA	School library	Women in mathematics: group report
Michelle	F	UG	21	Senior	Psychology	UGA	Philosopher: 7-page critique of article
Mike	M	HS	17	12th gr.	NA	School library	History of computers: group report

Partici-pant	Gender	Group	Age	Edu-cation	Content area or major	Typical access	Topic/project
Mond	M	HS	17	12th gr.	NA	UGA; school library	Women mathematicians: group report
Nurse	F	PL	63	M.S.	Nursing education	Science library; home	Peptic ulcer disease: nursing textbook chapter
Pat Sullivan	M	HS	17	12th gr.	NA	School library	History of computers: group report
RF	M	PL	37	M.Ed.	Trucking logistics	Public library	Trucking logistical management: background information for job
Robert	M	UG	23	Senior	Economics	UGA	Vending machine management: research paper
Savannah	F	HS	17	12th gr.	NA	School library	Women in mathematics: group report
Sharon	F	HS	17	12th gr.	NA	School library	Women mathematicians: group report
Teddy	M	UG	22	Senior	History, political science	UGA	Permian-Triassic extinction: 15-page paper

Analysis

A multi-step process for analysis was used to interpret the data gathered in this study. Transcriptions were professionally transcribed, and then verified by the research team. We transcribed observations and *ScreenCam* files directly. Next, we began the long process of open coding. This process involved reading through each piece of data, seeking unique meanings within them, and tagging individual text units with labels identifying their content. For example, the following text was coded in the following manner:

> RF: And they get, I think the magazines get older, so I always usually go and take the first hundred and stop, and then go back to where I saw the business publications and sorta harp on that, and which one did I look at- *Management Today*?

For this text unit, open codes assigned included "magazine," "specific magazine," "currency," "search," "strategy," and "10-25-50-100 grouper" because it provides data about each of these concepts. The entire analysis process was facilitated by *QSR NUD*IST*, a software package designed to facilitate the analysis of qualitative data. It

creates a database of text units with their assigned codes and allows sorting and multi-layer categorization as well as complex search functions.

After open codes were assigned to text units in each piece of data, these codes were sorted into a hierarchy of categories. Next, we used the original research questions to seek gaps in the open-code analysis. Because we did not use the questions as a coding framework in the first phase of analysis, it was necessary to search the data for answers to a small number of thinly supported questions. In addition, emerging patterns generated new questions that needed to be pursued. For example, we noticed that several participants chose databases that related directly to their chosen major. This relationship caused us to search the entire dataset to discover whether or not this trend was true of other participants (this idea is discussed on page 37).

The material in Section II (Results) presents the results of open coding, categorization, and reiterative searching, questioning, and coding. Section III presents our interpretation of these results and provides explicit conclusions.

Limitations

Several conditions limit the trustworthiness or value of this study. The study relied heavily on verbal reports of several kinds: think-aloud, stimulated recall, and interviewing. Critics assert that verbal reports may fail to match cognitive events (Bernard, 1988; Ericsson & Simon, 1993; LeCompte & Priessle, 1993), change the nature of cognition (Ericsson & Simon, 1993; Kelly, 1995; Murtaugh, 1985), and increase cognitive load to the point where participants do not respond (Brown, Bransford, Ferrara & Campione, 1983; Moll, 1987; Smith & Wedman, 1988). Ericsson and Simon recommended the use of multiple data sources to combat these problems, a procedure

followed in this study. However, readers must consider findings in the light of these claims against verbal reports.

Observation of participants brought to the study the possibility of several unique sources of error. First, participants may have performed artificially, allowing us to see only what they wanted to be seen or what they thought we wanted to see (Bernard, 1988; Evertson & Green, 1986). Second, we may have been influenced by primacy or recency effects, in which the first or latest observation biased impressions to the point that further events were distorted. Third, events occasionally transpired rapidly or concurrently, leading to possible loss of important features. Our attempts to address these sources of error are discussed below (see "Validity," page 102).

Also, the methods used to recruit participants in this study may have biased the information toward users who felt positively toward the system, as is often the case with volunteers. For some reason, respondents in the undergraduate group were primarily seniors, creating an upperclassmen bias. The data from high school participants were compromised by a very low level of experience. This problem is discussed at length in the "Past use" section (see page 16).

Researchers' Perspective

Peshkin (1988) asserted that naming the biases in a project helps to guard against their skewing the data. Also, the deliberate seeking out of subjectivity and its description may help protect against its belated discovery. Thus, we name our biases. We will, however, make every effort to "bracket out" (Patton, 1990, p. 408) these biases. In addition, we tried to be alert for unrealized biases.

Miles and Huberman (1994) named a type of bias that was possible in this study. First, the "elite bias" (p. 263), or the dependence upon upper-class, well educated, or economically advantaged people as participants, applied to two of the participant groups. It is true that our participants were members of the elite class in an educational sense; the undergraduates had reached a higher educational level than the overall population, and the high school students were academically elite within their own school. However, this characteristic was important to the sampling rationale of exploring the use of GALILEO within different contexts, including higher education.

In addition, as a career library media specialist and educator, our need to assist others is ingrained and automatic. In this study, we avoided intervening as much as possible, but it was difficult. When participants utterly could not figure out what to do next, we helped them by giving them just enough information to continue. These circumstances are identified in this account where appropriate.

Yet another perspective to be addressed is that of our own prior knowledge. We have studied themes related to the information quality issue, and could not avoid having our thoughts influenced by the work and previous research of others. However, we entered this study with genuine curiosity about the proposed research questions.

Validity

The limitations and researcher biases described above require us to recount our procedures for ensuring validity. Ericsson and Simon (1993) and Whitney and Budd (1996) assert that the listed limitations and biases are problems of validation and suggest the use of multiple data sources to mediate them. Particularly, combining concurrent

reports with retrospective accounts and electronic logs provided three windows that helped reveal the cognitive processes of the participants. Smith and Wedman (1988) suggest that limiting verbalization to thoughts, rather than explanations of thoughts, helps to avoid the problems of invalid reports and cognitive overload. In addition, LeCompte and Preissle (1993) and Bernard (1988) recommend using observation to triangulate verbal reports of all kinds. Thus, we used participants' thought verbalizations, two modes of observation of behavior matching those thoughts, and stimulated recall to provide four data sources describing the same period of behavior.

      <u>Observation</u>. An important part of the think-aloud was our observation of the participant's behavior during the think-aloud session. Primarily, visual observation provided a match or mismatch between the participant's physical actions and voiced thoughts. Also, it helped to compile a more complete record of cognitive activity. When voiced thoughts did not match physical actions, or when actions and thoughts seemed to contradict each other, we asked the participant to explain these behaviors during the stimulated recall.

      We employed three methods to record physical actions during think-aloud sessions. For interactions involving electronic sources, we captured screens and mouse actions with *ScreenCam* software. This package records a computer session as a moving image. A separate audiotape ensured adequate sound quality. Unfortunately, we could not use this software on library computers, where all of the public library sessions took place. Also, at the high school electronic files tended to end abruptly after the first print command. Manual observation notes compensated for these gaps in the electronic data, allowing approximately a 90% rate of reconstruction.

Evertson and Green (1986) also advocate reviewing primary data with peer debriefers. We employed this safeguard, both among ourselves, and with outside parties.

Motivation. An important pre-existing condition in this study was motivation, because unmotivated people are less likely to exercise their full range of judgmental ability (Flavell, 1981; Simonson & Nye, 1992). The mechanism for providing motivation in this study was through requiring participants to use a topic of personal importance to them, because relevance and motivation are linked by many theorists (Dewey, 1902; Frick, 1991; Tyler, 1949; Vygotsky, 1934/1962). Thus, it is important to establish for the sake of validity that participants were motivated at least to some degree.

All participants were paid $20 for their participation. There can be no doubt that some were motivated by this factor. However, it is unlikely that $20 was enough money to entice busy participants to engage in a one- to two-hour activity that would not benefit them in some other way. To be certain, we analyzed each participant according to one vital question: If we were not offering this $20 stipend, would this participant have conducted this information search? In each case, the answer seemed to be "yes."

Two final procedures were used during analysis to ensure internal validity. As data were aggregated, manipulated, and written as results, references to the sources of findings were retained to permit tracing backwards. At times, tracing results back to their source caused us to re-analyze for inconsistencies. Another procedure used was hypothesis-posing. As patterns and findings seemed to appear in the data, these were stated as hypothetical conclusions. We then searched all data for evidence contradicting the hypothesis. Only those conclusions that stood up to this challenge remained at the end of the study.

13

Generalizability

Qualitative research results are often criticized for lack of generalizability (Yin, 1994). Stake (1995) asserts that if the parameters of a problem are adequately described, readers can decide for themselves whether or not findings apply to other situations. Describing the parameters involved and clearly tracing the analytic path from data to conclusions provide the reader with enough information to evaluate the efficacy of the process.

At heart, the issue of whether or not to generalize is an epistemological one (Denzin, 1994). The relativist stance allows readers to weigh the evidence and construct their own interpretations. In keeping with this philosophy, we first attempted to build my own understanding of the data. This report communicates this interpretation as completely and straightforwardly as possible, according to Stake's recommendations (1995). Readers are free to apply methods and findings to personal situations and to construct their own conclusions.

II. RESULTS

In this chapter, the purpose is to present the results obtained through data collection. As much as possible, we will refrain from discussing or interpreting in this portion. Necessary inferences, however, have been made and are represented in this section.

For the sake of convenience, it makes sense to repeat the research questions here:

1. What cognitive processes do people use to evaluate information while using GALILEO?

2. What parts of this evaluation process are specific to a digital environment?

3. Are certain evaluative behaviors unique to GALILEO alone?

4. How does the use of GALILEO fit into the authentic research processes of individuals?

5. What misconceptions or problems occur as users use this particular system?

6. In what ways can GALILEO be improved to facilitate critical thinking in users?

These questions fall into three major thematic areas: GALILEO usage (questions 1, 3, 4, 5, 6), critical thinking (questions 1, 2, 3, 6), and systemic problems (questions 5 and 6). These three themes are discussed as major sections below. Within each section, subsections that emerged as sub-themes during coding and categorization are included .

Theme 1: The Use of GALILEO as a Tool in Authentic Information Tasks

Logically, the first task in summarizing the data gathered in this study is to describe the ways in which participants used GALILEO. Sub-themes in this section include a description of past projects related by participants, how they learned to use GALILEO, their current projects, and where they access it. In contrast to these rather concrete ideas, information appeared describing how they felt about GALILEO, and how well they understood it. Finally, two operations, category usage and searching, were prominently represented in the data and reveal a great deal about the skills and strategies used by participants.

<u>Past use</u>

A condition for participation in the study was that participants had used GALILEO at some point in the past. For undergraduate and public library participant groups, this requirement produced a set of people who, for the most part, knew their way around GALILEO. This condition did not work with high school students, however, as will be discussed. One early interview question asked participants to describe their use of GALILEO in the past. Some participants answered the question in a qualitative manner by providing a verbal characterization. Some provided a numerical answer, stating they had used it on a certain number of occasions. Others provided a combination of qualitative and quantitative information. Table 2 (below) summarizes information about past usage in qualitative terms.

Unfortunately, six participants fall into the "no prior usage" category. These participants all were a part of the high school group. It came as a surprise to us that

despite an Internet connection in the school, and confirmed local public library

availability of GALILEO, that this many students had never used it. We had also

encouraged students to use GALILEO on a special computer set aside for their use during

the weeks preceding our visit. Despite this disappointing limitation, we decided to

proceed with the project (given the conditions also that the school year was running as

was project time) and analyze these participants as novice users.

Table 2. Past GALILEO usage.

Usage category	Description	Participants	Example
None	No prior usage	Edward, Gidgit, Julie, Mike, Savannah, Sharon	These participants had no prior experience with GALILEO beyond our instruction.
Exposure	Noticed GALILEO in earlier situations, or talked about with others	Al, Katie, Pat Sullivan	Pat Sullivan noticed that the local public library used GALILEO as its homepage.
Professional	Direct support of job responsibilities	FG, Nurse, RF, Robert	RF had just started a new job, and sought information to help him fill in his background knowledge about logistics.
Leisure	Pursue topics of personal interest or curiosity	Erin, RF	Erin reported that she used GALILEO "for fun."
School research	Assignments for courses	Ann, Apple, Ben, Chris, Cleopatra, Crusty, Kathy, Michelle, Mond, RF, Robert, Teddy	The most common assignment was to write a "term paper" or "report" on a self-chosen but course-related topic.
Jump page	Avenue for reaching other Internet resources	Bob	Bob used GALILEO's Homepage as a front-end to the library catalog and other Internet Resources about computers, security, history, and technology.

Several categories of past GALILEO usage are apparent. Notice that two

participants used GALILEO in multiple categories. Robert, an undergraduate who also

owned his own business, used it both academically and professionally. RF, one of the

most extensive users, had applied GALILEO to professional, academic, and leisure situations.

Of the school research topics, by far the largest past usage category, projects fell into several categories:

Table 3. Breakdown of GALILEO usage in educational settings.

School research category	Description	Participants	Example
Papers	Find and synthesize literature on a course-related topic	Ann, Ben, Chris, Cleopatra, Crusty, Kathy, Michelle, Teddy	Ann had written a paper on body image for a psychology class; Teddy wrote his Senior Thesis.
Information gathering	Collect facts on a given topic	Apple, Crusty, Mond	Crusty gathered information to form a bibliography for a professor's research project.
Practice	Use some element within GALILEO as a study tool	Chris, Erin	Chris found that the *Psych Web* resource within GALILEO's Internet Resources provided practice quizzes that closely correlated with her coursework.

Learning to use GALILEO

In this study, there were four major avenues through which participants learned to use GALILEO: self-teaching, personal assistance from a librarian, a formal session introducing GALILEO, and through our intervention as action researchers (high school students only). In addition, several participants reported that they learned about GALILEO through a combination of avenues. Table 4 lists the learning avenues in their various combinations and the participants who reported each.

Table 4. Avenues for learning about GALILEO.

Avenue	Participant
No data	Bob
Self	Ann, Chris, Erin, RF
Assistance	Apple, Michelle, Nurse
Session	Crusty, Kathy, Mond
Assistance + Self	Cleopatra, FG, Ben
Session + Self	Teddy
Assistance + Session	Robert
MAF and CG	Al, Edward, Gidgit, Julie, Katie, Mike, Pat Sullivan, Savannah, Sharon
Self total	8 (i.e., eight people altogether reported learning about GALILEO on their own)
Assistance total	7
Session total	5
MAF total	9

Formal instruction sessions were most often conducted in conjunction with a class, as in an organized field trip arranged between the professor and library staff. In Mond's case, his high school debate team traveled to a university library where they received a special session introducing them to GALILEO.

Self-learning: An exercise in trial and error. Several participants mentioned that their self-learning involved a great deal of trial and error. Assistance was often obtained by asking library personnel.

Apple demonstrated an example of trial and error learning. Her topic involved searching for information about movies featuring the actor Bruce Willis. When her early search for "Willis" brought back 359 results, she tried to limit her search by adding his first name. She found the Limit screen, but she did not know exactly how to proceed. She began by typing "Bruce" into the "other terms" box. This search resulted in no items found. Then she explored further and applied the "named person" type of term limitation, resulting in one item found.

A contrasting example demonstrates a case where a participant made a mistake and did *not* learn from it. Cleopatra performed a search for "black community" in *PsycINFO*, which returned five citations. She decided to limit this search further by adding the term "racism." This search resulted in no returns. Instead of returning to the original "black community" list, she added an additional term ("physical attractiveness"), unknowingly trying to limit an empty search still further. She repeated a similar step twice more, expressing puzzlement at the behavior of the system, before giving up and initiating a new search.

Library staff. Ten participants (one speaking of public librarians, the rest of university librarians) commented about librarian assistance in their GALILEO work. Most of these participants indicated that librarians had been very helpful to them. As Teddy said, "they know it like the back of their hand, and so they're incredibly useful." Crusty provided the lone negative remark about professional assistance. She mentioned that librarians became "ornery" if students lingered over the university library computers when others were waiting, and that on those occasions she had learned to print out her materials for later study instead of reading selectively as she searched.[1]

Help files. FG said at one point during his think-aloud that he would use the help file to find out if a particular government publication was available online, although he did not follow up on this intention with action during the online session. Chris explored the Information icon when trying to figure out exactly what "Databases Available to: University of Georgia" meant. No other participant mentioned using the help files or

---

[1] In our opinion, this isolated complaint probably indicates crowded conditions in the library and responsive management tactics rather than a breakdown in service.

information screens generally or in the past, and no other participant used the help files intentionally at any point during observation.

Intervention. To clarify what we mean by researcher intervention, we provided instruction only when it seemed absolutely necessary. In the cases of undergraduate and public library users, this problem seldom happened, and the one exception is noted where appropriate. We did, however, offer hints and tips for these participants at the very end of their sessions, after the research portion of the session was complete. For high school students, the story is very different. When we discovered how low the level of GALILEO experience was among these students, we delivered a short orientation session that explained how to access GALILEO, suggested which databases would most likely be helpful, and modeled a sample search for them. During the research sessions themselves, we intervened only when the participant had no idea what to do next. At this point, we tried to determine what the participant wanted to do and then suggested one or more options to accomplish that purpose. These interventions were carefully marked in the data, and these sections were treated differently during analysis.

Present use

Another qualifying condition for participating in the study was that participants should bring to the interview an active project for which they expected to use GALILEO. All participants met this requirement. Interview questions were designed to verify that each participant's project had at least one motivating element beyond the money paid as an incentive to participate in the study.

Factors motivating participants to perform their information searches were extracted from statements describing their projects, plus spontaneous comments made as they answered other interview questions or commented during the think-aloud portion of the session.

Four motivating factors were found:

- academic (based upon the need or desire to graduate from high school or college)

- interest

- professional

- personal relevance

We assumed that all students (high school and undergraduate) were concerned with the need to graduate, especially since a high proportion (85%) were seniors about to graduate. Their projects, as part of course requirements, were steps on the path leading to graduation. No data suggesting low motivation appeared in these two groups of students. Statements indicating an interest in the subject of scrutiny beyond academic aspiration added an additional motivating factor. Several participants' projects revolved around their jobs. Finally, two participants indicated personal factors that added a life-connected relevance to their study.

The largest numbers of participants can be found in the academic (A) and interest (I) categories. Overall, academic factors motivated 20 participants, while interest alone or in combination with another factor motivated 11 participants. Professional concerns motivated 4 participants. The relevance factors are interesting; Kathy pursued her topic about the Japanese yen crisis because she planned to move there in the summer.

Cleopatra pursued an academic topic about skin color prejudice in part because she felt

that she had been a victim of such prejudice in the past. One student indicated that she

chose a topic because she was interested in it and already had a considerable amount of

prior knowledge about it. Altogether, 12 participants were motivated by two or more

factors.

Individual topics for the observed GALILEO session can be found in Table 1

(page 7). By academic discipline, topics break down into the following categories:

Table 5. Participants' topics categorized by discipline.

Discipline	No. of participants
Computing	3
Current events	1
Economics	6
Environmental science	1
Geology	1
Mathematics	7
Medicine	1
Philosophy	1
Psychology	4

The high number of mathematics topics (seven) is an artifact of participant selection,

because the students were all drawn from a calculus class and were required to pursue a

math-related topic. The three students researching computing make up the rest of the

class. The cluster of topics in the economics area seems to be a naturally occurring one.

Where did participants use GALILEO?

We asked participants where they typically accessed GALILEO. Several

participants reported more than one place. Their answers are reported in Table 6.

Table 6. Places where participants accessed GALILEO.

Place	Participants
School library	Al, Edward, Gidgit, Julie, Katie, Mike, Mond, Pat Sullivan, Savannah, Sharon
University	Ann, Apple, Ben, Chris, Cleopatra, Crusty, Erin, Kathy, Michelle, Mond, Nurse, RF, Robert, Teddy
Work	Bob
Home	FG, Nurse
Public library	RF

Several participants mentioned that it was most convenient accessing GALILEO at the university library, because they could immediately access indexed print materials. Four of these people were not university students.

Feelings about GALILEO

Data demonstrating participants' feelings about GALILEO occurred in several ways. Two questions, "Do you like GALILEO?" and "Is GALILEO useful to you?" provoked illustrative responses. In addition, participants often mentioned opinions in passing as they discussed other elements or performed the think-aloud portion of the interview. Because of unfamiliarity with the system, no such information appeared in the cases of Al, Gidgit, Julie, Katie, Mike, Mond, Savannah, and Sharon.

Three themes emerged from these affective data. First, many participants stated an overall opinion (positive, negative, or neutral) about GALILEO. Second, these data often contain designations of what participants considered to be advantages and disadvantages of the system. Finally, participants often answered the "usefulness" question by explaining precisely how GALILEO was helpful (or not) to them.

Overall opinion. Eight participants (named above) could provide no answer to the like/dislike question because they were not yet familiar enough with the system to form an opinion. Of the remaining participants, most (twelve) expressed a positive opinion about GALILEO. Four expressed a neutral opinion, usually through an answer like "It's okay." One participant was decidedly negative in his view.

Reasons associated with liking GALILEO revolved around ease of use and helpfulness. For example, Ann answered, "I do like GALILEO. It's easy. And it makes things a lot easier." Kathy answered, "Yeah, I love it."

Neutral answers focused on frustrating experiences, functionality, and lack of a better system: "It's OK; at times it can seem frustrating, because you're looking for something and it seems difficult to find…" (Apple); "It works. It's okay. I haven't seen anything better." (Crusty); "Yeah, it's okay. I think it has limitations…" (Nurse).

Bob held the lone decidedly negative opinion. Although he found the Internet Resources section somewhat helpful, he had no use for the database index: "To me this is just nuts, you know. This seems something more like a librarian would use."

Helpfulness. Except for Bob, participants agreed that GALILEO is helpful to them in a number of different ways. Specific advantages are provided in Table 7 below. Even the inexperienced high school students quickly grasped the utility of this resource. RF mentioned that GALILEO was the first, and often only, resource he visited to seek information for graduate school projects.

Advantages and disadvantages. Participants were quick to express their opinions about what they perceived to be advantages and disadvantages of the system, presented in Table 7:

Table 7. Participant perceptions of GALILEO advantages and disadvantages.

Item	Explanation	Example
Advantages		
Provides information	Powerful; opens up phenomenal possibilities; helps in locating materials; essential; provides "jump to" information; more useful than the Internet	"When we were in graduate school, to have been able to have this kind of thing as a research tool would have been phenomenal..." (Nurse)
Transparent	Easy to use	"While it's not intuitive, it's fairly easy to work with." (FG)
Fast	Not overly graphic	"It's not so laden with visual images that it's slow to load." (Bob)
Organized	Structure is immediately comprehensible	"When you look at it you get a pretty good idea of, you know, you get a choice of roads or avenues to take. And you don't have to figure out where the roads are..." (Bob)
Current	Information is current and usually provided in lists with most recent citations at top	"Well a good thing … a lot of the information you needed for a lot of papers had to be extremely recent. And so, that's the best thing about it." (Kathy)
Economical	Saves money for users	"It's a quick way of saving on … buying newspapers. I mean, if you missed some of the information long ago, you kind of can update yourself." (Robert)
Centralized	Indexes a great deal of information in one location	"It has everything right there together." (Teddy)
Disadvantages		
Difficult to use	Interface not always transparent; complex front end	"Sometimes it's a little thick to get through." (Ben)
Slow	Overly long loading time	"Sometimes it would be slow." (Ben)
Difficult to search	Difficult to find specific ideas; no universal search feature	"That's the problem with the keyword search. It's not as discriminating." (Teddy)
Difficult to access	Users experience problems in traveling to GALILEO terminals or in accessing it from home	"When you don't have the, this particular system at your home, it's hard to go on campus." (Robert)
Inconsistent	Search interfaces differ	"Not all of the searches are the same" (Kathy)
Insufficient full text offerings	Participant wants more full text	"...some full text. See, that bugs me. … I just don't want to be bothered with them if they're not full text." (Kathy)

Many of the disadvantages are discussed as problems in sections to follow.

How much did participants know about GALILEO?

This question is surprisingly difficult to answer. Participants often described themselves as experienced users of GALILEO, and then demonstrated shortcomings in their knowledge during the active portion of the interview. Also, the reverse phenomenon occurred, when participants spoke disparagingly of their GALILEO knowledge and then used the system in a sophisticated manner. For example, one participant classified herself as a heavy past user, but did not understand several basic features of GALILEO such as marking and full text articles. On the other hand, Teddy called himself a "novice" user of the system, but demonstrated one of the most sophisticated usage patterns of all participants.

The most telling data within this area were incidents during the think-aloud portion that pointed out misconceptions or shortcomings in operative knowledge. Other valuable clues to depth of knowledge were the questions participants asked. We will relate some of these incidents here, organized according to the GALILEO feature about which knowledge was lacking. Because searching figures prominently as an indicator of system understanding, it could be discussed here. However, so much information was available about searching that it deserves its own special section, and knowledge indicators relating to searching are saved for that section. For the purposes of this discussion, the high school students are largely omitted due to their low level of sophistication. However, a special section about them is included last because their data helps us understand what the GALILEO experience is like for new users.

Definition. Six participants (not including high school students) seemed confused about what GALILEO was, or the difference between it and the local online public access

catalog (OPAC)[2] or the Internet itself. Ben admitted that he did not know that the OPAC

and GALILEO were different after looking for a catalog listing of books within the Full

Text Books category. Michelle described how she had experienced trouble

distinguishing between GALILEO and the Internet at first: "I just didn't know what it

was, I think. I think I thought it was part of the Internet or, I mean, I didn't really know

exactly what it was." Chris sought *Psych Web*, one of the Web sites indexed within the

Internet Resources, within *PsycINFO*. She also asked if the OPAC and GALILEO were

equivalent. Erin likewise mentioned that she used GALILEO to find study quizzes for

her class, a resource more likely to be found within the Internet Resources. Ann clicked

the browser search button when she wanted to search GALILEO, and seemed completely

confused when an Internet search engine appeared. Robert admitted, "Sometimes I

confuse it with, not GALILEO, but another system they have where it's all, like black

screen? What is it?" By black screen, he was likely referring to the OPAC.

Opening menus. One pre-interview question asked patrons to describe their "plan

of attack," or how they expected to find the information they needed. Four participants

revealed a fuzzy concept of GALILEO's opening menus, because they could not describe

exactly how they would proceed to their destination within GALILEO. For example,

Cleopatra answered, "Well, I don't really remember the setup, so I guess I'll read that and

go into a subject find. However it works." She had no problem, however, in finding her

path once the menus appeared in front of her. Michelle, Nurse, and Robert gave very

similar responses. Robert initially seemed to flounder by straying into the Internet

Resources section, but soon discovered his way back into the Databases, where he sought

---

[2] In most cases in this study, the OPAC was GALIN. Data were collected several months prior to the
change over to GIL.

newspapers. Cleopatra reported 5 to 10 previous visits, Michelle many, Robert six or seven. Nurse had not used GALILEO's front end extensively, but was highly familiar with *MEDLINE*. Thus, this confusion or lack of memory about the opening menus did not seem necessarily related to inexperience with the system.

Availability of items listed in databases. Chris demonstrated an interesting misunderstanding of the category "Databases Available to: University of Georgia":

> I'm not sure...what this available to University of Georgia means, so I guess I can find out now if that means that everything they list is in UGA's library catalog. … Change of mood during sleep, that looks interesting. <pause> …it was performed on depressed people. Yeah, this one actually looks interesting, so I'll probably print this one out. Yeah, I will take it. See if UGA has this one, which they probably do since I got this one under UGA catalog, or whatever the title was, caption was.

It seems that Chris interpreted her initial selection of the "Databases available to: The University of Georgia" as guaranteeing that any abstracts found would lead to journals that would be present on the library shelves.

10-25-50-100. Very few participants seemed to notice or to need the feature that would allow them to view large numbers of citations at once. Three exceptions were Crusty, RF, and Michelle. Michelle said during her think-aloud: "And, since they only give you ten at a time, I'm gonna go to the hundredth, click on a hundredth, so I don't have to keep doing next group."

Display Locations. Several misconceptions surfaced about the "Display Locations" feature. Useful as a way of determining whether or not indexed journals are available in the local university library, this feature is available when the GALILEO database is able to interface with the local periodical index database (GOLD). Therefore, the "Display Locations" button is sometimes present, and other times not. Also, if no

29

holdings of a particular journal are found, clicking the button displays a message to that effect.

Ann clicked the Display Locations button with almost every abstract she viewed within *PsycINFO*, assuring herself that the article would be available if she liked it. She understood that the presence of the button did not necessarily indicate that the journal would be available in the local library. She was puzzled, however, when the button did not appear with an abstract in the same database, and had no clue as to what that meant. Chris demonstrated a similar level of understanding by asking this question point blank: "If it doesn't say that [Display Locations] down here, that means it's not at UGA?" Chris did not attempt to use the button, however.

Crusty encountered an abstract without the button, and remarked that she would not bother to consider it. Upon later probing, she said she knew of no other way to determine the item's location. When we probed further and asked if she had used the library catalog to find journal call numbers, she said she had but considered the process too cumbersome: "And sometimes it still doesn't come up, so, and then sometimes it will, but it's just a hassle to do all that, when you're on limited time and so if it doesn't say display locations, I just skip it generally."

No other participant besides Michelle demonstrated use of the Display Locations feature.

Mark citation. Very few participants used the "Mark" feature. Chris mused to herself that she could have tried the feature, but seemed uncertain if it would work or not. Ann described how she had tried the feature in the past but could see no benefit to using it. Nurse wanted to use the Mark feature at the public library, but remembered that

printouts would cost, and so simply jotted down her citations instead. Teddy, on the other hand, marked several items and eventually printed them as a group. Cleopatra would have marked her citations, but the printer was not working that day; she saved her abstracts electronically instead. Other than these five participants, no others mentioned the Mark feature. No participant using the Mark feature complained about it in any way.

Full text. Many patrons seemed unaware of the full text capability of certain databases, while others depended upon this feature.

Ann, one of several participants who loyally used *PsycINFO* without exception, had not sampled full text: "I never learned how. If I could use it, I would, because I spend so much money at the copying machine. But, yeah, I would love to use the full-text."

Erin worked between several databases in search of information about a specific business, including one that provided full text articles. She was surprised when we pointed out to her at the end of the session that several of the abstracts she had printed led to full text articles. Her surprise is an example of "button blindness," involving failure to look at all the features on the screen.

Conversely, Teddy demonstrated a sophisticated understanding of GALILEO's full text capabilities: "Full text is a very handy thing to have, and so, pulling it off full text if possible. Most of the databases don't really have full text."

RF and Kathy were public library patrons who deliberately sought full text resources whenever possible. Depending upon their purpose, they chose databases with this purpose in mind. Kathy, RF, and Crusty used the option provided by some databases

limiting articles to full text. Altogether, of 15 experienced[3] GALILEO users, only four

definitely knew about and used full text. Two definitely did not know.

High school students: Naïve questions and misconceptions. Because most of the

high school students had very little or no experience with GALILEO, their data provide

valuable insights into what early encounters with it are like. Their sessions were marked

by many questions, and often it was necessary to answer the questions in order for the

project to proceed in a constructive manner. Table 8 lists some of the questions high

school students asked and some of the misconceptions they demonstrated.

---

[3] "Experienced" users refer to public library and undergraduate users, not high school students.

Table 8. Questions asked by inexperienced users.

Question or comment	Puzzling feature	Participant(s)
"Can people actually see what we're sending?"	General	Sharon
"Will this have more than magazine articles? Will it have, like, book articles?" and "So, when we're doing this, you just have to find the book on it, and then get it?"	System definition	Al Savannah Gidgit
"This screen tells me, when I pushed in algebra, it brought up all the information that it has on the Internet. And it's got ten of 'em."	System definition	Gidgit
"Do you know whether or not [GALILEO] is available at other colleges?"	System definition	Mond
"Is all this [Internet Resources section] under GALILEO?"	System architecture	Al
"How do I get back to the screen that I was just at?" [Databases] and "How do I get back to the first page?" [Results]	Navigation	Julie, Katie, Mond, Savannah
"Can you narrow this search down?" and "How?"	Searching	Mond
"No comma or anything? Just simply women algebra?" and "Does that have to be capitalized?"	Search syntax	Gidgit Katie, Sharon
"Oh, we did this one." (Sharon thought that because words from a previous search appear in the search box of a different database, that she had already searched that database.)	Automatic transfer of search terms from database to database	Sharon
"Where is it gonna go if I go in this searchable field labels?"	Limit screen	Julie
"See, I would have thought that meant like you had to have a specific title. I wouldn't have thought you could just do a subject right there. And title."	Limit screen	Katie
"What does results 1 of 6 mean?"	Results	Pat
"Is there on GALILEO … like a bar, that, like, says 4 blocks or, the most information on a certain things, or, like 90% relevant, or something like that?"	Results	Mond
"Does this say there's a total of nine pages?" [Citation reads 1/9 pages, meaning a fraction]	Citation information	Al
"What do the little dots mean, by certain ones?"	Full text indicator	Savannah; similar: Julie, Mike
"Is it supposed to be all here? Oh, it is? I gotta click that?"	Article text button	Julie; similar, Mike
"How do we like, get page down?"	Next group	Savannah

How did participants use categories?

Category choices among participants were widely distributed, and Table 9 lists

categories visited by each participant. Thirty-four names are listed, representing 34

episodes in which categories were used over all 25 think-alouds. One student who could

not figure out what to do at first was able to use categories on the next try, and this choice

is reflected in the table in the choice of IR/Student Resources by Edward.

In seven cases in the "confused" category, participants were unable to choose.

Six of these were inexperienced high school students. This choice, in cases marked by

asterisks in the table below, was guided by us when the student had no idea about where

to start. In these seven confused cases, we pointed out databases that we thought would

be particularly helpful. Category choices influenced by our intervention are not included

in the discussion below the table, except in the case of FG. FG, although a relatively

experienced user, became lost, and asked for assistance. This incident is described below

as well.

Table 9. Categories visited by each participant.

Category	Participant(s)
Alphabetical listing	Cleopatra (C), Chris (D), Al (C)
Arts and Humanities	Michelle (D)
Business and Economics	Apple (D), Ben (D), Erin (D), Kathy (D), Robert (D)
Confused or unable to choose	FG, Edward, Gidgit, Katie, Mond, Pat Sullivan, Savannah
Earth Sciences	Teddy (D)
Education	Julie (D), Sharon (D)
Full Text books	Ben (D)
Full Text Journal/Newspaper Articles	RF (D), Mike (D)
IR/Business & Economics	Robert (D)
IR/Electronic Journals & Texts	Al (D)
IR/News, Media, & Publishing	Bob (D)
IR/Social Sciences	Chris (D)
IR/Student Resources, K-12	Edward (D)
IR/Technology	Al (D)
Medicine and Health Sciences	Chris (C), Nurse (D)
Newspapers	Apple (D), Robert (D)
Social Sciences	Ann (C), Crusty (C)

Function of categories. Participants used categories in two major ways. In the

first mode, participants knew which database they wanted, and used the category only as

an intermediate click to get there. For these participants, the category list served no

purpose during the current episode. For example, Cleopatra used the Alpabetical Listing

in this way to arrive at *PsycINFO*. Of the episodes listed in the table, not including the

cases influenced by intervention, five fell into this classification. These categories are

marked by (C) for "conduit." Another major type of category function was as a decision

aid. Participants used categories to narrow down GALILEO's universe of material into

the discipline of interest, and more importantly, to identify the specific databases which

would offer information in their area of interest. RF described his database-choosing

strategy:

> I have used Business and Economics, and also Newspapers, and some of the
> books in education, but basically, if it's such a broad, broad topic you would start
> with the larger, I guess, category or subject, so um, I guess full text. And this
> sorta narrows it down, I would always use [*Periodical Abstracts*].

Of the cases listed above, 22 fell into this classification and are marked by (D) for

"decision." Interestingly, Chris seemed to use the category of Social Sciences in the

Internet Resources as a memory aid as well as a decision tool; she remembered a specific

resource *(Psych Web)* but not its exact location, and the category helped her find it.

Of the decision-type cases listed in Table 9, one was somewhat unique. In this

instance, the participant used another category because he had tried all other options

considered as better choices. Al, using the high school's balky Internet connection on a

particularly bad day, had attempted to use several different databases. He experienced

difficulties ranging from unsuccessful searches to system crashes. He then turned to the

Internet Resources as a last resort, and was satisfied with items found there.

Another unique case among the experienced GALILEO users was FG, who had

no clue where his topic (landscape design legislation) fell within the categories listed: "I

would go to the reference librarian and say …what would be most likely where we could

find, find this. And, um, I'm sort of stuck and I guess I'll just start trying some things."

At this point, we intervened and assumed the role of the reference librarian, to make the

situation as authentic as possible. With guidance, he finally chose *PAIS*. Within this

database, his search was ultimately successful. His confusion helps to illustrate a factor

involved in using categories as databases. As he sought information about universal

landscape design (in which landscapes are made accessible to people with physical

disabilities), he found that the database titles were insufficiently descriptive.

Misconceptions about categories and problems using them. Two misconceptions

concerning the use of categories have already been described in other contexts (see

"Opening menus," page 28, and "Availability of items listed in databases," page 29. At

an early stage in his search, Ben wanted to check the library catalog to gain an idea of

what major case studies were available on his topic (centralized organizational

management). He remembered that there was a link to the catalog somewhere within

GALILEO, but not specifically where. He entered the Full Text Books category,

mistakenly thinking they were located there. Also, Chris made the following statement

during her think-aloud: "I will take it. See if UGA has this one, which they probably do

since I got this one under UGA catalog," meaning the link "Databases Available to:

University of Georgia (alphabetical list)." Chris thought that all materials listed under

this database would be available as print journals in the library, not understanding that the

database and the library collection are two independent entities.

A simple problem expressed by several participants is that they felt overwhelmed

at times in finding the proper category or database to search. Apple said it took time to

learn "where to go." FG stated that he simply had no idea where his topic would fall.

Michelle said using GALILEO became much easier when she learned "which part to work in. … it's still what I have a problem with, I think."

Relationship between major, profession, or course and category chosen. In 15 instances involving 12 participants, there was a direct correspondence between category or database chosen and the participant's major, profession, or course involving the topic under study. For example, Erin was a real estate major, and chose the Business and Economics category immediately. Over the course of her searching, she returned to it often, never venturing outside it, trying out different databases within the category. Teddy was enrolled in a basic geology course and quickly chose the category Earth Sciences. Edward, a high school student, was attracted to the K-12 Student Resources within the Internet Resources. Nurse, a nursing educator, chose the Medicine and Health Sciences category.

Searching

Due to the capture of electronic files during the think-aloud portions of the interviews, a substantial amount of information involving searching was available. Specifically, present data allow a description of participants' initial plans of attack, the mechanics of their search processes, search strategies, and how participants sometimes learned from searching itself. Misconceptions and gaps in participants' knowledge also emerged in our examination of their searching procedures.

Plan of attack. We asked participants what they planned to do first in GALILEO and then how they would proceed to find information about their topics. This question revealed information about how much participants knew about GALILEO in general

37

(reported above, see page 27), and also how they organized their searches. Table 10

presents a typology of participant plans of attack.

Table 10. Participant plans of attack.

Category	Explanation	Participants	Example
Specific resource	Named specific resource as a target	Ann, Chris, Al, Crusty, Kathy, Bob	Bob sought a news resource to learn about school shootings that had occurred earlier that day.
Search term	Listed search terms as focus of plan	Apple, Ben, Crusty, Kathy, Katie, Mike, Mond, Nurse, Edward, FG, RF	Crusty planned to look up "polygraph" and "lie detector."
Trial and error	Planned to try several different procedures, not sure which would work best	Apple, Ben	"I would probably have to experiment" (Ann).
Category	Named specific category as focus of plan	Bob, Chris, Michelle, Teddy, Nurse, Erin	Chris named Health and Medicine as her destination.
Specific feature	Named a specific feature as focus of plan	Cleopatra, Katie, Michelle	Michelle named "abstracts" as her target.
Browse through databases	Planned to browse through database titles	Nurse, Julie	Nurse expected to browse through the Medicine and Health category to find a likely database.
Look for something "interesting"	Mentioned "interesting" as a target characteristic	Chris, Mike	"I'm gonna try to find something that seems like it would have something interesting pertaining to the history of computers." (Mike)
Multiple choice	Intervention: due to lack of system knowledge, we provided several alternatives from which participants chose	Savannah, Mike	Mike admitted he was choosing at random.
Where partner left off	High schoolers worked in groups; partners planned to start where their predecessor had stopped	Pat Sullivan, Gidgit	Al and Pat Sullivan were partners. Al found more resources than he could browse in the Internet Resources, and bookmarked them. Pat Sullivan expected to use this bookmark.

Also, Teddy described plans of attack for both of his current projects, and the one

he pursued is included in the above categorization. The other project, however, required

a different plan of attack. For that one, an exploration of Christian Samurai warriors, he expected to begin with books:

> Because with a topic like that I'd go try to find books to get some general, um, at the same time I'd also just run in here [to GALILEO] and ... Christianity and Samurai, something like that, searches. And go for that. Skim through some of those, some of the journal articles and such. And just see kind of basically what they're saying, and then go for the details. Because details don't do you any good until you're like, okay, so this is what they're talking about.

Narrowing, limiting, and broadening. Participants did not always change the scope of their searches in accordance with standard principles of searching (e.g., Katz, 1997). In studying the use of this concept, examination of how participants used the Limit feature is useful. Also, participants sometimes sought to limit their searches in other ways. In this discussion, "narrowing" refers to setting up a precise search initially, and "limiting" refers to reducing a large list of returns when the searcher judges it to be too large.

Many participants used no limiting at all: Al, Ann, Ben, Bob, FG, Michelle, and Pat Sullivan. They did not mention the concept of narrowing or limiting in any way. For example, Ann scrolled through 70 of 5,747 returned citations in one search, despite having a firm topic focus. She explained that she deliberately used a broader term to give her "a wide variety of things to look at." Ben likewise spent a good deal of time looking through *Encyclopedia Britannica Online*'s outlined list of 1,722 returned items. In the other five cases, however, the need for limiting may simply have not been present. Al, for example, found only fourteen items in his search, and the other participants produced similarly low numbers. Bob performed no searches at all, but was instead browsing through the Internet Resources' directory structure for a specific news item. FG and Pat Sullivan both had difficulty finding any information at all. Michelle's assigned topic was

extremely broad, and within the loose confines of her assignment her list of 131 returns did not seem too long.

Several participants voiced a wish or need to limit their searches, but did not seem to know how to do so. Mond, Savannah, and Sharon, all high school students, fall into this group. Mond asked for help in limiting a list of 42 returned items. Sharon, who experienced difficulty in finding relevant information, wanted to make her searches narrower. Thus, she understood the concept of limiting, but did not understand how to apply it appropriately.

Five participants used a type of limiting we label "manual." In these cases, participants used a broad search initially, and then started over with a narrower set of terms. For example, Edward began with the search term "Banneker" and later narrowed it by starting a new search using "Benjamin Banneker." This procedure seemed to work well for each of these participants when they could identify the proper words.

Yet another group of participants used initial narrowing terms that constrained their searches sufficiently to prevent the need for further limiting. Kathy, Nurse, and RF fall into this group. Kathy combined "Japan" and "yen" and the full text limitation, resulting in a list of 139 results. RF also used the option narrowing results to full text items.

Three participants used the Limit feature provided by GALILEO, but experienced difficulties with it: Apple, Cleopatra, and Robert. Robert misunderstood that he was specifying that the words "cash cards" appear in the title of citations by typing them into the "other terms" box, and gave up when the search was completely unsuccessful. Apple and Cleopatra experienced similar problems when they failed to notice that GALILEO

was limiting in ways they did not intend. Distracted by adding a succession of limiting terms, one after the other, they overlooked that GALILEO was reproducing a previous search for each new limit. They both did not realize that they were beginning with lists of zero returns, and that they were continuing to try to limit that empty list further. This oversight happened despite the fact that the problematic words automatically appeared in the "Your Search" box each time on the Limit screen.

Finally, two participants showed a sophisticated understanding of the Limit feature, and applied it to great advantage. Crusty used a combination of simple limits like dates of publication and broad limiting subject terms in an overall strategy of synonym substitution, methodically switching databases until she felt she had found enough information. Teddy began with an overly narrow search, broadened it through deletion of terms, and then subsequently added in one limiter at a time until he produced a list of 39 satisfactory results. He made one major error by trying to limit results to English, using "English" as a descriptive keyword instead of a language. When no citations were found, he backed up one step, discovered his error, and corrected the problem.

One final observation is that participants varied widely in how many results they thought required limiting. Crusty performed a limit on a list of 37 results, although most participants seemed satisfied with lists this small. At the other extreme, Ann looked through the first 70 of 5,747 citations before launching another search. Often, participants looked through the first set of these large lists to determine if their search was on target, before limiting it further. Apple expressed another dilemma: "I'm sure

there's a simpler way to make this more focused, but I don't know right now, I don't want to lose what I have."

Boolean and Precision Searching. Although we did not pursue Boolean logic as a standard interview question, occasionally the concept emerged in the dialogue. It is interesting to note that only Bob and FG mentioned an understanding of Boolean logic as something they use in information searching and as a concept they knew by name. In situations where combination searches were needed, it occasionally occurred to us to ask participants if they knew about it. RF, Julie, Sharon, and Gidgit answered "no" to this question. This lack of understanding was reflected in the fact that only Kathy used command-line style syntax in her searching. In Gidgit's case, someone had exposed her to the idea of Boolean searching in the past, as evidenced in this question: "You think it should be women AND algebra or women?" She did not know the concept by name, however.

More important, in the entire study, no participant used Precision Search. Ten participants, a group with representatives of each participant type, were clearly surprised or unfamiliar with its capabilities when we demonstrated this feature to them. (This intervention was used at the end of sessions when it seemed that participants needed to understand its power in the context of what they were trying to do.)

Searching strategies. Participants demonstrated a number of strategies in their attempts to find relevant information. Some of these strategies appear in relation to other topics elsewhere in this report. For example:

- Cleopatra examined descriptors and subject headings of likely citations to help her find additional citations. She jotted these terms down in a notebook for current and future reference. RF described a similar strategy.

- Gidgit found names within an abstract of two female mathematicians (her topic), which she then performed searches on.

- Crusty listed synonyms to help her construct search terms.

- Erin and Crusty both used an overall plan of using a series of search term combinations sequentially in a number of different databases, demonstrating their understanding that databases cover different but sometimes overlapping territory.

Learning from searching. Four participants made comments about learning content knowledge through the searching process. Apple's goal for her session was to establish effective search terms and the location of likely information resources. Her earnest gathering was to take place at a later date. To accomplish this goal, she felt she would remember the types of information she found in her fast and broad-ranging searches. Thus, she expected to learn her objective information, at least temporarily. Erin, seeking information about a local telemarketing company as background for an upcoming site visit, expressed surprise at the "good bit" she learned through her searches. She said that her abstract printouts would help her study further and remind her of what she had seen. She did not intend to track down the articles themselves. Nurse exclaimed several times over interesting findings uncovered in her search of *MEDLINE* about stomach ulcer bacteria. Robert spoke of absorbing "bits and pieces" of information from his searching, contributing to one of his goals of staying current with developments in the topic area. Teddy summarized:

I don't know how much, you know, mainly today's stuff has been based on what the title was. I don't know how much learning you can really get done from that. Although, I definitely have learned some things about some crinoids. Um, no, I'd say most of, a vast majority of the learning takes place when you're actually sitting there reading it. Although, yes, you do learn some from the abstracts, if it, the abstract is very important.

Participant knowledge about searching. Shortcomings in searching concepts

appear above in presentations of data about limiting, Boolean, and Precision searching.

Numerous shortcomings in participants' knowledge about the mechanics of searching

were evident as well. Apple spoke of the frustration caused by searching difficulty:

At times it can seem frustrating, because you're looking for something and it seems difficult to find, or if you find something with the information you want, it doesn't give you enough information and you can't get further, so at times it's frustrating.

Later, during her think-aloud, she struggled with finding a specific person and said, "It

should be easy." RF, however, voiced a different attitude: "Sometimes, … if you didn't

put the words in there properly. it'd just look at ya, so that's like my fault.…"

Many shortcomings in participant knowledge about searching demonstrated

themselves as questions or problems concerning syntax. Apple puzzled over names: "I'm

not sure how to look up names….complete name, I wonder if that includes the middle

name…." Gidgit wondered if she should use punctuation between multiple terms. Katie

asked if a term (SAT testing) should be capitalized, and Sharon had a similar question.

Nurse could not remember whether or not to use the plus sign (+) as part of her search

string.

Spelling also caused questions. Apple jokingly said "I'm very dependent on

spell-check" after mis-typing a search word. When a search was unsuccessful, she

double-checked her spelling and wondered if capitalization was the cause. Chris and

Cleopatra had similar problems. Edward's search for "Benjamen Bannakar" was completely unsuccessful and his search floundered until we intervened and suggested that he check spelling. Gidgit likewise had trouble figuring out the problem when her search for "mathamatics" returned nothing. RF suggested that spell-check would be a welcome added feature. On the other hand, Ben, who had serious spelling problems and was aware of this difficulty, typed "industrail management" into *Encyclopaedia Britannica Online*. The database compensated for his error and produced a satisfactory list of items. Ben never noticed this particular spelling error.

Problems with searching. FG spoke of the difficulty of finding a specific magazine (*Southern Living)*, due to being unable to determine the category it would occupy. In this example from the past, he needed a specific article from a back issue, but was completely unsuccessful in finding it through GALILEO. He said that one of GALILEO's most frustrating aspects was its lack of a "universal search" feature. Mond wanted to know if GALILEO had a relevancy ranking feature, like Internet search engines typically do. At least one person – Robert – felt that *Yahoo* was easier to use that GALILEO:

> MAF: You said that GALILEO was much different from *Yahoo*. How is it different?
> Robert: Okay, well, if I could, you know, because I'm not used to trying to find out when to use search limit and so forth on the GALILEO. I've never done that, but on *Yahoo* you can just type in vending machines and it will find everything in vending machines.

This passage illustrates two important points. First, Robert may have assumed that *Yahoo* performs a thorough and exhaustive search of the Internet, a common misconception about all search engines. Second, Robert felt that *Yahoo* was easier to use than GALILEO.

Under the first theme of GALILEO usage, we discussed a number of issues that appeared in the data. These issues included purposes, access, learning, feelings, knowledge, category usage, and searching. Altogether, these glimpses help to tell the story of what part GALILEO is playing in the lives of the participants. It points to some problems as well, a theme to be explored later.

Theme 2: Critically Thinking About GALILEO's Resources

In this study, participants exhibited three major processes in evaluating information: determining relevance, evaluating the information itself, and deciding which items to retrieve. This summative statement is possible only after extensive analysis, but we make it here to help organize the evidence to follow. Evidence for these three processes is provided below.

We begin this section by providing several types of evidence. First, we provide reasons participants gave for "keeping" and "rejecting" information. Next, we present information about the strategies participants used to evaluate information. Finally, we describe the decision-making used by these participants. We end this section by presenting a small amount of evidence about differences between GALILEO, print, and the Internet in terms of critical thinking.

Reasons for retrieval

In a discussion of information evaluation, it is constructive to examine the reasons participants gave for accepting or rejecting a given piece of information. The simplest

way to present this information is in tabular form (see Table 11). Items were easily

identified as "rejects" or "keepers" by noting which ones were printed, in most cases.

Participants often gave multiple reasons for retrieving a given citation or article,

and these reasons were separated by type. We made no systematic effort to choose a

single reason for each acceptance or rejection episode because of the difficulty of judging

relative importance when multiple reasons were given. "Cases" refers to the total number

of acceptances that fell into a category, while "spread" refers to the number of

participants involved. Often, a participant used the same reason to accept more than one

item.

Reasons for "keeping" items fell into four large categories: evaluative (E),

relevant (R), affective (A), and convenient (C). Evaluative reasons referred to the quality

of the information itself in some way. Relevant reasons clustered around usability and

relatedness, and the different shades are presented as sub-categories below. Affective

reasons implied an emotional element, e.g., "I like this." In several instances, it seemed

that the participant retrieved the information merely because it was available in full text,

or for some other reason involving convenience or logistical hardship.

Table 11. Reasons for accepting information.

Cate-gory	Reason	Explanation	Cases	Spread	Example
E	Author	Well-known or important author	4	3	"The man who discovered that this helicobacter was a factor is this Marshall…." (Nurse)
E	Authority	Recognized professional association or business	3	3	"Coke is like…a very prominent player" (Robert)
E	Perspective	Presents an alternate view	4	4	"It would be great if you wanted to know what other people thought." (Mond)
E	Currency	New: scientific finding	4	2	"…something on the forefront…" (Nurse)
E	Compre-hensive	Provides overview	1	1	"it probably gives a[n]…overall…" (Nurse)

Cate-gory	Reason	Explanation	Cases	Spread	Example
E	Context	Located in reputable publication	4	2	"Because like whenever I look up stuff, I usually like go to the …encyclopedia, this is always helpful to me. … This is where I get most of my information for reports, it's like, instead of books and stuff." (Pat Sullivan)
E	Methodo-logy	Scientific method seems sound	9	6	"I can use all these statistics and we can compare them later." (Apple)
E	Examples	Provides illustrative and/or evidentiary examples	2	2	"It gives you different examples…" (RF)
E	Addresses con-troversy	Provides useful material applicable to an established controversy	6	4	"I would like to just concentrate on one that seems like it would be in line to kind of see two different point of views. Not really sure exactly what side he's on..." (Michelle)
E	Good	Verbatim; no specific reason given	4	4	"Okay, it's about drug abuse. And medicine and tolerance. That looks good. Okay. Basically, what I do now is print it out." (Chris)
R	Simple	Mentions relevance, with no qualification	4	4	"It's all about women."(Sharon)
R	Specific idea	Names specific relevant piece	23	13	"Ah! I hit the jackpot. Dark skin males, fair skin males. Ah, lovely. All right, let me mark that." (Cleopatra)
R	Target	Looked for specific idea(s) proactively	4	3	"That worked out good, it's exactly what we want. SAT scores." (Katie)
R	Back-ground	Piece provides background or general information about the topic	5	4	"But that's good, that would be a start." (RF)
R	Divergent	Encounters idea not considered before	3	3	"I didn't think of coming up on something about the company." (Erin)
R	Useful	No qualification given	1	1	"Yeah, I'll use this." (Apple)
R	Essential	Important part of the issue; would be negligent to leave it out	1	1	"It's slightly off the subject, but it's something I have to address." (Ben)
R	Helpful	Verbatim; no further explanation	1	1	"This might help." (Ann)
R	More is better	Not sure about relevance, but keep it anyway just in case	4	3	"This doesn't look like what I really want, but I'm gonna go ahead and print it out anyway." (Al)
R	Specific use	States purpose this information will serve	9	8	"We're gonna use, … like, in the earliest part of our history of computers." (Pat Sullivan)
R	Important	In addition to being relevant, especially important	2	1	"…but because so many people are living so much longer, it may be important…" (Nurse)
R	Practical	Applicable	7	2	"…gives you certain steps…" (RF)
R	Serendipity	Relevant to some other project	1	1	"This actually would be pretty good for, um, my other one." (Ann)

Cate-gory	Reason	Explanation	Cases	Spread	Example
R	Prior knowledge	Covers familiar territory	1	1	"This also has to do with some stuff we talked about earlier in the semester." (Crusty)
R	Lead	Provides lead to more information	1	1	"Are probably mathematicians that, that I could probably type in their names and go and look and find information on them. … Instead of having to waste more time trying to find other articles…" (Gidgit)
R	Interesting	Verbatim	19	14	"Yeah, this one actually looks interesting, so I'll probably print this one out. Yeah, I will take it." (Chris)
A	Disturbing	Information is unsettling	1	1	"…the result and unique damage to children. That always bothers me. Mental health, hmm. Copying this. Is there anything in here that I don't want? This is great. I went through enough when I was a child. I'm going to try to fix it for other people." (Cleopatra)
A	Like	Verbatim	3	3	"Oh, I like this!" (Teddy)
C	Full text	Because it's there	1	1	"That sounds pretty good, since we've got the whole article." (Katie)
C	Available	Easy availability increases attractiveness	2	2	"That looks interesting and it's in BF, and I'm always in the Main Library, so-" (Ann)

Reasons for rejection

Likewise, it is useful to examine the reasons participants gave for rejecting items.

These are summarized in Table 12. Categories remain the same. "Rejects" were

identified as items initially found interesting or relevant but later rejected for one of the

reasons given below. Usually, this process involved browsing through a list of titles,

clicking on one, and then perusing the abstract and full text (if available). To qualify as a

reject, the item was at minimum viewed in abstract or citation form. Under the

circumstances provided during this project, time lapse between accessing a title and

making a decision about it was usually short – in most cases, less than one minute.

Table 12. Reasons for rejecting information.

Cat-egory	Reason	Explanation	Cases	Spread	Example
E	Authority	Professional sponsor is suspect	1	1	"I don't want to use anything from the military…" (RF)
E	Currency	Item is too old	2	2	"That might be a good one. '94 - real old." (RF)
E	Context	Item appears in questionable context	3	3	"A lot of these are book reviews, so that's not gonna work." (Michelle)
E	Method-ology	Avoid specific methodological types	1	1	"Oh, wait a minute. This is a study. I'm not really interested in studies." (Cleopatra)
E	Incon-clusive	Study did not produce firm, positive conclusion	4	1	"It's not indicative, so I won't bother to use that." (Nurse)
E	Trivial	Item seems silly, unimportant	2	2	"…expecting ..sell...should be paid for it. Ah. Obviously." (Erin)
E	Im-practical	Item will not be helpful in any applied way	1	1	"I was just looking for something to give me information for when I go." (Kathy)
E	Disagree	Participant disagrees with the item	1	1	"I see something that says polygraph testing has overall accuracy rates of 98%, and I'm automatically skeptical of that. … General Child Sexual Abuse. I don't think I'll use this one…" (Crusty)
E	Strange	Item contains feature that seems "strange," "weird," "crazy"	3	3	"It's kind of like just a weird title." (Gidgit)
E	In-sufficient	Not enough information presented to be of use	15	10	"Might not be enough to get anything from." (Edward)
R	Simple	No reason given beyond the statement that the item is irrelevant; includes "don't want"	14	8	"It has nothing to do with my paper, but it sounds interesting." (Cleopatra)
R	Banned idea	Item contains a specific idea participant does *not* want	14	7	"*Armageddon*, I don't want *Armageddon*." (Apple; she sought another movie instead.)
R	Lacks specific idea	Participant seeks a specific type of information, which is lacking in the item	7	6	"I don't see anything about pay…" (Erin)
R	Apples and oranges	Topic of information is not closely related enough	4	2	"But there's children again, so I would not use that…" (Nurse, trying to write a nursing guide for adult patients)

Cat-egory	Reason	Explanation	Cases	Spread	Example
R	Over-specific	Information spends too much space on concepts that are narrower that topic of interest	8	6	"It was about one guy. I want a general history." (Al)
R	Not useful/ helpful	No qualification	8	6	"I'm gonna try Bannekers Break Ground...ah, this probably won't help me." (Edward)
R	Mis-leading title	Title seemed relevant, but information is not	1	1	"I think that first little phrase was to draw me into their little site … But this is not what I want." (Mike)
R	Close	Search produces names that are similar, but irrelevant	3	1	"Jane Cox? I don't think so." (Sharon, seeking Mary Cox).
R	Flawed search	Search was flawed in some way and thus did not return relevant items	3	3	Mike found far too many items about history which did not contain "computer"
R	Multiple meaning	Search term has more than one meaning, and this item describes the wrong one	1	1	"Not necessarily 'organization' in the way I want it." (Ben)
R	Not interest-ing	Verbatim, no other reason given	4	3	"Ok, the title was interesting, but not the abstract." (Chris)
A	Dislike	Simply stated, no other reason given	2	2	"I don't really like that." (Al)
C	Vocab-ulary	Difficult to understand or inconvenient	3	2	"… but it looks like there's a lot of long words and I'm typing this, so I probably wouldn't choose this one." (Chris)
C	Difficult	Difficult to comprehend; confusing	6	6	"I was just thinking it sounds confusing when you read it." (Julie)
C	Not available	Print version difficult to access	7	4	"This one also doesn't have display location, so I just wasted that time." (Crusty)
C	Full text	Lacking	3	2	"So it doesn't have full display, which is very irritating." (Kathy)
C	No abstract	Citation does not include abstract, abandon immediately	1	1	"There's no abstract, so I wouldn't even bother with it, unless I could get the abstract." (Nurse)

Evaluative strategies

"Evaluative strategies" are procedures used by participants to assess information.

The extraction of strategies began by open coding all the data for evaluative incidents.

This procedure involved marking sections of think-alouds and interviews in which the

participant seemed to be making judgments about information. These incidents were

examined closely for expressed strategies. For the purposes of this study, these strategies

are broken down into the smallest discrete unit, as expressed by the participant. For

example, RF said, "I don't agree with some of the logic the military has." He sought

information about logistical management in a business setting, but uncovered many

articles written in a military context. He rejected these articles immediately because of

his prior assessment of military logic. Thus, assessing the use of logic is a strategy

clearly used by RF. However, logic is an extremely complex system of heuristics, and

RF did not define his use of logic further. Therefore, the smallest unit we can break this

strategy down into, in this case, is "Examine the quality of the logic used."

On the other hand, Michelle spoke of using logic in a slightly more specific sense:

Well, just looking at the argument that the philosophers and, actually I took a
logic class and, … I mean, at the conclusion and seeing actually how they, first of
all, came up with the premises. And, that leads to a good conclusion.

In this example Michelle displays some prior knowledge about logical analysis, and

condenses the procedure into the examination of premises and conclusions. Her strategy

is probably very similar to RF's, but she explains it in slightly more detail. Therefore, we

were able to summarize her strategies as "Examine assumptions (premises)" and

"Examine the sequence of arguments leading to conclusion." Neither of these is

sufficiently detailed to teach a novice how to perform them, but they communicate the

process well to someone who already understands the procedures involved.

Often, strategies are simply the questions participants ask themselves about

information as a way of determining its quality. They use the answers to these quality

questions to clarify their thoughts about the information. Strategies demonstrated by

participants in this study are provided in Appendix G. In many cases, no evaluative strats

were explicit, and we did not think it appropriate to infer strategies. Thus, the universe of

strategies used by these participants in these information interactions is likely to be

larger, possibly much larger, than those listed in Appendix G.

After extracting strategies and sorting them by type, we then examined numbers

of strategies demonstrated by types of participants. Counting separate strategies only

once per participant, the following statistics were obtained:

Table 13. Strategies demonstrated by participant type.

Type	Number of different strategies demonstrated[4]	Avg.	Total strategies executed[5]	Avg.
High school	19	1.9	20	2.0
Undergraduate	70	7.0	89	8.9
Public library	55	11.0	65	13.0

Thus, high school students demonstrated a total of 19 different strategies, or an average

of 1.9 each, and 20 total, or 2 each. In contrast, public library participants demonstrated

55 different strategies (11 each), and 65 total (13 each).

Decisions

Decisions, or judgments, were easier to collect as data than other evaluative

phenomena, because decisions were enacted by printing or not printing items as an

observable outcome. We were able to gather some descriptive information about these

---

[4] Not counting duplications in individuals
[5] Counting all strategies demonstrated including duplications in individuals on different items

decision-making methods. It seems that decisions occurred through one of three

mechanisms, which we will call "no objections," "single strategy override," and

"balancing."

No-objections decisions. In some cases, participants saw nothing objectionable in

the information, and accepted it. Although the participant executed one or more

strategies, none had negative results. Although they executed several strategies, no

negative characteristics were found. For example, Ben read an article in *Encyclopaedia*

Britannica Online:

> This one builds straight from the thing I just read, um, it says the company of
> corporation, unlike the partnership, is formed not by simply an agreement that,
> between the first of its members. Um, so this one would be good because it's a
> contrast between, uh, what I just printed, basically, what I'll end up reading and
> having to mention and getting back to the original topic at hand. Um, let's see...
> if the whole thing is worth it, or just that one section. Ah, for practical purposes,
> however, public and private companies function the same ways in countries. This
> is perfect. Um, I'm trying to get, uh, closer to that governmental control. Um,
> management form vs., uh, you know, the bureaucracy.

In this example, Ben mentioned relevant portions, remarked that it provided a "contrast"

to a previously printed item, called it "perfect," and decided to print it. To the observers,

it appeared that Ben had no negative thoughts, or objections, to the piece, and thus he

printed it.

Single strategy override decisions. These decisions occurred after a series of

strategies as well. However, a single dominant strategy accounted for the decision.

Cleopatra provided an example:

> That is a very good idea, 'cause I'm seeing - yes, I'm seeing all of these different
> possibilities here. Color and racial attitudes in white, black, and biracial children.
> I have an interest in that outside of the project, seeing as how I'm one of them.
> White-skin and light-skin biases. Pro-white, pro-light skin. Pro-white, anti-black.
> Hmm, pro-light skin bias in black and biracial children. It's sad that it's not
> surprising, since white is the dominant culture. So anything as close to that as

possible makes sense. But, it's a shame. Oh, wait a minute. This is a study. I'm not really interested in studies.

Here, Cleopatra listed several positive aspects of the article, including ideas for how she might use the item, relevant points, the personal nature of her interest, and agreement with the article's thesis. Then, she noticed that the article was a research study – a fatal flaw in her eyes, and she moved along to the next item.

Balancing decisions. In a final type of decision method, participants upgraded information on the basis of some strategies and downgraded it on the basis of others. Then, in a rapid balancing procedure, they decided that the good outweighed the bad or vice versa. Participants indicated this operation through summary statements that followed the pattern of listing good points, bad points, and then a final judgment. We inferred from this type of summary that the participant considered both strengths and weaknesses, but more weight rested on one side of the equation than the other. Teddy provided a rare example of this type of decision making:

> Um, this is one of those sort of fringe ones. It has to do with life over the entire time. Obviously bio-diversity and geological time, however they do talk about extinction and its events. Um, it's only nine pages in length, so it really can't go into very much details if they're covering the entire history of the world and its animal life. I think I'm gonna pass this one up. Actually, no, I'll mark this, but I probably won't check this out unless I'm getting in trouble for information. Then I might go back just to see what it holds. Or if I have to look up American zoologists, anyway.

Teddy began this episode with his judgment, and in the end decided to mark it at least temporarily. Along the way, he named relevant points and positive characteristics, but is not happy that the length (nine pages) seemed incompatible with the scope. At the end of the session, however, he printed out all of his marked items, including this one.

Differences between GALILEO experiences and print

In this study, GALILEO material most often served as the object of participants' thinking. However, participants offered examples of evaluation in other contexts occasionally, usually as incidental or volunteered information. This information is included in this analysis. Also, we sought examples of how participants' thinking may have been different using GALILEO than if they used print resources. In this section we recount several vignettes resulting from this perspective. We end the section with data about time allocations related to higher-order thinking.

The full text difference. As Julie browsed through a list of citations within *EBSCO High School Search*, she clicked on one with full text. She said: "I was just looking for something with a, that had a full text, or it was supposed to." Later probing established that she felt she had to consider the item because it was available in full text, although she would have normally skipped it, judging by the title alone. Mond and Savannah likewise were more likely to click on a title accompanied by a full text article. These participants spent time studying less attractive resources simply because they were available in full text.

For many participants, narrowing their searches to items with full text was a way of saving time. Crusty, Edward, and RF minimized their frustration by retrieving only articles that were readily available, and saved the time and effort needed to visit the library.

Al used the full text articles, where possible, to find out more about the scope of the information. At least on one occasion, a promising abstract led to an article that he rejected. This behavior would not have been possible with the print indices of the past, without actually going to the shelf and pulling the article itself. Mike demonstrated a

similar behavior; as the session progressed, he spent little time on the abstract, moving

directly to the article text for assessment.

Just the abstract, please. In direct contrast to the enthusiastic and exclusive use of

full text articles, at least one participant chose to use only abstracts for her research and

had no intention of retrieving the full articles:

> MAF: Do you have any particular interest in going and finding the articles that
> those go with?
> Erin: No, no.
> MAF: You're just looking for-
> Erin: -actually, when you told me that you could pull up the article, I had no idea
> that you could do that because each time I had used GALILEO, I would just get
> the summary, which was basically, you know, all I needed anyway. Because that,
> when I'm doing a real quick research, I don't have time to sit through, you know,
> read a whole article. I just like the summary like that is, so no, I won't go back
> and print out the article.

Erin's purpose in this instance was to gather background information for an on-site visit

to a business the next day, quite different from conducting a full-blown research project.

However, her mention of this practice being a customary one for her raises the question

of appropriate use.

Is it here? Crusty used the Display Location feature as an integral part of her

decision-making process. Before the days of OPACs and similar linked catalogs, the

only way to accomplish this task was to work between the periodical index and the

library's periodical holdings list. However, using this feature was burdened by

misconceptions, as discussed above (see "Display Locations," page 29).

Time allocation and thinking levels. The data suggest that participants spent a

large proportion of their online time involved in higher-level thinking. The think-aloud

portions of undergraduate and public library transcripts were almost completely involved in searching, reading, and considering the information found. Very little time was spent waiting on downloading or hand-copying of citations. While searching itself took a large proportion of time, and perhaps could be considered inefficient when searching strategies were inept, participants were still engaged in problem-solving until they were able to operate the system in a successful manner. This observation is an overall, general one rather than a detailed time analysis. The opposite is true of the high school sessions, because much time was spent waiting for data transfer.

While this observation must be considered tentative, it suggests an important difference between information use in print environments versus that in GALILEO. While the same higher-level thinking must occur when using traditional print resources, large amounts of time must be spent in physically accessing the items and transferring the information via machine or photo-copying. Searching through printed indices is an especially time-consuming task involving much more page-turning than higher-order thinking.

Differences between GALILEO experiences and other digital information resources

As stated earlier, data from this study provided only incidental information comparing GALILEO with the Internet. We directly asked participants what they thought about GALILEO, and many of their responses appear below. Internet information, usually not directly solicited, crept in, nonetheless. For example, Katie made this remark about using the Internet for homework help: "Oh, yeah, some of it's just like, people that, people's opinions on it and stuff, which is helpful on some things, but where we need the facts, it's not very helpful."

Table 14 compiles these incidental comments across participants. We attempted to provide corresponding comments in horizontal juxtaposition to each other. Blanks occur where features in one environment have no corresponding features in the other (as indicated by the data).

Table 14. Characteristics of GALILEO versus those of the Internet.

GALILEO	Internet
Easy (Ann, Michelle)	
Helpful (Ann)	Makes life easier (Bob); more useful than GALILEO (Robert)
Essential for research (Kathy: "I don't think I could have written half my research papers without it")	Useful for school reports (Al, Gidgit, Julie, Katie); useful for literature if you have not read the book (Al), or to help you understand it (Gidgit, Julie, Katie, Savannah)
Convenient: (RF: "…used full text. I didn't have the time or no other resources to get to UGA…")	
Provides update information (Robert)	Current (Robert); not always current (Mond)
Particularly useful for background information (Teddy)	
Contains same information as in the corresponding print versions (Ann)	Has magazines (Julie) and "newpaper publications" (Robert)
Sometimes inaccessible (place) (Ben)	
"Something more like a librarian would use" (Bob)	
Useless; waste of time (Bob)	
Overwhelming: "too many roads to choose" (Bob)	
No universal search (FG)	Has *Yahoo* and *Alta Vista*
Easily confused with OPAC (Robert)	
More about academic information, less about real world updating (Robert)	Useful for news (Bob)
More difficult to search than *Yahoo* (Robert)	Assume information is there, but sometimes difficult to find (Gidgit)
No "related topics" equivalent (Robert)	Has "related topics" feature in many search engines
Fun (Erin)	Provides sports scores and games (Al); enjoyable (Bob)
	Just another resource (Bob); similar to TV in information quality (Bob); "subject to verification" (FG)
Provides useful practice quizzes (Chris)	Provides useful practice quizzes (Erin)
	Helps with taxes (Gidgit)
	Useful for consumer decisions (Gidgit, Mond, Savannah)
	Useful for talking to friends at a distance cheaply (Gidgit, Katie)
	Provides information about colleges (Julie, Mond) and scholarships (Mond)

GALILEO	Internet
	Allows discourse that would not be permitted elsewhere, sometimes "extremist" or "offensive" (Bob)
Contains indices of journals, which are required by many professors for research (Crusty)	Contains "pretty good" information (Gidgit)
Provides information that cannot be found on Internet (Ben)	"You can find anything" (Gidgit); "vast" (Robert)
	Everyone is jumping on (Robert)
	Allows academic networking (Teddy)
	Opinion (Bob, Katie)
Slow at times	Slow at times (Julie)
	Misbehavior in chat rooms (Katie)
	Provides "fake" information (Al)
	Virtual; ephemeral (Bob)

Summary: Theme 2

In this section, we provided information about how and why participants chose to reject or retrieve information items. We also discussed discrete strategies and mechanisms for making decisions. Interwoven within these types of data was information about how participants perceived relevance and information quality, as well as how these judgments jelled together into a decision to keep or reject. We ended the section with a recounting of participant comments about how GALILEO differs as a resource from print and other Internet resources. These items provide further information about thinking in the GALILEO environment.

Theme 3: Systemic Problems

Throughout the data, information occurred indicating problems with GALILEO as a system. The problems reported below, for the most part, did not occur pervasively. Therefore, these incidents do not represent a consensus of opinion or a common finding among a significant number of participants. However, we consider them to be important merely because they happened. For example, if one in ten users experienced connection

problems, then this occurrence might be of interest to GALILEO designers and managers.

Problems are presented as vignettes, with similar occurrences grouped together. It is

important to note that only the specific participants named in relation to each problem

actually experienced that particular problem.

Overwhelming

Bob complained that GALILEO seemed overwhelming, providing "too many

roads to choose." He suggested that the front end be made simpler. Apple spoke of not

knowing "where I should begin right now."

Transparency

Participants voiced several complaints about GALILEO being generally difficult

to use. For example, Apple felt that GALILEO was difficult to learn, and told of asking

librarians to help her when she first began. FG called the interface "not intuitive," but

also said that it was "fairly easy to work with." Robert called it "a little confusing" at

times. Early in his session, Edward said he thought he could figure it out by himself, but

later admitted that he was stuck and needed help. However, several participants voiced

the opposite perspective. Ann felt GALILEO was easy to learn and proclaimed herself to

be almost entirely self-taught, and Chris considered it self-explanatory. Cleopatra used

the same term, and mentioned that she was happy to ask a librarian when she ran into

difficulty. Crusty, Erin, and Michelle also remarked that it was easy to use.

<u>Navigation</u>

Overwhelmingly and with very rare exceptions, participants used the browser Back button rather than the "Results" button provided on the GALILEO toolbar. Aside from habit, there were at least two incentives for doing so. In databases with special interfaces like *Lexis-Nexis*' *Academic Universe* and the *New York Times*, no Results button is provided, and the Back button is essential. Also, when the few participants who used the 10-25-50-100-item lists button did so, the Results button took them back to the first item on the list. The Back button, however, took them directly to the place where they had just been on the list, a major timesaving. RF voiced his irritation: "When you click on one, it always goes back to that particular screen, I don't like that."

Many questions asked by the novice high schoolers were of the "Where is…" or "How do I get to…" type. For example, Julie asked "How do I get back to the screen that I was just at?"

Another problem occasionally observed was the failure of links to turn color once visited. This happened to Mond and Edward within the standard GALILEO interface, and caused them great difficulty in remembering where they had been. Julie could not remember which databases she had visited because of the failure of their titles to change color. Sharon was confused the first time she switched databases to see her old search terms already present in the search box. She thought this meant that she had already used this database.

Button blindness

Occasionally, participants asked a question or experienced difficulties with a feature that was answerable from information displayed on the page. These questions were most common among the naïve high school students. Mike misunderstood what "8 results" meant and asked where the "next page" button was. Savannah also had trouble finding the "page down" button. Mond confused the buttons provided by GALILEO and those resident in the browser. For Savannah and Mike, bullets or "dots" denoting full text articles did not convey an obvious meaning, despite their definition on the page: "What do the little dots mean, by certain ones?" (Savannah; similar, Mike). Erin had never noticed the "Article Text" button and did not know how to use it. FG and Mond were confused when pressing the enter key did not execute the desired action, as on the limit screen where it is necessary to click the "Start Limit" button.

No abstracts

Participants felt handicapped when specific databases did not provide abstracts, particularly when provision of abstracts was inconsistent within the same database. Nurse encountered this problem with *MEDLINE*, and Michelle with *Humanities Abstracts*. Nurse simply ignored citations when she saw that the abstract was not present. However, Cleopatra was not deterred by the absence of abstracts.

Graphic elements

RF complained mildly that he missed tables and pictures typically not provided by GALILEO full text articles.

Slowness and connection problems

       Ben, RF, and Teddy noted that they had observed slow response times from

GALILEO in the past in various lab settings. Of ten interviews conducted in a faculty

office on campus, two participants complained that the system seemed slow that day. At

the high school site, seven of the ten sessions were considerably hampered by both slow

transmission speeds and difficulty accessing the GALILEO page. During most of the

high school sessions, we were abruptly halted in our work at least once and required to

re-enter from the beginning. Many times, the computer crashed completely. Part of this

difficulty may have been due to the fact that all of the high school sessions took place

during the lunchtime part of the day, a traditionally slow period of Internet use. It is

unknown if these problems were caused by GALILEO, the Internet service provider,

local software conflicts, or the specific computer used for all of these interviews.

Unavailability of GALILEO

       FG is an example of a participant who had tried to access GALILEO from a

variety of locations, including the university and his home. He had talked to other

GALILEO users about their access, and he knew that all databases were not available in

each location. To him, this variable availability was frustrating, seemingly more so

because he knew about databases available in some locations and missed them when they

were not available.

<u>Unavailability of indexed materials</u>

Participants often spoke of finding promising indexed materials, and then not being able to access these materials in their print form. Crusty described a past incident: "…It was really, really good and I needed it and they don't have it. And I'm just like, well, oh well." FG found a pair of government documents that seemed relevant to his project, but knew of no avenue for discovering their location. Michelle complained that it seemed to her that books or bound journal collections she needed were often charged out from her library. Gidgit became very excited over a relevant book she found reviewed, and was disappointed when she realized that she had no convenient or timely way to find the book. The high school students quickly learned that they needed to limit their searches to full text because of the likely unavailability of journals in their own library. In fact, none of them ever considered searching their local school or public library for promising articles.

Conclusion to Section II

To summarize this long Results section, we return to the original research questions and attempt to answer them in short form. The sections where each question was discussed are provided for the reader's convenience.

Table 15. Concise answers to research questions.

Research question	Short answer	Section
What cognitive processes do people use to evaluate information while using GALILEO?	Determination of relevance; evaluation; decision-making. Evaluation involves analysis through strategies.	"Theme 2" (page 46); Appendix G
What parts of this evaluation process are specific to a digital environment? Are certain evaluative behaviors unique to GALILEO alone?	No evidence was found to support the notion that evaluation is essentially different between traditional, digital, and the GALILEO environment except that more information is available upon which to base decisions. Negative factors, however, may create obstacles to evaluative thinking (see "Theme 3," page 60). Through its power and convenience, GALILEO may provide more opportunity for higher-order thinking in general than more traditional information environments.	"Differences" sections on pages 56 and 58; Table 14, page 59; "Summary," page 86
How does the use of GALILEO fit into the authentic research processes of individuals?	By many participants in this study, GALILEO was considered essential to scholarly information-finding. Almost all consider it extremely helpful.	Theme 1, page 16; "Usage patterns," page 67
What misconceptions or problems occur as users use this particular system?	Boundary confusion; searching difficulties; connection problems; lack of system knowledge.	Theme 3, page 60; "How much did they know?" page 27
In what ways can GALILEO be improved to facilitate critical thinking in users?	Suggested improvements are minor in relation to the system as a whole, but may alleviate some of the obstacles observed in this study. User instruction is the most important systemic improvement.	"Modifying the Tool," (page 91), "Improving user knowledge," page 87; and "Recommen-dations" (page 98)

Not all research questions were answerable directly from the data, but required interpretative analysis. These interpretations are provided in the final section to come.

III. DISCUSSION, CONCLUSIONS, AND RECOMMENDATIONS

In this section, we will interpret the results presented in the previous section. Recall that the Results section represented the outcome of two phases of analysis. This section represents a third round of analysis, in which we examined the results of the study, attempted to relate them together, and conducted additional questioning to answer the research questions and ensure validity. We also generated single conclusive statements and recommendations for GALILEO development and instruction.

As before, this section is arranged by themes. The first section, "Usage Patterns," provides overall observations about how participants used GALILEO. Next, we explore the topic of thinking within the GALILEO context, drawing together results about the higher-order thinking processes described earlier. In response to problematical patterns observed in the Results section, the next two sections consider how user processes might be improved, and then how the tool itself might be improved. We end the section with concise conclusive statements, recommendations for action, and ideas for further research generated from this study.

Usage Patterns

This study makes no claims about GALILEO usage patterns in the general population, because the advertisements deliberately attracted GALILEO users. Thus, we can make no statements about what portions of the three populations in actuality use GALILEO. The methods used to recruit participants in this study most likely recruited users with a positive bias toward the system. These sampling factors together form a

limitation in this study. This positive bias, however, is somewhat balanced by several

elements. For one, Bob comes close to representing non-users and the high school

students represent naïve but eager users. Also, participants readily voiced their desires

for a more "perfect" GALILEO, and their complaints about it. Valuable information

about problems in the system and its reception appeared as well.

Keeping the limitations stated above in mind, the evidence in Section II (page 15)

suggests that GALILEO seems to be making its way into the information process habits

of at least two of the three target groups. Usage among the undergraduate participants,

especially upperclassmen, seems firmly established. Non-student use is thriving, but at

this point the data support the statement that it is doing so only among people who

already know about GALILEO from a prior academic connection. In all five public

library cases, this connection happened to be one of two local institutions of higher

education. The results show that the university library remains the most favored place for

accessing GALILEO for both of these groups, due to its confluence of indices and

indexed material. Four non-university students described overcoming parking and other

difficulties to visit the university library because of the services it offers. The public

library is not yet a prominent access point for these particular users, although it does play

an important role. Two non-university students admitted that they had accessed

GALILEO in ways that were against the rules by using an illicitly obtained password, or

by sneaking into university computer laboratories.

Within the public schools, the situation seems different according to the data

gathered in this study. First, it was somewhat difficult to locate a nearby school with

both a cooperative media specialist and an established pattern of GALILEO access. We

add to study data a consensus gained from many conversations with media specialists from all over the state. While many media specialists report using GALILEO with success, some still do not. Some media specialists seemed confused about the services provided by GALILEO, how to access them, and associated costs. In addition, the exasperating connection problems experienced at the high school have been reported in rural settings elsewhere (Arciero, 1999; Hunter, 1999; Lieberman, 1999), and likely contribute to low usage of GALILEO in certain areas. These infrastructure problems cannot be blamed upon GALILEO itself. However, the difficulties of telecommunication in general, especially in rural areas, continue to add restrictions to how GALILEO is used.

General observations

There were few surprises in the data concerning how users applied GALILEO to their authentic information projects. The projects themselves tended predominantly to be scholarly tasks requiring varying levels of engagement and application. One minor surprise was the occasional mention of using GALILEO for leisure or curiosity. Participants seemed to like GALILEO, or to have positive affect towards it, although most experienced users named specific points that irritated them. These points of irritation appear as disadvantages in Section II (Table 7, page 26).

Ironically, it may be only the older users who have a genuine understanding of the painstaking work GALILEO relieves. Nurse, the oldest participant at 63, recalled how difficult research used to be: "When we were in graduate school, to have been able to have this kind of thing as a research tool would have been phenomenal." It may be that only participants who have struggled with multiple volumes of print indices and thesauri

can fully appreciate the power and convenience of GALILEO. Appreciation on this level

of awareness was notably missing in this study, with the exception of the three oldest

participants (Nurse, RF, and FG). RF, however, made another important point: "I'm not

really sure if it's the best because I, really I don't have anything else to compare it to."

Despite his lack of points of comparison, RF had an extremely high level of appreciation

for GALILEO. Unfortunately, most participants seemed to have little relative sense of

the value of GALILEO, with literally no objects of comparison available.

A dramatic contrast between individuals

Although this study can make no general statements beyond those describing the

groups observed, we can summarize the patterns observed in individuals. The cases of

RF and Bob, both public library users, represent polar extremes in usage patterns. During

the initial recruiting conversation, Bob claimed that he had used GALILEO in the past.

The interview, however, revealed that his usage was limited to accessing the front end as

a conduit to GALIN and the Internet Resources. He had no use for the Databases

themselves: "This seems something more like a librarian would use." To him, GALILEO

had no use outside of Academia, and although he was a vocational school teacher, he

could see no personal or professional use for the databases now that his graduate degree

was complete.

On the other hand, RF described using GALILEO's databases frequently for a

number of purposes:

> RF: I guess for my professional line, you know, on the other side I would always
> look up other topics, in business, also in sports and, a lot of newspapers, I would
> see things, and I would remember this, and so I would plug in if it, if they had a
> database out, it would sometimes come up.
> MAF: Things that had nothing to do with your schoolwork...

RF: Right, right, so I'd start using it for everything, and I found out you could, so it helped me a whole lot.…it's like I'm a, I guess a professional student, I'm always looking up something, something that I don't understand…"

RF discovered the utility of GALILEO as a graduate student and continued to use it as a primary information source after graduation. He was experienced with the system and had a thorough grasp of the resources it offers. His present job was based in industry, and yet he still found frequent relevant applications. Neither Bob nor RF had Internet access at home, and only Bob had online access at work. Both men are curious, intelligent people, eager to use technology to make their lives easier. Yet, one appreciates the utility of GALILEO as an information system while the other does not.

Usage of GALILEO features

The information presented about participants using specific GALILEO features (Theme 1, page 16, and Theme 3, page 60) can be used in two ways. First, GALILEO developers may examine usage patterns, determine whether or not usage matches the purposes for which features were designed, and make future decisions based upon this information. Second, these patterns provide a useful overall picture of users' levels of understanding. This information may inform future user instruction. Occasionally, features seem to have been misused (in terms of their purpose), and modifications in the features themselves could help. Given the findings described earlier, GALILEO developers are in the best position to make such judgments. It would be a mistake to institute large-scale changes based upon the mistakes of a few people, so these judgments must be considered carefully. Aspects of participant knowledge about GALILEO appear in the sections below about educating users and modifying the system.

<u>Convenience – or scholarly shortcutting?</u>

Crusty's comments about the Display Location feature (see page 29) are disturbing from a cognitive point of view. From one perspective, GALILEO has enabled her to cut some corners in her scholarship. By providing a rich array of resources, more than she could possibly use, she is able to be more selective. However, her selectivity is artificially enhanced by eliminating all items not located in the library. Even though she had used the OPAC to find periodical locations before, she now considers this step an extra cumbersome one, further limiting her list of possible citations. At the undergraduate level, in the context of a minor course project, this tendency toward efficiency may be appropriate. However, it is not a practice that can be considered rigorous in a scholarly sense. In another study, doctoral students were observed on occasion limiting their searches by availability as well (Fitzgerald, 1998). This problem is one that can be addressed in an information use course, but will need to be systemically considered by college faculty of all subjects requiring library research.

Limiting searches to full text is another potential source of problems in scholarship. In full-scale literature reviews, using limits based upon full text availability would be unconscionable. The participants observed using full text limits (RF, Crusty, and Edward) were not performing full-scale literature reviews, however. Within the context of their information tasks, their choices seem reasonable. In the universe of information available, which was far greater than they could apply to their needs, they opted to examine the items that could be obtained in three mouse clicks. It is encouraging that this behavior was not observed in students performing more intensive projects. However, the question of compromising scholarship through artificial and convenience-based limits remains open for exploration.

Another concern is raised by abstract-only research (see page 57). In addition to the one overt case observed, we were surprised to hear four participants comment about how learning can take place through searching, presumably primarily the browsing of abstracts. These observations alone are not problematic, because they all seem reasonable in context. However, their occurrence raises the question of whether students use similar shortcuts on a routine basis. If students depend upon abstracts for all of their research, their learning will be shallow at best. Also, no author of a research study can possibly communicate the full context of findings in a one-paragraph abstract. We feel this question needs exploration, if only to lay the concern aside.

GALILEO and Thinking

Many thinking processes are necessary during a GALILEO session. Users must use prior knowledge (memory) to operate the system and to help them structure their searches and evaluate their findings. They must use problem-solving to address the inevitable challenges that occur when trying to figure out how to make the software perform desired operations. They must judge whether items are relevant or not. They must use evaluation (a form of critical thinking) to assess the quality of information they access. Finally, they must use decision-making skills to decide which items to use from among many possible candidates.

The data-gathering techniques of this study were most efficient at gathering information about the thinking processes for which they were designed: evaluation and decision-making. In addition, relevance-judging is a process closely related to evaluation, and occurs in close time proximity to it, especially in the early stages of

judging an item. A great deal of data were available about relevance-judging because of

this proximity. This section will discuss these three processes in depth. It ends with a

minor observation of a mildly creative solution to a searching problem, one that emerged

incidentally from the data.

Taking it or leaving it

One type of data describing thinking with the GALILEO context occurred as

participants made keep/reject decisions. Often, they gave reasons for these decisions.

Table 11 (page 47) and Table 12 (page 50) provide a compilation of these reasons. By

combining reasons across keepers and rejects, and summing the incidents in the four

categories, the figures in Table 16 are obtained.

Table 16. Reasons given in conjunction with rejecting or accepting information items.

Reason Category	Keepers	Rejects	Total
Evaluative	41	33	74
Relevant	86	67	153
Affective	4	2	6
Convenient	3	20	23

Keep in mind that the items counted in this table are reasons given in conjunction with

why participants kept or rejected information items. Often, more than one reason was

given for a specific item. Also, reasons were sometimes mixed between positive and

negative (see "Mixed episodes," page 83). It is not surprising that relevance is, by far,

the predominant force operating in the keep/reject thinking of the participants in this

study. We were encouraged to find evaluation occurring at a level approximately half

that of relevance. Affect played only a minor role, and it would be inappropriate for

participants to use affective thinking in this context very often. However, the number of

reasons involving convenience seems disturbing. The numbers of 23 separate statements

involving convenience in association with accept/reject decisions, and 20 statements in conjunction with rejected items alone seem significant in the context of this study. For example, one participant was reluctant to retrieve items from one library because she disliked that particular library. Concerns about convenience-based decisions were raised earlier (see page 72).

Reasons given in Tables 11 and 12 for keeping and rejecting items often appear as mirror images of each other, suggesting that participants have criteria or standards in mind against which items are judged to pass or fail. For example, authority appears as an evaluative reason in both tables. In the keeper table, Robert retrieved an item associated with a prominent soft-drink manufacturing company because he respected its business practices. In the reject table, RF rejected an item associated with a branch of the US military because he had observed them use illogical procedures in the past. In both cases, participants were holding the criterion of known and respected authority in mind, and retrieving or rejecting items based upon the item's "performance" on this measure.

Relevance most often was considered first, followed by evaluation if it were present, and then a decision was made. For example, Savannah shows this pattern in this episode, involving her topic of female mathematicians:

> I was just thinking about our topic against the women and stuff and it's got statistics in it and stuff ... it says it does. <pause> Statistics right there. See, I think that's interesting, when it's compared to different stuff … women to other people in the same fields and stuff, like the men and stuff, that's interesting. <pause> Cause you wouldn't think, you'd think women have more than men; I would, that's kinda interesting. I think this one'd be neat to print.

The four categories of keep/reject reasons (Table 16, page 74) represent at least three different mental processes: judging relevance, judging quality, and affect. We will

not discuss affect in the context of this study because it did not figure prominently as a reason for observed behavior, although this relationship has been observed as an influential factor in the past (Fitzgerald, 1998; Isen, Means, Patrick, & Nowicki, 1982). The fourth reason, convenience, is difficult to classify in terms of thinking process. It relates to evaluation as a criterion ("How easy is it to obtain this item?") and to affect ("How much extra trouble is retrieving this item going to cause me?"), but seems to have more to do with personal behavior than thinking. Thus, it is discussed under usage instead. Below, we will discuss the three major thinking categories in the approximate order of their occurrence.

Relevance

Deciding whether or not a source is relevant is a mental process separate from evaluating its quality. Determining relevance can be considered a type of evaluation, because criteria are involved and a decision results. Relevance seeking is an extremely complex cognitive process worthy of its own research. In any information process context, it is bound to play a leading role. Often, these processes seemed to occur concurrently. However, relevancy was not a primary object of this study. Thus, we endeavored to determine when a participant was evaluating relevancy versus when that participant was judging information quality. A significant difficulty in this study was trying to distinguish relevance and evaluation processes from each other, and identifying each correctly. The fact that we experienced this difficulty supports the interconnected nature of the two.

The data in this study support three statements about relevance-seeking. First, relevance-seeking usually occurred independently of evaluation. Second, although the processes were usually independent, they often occurred almost concurrently. In other words, the participant seemed to jump back and forth between the two processes. Finally, relevance remains the strongest reason for choosing or rejecting information items, as evidenced by the near 2-to-1 ratio of reasons given in Table 16 (page 74).

Evaluation

Two areas need exploration under the topic of evaluation: the strategies demonstrated by participants, and evaluative episodes involving both positive and negative strategy outcomes.

Strategy categories. Strategies are arranged by category in Appendix G. These categories are simply clusters of similar strategies, and should be considered only as one of many possible ways to organize them for discussion.

The five categories of strategies are:

- Conceptual: the participant considers the ideas in a piece of information

- Concrete: the participant notices obvious (but often important) characteristics of the information

- Empirical: the participant draws upon specialized knowledge of research techniques

- Metacognitive: the participant chooses or regulates strategies

- Interactive: the participant draws upon some element of self to evaluate the information, such as prior knowledge or opinion

In Appendix G, these major categories are divided further into subtypes, and even further in many cases. The first two types, conceptual and concrete, focus upon specific features of the information. These make up the bulk of the strategies. The metacognitive category likewise contains strategies that could be classified as conceptual but contain a dominant regulatory component.

These strategies correspond somewhat to Taylor's (1986) characteristics of information quality and parts of Ennis' taxonomy of critical thinking abilities (1987). However, these strategies are far more specific than either and add concrete criteria and procedural prescriptions.

It is also interesting that certain positive aspects in texts seemed to serve as quality markers, and caused participants to upgrade their opinions of texts. For example, Cleopatra and Katie elevated their opinions of pieces that contained personal stories and insights. These positive characteristics are indicated as "quality markers" in the strategy table (Appendix G).

Strategies as cognitive operations. Another way of classifying these strategies is by cognitive operation. Under this paradigm, we observed four simple types: grading, identifying, classifying, and comparing.

- Grading: participants either raised or lowered their opinion of a source in response to a particular information characteristic. For example, Apple upgraded abstracts that contained statistics.

- Identification: participants sought a particular information feature, which lead to further strategies. For example, Nurse identified the type of doctor that

would typically read an article she found; for her purposes, articles aimed

towards general practitioners were best.

- Classification: a special type of identification in which a participant placed a

  source in a special category. For example, Cleopatra classified articles as

  research studies or non-research studies, preferring the later.

- Comparison: participants identified similarities and differences between

  features. To illustrate, many participants compared new information to

  information held in prior knowledge. Any disagreement between the two

  resulted in further strategies.

Each of these operations needs further explanation. In addition, the metacognitive type,

which corresponds to the metacognitive category above, can also be considered a type of

cognitive operation. However, the strategies in this category are complex, usually

combining strategies of several simple operational types.

Grading is a process found in many strategies. Often, participants asked a

question that had a clear yes or no answer. Based upon the answer, they either upgraded

their opinion of the information or downgraded it. Most often, this process seemed to

operate negatively. That is, most strategies seemed designed to uncover weaknesses in

the information. To clarify this process, we have included a (y-) or (n-) symbol after such

strategies in Appendix G. The "y" or "n" refers to a "yes" or "no" answer. A minus sign

(-) indicates downgrade, and a plus sign (+) indicates upgrade. Therefore, (y-) means that

if the question is answered by "yes," then the information is downgraded[6]. Only a few

strategies operate as upgrades. In this context, upgrading is not the opposite of

---

[6] We worded the questions in such a way as to avoid confusing negatives, and that is why some are "yes"
questions and some are "no."

downgrading. Sometimes a participant noticed a feature in information that raised their opinion. If this feature had been missing, the participant would not have necessarily downgraded it. This procedure works much like a luxury feature in a new car. For example, Nurse remarked that one article contained a new discovery that a type of over-the-counter medication seemed to protect against stomach ulcer formation. She upgraded her opinion of this information because it seemed new and interesting. She never, on the other hand, downgraded information that did not contain discoveries in any procedure we observed, and it does not follow logically that she would do so.

In grading strategies, participants were using criteria. That is, they were judging information based on a "good" or "bad" rating on one particular feature or variable. Bloom, Engelhart, Furst, Hill and Krathwohl (1956) identify criteria as a primary mechanism for evaluation. In their view, people compare a list of items in their heads against information for consideration. We did observe this type of process, but participants tended to use criteria in a reactive rather than a proactive manner. Participants reported lists of criteria they sought when we asked them how they approach a piece of information. For example, Ann listed authority, writing quality, and context as her quality criteria. Under observation, however, she focused on the criteria of methodology and context, mentioning them as she came upon them. Thus, participants clearly used criteria, but not in the form of a detailed, pre-determined checklist.

In identification strategies, participants looked for a particular feature in the information. For example, they often sought to identify the methodology used in a study. Participants used the identified methodology as a way to select more specialized types of empirical strategies. Evaluations of sampling and conclusions were often contingent

upon the methodology identified. Thus, identification is often the first in a series of strategies. In strategies involving classification, the participant performed a special kind of identification where typologies were known. The participant simply tried to fit the strategy into one of these typologies. This process occurred often, especially for the empirical versus non-empirical classification.

Another common type of operation was comparing. In this operation, participants selected two or more concepts or assertions and identified similarities and differences. The purpose of this operation often seemed to be to identify inconsistencies or to verify the accuracy of information. For example, FG, Bob, and Ben described how they routinely double-checked information in more than one type of source. From these side-by-side comparisons, they were able to raise their confidence in the veracity of specific facts.

One whole category of strategies does not fit into the simple operation types described above. These strategies are all found in the metacognitive category in Appendix G and are difficult to classify by operation. Some seem regulatory in nature. Others are systematic attacks. These strategies are generally non-reactive and they can generally be considered "meta-strategies," or strategy systems. For example, the balancing strategy, in which Apple sought positive and negative features in texts and then balanced them together, can then be broken down into simpler operations such as "identify strengths."

In summary, there are no grand surprises or magical keys to clear judgments hidden among these strategies. When combined into a single group, they are intriguing by virtue of their variety, specificity, and number. The substantial variety, which

expands a larger list demonstrated by a set of sophisticated information user participants previously (Fitzgerald, 1998), leads us to think that there are many more to be found, an implication for future research. This remarkable variation also corroborates the idea that evaluation is complex. The number and variety of strategies involved for one cohesive information search project is appreciable. This listing of strategies contributes understanding to the evaluation process, and adds value to the prescriptions of Ennis (1987), Stripling and Pitts (1988), and Weisburg and Toor (1994).

Differences in evaluation between groups. From Table 16 (page 74), it is clear that high school students performed far fewer evaluative operations than either of the other two groups. In addition, the undergraduates demonstrated a significantly lower number of strategies than the public library participants, although the gap is not nearly as wide. These data are insufficient for a detailed statistical analysis, but the findings are suggestive. Epistemologists (e.g., King & Kitchener, 1994) predicted and observed that older, more educated people engage in deeper reflective and critical thinking than younger people. Although their findings apply to critical thinking ("reflective judgment") rather than evaluation itself, the constructs are closely related. Thus, the findings of this study harmonize well with theirs. It would be interesting to investigate whether evaluative behavior truly increases with age and level of education in terms of information evaluation.

As stated earlier, conditions during the high school sessions were less than ideal, due to students' unfamiliarity with GALILEO and serious telecommunication problems. Perhaps these conditions created such a high cognitive load that their higher-order

thinking was constrained. We would like to conduct further studies with high school students to explore this issue.

Mixed episodes. Altogether, there were 31 occurrences of mixed reasoning in relation to evaluation and keepers or rejects. For example, RF thought aloud about a logistics information item:

> Right, it's, it's some type of system. Manufacturing resource planning, something's already laid out, here are the examples of companies. That might be a good one. '94 - real old.

His initial thoughts were positive, indicating relevance ("manufacturing resource planning," which related directly to his topic), and practicality ("something's already laid out") with examples. Then, he saw the 1994 publication date and rejected it immediately as too old for his purpose. In this example, one overriding strategy caused immediate rejection.

The 31 mixed episodes were spread over 13 participants, meaning that 12 participants demonstrated no mixed episodes. This distribution of incidents suggests that this mixed mode of reasoning was more habitual for some participants than for others. In other words, approximately half of the participants showed no signs of mixed reasoning. Eight undergraduates demonstrated mixed reasoning, while three public library participants and two high school participants did. Thus, very high percentages of the first two groups (80% and 60%, respectively) demonstrated mixed reasoning, but a very low proportion (20%) of the high school students did so. Perhaps this mixed reasoning is a symptom of maturity. Again, it is also possible that the cognitive demands placed on the high school students of learning a new system kept them from engaging in mixed reasoning.

Mixed reasoning corresponds with two decision types below, single-strategy

override decisions, and balancing decisions.

<u>Decision types</u>

The decisions of interest in this study are value judgments. They answer the

question, "Is this information useful to me?" As recounted earlier, the reasons for

keeping or rejecting items involved relevance, evaluation, convenience, and affect. For

evaluative decisions, participants used strategies alone or in combination to form their

answers to this question, and accepted or rejected information based upon the result.

Although we will not discuss the "rightness" or "wrongness" of participants'

decisions, we can describe how participants arrived at their decisions. In Section II, we

presented evidence that judgments occurred through one of three mechanisms in this

study (see page 53). Sometimes a single strategy accounted for a decision. Other times,

the participant executed several strategies and accepted the information because none of

these strategies had a negative result. Finally, participants in a few cases seemed to

weigh good points against bad points and arrived at a net negative or positive judgment.

These judgment mechanisms can be represented as in the following schematics:

1. Single overriding   Strategy 1 → result
   strategy: Strategy 2 → result
                       Strategy n   ←**verpowering result** → Judgment (Accept or Reject)

2. No objections: Strategy 1 → acceptable result
                       Strategy 2 → acceptable result
                       Strategy n → acceptable result → Judgment (Accept)

3. Balance: Strategy 1 → negative result
                       Strategy 2 → positive result
                       Strategy 3 → positive result
                       Strategy n → positive result → $(-S_1 + S_2 + S_3 + S_n)$ → Judgment (Accept if positive,
                                    reject if negative)

Figure 1. Events in three types of judgments.

This schematic suggests how the process might proceed. No particular number of strategies is implied, and an infinite number of strategy sequences and results are possible.

All three decision types corroborate findings of an earlier study (Fitzgerald, 1998). No additional types of decisions emerged from this dataset. The finding about balanced decisions corroborate King and Kitchener's similar idea of "balancing one view against another" (1994, p. 66). It also affirms Glatthorn and Baron's observation (1985) that critical thinkers must be able to hold conflicting ideas in memory simultaneously until evidence supports one idea over the other. For now, this balancing process remains mysterious. Participants in this study did not formally calculate the results of their balanced equations, but instead seemed to estimate the value of good points against the value of bad points quickly in their heads. It is important to note that although these three mechanisms account for all decisions observed in these data, other evaluative decision mechanisms may exist.

Often, acceptances seemed conditional, as if the participant accepted the source for now, contingent upon the revelation of faults in the future. Whether participants returned to these sources and considered them again is unknown.

Manual limiting: Creating a way to make it work

Finally, we mention here a type of thinking unrelated to the judgmental processes discussed above. It is interesting that users have, in some cases, learned how to limit searches without using the formal Limit feature, as demonstrated by the "manual"

searches of five participants (see page 40). Although this coping strategy may seem simplistic at first, it actually represents an adaptation on the users' part. Without studying the system thoroughly to see if it would perform the desired function for them, they invented a way to accomplish what they needed. Alternatively, they may have "borrowed" this behavior from other search engines that do not provide a limiting feature. In either case, this adaptation demonstrates their understanding of the concept of limiting, their lack of fluency with the system itself, and their compensation for this lack. Interestingly, this manual form of limiting will serve them well within GIL (GALILEO Interconnected Libraries, the new statewide online catalog), which has no post-search limiting feature. It also works well with Internet search engines.

Summary

Data from this study contribute substantially to an understanding of three important thinking processes that seem to take place during a session of work with an online information system. Knowing the complexities involved may help designers to construct more transparent systems, and instructors to prepare students for the substantial task of accessing, evaluating, and applying information.

Two of the research questions guiding this study sought potential differences in thinking using traditional print resources, digital information environments, and GALILEO itself. Minor differences in the behavior and perceptions of users are found in two sections (pages 56 and 58), and Table 14 on page 59. In our opinion, the important differences are only indirectly reflected by these data. Important considerations in relation to these questions are the timesavings, convenience, and improved access and indexing power delivered by GALILEO. These factors should all work together to make

the information tasks of participants less laborious, thus freeing participants for the intensive thinking involved. The data describing how participants feel about GALILEO and its helpfulness to them relate to these factors (see page 24 and Table 7 on page 26). In our opinion, GALILEO most enhances thinking by providing information to users in locations where they have never had access to it before, as in the cases of the high school students. In terms of thinking itself, it is ever more important that users exercise the critical thinking skills that have always been necessary in information tasks as GALILEO competes for attention amidst the many information sources available to people today. The strategies and operations observed in these participants were not substantially different from those described in earlier studies and prescriptions (Ennis, 1987; Kuhlthau, 1988; Pitts, 1994), although they are considerably more detailed.

While we do not believe that thinking within the GALILEO environment is significantly different than in more traditional information environments, it is likely that more intense thinking takes place in a shorter period of time due to the alleviation of time-consuming but mindless activities like copying down citations. This intense thinking may be enhanced by several minor changes that would further shift low-level tasks from the user onto the system itself. These changes are suggested in a section to come.

Improving User Knowledge

In the section entitled "How much do participants know About GALILEO?" (page 27), data representing most significant items of misunderstanding were presented case by case. Also, examples of clear positive understanding were presented where

possible. Unfortunately, negative examples are much easier to identify than positive ones, due to the open-ended nature of the questions asked and the to think-aloud activities in this study. It is tempting to think that for each negative example, the corresponding number of positive examples can be assumed. For example, when Chris misunderstood the meaning of "Databases Available to: University of Georgia," but no one else demonstrated this misunderstanding, it is tempting to conclude that 24 participants understood it correctly. This conclusion, however, does not follow logically. Simply because a participant seemed to use a feature correctly, without further explicit demonstration of understanding, does not indicate true understanding of the feature. On the other hand, we have tried to avoid the mistake of over-inflating the importance of negative examples. It seems to us that one-fourth is a significant proportion: if one-fourth or more of users experience difficulty with a feature, then this is a significant problem that should be studied for a remedy. In this specific analysis, we do not count the high schoolers within this one-fourth proportion because of their low experience level. In this study, fewer than four negative examples about a feature are interesting for reporting purposes, but probably not significant. They are interesting because they may reveal a way of thinking about a feature not considered before. In the case of Chris and database availability, her misunderstanding is probably not significant.

System definition

Six of 15 experienced GALILEO users demonstrated evidence of blurring the boundaries between GALILEO, the local OPAC, and the Internet (see page 27). It is difficult to understand how users could confuse GALILEO with the now-defunct GALIN, considering their strikingly different appearances and interfaces. Now that GALIN has

been replaced by GIL, which has many more similar features to GALILEO, this problem

may increase. Yet, GALILEO, GIL, and the Internet represent three entirely different

types of resources in terms of information type: GALILEO, for the most part, indexes

periodicals, GIL indexes library holdings, and the Internet presents a cornucopia of

information sponsored by an infinite variety of individuals and organizations. Most

important, the quality of information found within these resources differs widely. If users

confuse the boundaries of the resources themselves, they lack the ability to use context-

based evaluation strategies that figure prominently elsewhere in their evaluation

processes.

Recall that FG commented about universal searching, Robert remarked about the

ease of using *Yahoo*, and that Mond queried us about relevancy ranking. These

occasional expressions of preference for the Internet's search capabilities over

GALILEO's point to an important possibility. No participant mentioned that GALILEO

searches are more reliable and consistent that those of Internet search engines. It is likely

that they do not understand or appreciate this distinction. (See page 44, "Participant

knowledge about searching.")

Thus, it seems important that instructional efforts begin with an explicit

description of these three systems and what their boundaries are. Perhaps these

descriptions could be accompanied by a graphical representation of the information

domains covered by these three databases to help imprint the idea upon users' memories.

<u>Underused features</u>

In our opinion, several powerful features of GALILEO were underused by

participants in this study. We identified these by noticing which features were used by

less than one-fourth of experienced users (the undergraduates plus the public library users), or four participants. The most prominent of these features is Precision Searching, which was used spontaneously by no participant in the whole study. Other underused features include the 10-25-50-100 grouper, marking, help files, Display Locations, and full text articles. It is possible that participants used help files so seldom because they did not want to display ignorance in front of us, or to waste valuable research time by viewing the files. This is an interesting question to ask future participants. No problem with the features themselves were noted, beyond the issues discussed earlier about Display Locations and Full Text (see pages 29-31).

Managing access

Off-campus participants often seemed at a loss as to how to access items indexed by GALILEO. As mentioned on page 65, they did not consider the possibility that items might be available in local public or school libraries. Neither did they consider the possibility of using InterLibrary Loan. All library users need to become more aware of how to use library networks to obtain locally unavailable items. Public librarians and school media specialists can contribute substantially to this effort. Also, users in small libraries can be advised to learn more about what materials are available onsite before they begin their searches. For example, if they know that the local library has issues of *Time* and *Newsweek* dating back five years, they can limit searches accordingly or make special note of citations found within those journals.

<u>Learning</u>

Efforts by library personnel to educate users about GALILEO seem successful where they have occurred. It appears, at least in the local university community, that professors and librarians could collaborate more to provide more of these sessions, or to ensure attendance in some other way. We base this observation not on participant complaints but on the low number of participants attending formal sessions (5, see Table 4, page 19), combined with obvious shortcomings in their knowledge. In other words, they may not think they need formal instruction, but we think they do.

From the standpoint of finding information, students are using GALILEO successfully, because they usually are able to produce results. However, the problems observed in this study with limiting and the general level of naivete about GALILEO's power indicate that self-learning is not accomplishing the task to a high degree.

Modifying the Tool

Complaints from participants, their perceptions of disadvantages, and problems involving GALILEO appear sprinkled throughout the Results section. In this section, we will try to draw these findings together into a cohesive overview. Obviously, participants often disagreed over whether a feature created obstacles or not. This disagreement is well illustrated by the pairs of polar opposites found in the Advantages/Disadvantages table (Table 7, page 26). Often, there was no clear consensus. In these cases, observations of participant behavior and the system itself helped to gain an overall perspective. Four participants complained that GALILEO was not always easy to use (see Table 26 [disadvantages], and "Transparency," page 61), but six expressed the

opposite view. Thus, the complementary view prevails. Although the system can be considered user friendly according to the data in this study, perhaps the following suggestions may help to enhance overall transparency.

System definition

As stated above, users seem to experience problems in differentiating between GALILEO, GALIN, and the Internet itself. Although it would seem that the welcome pages of each of these resources explicitly define themselves, perhaps designers can find ways to define them more immediately and clearly. The GALILEO Homepage provides a sponsor note, menu options, and help links, but there is no one-sentence definition or explanation that immediately communicates an identity.

Searching

Participants did not complain to a large degree about the difficulty of searching, beyond scattered comments about the frustration of not finding items, the lack of a universal search feature, and inconsistency among database interfaces. However, we feel from our observations that it poses a serious obstacle for users, primarily through a lack of understanding of searching techniques.

Several participants expressed a desire for a universal search feature. These participants had no interest in why such a feature is not possible at the present time and did not pause to think about how cumbersome it might prove, given the huge numbers of citations returned in some databases on overly broad topics. As long as they perceive the Internet to be a competing information source, with the simplest of all search interfaces, this problem is going to be difficult.

In our opinion, participants lacked knowledge about searching to a critical degree, in our opinion. Most did not understand Boolean searching. Our observations of problems with the Limit feature, browsing through huge lists of returned citations, and the failure of anyone to initiate a Precision Search support the finding that participants understand searching to only a rudimentary degree. It seems clear that searching technique is a new literacy skill that needs to be integrated into curricula beginning in the early grades. For the current generation of students and graduates that have never had the opportunity to learn about searching, we suggest the creation of an online information skills course. We further suggest that undergraduates should experience such a course as a part of their core curriculum, or alternatively demonstrate competency.

Spelling presents a substantial obstacle to GALILEO users, according to data from this study. While improving spelling skills in users would be the best course of action, this goal becomes less likely as automatic spell-checkers become available in many computerized contexts. As we observed with Ben's spelling error and the "intelligent" response of *Encyclopaedia Britannica Online* (see page 45), some databases already have this capability. Perhaps the possibility of adding an optional spell-checking capability could be explored. We do not recommend that the standard GALILEO interface incorporate automatic spell-checking, however. One of the greatest strengths of GALILEO's standard interface, in our opinion, is its perfectly literal operation. Sophisticated users need the power provided by this literal operation.

A final complicating factor is illustrated by Nurse's inability to remember whether or not to use a plus sign in her search string to indicate the AND Boolean operator. This minor incident shows the influence of Internet search engines or possibly

other databases on her searching process. GALILEO contains several different search interfaces. Add to those interfaces the many different Internet search engines, all operating according to their own set of rules, and this variety of differently-behaving search engines inevitably causes memory errors due to cognitive dissonance. Users can cope by limiting search engines to a few familiar ones, reading the help files to discover this information, and learning in-depth how to use those. Search engine developers could do much to alleviate this difficulty as well, but their behavior is beyond the scope of this report. Perhaps this complex problem will eventually disappear, but it seems reasonable that developers may have to agree upon a standard at some point.

The Display Locations feature presents a challenge in terms of interface design. As a feature, it provides a powerful service that some participants, at least, depended upon heavily. However, we doubt that any of the participants who used it understood exactly what it meant, owing to the fact that two of them demonstrated their misunderstanding directly. Also, we needed assistance from Dr. Kelly in understanding it ourselves. We feel that a full explanation of the complex reasons why it is only sometimes available is unnecessary. However, a one-screen help file available directly from the button (as a right-click window or pop-up balloon) could explain two things: that usually the button shows the local location of the item, and that its absence or "no locations were found to display" does not necessarily mean the item cannot be found in the local library. Naturally, the best solution to Display Location confusion is to continue to strive toward consistency across databases and universal availability. While these thorny problems are worked upon, a help file might provide an interim solution.

<u>Slowness</u>

If GALILEO runs smoothly with short waits most of the time, users will still tend to remember the one time they had to wait. However, altogether, twelve complaints or firsthand researcher observations (out of 25 cases) of slowness add up to a substantial finding. Unfortunately, it is not possible to discover from the data whether other problems beyond the GALILEO servers themselves caused or contributed to the slowness. At this point, we can only remark that some participants perceived GALILEO to be slow at times. Overall, they seemed tolerant of this limitation. The high school students, especially, exhibited amazing patience through the many long waits after the "Search" button was pressed.

<u>Insufficient full text offerings</u>

Although a few participants did not know about full text, this is obviously an area in which expansion will be welcomed. While participants on campus benefit to a degree from increased access to journal articles, the real beneficiaries are off campus. In the rural high school where this study was performed, full text items within GALILEO could not be easily obtained in any other way due to limited local resources, and the prohibitive distance to a major public or university library. Unfortunately, now that users have glimpsed the possibilities provided by full text online access, their appreciation for its benefits may increasingly be displayed as clamoring for more full text availability.

<u>Choosing categories</u>

For most participants, the first decision required, beyond the decision to use GALILEO itself, was which category to visit. As discussed in the Results section (see

"How did participants use categories?" on page 33), this choice was simple for experienced users. Their established preference for a favorite database or category, or a category aligned with their course of study or profession, made their decision an easy one. Personally identifying with a category, as they often did, allowed them to feel more at home within the system. Thus, the categories are largely working well as a front end organizer. They are vital to successfully navigating GALILEO, and learning how to use them is one of the most important tasks for new users.

Thus, the problem of the new user who does not know where to begin, as well as the occasional experienced user (as in FG's case), should be addressed. To new users, the Database screen seemed to have many categories. New users wasted a great deal of time finding a database in some cases. Our observation of this problem in the first few high school cases, which remained a problem even after some initial instruction, required us to intervene in several cases and help them make this choice. This problem leads us to suggest that an optional category search be created to help new users. Such a search, available from the first or second GALILEO screen, would allow a user to type in a general topic area (such as "landscape design" or "computers"). The engine would then produce a list of databases likely to index information about that topic.

Conclusions

We end this report with a re-statement of conclusions, recommendations, and suggestions for further research.

1. The preponderance of evidence in this study points to positive and constructive use of GALILEO especially among undergraduates, and less but still positively use in public library and high school settings.

2. Using GALILEO for authentic information search tasks includes, at minimum, three types of thinking: relevance-judging, evaluation of information quality, and decision-making.

3. Critical thinking of participants in this study involved a number of strategies which expand a larger listing of strategies found in an earlier study (Fitzgerald, 1998). These strategies are listed in Appendix G.

4. Decisions of accepting or rejecting information items were most often based upon relevance, about half as often on information quality, and occasionally upon affective reasons. Decisions were related to convenience in a small, but significant, number of cases.

5. Although this study provides more detailed information about the thinking of participants in information-use situations than some studies of the past, we found little significant difference in thinking required in traditional print formats, other digital environments, and GALILEO itself.

6. Problems involving GALILEO primarily included searching difficulties, network connection problems, lack of system knowledge, and confusing GALILEO with other network-based systems.

7. Considering GALILEO usage holistically, the most important avenue for improvement is user instruction, because far greater weaknesses were found in participant knowledge than in the system itself. Minor enhancements that may help to remove obstacles for users (such as a spell-checker and topic search engine) were suggested.

Recommendations

1. Data from this study suggest that GALILEO usage will continue to expand. Reasons for likely expansion include:

   - as the system improves through the addition of more databases, more users will be attracted
   - public university enrollments are expected to increase
   - state population is projected to increase
   - usage in public schools should expand due to E-Rate funding and continued GALILEO promotion
   - a college graduates familiar with GALILEO will continue to seek its usage

   Thus, the infrastructure required to support this increased usage must continue to grow. Funding to support this expansion should likewise expand.

2. At the college level, formal instruction of students in the use of GALILEO needs to increase. We recommend the drastic step of instituting a one-hour required course for all undergraduates in information use. This course would naturally include orientations to GALILEO and GIL, as well as general information literacy skills. This course would fit naturally into a web-based delivery mode, an idea now being pioneered at James Madison University[7].

3. Continue communication efforts within the public school arena, because not all schools are using GALILEO at this time.

4. Instruction about the use of GALILEO should contain, at minimum, the following concepts:

   - Boolean and Precision
   - Limiting (when to apply it; how to interpret the types of limiting terms)
   - Paying attention to the "Your Search" box at the top of each Results screen to help learn about how searches are structured, to see if the system is behaving as expected, and to monitor self-learning
   - Information about how GALILEO differs from the Internet
   - "Guided tour" tutorial of GALILEO, including prominent underused features

---

[7] See http://library.jmu.edu/library/services/libinst.htm.

- Using local collections in conjunction with GALILEO; how to obtain items not available locally (especially important for remote users)
- Encouraging users to identify a set of personally useful databases that they can become comfortable with (see page 37).

5. Suggested system modifications include:

- Seek ways to define system boundaries more explicitly.
- Consider adding a top-level search feature that would allow users to discern under which database a given discipline area would fall. Broad terms entered as search terms would result in links to the appropriate databases.
- Continue to expand full text offerings, and maintain the present subscriptions. Results of this study demonstrate the benefits of full text.
- Consider the idea of adding an optional spell-checker within the standard GALILEO interface.

Directions for Further Research

The public school setting continues to be an interesting one for further probing the use of GALILEO. We observed usage in one high school as GALILEO was just being introduced. What will happen next in this school? A revisit in a year or two could trace a developmental path. Also, case studies of schools with well established GALILEO usage patterns are needed at all levels. A statewide survey would be useful to establish usage patterns. Such a survey should ask media specialists to report the nature of their GALILEO connection, which portions are used for what purposes, and approximately how often it is accessed.

The problem of scholarly shortcuts enhanced by GALILEO that were observed as scattered occurrences in this study should be explored. Is this truly a problem? Under what circumstances is it reasonable to limit the scope of information searched to that available online as full text? These are questions that need to be addressed on a philosophical level within the information science field at large, and in educational arenas as well.

This study gathered information only about GALILEO users. What about non-users? Why did so few underclassmen answer our advertisement? Is there a population of one-time-only users, people who attempted to use it once, had a bad experience, and never tried again? Efforts should be made to gain an overall sense of the undergraduate population and to determine what percentages fall into several categories of usage.

Finally, the discovery of additional evaluative strategies used by participants in this study suggests that more are yet to be found. Continued studies along this line of research are needed until redundancy occurs.

References

American Association of School Librarians, & Association for Educational Communications and Technology. (1998). *Information power: Building partnerships for learning*. Chicago: American Library Association.

Arciero, M. (1999, May 24). State needs affordable Internet access for all. *San Francisco Chronicle,* pp. A23.

Bernard, H. R. (1988). *Research methods in cultural anthropology*. Newbury Park, CA: SAGE.

Bloom, B. S., Engelhart, M. D., Furst, E. J., Hill, W. H., & Krathwohl, D. R. (1956). *Taxonomy of educational objectives: The classification of educational goals*. New York: David McKay.

Brown, A. L., Bransford, J. D., Ferrara, R. A., & Campione, J. C. (1983). Learning, remembering, and understanding. In P. H. Mussen (Ed.), *Handbook of child psychology* (Vol. III: Cognitive Development, pp. 77-166). New York: John Wiley & Sons.

Denzin, N. K. (1994). The art and politics of interpretation. In N. K. Denzin & Y. S. Lincoln (Eds.), *Handbook of qualitative research* (pp. 500-515). Thousand Oaks, CA: SAGE.

Dewey, J. (1902). *The child and the curriculum*. Chicago: University of Chicago Press.

Ennis, R. H. (1987). A taxonomy of critical thinking dispositions and abilities. In J. B. Baron & R. J. Sternberg (Eds.), *Teaching thinking skills: Theory and practice* (pp. 9-26). New York: W.H. Freeman.

Ericsson, K. A., & Simon, H. A. (1993). *Protocol analysis: Verbal reports as data*. (rev. ed.). Cambridge, MA: MIT Press.

Evertson, C. M., & Green, J. L. (1986). Observation as inquiry and method. In M. C. Wittrock (Ed.), *Handbook of research on teaching* (3rd ed., pp. 162-231). New York: Macmillan.

Fitzgerald, M. A. (1998). *The cognitive process of information evaluation: A collective case study.* Ph.D. dissertation, University of Georgia, Athens, GA.

Flavell, J. H. (1981). Cognitive monitoring. In W. P. Dickson (Ed.), *Children's oral communication skills* (pp. 35-60). New York: Academic.

Frick, E. (1991). Critical analysis as a pivotal act: Information literacy or spinach? In L. Shirato (Ed.), *Judging the validity of information sources: Teaching critical analysis in bibliographic instruction* (pp. 1-6). Ann Arbor, MI: Pierian.

GALILEO Assessment Overview. (1998). Available: http://www.peachnet.edu/galileo/assess.html.

Glatthorn, A. A., & Baron, J. (1985). The good thinker. In A. L. Costa (Ed.), *Developing minds: A resource book for teaching thinking* (pp. 49-53). Alexandria, VA: Association for Supervision and Curriculum Development.

Hunter, M. H. (1999, February 10). Rural Colorado waiting for telecom revolution. *Denver Post,* pp. C-01.

Isen, A.M., Means, B., Patrick, R., & Nowicki, G. (1982). Some factors influencing decision-making strategy and risk taking. In M.S. Clark & S.T. Fiske (Eds.), *Affect and cognition: The 17th Annual Carnegie Symposium on Cognition* (pp. 243-261). Hillsdale, NJ: Lawrence Erlbaum.

Katz, W. A. (1997). *Introduction to reference work*. (seventh ed.). (Vol. II). New York: McGraw-Hill.

Kelly, J. J. (1995). *What do they think they're doing? : Mental models of online catalog users in an academic library.* Ph.D. dissertation, University of Georgia, Athens, GA.

King, P. M., & Kitchener, K. S. (1994). *Developing reflective judgment: Understanding and promoting intellectual growth and critical thinking in adolescents and adults*. San Francisco: Jossey-Bass.

Kuhlthau, C. C. (1988). Developing a model of the library search process: Cognitive and affective aspects. *RQ, 28*(2), 232-242.

LeCompte, M. D., & Priessle, J. (1993). *Ethnography and qualitative design in educational research*. San Diego, CA: Academic Press.

Lieberman, D. (1999, October 11). American's digital divide: On the wrong side of the wires. *USA Today,* pp. 1B.

Merriam, S. B. (1998). *Qualitative research and case study applications in education*. San Francisco: Jossey-Bass.

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis*. Thousand Oaks, CA: SAGE.

Moll, T. (1987). On methods of analysis of mental models and the evaluation of interactive computer systems. In M. Frese, E. Ulich, & W. Dzida (Eds.), *Psychological issues of human computer interaction in the work place* (pp. 403-417). New York: Elsevier Science.

Murtaugh, M. (1985). The practice of arithmetic by American grocery shoppers. *Anthropology & Education Quarterly, 16*(3), 186-192.

Patton, M. Q. (1990). *Qualitative evaluation and research methods*. (2nd ed.). Newbury Park, CA: SAGE.

Peck, K. L. (1998). Ready...fire...aim! Toward meaningful technology standards for educators and students. *Tech Trends, 43*(2), 47-53.

Peshkin, A. (1988). In search of subjectivity--one's own. *Educational Researcher, 17*(7), 17-21.

Pitts, J. M. (1994). *Personal understandings and mental models of information: A qualitative study of factors associated with the information-seeking and use of adolescents.* Doctoral dissertation, Florida State University, Tallahassee.

ScreenCam97. (1997). [computer software] . Cambridge, MA: Lotus Development Corporation.

Simonson, I., & Nye, P. (1992). The effect of accountability on susceptibility to decision errors. *Organizational Behavior and Human Decision Processes, 51*(3), 416-446.

Smith, P. L., & Wedman, J. F. (1988). Read-think-aloud protocols: A new data-source for formative evaluation. *Performance Improvement Quarterly, 1*(2), 13-22.

Stake, R. E. (1995). *The art of case study research: Perspectives on practice*. Thousand Oaks, CA: SAGE.

Stripling, B. K., & Pitts, J. M. (1988). *Brainstorms and blueprints: Teaching library research as a thinking process*. Englewood, CO: Libraries Unlimited.

Taylor, R. S. (1986). *Value-added processes in information systems*. Norwood, NJ: Ablex.

Tyler, R. W. (1949). *Basic principles of curriculum and instruction*. Chicago: University of Chicago Press.

Vygotsky, L. S. (1934/1962). *Thought and language* (E. Hanfmann G. Vakar, Trans.). Cambridge, MA: M.I.T. Press.

Weisburg, H. K., & Toor, R. (1994). *Learning, linking and critical thinking*. Berkeley Heights, NJ: Library Learning Resources.

Whitney, P., & Budd, D. (1996). Think-aloud protocols and the study of comprehension. *Discourse Processes, 21*(3), 341-351.

Yin, R. K. (1994). *Case study research: Design and methods*. (2nd ed.). Thousand Oaks, CA: SAGE.

Project Personnel

The Principal Investigator for this project was Dr. Mary Ann Fitzgerald, who performed most of the project activities. Mr. Chad Galloway, a Research Assistant and Doctoral Student within the Department of Instructional Technology, assisted in all phases of the project. Dr. Judith J. Kelly, Director of Virtual Library Development for the University System of Georgia and member of the Libraries Faculty, University of Georgia, a key designer of the GALILEO system, served as advisor and GALILEO liaison. The project was conducted with resources provided by a grant from the GALILEO Steering Committee.

APPENDICES

Appendix A: IRB Approval

Appendix B: High School Participant
CONSENT FORM
Minor Participants

I agree to participate in the research titled *Critical Thinking, Information Use, and Decision-Making in GALILEO Users: A Descriptive Study,* which is being conducted by Dr. Mary Ann Fitzgerald (University of Georgia, Department of Instructional Technology, 542-4030).

I understand that this participation is entirely voluntary. I can stop the interview at any time and decide not to participate any more. I can also decide later to withdraw my consent and have the results of my participation removed from the research project My name will not appear on the data. Instead, I will be allowed to choose a make-believe name.

The following points have been explained to me:
1)   The reason for the research is to describe the skills necessary to evaluate online information, and to examine how people use GALILEO under realistic conditions. This project may help me to be more conscious of how I use electronic information sources.
2)   The procedures are as follows: the interview will take place in the school library. I will be asked several questions about my prior experience with GALILEO, and my opinions about it. Then, I will conduct some of my own research with GALILEO, and my interactions with the computer will be electronically recorded. We will end with a few questions about what I did. The procedure will take between one hour and ninety minutes.
3)   No discomforts or stresses are foreseen. If I need to stop the interview for any reason, I only have to say so.
4)   No risks or future dangers are foreseen. This project has nothing to do with my schoolwork whatsoever.
5)   The results of this participation will be confidential, and will not be released in any individually identifiable form without my prior consent, unless otherwise required by law. The entire session will be audiotaped. Tapes and data will be kept indefinitely in secure office storage for further research purposes.
6)   Dr. Fitzgerald will answer any further questions about the research, now or any time in the future, and can be reached by phone at (706)542-4030.

_____

Signature of Researcher   Date

_____

Signature of Participant   Date

PLEASE SIGN BOTH COPIES OF THIS FORM. KEEP ONE AND RETURN THE OTHER TO THE INVESTIGATOR.

_____

_____

Appendix C: Parental Consent Form
CONSENT FORM
Parent

I give my consent for my child _____ to participate in the research titled *Critical Thinking, Information Use, and Decision-Making in GALILEO Users: A Descriptive Study,* which is being conducted by Dr. Mary Ann Fitzgerald (University of Georgia, Department of Instructional Technology, 542-4030). I understand that this participation is entirely voluntary; I or my child can withdraw consent at any time without penalty and have the results of the participation, to the extent that it can be identified as my child's, returned to me, removed from the research records, or destroyed. My name will not appear on the data. Instead, I will be allowed to choose a pseudonym.

The following points have been explained to me and my child:
1)   The reason for the research is to describe the skills necessary to evaluate online information, and to examine how people use GALILEO under realistic conditions. The benefit I may expect from it is that my child may become more aware of how he/she uses electronic information sources.
2)   The procedures are as follows: the interview will take place in the school library.   My child will be asked several questions about his/her prior experience with GALILEO, and his/her opinions about it. Then, my child will conduct some of his/her own research with GALILEO, and his/her interactions with the computer will be electronically recorded. The session will end with a few questions about what my child did. The procedure will take between one hour and ninety minutes. It will not interfere in any way with normal school instruction, and this project has no relationship with my child's schooling or any particular class.
3)   No discomforts or stresses are foreseen.
4)   No risks are foreseen.
5)   The results of this participation will be confidential, and will not be released in any individually identifiable form without my prior consent, unless otherwise required by law. The entire session will be audiotaped.   Tapes and data will be kept indefinitely in secure office storage for further research purposes.
6)   The researcher will answer any further questions about the research, now or during the course of the project, and can be reached by phone at (706)542-4030.

_____

Signature of Researcher   Date

_____

Signature of Participant   Date

PLEASE SIGN BOTH COPIES OF THIS FORM. KEEP ONE AND RETURN THE OTHER TO THE INVESTIGATOR.

_____
Research at the University of Georgia which involves human participants is overseen by the Institutional Review Board. Questions or problems regarding your rights as a participant should be addressed to Julia D. Alexander, M.A., Institutional Review Board; Office of the Vice President for Research, University of Georgia; 606A Boyd Graduate Studies Research Center, Athens, Georgia, 30602-7411; Telephone (706) 542-6514; E-Mail address JDA@ovpr.uga.edu.
_____

Appendix D: Undergraduate Consent Form
CONSENT FORM
Undergraduate Participants

I agree to participate in the research titled *Critical Thinking, Information Use, and Decision-Making in GALILEO Users: A Descriptive Study,* which is being conducted by Dr. Mary Ann Fitzgerald (Department of Instructional Technology, 542-4030). I understand that this participation is entirely voluntary; I can withdraw my consent at any time without penalty and have the results of the participation, to the extent that it can be identified as mine, returned to me, removed from the research records, or destroyed. My name will not appear on the data. Instead, I will be allowed to choose a pseudonym.

The following points have been explained to me:
1)   The reason for the research is to describe the skills necessary to evaluate online information, and to examine how people use GALILEO under realistic conditions.   The benefit I may expect from it is that I may become more aware of how I use electronic information sources.

2)   The procedures are as follows: the interview will take place in the Department of Instructional Technology, 604 Aderhold Hall.   I will be asked several questions about my prior experience with GALILEO, and my opinions about it. Then, I will conduct some of my own research with GALILEO, and my interactions with the computer will be electronically recorded. We will end with a few questions about what I did. The procedure will take between one hour and ninety minutes.
3)   No discomforts or stresses are foreseen.
4)   No risks are foreseen.
5)   The results of this participation will be confidential, and will not be released in any individually identifiable form without my prior consent, unless otherwise required by law. The entire session will be audiotaped. Tapes and data will be kept indefinitely in secure office storage for further research purposes.
6)   The researcher will answer any further questions about the research, now or during the course of the project, and can be reached by phone at (706)542-4030.

_____
Signature of Researcher   Date

_____
Signature of Participant   Date

PLEASE SIGN BOTH COPIES OF THIS FORM. KEEP ONE AND RETURN THE OTHER TO THE INVESTIGATOR.

_____
Research at the University of Georgia which involves human participants is overseen by the Institutional Review Board. Questions or problems regarding your rights as a participant should be addressed to Julia D. Alexander, M.A., Institutional Review Board; Office of the Vice President for Research, University of Georgia; 606A Boyd Graduate Studies Research Center, Athens, Georgia, 30602-7411; Telephone (706) 542-6514; E-Mail address JDA@ovpr.uga.edu.
_____

Appendix E: Public Library User Consent Form
CONSENT FORM
Public Library Users

I agree to participate in the research titled *Critical Thinking, Information Use, and Decision-Making in GALILEO Users: A Descriptive Study,* which is being conducted by Dr. Mary Ann Fitzgerald (University of Georgia, Department of Instructional Technology, 542-4030). I understand that this participation is entirely voluntary; I can withdraw my consent at any time without penalty and have the results of the participation, to the extent that it can be identified as mine, returned to me, removed from the research records, or destroyed. My name will not appear on the data. Instead, I will be allowed to choose a pseudonym.

The following points have been explained to me:
1)   The reason for the research is to describe the skills necessary to evaluate online information, and to examine how people use GALILEO under realistic conditions. The benefit I may expect from it is that I may become more aware of how I use electronic information sources.

2)   The procedures are as follows: the interview will take place in the library. I will be asked several questions about my prior experience with GALILEO, and my opinions about it. Then, I will conduct some of my own research with GALILEO, and my interactions with the computer will be electronically recorded. We will end with a few questions about what I did. The procedure will take between one hour and ninety minutes.
3)   No discomforts or stresses are foreseen.
4)   No risks are foreseen.
5)   The results of this participation will be confidential, and will not be released in any individually identifiable form without my prior consent, unless otherwise required by law. The entire session will be audiotaped. Tapes and data will be kept indefinitely in secure office storage for further research purposes.
6)   The researcher will answer any further questions about the research, now or during the course of the project, and can be reached by phone at (706)542-4030.

_____
Signature of Researcher   Date

_____
Signature of Participant   Date

PLEASE SIGN BOTH COPIES OF THIS FORM. KEEP ONE AND RETURN THE OTHER TO THE INVESTIGATOR.

_____
Research at the University of Georgia which involves human participants is overseen by the Institutional Review Board. Questions or problems regarding your rights as a participant should be addressed to Julia D. Alexander, M.A., Institutional Review Board; Office of the Vice President for Research, University of Georgia; 606A Boyd Graduate Studies Research Center, Athens, Georgia, 30602-7411; Telephone (706) 542-6514; E-Mail address JDA@ovpr.uga.edu.
_____

Appendix F: Interview Protocol

Preliminary Interview *20 minutes*

1. How much have you used GALILEO in the past? Do you like it? Is it helpful to you?
2. What are you planning to do with GALILEO here today?
3. How do you know high-quality information when you see it? What are its characteristics? How can you tell when something is true? When there is a controversy about a topic, how do you choose a position? Give an example.
4. Let me ask you about a hypothetical situation. Let's say you have a new information source here. Let's say it's a journal article (*or some other format appropriate to the content area*). Tell me exactly what you would do as you FIRST begin to look at this article.
5. What is your topic? Why are you studying this information? Tell me about your research project.
6. How much do you know about the content area addressed by this information? Rate yourself on a scale of 1 to 10.
7. Are there any controversies or arguments about this topic? Explain.
8. What is your opinion about this topic? *Where do you stand on this controversy?*
9. Why did you choose to use GALILEO today?
10. What do you plan to do first? *What is your "plan of attack" or strategy?*

Think-aloud procedure *20 minutes, including instructions and warm-up*
Instructions: "As you work with GALILEO today, I want you to tell me your thoughts, to 'think out loud.' Let me model this for you in another type of situation. Let's pretend I'm thinking aloud as I check my email: [As I "think though" checking email, I will perform the corresponding operations on the computer.]

First I have to launch Netscape. Use the mouse, click up here on this lighthouse icon…..hum, this takes a second or two. OK, here's my homepage. Now I go down here to the inbox icon and click on it. It says it wants my password, OK, type that in. …… Now it goes to the server and gets my mail. Looks like I have 12 messages – not too bad. Let's see what I have…most of it is listserv junk, I can tell by the header. Is there something here from a REAL person? Yes, Jim sent a note. I better read that because it might be important.

Do you get the idea? Would you like to practice? (Allow, if desired, with feedback).

I do NOT want you to explain what you're doing, but merely to say your internal thoughts out loud. If you fall silent, I may remind you to speak. Do you have any questions? We'll do this for 20 minutes at the most. If you would like to stop at any point, please say so. If you're ready, I'll start the computer recording now."

While the participant thinks aloud about, I will:
- Take fieldnotes, observing and recording the physical actions (annotation, facial expressions, movements forward and backward through source, mouse actions, etc.) of the participant along with verbal placeholders
- Identify parts of the participant's process that need explanation

Stimulated recall

1. I'd like you to summarize what you just did.
2. I was puzzled by _____. Can you explain what you were doing and why you did that?

Summary questions

1. What do you think of this source? (specify an article accessed during the session)
2. How might you use it?
3. Do you think it will add to your knowledge? How? Do you think it might change any of your previous knowledge or opinions?
4. Your judgment of this piece seems to be *favorable, unfavorable.* What specific words of characteristics led you to this judgment? How did you arrive at this judgment?

Final questions

1. Do you think of yourself as critical? As a critical thinker? Why/why not? How did you come to be this way?
2. I know that sometimes I change my mind about a source over time. Can you think of a time when this might have happened to you? Describe. *Give example if necessary.*

Appendix G: Evaluative Strategies

Conceptual
 Purpose
  Identify audience.
  Remember that powerful speakers can argue persuasively on any topic.
 Affective
  Beware an overly favorable evaluation of a person who is/was a "nice" or well-liked person.
 Complexity
  Is it confusing? (y-)
  Downgrade if it omits an issue I know to be important within the content area.
  Upgrade information that provides incremental steps for accomplishing a complex task.
 Practical
  Can I use this information?
  Does it contain important ideas?
  Did it work?
  If the idea worked in other cultures, consider whether it might work in this one.
  Of two methods, which worked better?
  Consider in terms of a hypothetical situation.)
  Downgrade information that advocates dangerous practices.
  If it worked somewhere else, will it work here?
 Miscellaneous
  Is the title representative of the information?(n-)
 Organization
  Is it well-organized? (n-)
  Upgrade if it is possible to find desired information quickly.
  Downgrade resources that present too many paths to follow.
  Downgrade incoherent information.
 Scope
  Are important issues left out?
  Consider the whole situation.
  Upgrade if seems to cover all aspects of the topic.
 Compare
  Compare with information in prior knowledge.
  Compare with information from other sources.
  Use contradictions between sources as a signal to investigate further.
  Compare with conclusions of authorities.

 Support
  Upgrade grounded opinions.
  Downgrade opinions.
  Quality marker: uses scholarly literature as support.
  Is evidence sufficient to justify claims? (n-)
  Quality marker: personal stories and insights.

 Perspective
  Does it include other perspectives?
  Upgrade information that provides a contrasting perspective.
  Does it contain bias? (y-)
  Does it contain a commercial bias? (y-)
  Downgrade if contains strong, unbalanced liberal or conservative bias.
 Logic
  Examine the quality of the logic used.
  Do the arguments in the information make sense?
  Choose the most persuasive argument.
  Examine assumptions (premises).
  Are cause and effect falsely linked?
  Examine the sequence of arguments leading to conclusion.
Concrete
 Miscellaneous
  Downgrade information that contains "strange" or "weird" wording, or that seems odd.
  Downgrade the ridiculous.
  Downgrade Web sites that contain dead links.
  Upgrade Web sites that have their own search engines.
  Upgrade a resource that identifies its purpose and scope.
  Examine adjectives to identify opinion.
 Currency
  Is it current?

Remember that books are often up to five years behind the pace of scientific development.

Size

Consider size.
How many words does the item have?
Downgrade short abstracts.
Upgrade short pieces with tight foci.
Downgrade items that provide insufficient information.
Upgrade long pieces when seeking general or background information.

Visual

Downgrade Web pages that are overly burdened with graphics.
Do photographs look authentic? [n-]

Language

Quality marker: clarity.
Downgrade if it contains harsh language.
Downgrade information that contains politically incorrect ethnic terms or racial slurs.

Context

Trace the editing process for the piece, including criteria for inclusion. .
What are the credentials of the editor?
Examine the list of members of the editorial board and their credentials.
Is this piece situated in an authoritative source?
Choose well-known, highly reputable resources as starting points.
Upgrade items published by university presses.
Downgrade if published in the popular press.
Downgrade a research study reported in popular magazines.
Have I heard of this magazine?
Television, newspaper, and Internet information especially needs to be compared to that in other sources.

Format

Reject reviews in an open search.
Consider television information to be largely opinion.

Authority

Build a guru list over time; use it to aid name recognition.
Ask known experts to identify the authorities in the field.
Is the item sponsored by a professional organization? (y+)
Upgrade if contains one or more authority markers:
is associated with a large, hi-ranking company
made important discovery in this area

Quality markers

Upgrade if any of the following appear:
clear
interesting
uses examples as support
well written
contains personal stories and insights
contains appropriate sample size
contains new discovery
contains references

Empirical

Consider overall methodology.
Who conducted the study?
Is the sample drawn from a limited geographical area? (n+)
Were controls used?
Was random assignment used? (n-)
Upgrade information that contains statistics.
Avoid quantitative studies when your purpose is to understand personal perspectives.
Is the methodology clearly and completely described? (n-)
Is the sample size appropriate? (n-)
Are statistics creatively interpreted? (y-)
Downgrade surveys because they are impersonal and don't provide personal details.
Does it contain a substantial finding? (n-)
Upgrade case studies when your purpose is to learn how to do something.
Downgrade case studies because they are too limited.

Metacognitive

Experience

Balance the experience filter with academic reading.
Consider information in the light of personal experience.
Consider information in the light of experiences of people I know.

Balance

Seek good and bad points.
Add up details to determine the overall picture.

Triangulate
    Seek triangulation.
Read opinions (reviews) about the work.
Upgrade information found to be consistent over time in different resources.
    Consider the opinions of others about a source as a point of triangulation.
    Measure theory against the beliefs of others.
    Consider information in the light of the experiences of others.
Select
Select several high-quality resources in a content area and use these as starting points.
    Hands
    Count the "hands" (firsthand, secondhand). The higher the number, the less credible.
    Self-awareness
    Use intuition as a way of sensing truth.

Interactive
    Affect
        Why is this information making me mad or frustrated?
        Downgrade offensive information.
    Opinion
        Do I agree?
        What is this person's opinion, and how can I use it to show other perspectives?
    Stimulating
        Upgrade if it is interesting.
    Experience
        Use experience, especially multiple experiences, as a validity check.
        Is it useful?
        Use experience, especially multiple experiences, as a validity check.
        Use intuition to help sense truth.
        Judge adequacy of approach by visualizing personal application.

    Prior knowledge
        Construct a list of preferred journals, and access information in these first.
        Upgrade information written by authors with authority markers above, according to the domain.
        Downgrade a single rebellious opinion.
        Find out as much as possible about an issue before making important decisions