Educating Responsible Citizens in the Information Society

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Introduction

Recent decades have witnessed repeated elaborations on the trend towards an information society. From the efforts of visionaries such as Vannevar Bush (1945) (Memex) to more recent acclamation of the information society arrival by authors such as Daniel Bell (1973) (post-industrial society) and John Naisbitt (1982) (Megatrends), the popular culture has increasingly accepted that the industrialized world is being transformed into a knowledge-based world. The proliferation of electronic information technologies for computation and communication has accelerated this transformation in the workplace and more deliberately in the school. As with any social change, there are conflicting goals, perceptions, and developments associated with emphasis on abstractions such as information rather than on traditional tangibles such as the production of food and material goods.

On the one hand, the promises of the information society include increased productivity, enhanced collaboration and participatory democracy, and improved health and quality of life. These promises are based upon:

- rapid and comprehensive access to information (e.g., online resources, personal and corporate monitoring, and transaction logging);
- new storage and organization tools and techniques (e.g., disk arrays and optical discs; powerful indexing techniques, and interoperable indexes);
- powerful analytical tools (e.g., spreadsheets and statistical packages; textual parsers for spelling, grammar, and pattern feedback; data mining procedures); and
- global communications (e.g., universal e-mail, teleconferencing, chat rooms, MUDs/MOOS).

On the other hand, our present experience with the information society has also brought a host of new challenges to productivity, democracy, and

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quality of life. These challenges include:

- information overload and multi-tasking stresses (both volume and complexity of information flow; growing expectations for concurrent processes such as cell phone business conversations in traffic);
- various inequities (access to hardware, software, and repositories; educational opportunities);
- disorientation, distraction, and addiction (lost in hyperspace and lack of task closure in electronic environments, off-task seductions during work and learning, couch potatoes, and Web surfer addicts);
- privacy and security (especially health and legal information, viruses and electronic crime); and
- social control (ubiquitous broadcasting with no backchannels, naming authorities).

These conflicting but interrelated elements of an information society juxtapose the fundamental limits of human attention with the exponentially expanding volume of information. Our human limitations of 86,400 seconds in our day is strictly fixed, and our limited bandwidths for reading (200–300 words per minute), speaking/listening (120 words per minute), visual recognition (50–300 milliseconds), and cognitive cycling (70–100 milliseconds) have not changed dramatically in the course of recorded history.[1] On the other hand, Moore's Law (computing power doubles every 18 months) continues to apply, and the number of Internet packets sent each day continues to increase dramatically. Cerf (1998) estimated that there were three million domains, 45 million hosts, 240 IP countries, and 100 million users of the Internet in July 1998; there were 1.5 million Web sites and 350 million Web pages early in 1998; 200 terabytes per week are exchanged on the MCI Internet backbone alone; and governments and institutions generate increasing volumes of information (single projects such as the Earth Observing System promise to generate a terabyte of raw data per day). In industry, continuing education demands huge investments (e.g., technology and pharmaceutical companies offer thousands of courses and seminars per year for employees who must keep up with the latest products).

Clearly, the information society requires citizens to be life-long, self-directed learners with filtering skills and tools perhaps even more

[1]These rates are estimates from various research literatures. See Marchionini, 1995, Chapter 2 notes, p. 197, for sources.

powerful than finding skills and tools. The confluence of these issues has led some to advocate information literacy as a basic skill that must be addressed in the formal learning environments at all levels.

The purpose of this article is to differentiate and illustrate three important concepts central to responsible citizenship in the information society. First, information literacy is a lowest common denominator set of skills and concepts that all citizens must attain to be functionally competent. Second, information seeking is a basic human process that has always contributed to survival but takes on additional value in the information society. Developing students' understanding of the information-seeking process is one key element of information literacy instruction. Third, information science is an emerging interdisciplinary field that aims to discover new principles and invents new systems that advance the quality of life in the information society. Just as computer literacy and programming are strongly dependent on the field of computer science, information literacy and information seeking are dependent on the broader field of information science. Like any field of study, information science principles and practices will increasingly become embodied in curricula at all levels of education.

Information Literacy

Although there can be little doubt that people who work and live in developed countries will benefit from various information-specific skills, there are a variety of propositions on what those skills are and how they should best be developed. Some see information literacy as an extension of computer literacy, but more people are looking at what people *do* with the technology. This view that computer literacy is not enough for good management is represented in the current attention to knowledge management in industry and government. Drucker opined in a *Wall Street Journal* editorial (1992) that executives must become data literate—to know what to know about their job and how to find that knowledge. Many in the library community see information literacy as an extension of bibliographic instruction, which has a rich tradition of research and practice. Breivik & Gee (1989) see information literacy as promoting good information consumers, who understand how

information resources are managed and manipulated. This tradition has yielded taxonomies of library skills (e.g., Jakobovits & Nahl-Jakobovits, 1987), and evidence of the effectiveness of libraries and bibliographic instruction when it is tied to project goals (Mancall & Drott, 1983; Shoham & Getz, 1988). Others have investigated the cognitive strategies of information seekers of various ages in electronic environments (e.g., Marchionini, 1989; Neuman, 1993) to develop general models of information seeking. Recognizing that information seeking is embedded in larger tasks, researchers have developed models that encompass affective and other contextual attributes in addition to cognitive aspects. Kuhlthau (1997) has conducted longitudinal studies in the educational context and developed a staged model of the search process. Other work has offered comprehensive models of the roles that information plays in education (e.g., Eisenberg & Small, 1993; AASL/AECT, 1998).
A broader view of information literacy is advocated by Shapiro & Hughes (1996). They argue that information literacy is a liberal art that includes many factors beyond the technical skills promoted by computer literacy and bibliographic instruction traditions. They list seven types of literacy that in aggregate make up information literacy: tool literacy (traditional computer literacy), resource literacy (a major aspect of bibliographic instruction), socio-structural literacy (recognizing the contextual nature of information in group/institutional settings), research literacy (methods and tools), publishing literacy (writing, producing content), emerging technology literacy (adaptability, life-long learning), and critical literacy (evaluate information and information technologies). These literacies map well onto the concepts, principles, and processes central to the developing field of information science.
Marchionini (1995, p. 12) argues that people develop personal information infrastructures that are composed of mental models for knowledge domains, search systems, and past information-seeking events; general cognitive skills and

specific information-seeking skills; attitudes and mental control mechanisms; and material resources such as time, money, equipment, and physical documents. Our personal information infrastructures are applied to information problems in an array of contexts and continue to evolve as a result of our struggles with and conquests of these problems. The development of our personal information infrastructure is roughly equivalent to our level of information literacy. Thus, information literacy is best considered to be a continuum of skills, concepts, attitudes, and experiences related to information access, understanding, evaluation, communication, application, creation, and value (see Table 1).

Table 1. Information literacy: Stimulating students' thinking.

Information literacy can be promoted in any class at any grade level. The following sets of questions and assignments are meant to stimulate activities and discussions that may be an integral part of other classroom events or used as follow-ups to assignments. The list is not meant to be exhaustive and the range is deliberately broad to be suggestive for different grade levels and disciplines. The questions are organized by key information literacy elements.

- **ACCESS**
  What is an index? What examples can you give? Are they all the same?
  Compose three different ways to ask for information on ___________.
  How do you ask a good question?
  How many sources of information do you know about? How do they differ?
  Go on an information Treasure Hunt: Find _________________ and be sure to list exactly what you did to find it.

- **UNDERSTAND**
  What are the main ideas in this

information? [try this with non-textual materials too]
Summarize this information in your own words.
What is the purpose of this information?
Who created this information? Why do you think they created it?
Is this information relevant to your question or problem?
Do you think there is other information somewhere that agrees with this? That disagrees?

- **EVALUATE**
  Where did this information come from? Do you trust it? Believe it? Why?
  Does this information show any biases?
  Is the information up to date?
  If you get two different answers to a question, how do you decide which one to use?
  Is this information complete?

- **APPLY**
  How will YOU use this information? How might a news reporter use this information? How might your mom use it?
  Will anyone be hurt by this information? Helped?
  How has this information been used before?
  List two decisions that you could make based on this information.

- **COMMUNICATE**
  How would you give this information to your best friend? To you grandmother? To your teacher?
  How is sharing information different than sharing your food?
  Can you draw a picture for the ideas in a paragraph? Could you make a video from a text?
  How do words and pictures help each other?

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How is electronic mail different from television?

- **CREATE**
  How would you organize your favorite music CDs? Videos?
  How would you go about asking 50 kids in your school their opinion on a topic?
  Do you make an outline before writing a story?
  What is a storyboard for a video?
  How do you use other people's ideas in your own work?

- **VALUE**
  How do you acknowledge someone else's ideas?
  How do you protect your privacy at home? At school? How do you protect your personal information? Would you give your name and address to a stranger on the street? On the Internet?
  Why do we pay for newspapers? For books? For video games?
  How much does this information cost?
  Should everyone have access to everything on the Internet? In magazines? On TV?

Regardless of how information literacy is defined, the educational community has begun to grapple with how best to incorporate relevant principles and skills into an already over-crowded curriculum.[2] Marchionini and Maurer (1995) have argued that as information resources and technologies are integrated in digital libraries, we will see a confluence of formal (K–12 and tertiary), professional (inservice), and informal

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[2]For example, the information literacy research and practice overview developed by the Maryland State Department of Education (1997) includes sections on information literacy as process knowledge; access tools; the integrated approach to using information skills to learn content; support and confrontation in the learning cycle; media formats; flexible scheduling; using information in contextualized problem solving; generating questions; self-directed learning; etc.

(incidental, self-directed) learning. Formal instructional settings that recognize this trend will provide problem-centered, guided exploration, collaborative learning experiences for students, and will foster collaborations among teachers, parents, media specialists, and students beyond the classroom walls. Christel and Pendyala (1996), Marchionini *et al.* (1997), Soloway & Norris (1998), and Taylor (1996) provide reports of digital libraries created for use in schools. Information industry companies that recognize this trend will provide rich, alternative interfaces to their products and services, and build help and context-sensitive guidance into their products that not only allow users to solve their information problems but also consciously build their personal information instrastructures to improve future performance (i.e., learn).

Information Seeking

Information seeking is a fundamental human process. From the first hours of life, our senses seek stimuli that inform our survival. The infant's nose, ears, and body react to the world while seeking warmth, sustenance, and love. We are information-seeking organisms. Like other basic human processes, such as deduction, rehearsal, and reflective evaluation, information seeking is most often an adjunct to or embedded in larger processes. One of these larger processes is learning. The acts of recognizing and defining information requirements, identifying sources, searching and browsing in promising information spaces, judging relevance, extracting meaning and assessing quality, and determining when to stop information acquisition are essential to knowledge construction. Organizing the results of information seeking, mentally storing and integrating new acquisitions with one's existing knowledge, applying results to the problem at hand, and reflecting on the overall activity completes the learning process.

Formal learning environments tend to emphasize efficiency and standardization by authorizing the teacher to provide information for learners to acquire. Although this may offer economic efficiencies for society, it abbreviates the full learning experience. Certainly, term paper assignments and scientific investigation assignments require students to define information needs and seek out the raw materials needed for critical thought and creative expression, but these are exceptions rather than the rule. There is likely some continuum of increasingly self-determined action that optimizes learning over a lifetime. Early on in life, learners need considerable guidance and models to develop skills and learn how to learn. As they gain experience and fundamental cultural skills related to information seeking, education should provide more self-directed opportunities and model/teach increasingly abstract levels of cultural wisdom (formal training).

Several factors influence information seeking. Certainly, the characteristics and experiences of the **information seeker** are essential to determining how tasks are defined, how interaction with various systems takes place, how and what information is examined and extracted, how progress is monitored, and when to turn attention to other tasks. Professional intermediaries have deep knowledge about many different databases and search systems, hone strategies for question articulation, and apply a host of search tactics (Bates, 1979). Domain experts searching in their area of expertise are able to use their deep knowledge of the discipline to identify the most salient terms and quickly recognize relevant results.

Learners in K–12 settings typically have little expertise in searching or in specific domains of knowledge. Through guided practice, they will learn about a variety of information resources and develop information-seeking strategies that are transferable to other situations. Information seeking is prompted by the need to fill a gap in knowledge (Dervin & Nilan, 1986). Belkin (1980) argues that people bring anomalous states of knowledge to information tasks, and Taylor (1996) described four stages of need: the visceral (perception of need), conscious (mentally defined), formalized (articulated verbally or in writing), and compromised (mapping of the natural language articulation onto some search system language). The individual's abilities and experiences determine how the information need is developed and turned into an information-seeking task.

The **task** is the manifestation of the information seeker's need. Tasks vary on several non-orthogonal dimensions: complexity, abstraction and specifiability, expectation, criticality, and volume. Task complexity may be simple (e.g., find a single name or date or concept), or involve relating many different concepts (e.g., the effects of internal combustion engines on the ozone in the past decade). Task concepts may be concrete (e.g., tiger) or abstract (e.g., responsibility). Closely related to abstraction is how easy it is to recognize and verify the needed information. Thus, a concrete concept may be easy to specify in a query as well as to recognize in a retrieved set of documents, whereas abstract concepts offer challenges for querying, examining results, and closing search. The information seeker develops expectations about how long it will take to complete the task, what the costs will be, and how much mental and physical effort will be required.

These expectations evolve as search progresses, but people may be strongly dissatisfied even when they find the information if the search takes much longer or is more expensive than they had expected. Another characteristic of the task is the level of importance of the need that gave rise to it. Life-critical tasks will clearly receive more attention and effort than artificial assignments due next Tuesday. Finally, the volume of information that satisfies the task may be small (e.g., a word or number) or infinite (e.g., how do humans learn)? By crossing these dimensions, various task variants may be defined. One particularly important variant is the knowledge accretion task. Everyone develops certain interests for which there is ongoing information seeking (e.g., careers, and hobbies). Strong motivation and deep learning result when instructional tasks that develop and practice information-seeking skills are embedded in interests and applications relevant to the learner.

The **search system** exerts a strong influence on information seeking. In general, people are the most sophisticated search systems, and children use parents, siblings, and teachers as key sources of information. Using colleagues as primary information sources extends into adulthood—as studies of the information-seeking behaviors of physicians, academics, and other professionals consistently demonstrate. As all adults know, it is particularly important to choose knowledgeable people when seeking information. The interactive, rich communication that is possible when people interact to address an information need is best formalized in school library media centers by the reference process. One aspect of the information society is the concept of self-service, and we are increasingly responsible for helping ourselves. Thus, information seeking often depends on self-directed search systems—increasingly, these are electronic systems.

Self-directed search systems are composed of two main components—a database and an interface. The database is characterized by its topicality, aim, data types, size, quality, and granularity. It is essential that information seekers first pick databases that are topically relevant to the information-seeking task. The other characteristics will also influence search, and teachers act as database guides when they succinctly characterize several databases and work with learners to decide which databases best match the task. The interface to a search system has both physical and conceptual parts. The physical interface consists of input and output devices that control the human-computer interaction. Computer-based interfaces tend to give users more interactive control than book or video interfaces that provide a small number of interactive options. Unlike the card catalog that was customized for information-seeking purposes, today's physical computer interfaces (e.g., screens, keyboards, and mice) are generic devices that have not been optimized for information seeking. Physical interfaces will continue to evolve to allow multiple options for input and output, including perhaps specialized devices to support search.

The conceptual interface defines the rules and protocols of interaction. For computer interfaces, the interaction style (e.g., direct manipulation, menu, command), representational structure (e.g., left-to-right list, hierarchy, hyperlinked network), and search mechanisms (e.g., natural language or Boolean query form, embedded menus) influence information seeking. Search mechanisms in the World Wide Web have changed dramatically in the recent past and will surely continue to evolve. Today's search engines support hybrid approaches (both word-based queries that return ranked lists of candidate documents [ala *Excite*, *Alta Vista*, etc.] and drill-down selections in pre-arranged categories [ala *Yahoo*]).

The **domain** and the **setting** both influence information seeking. Domains differ in types of materials (e.g., humanities domains may depend on monographic texts, social science domains on journal articles, artistic domains on images, scientific domains on mathematical symbols and models), rate of growth (neuroscience and electrical engineering are growing rapidly, classical studies are growing slowly), and have specialized organizational structures (e.g., biology depends on hierarchical classifications, history depends on chronology). The setting provides constraints on information seeking. Where information seeking takes place (e.g., public/private, familiar/unfamiliar), whether it is done alone or in collaboration, and how much time and money are needed influence the information-seeking process and eventual outcomes.

The final component of information seeking is particularly important for learning. **Outcomes** are both products and processes. The outcomes of search are first the responses given by people or the items provided by a self-directed system, and second the interpretations and understandings the information seeker extracts from those items. Outcomes are often intermediate steps in information seeking that continues until the information need is met (fully or partially) or abandoned. The extracted information—the results of information seeking—should advance the larger tasks in which the information seeking is embedded (e.g., writing a document, making a decision). Outcomes may also be used to evaluate information seeking. By extension, reflecting on outcomes and remembering the process will support future information seeking, i.e., represents learning.

These information-seeking factors combine to determine how and whether an information need is met. The activity defines the information-seeking process. This process is both systematic and opportunistic—it proceeds according to general strategies applied by the information seeker but is flexible enough to allow changes in tactics and strategies to take advantage of serendipitous opportunities. The main subprocesses are:

- recognize and accept information need;
- define the information task;
- select information sources;
- formulate strategy (e.g., query, browse);
- execute strategy;
- examine results;
- extract information (understand, evaluate); and
- reflect, iterate, or stop.

These subprocesses may default to phases or steps in a sequential algorithm, but they are better considered as functions that may be called into action recursively at any time, that may be continuously active (daemons, in programming jargon), that are 'on hold' while others proceed, and that may make calls to other subprocesses. A fluid overall process allows people to take advantage of opportunities that arise from intermediate or random results. The degree to which the information-seeking process deviates from a top-down, sequential default provides a basis for characterizing analytical and browsing strategies and is a gross measure of interactivity.

Electronic systems have changed the nature of information seeking. Studies of children searching electronic encyclopedias have demonstrated how the possibility of getting many articles for a query term adds a new, substantial step in the information-seeking experience for students (Marchionini, 1989, 1995). In today's World Wide Web environment, substantial amounts of time are spent reviewing long lists of potentially relevant documents. In paper-based systems (e.g., card catalogs, indexes), people may have to follow up large numbers of citations to eventually get to actual documents in different locations (physical activity that itself stifles comprehensive and timely search). In electronic systems, not only is the number of citations often larger, but the resources are increasingly available with another click. This availability speeds up the query-examine cycle dramatically and allows many more iterations and variations. Additionally, electronic systems provide many more access points than manual systems (e.g., every word in a document can be indexed, whereas in manual systems only a few controlled vocabulary words, a title, and author are available as entry points). Also, today's electronic environments provide more alternatives in terms of systems, sources, and strategies. Finally, the availability of full texts with hyperlinks to other related documents has made the examination subprocess much richer. Electronic information systems have changed the information-seeking process in several ways:

- increased the volume of information available to individuals;
- altered the cost-benefit tradeoffs in time and effort required to solve information problems;
- increased the variability of formats and management techniques for information resources;
- changed the physical actions that users take during information seeking;
- influenced how resources are allocated and distributed;
- broadened the ways information is organized and represented;
- stimulated the creation of new information processing tools;
- increased the level and type of interactivity;
- changed how we view information seeking and our expectations about results; and
- augmented the strategies and tactics used (Marchionini, 1995, 163–174).

We can certainly anticipate even more changes in how people seek information as digital video, open source program libraries, and other active objects become available in large quantities.

These changes are not without their disadvantages. Information overload, disorientation, distraction, quality assurance, and lack of closure may increase in an electronic environment in which all the work is done with the same input/output devices, all the texts and documents look and feel alike, and every Web page leads to many others. Electronic environments have significantly raised the importance of browsing and selection as information-seeking strategies. Browsing strategies typically trade mental effort for time—browsing takes longer but requires recognition rather than more mentally demanding recall. From a learning perspective, practicing both the mental discipline of analytical search and the creative exploration of browsing is essential.

Professional intermediaries have developed different search strategies for searching large online databases. Using the building blocks strategy, information seekers identify the different facets of the information problem, conduct searches for each facet independently, and then combine the results to get results for further examination. The successive fractions strategy starts with the entire problem and successively eliminates portions of the results. In the pearl growing strategy, information seekers use one highly relevant document to find more like it. Today's Web environment supports two main information-seeking strategies: 'natural language' queries, and hypertext selection. These query systems work better with longer queries, since frequency of occurrence and co-occurrence statistics can eliminate more noise with more parameters to match queries and documents. Unfortunately, the average query length is less than two words (although query lengths are getting longer as people gain better understanding of how the search engines work). Thus, the power of the statistical algorithms is not being fully leveraged by users. Some systems are providing "more like these" features that tend to support iterative and improved results. Selection systems provide lists/menus of categories and topics that information seekers navigate ('drill down') to find relevant information. Selection (navigation) strategies are popular with users because they require less mental effort than query formulation strategies, however, they limit what is available to pre-coordinated links (menu selections) that are not time efficient in non-hierarchical information collections.

Information seeking is a process that humans learn to apply throughout their lives. The information society has made this process more essential for responsible and productive citizenship. Electronic systems have influenced all the information-seeking factors and expanded the strategies and applications of the information-seeking process. These changes are what make information literacy much more important in the information society.

Information Science

Information science is a rapidly emerging discipline that draws upon many different branches of knowledge. Information science has its deepest roots in classification theory beginning with Aristotle's categories of objects (genus, species, etc.) and progressing through the efforts of Liebniz to assign prime numbers to key concepts that in turn could be combined logically to yield all possible concepts or allow concepts to be factored into their prime components. This tradition, which today is an essential component of what is termed 'knowledge representation' was instantiated in library science by classificationists such as Melville Dewey (1979) and S. R. Ranganathan (1951). The problems of structuring information, devising retrieval algorithms, and inventing practical systems that operationalize retrieval theories define this branch of information science. The application of computational technologies to the problems of retrieval proposed by H. P. Luhn (1958) and developed by Gerald Salton (1989) and others vitalized an active information retrieval community. The growth of the Web has spurred many to revisit these roots to devise new organizational structures for digital objects. Some key development challenges include inventing effective search engines for distributed, multimedia information objects; creating and representing metadata; designing overviews and previews for information collections and objects;

and insuring interoperability among various information systems.

A second ancient human need is to ask and answer questions—another primary concern of information science. Approaches range from Socratic dialogues to today's library reference services, frequently asked question (FAQ) lists, and Web search engines. This branch of information science begins with human needs and draws upon the traditions of psychology, communications, and sociology to advance theory, meet human information needs, and invent usable information systems. The study of human information needs builds upon psychological theory and research methods. The goal of understanding why and how people seek and use information drives much of the current research in human information behavior and information seeking strategies discussed in the previous section. The challenges are especially difficult in global electronic environments where diverse cultures and many media formats are available.

Communications theory is central to information science because questions must be elicited and articulated and messages must be communicated accurately and efficiently. Key work in the early and mid parts of the twentieth century established baselines for the interactive nature of information science research. Claude Shannon (Shannon & Weaver, 1949) provided a framework for the technical problems of information transfer as well as metrics and boundary conditions for information flow; Norbert Wiener (1948), Ross Ashby (1956), and other cyberneticists provided fundamental feedback models for interaction; and media theorists like Wilbur Schramm (1963) and Ithiel de Sola Pool (1977) broadened the scope of information transfer from interpersonal to communication networks with multiple nodes that included organizations rather than individuals alone. Today's information science scholars investigate how distributed, ubiquitous communication capabilities can be leveraged to better serve human information needs.

A third thread of information science grew out of the efforts of historians of science and sociologists to understand how knowledge is created and spread. Early in this century, scholars such as S. E. Bradford (1934) observed that research papers appeared in different journals according to distinct distribution patterns where a few journals contained the bulk of the papers in a field while the remaining papers were spread out over a large number of journals (these came to be known as Bradford distributions). Later, Derek de Solla Price (1961) and others noted similar trends with the increase of scientists, spread of scientific ideas, and the way that scientists cited each others' work. Eugene Garfield (1979) operationalized these observations in database services such as the *Science Citation Index*. Today, the branch of information science known as informetrics (bibliometrics is an alternative term) aims to describe the structure and growth of knowledge based on empirical analyses of documents. The Web has opened new opportunities for information scientists to investigate the relationships among diverse media and to adapt methods to problems of collaborative filtering and information visualization.

Information scientists are also concerned with a fourth class of problems related to the roles of information in the social and cultural milieu. Drawing upon varied social and political theories, information scientists today study the problems of information equity, information security and authenticity, the economic and political values of information, and intellectual property rights, and address challenges such as digital democracy and global communities. The term 'social informatics' is sometimes used to describe this research thread.

A fifth research thread of information science has begun to gain momentum and promises to stimulate the field dramatically in the years ahead. This thread addresses the classical knowledge representation problem of the field but starts with human needs and capabilities augmented by interactive electronic technologies rather than relying on the inherent structure of knowledge alone. This emerging perspective has many labels, such as information design, information architecture, and interaction design. I prefer interaction studies as the general term because, first, interaction clearly connotes a process rather than a product and, secondly, studies is broader than design to include usage and evaluation, which are inherently part of the interactive nature of information-seeking and electronic-information environments.

Interaction studies draws principles and guidelines from other new fields, such as human-computer interaction, and from more established fields like architecture, electrical engineering, instructional design, technical writing, and graphical design.[3] The information scientist is central to this emerging new discipline in two ways. First, information scientists leverage their interdisciplinary experience and training to bring together the technical and humanistic perspectives necessary to productive and satisfying interactions. Second, they add value by insuring that interactive experiences are well structured and properly positioned within the global information infrastructure. Thus, interaction designers must not only create well-organized and useful products but also annotate and place them appropriately so that they are optimally found, used, maintained, and retired. One current research and development area that draws upon interaction studies products is the digital library. Digital libraries require cutting edge technologies to manage and deliver huge volumes of information, multiple organizational principles that meet the needs of varied user communities, and practical interoperations with other services and systems.

Information science is emerging as an interdisciplinary subject that draws theories and principles from may fields and has begun to expand from its traditional application base of libraries to offices, museums, schools, and homes. Documentation writers, linguists, archivists and curators, Web site designers, instructional designers, computer scientists, and educators are making valuable contributions to this growing field and we can expect new penetration of information science topics into the undergraduate and K–12 curriculums in the years ahead.

Responsible Citizenship

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[3] Xerox's Palo Alto Research Laboratory represents the most visible and successful center of work since its founding in 1970 to develop the architecture of information in offices of the future. This lab draws people from a wide ranges of fields, including computer science, engineering, anthropology, and psychology.

The *brief* overviews of the three concepts—information literacy, information seeking, and information science—are meant to lay a foundation for educators to consider what exactly they wish to do to prepare their students to be responsible citizens in the information society. It seems sensible that all educators contribute to promoting and insuring information- literate students, just as they promote and insure that they are good readers, speakers, and writers. The basic human process of information seeking has become more explicit in today's electronic environments, and information literacy instruction may help people hone that process, but ultimately, every individual constructs his or her own personal information infrastructure that goes beyond any classroom walls.

Finding ways to incorporate active and reflective information-seeking experiences in all instructional settings is a universal challenge. Because information literacy and information-seeking processes must be taught within contexts, it is important to distinguish information science as a discipline that will continue to emerge as a distinct discipline with principles and skills that are manifested in courses and curricula at all levels. Drawing upon these three concepts, we can aim to prepare citizens who regularly exercise their information rights and responsibilities.

Intelligent and responsible citizens of the information society should expect basic rights of access to information and to the educational and training systems that allow them to effectively execute such access.[4] Citizens should demand and expect:

- direct access to basic survival information (availability);
- access to accurate and authoritative information;
- access to timely information (up to date information);
- cost-effective access to information (fair pricing);

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[4]See http://www.ala.org/work/freedom/lbr.html for the American Library Association's Library Bill of Rights, first adopted in 1948.

- powerful, easy to use systems for accessing and using information;
- open (uncensored), high-bandwidth (not text only) public channels for communication and information transfer;
- privacy in accessing and using information; and
- alternative sources and forms of information.

An ongoing problem is to determine exactly what information should be freely available as a right of citizenship (e.g., legal, health, etc.). Although the Web has opened the door to a world of information resources, most databases are not freely available, and information that is available varies in quality and value. Clearly, not all information should be available without any fees that support and promote their creation and maintenance. However, the information that is available, especially government information, must be provided in organized ways to meet the diverse needs of users. It is not enough to provide free or inexpensive access to information resources if the tools and procedures required to access these resources require extensive training. Providing users with bad user interfaces has the same effect as denying access through economic or political means.

Just as we are challenged to determine basic levels of information rights, we must also identify the concomitant responsibilities of citizens in an information society. Citizens have responsibilities to remain informed about key issues and to vote in a democracy, to obey laws, and to contribute to the good of the society in various ways (taxes, military service, community service, etc.). Citizens must act responsibly in several ways with respect to information:

- by demanding high quality information resources (e.g., government information that is usable as well as available, basic legal, medical, and community information);
- by demanding high quality systems (low cost, easy access, good interfaces, interoperability across different systems, and customization options);
- by demanding high quality education and training (beyond information literacy);
- by contributing feedback to information providers (through questionnaires, collaborative filtering ratings, etc.);
- by practicing safe information seeking (posing thoughtful queries that avoid

overload, respecting the privacy of others, applying appropriate filtering for children, etc.);

- by practicing positive communication (not passing on misinformation, respecting the sensitivities of others, not spamming);
- by practicing sensible self defense (protecting personal identity, applying appropriate filters, etc.);
- by giving credit and paying required fees (acknowledging sources, avoiding software or information piracy);
- by promoting free access to information as a democratic right (fighting censorship);
- by avoiding addictive and wasteful behaviors (over-surfing, confusing real and virtual worlds, cyber terrorism); and
- by evaluating and thinking critically about one's own needs, the information gathered to meet those needs, and how one's needs and information resources relate to the needs of other citizens.

In sum, we want citizens to understand their information rights and responsibilities, participate in the important conversations of the community, promote attitudes and skills that strengthen information-seeking abilities, and critically assess information received and given.

A new information and communication epoch is upon us. How do we prepare ourselves and our children to live and work in a physical world that includes virtual extensions and is dominated by ephemeral objects that have real power to affect our lives? Responsible citizens have always lived in dangerous worlds; those that thrive are well informed. Responsible citizens of the information society are well informed and prepared to exercise information rights as well as accept information responsibilities. They are information literate, have highly developed personal information infrastructures that support effective and efficient information seeking, and exhibit some basic appreciation for the principles and techniques of information science. ☐

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