The School as an Information Ecology: A Framework for Studying Changes in Information Use

Anne Marie Perrault

School of Library and Information Studies,
University of South Carolina, USA

This article explores the concept of the school as information ecology and proposes the use of this concept as a framework for studying the dynamics of online information-seeking behaviors of educators within the ecology. From an earlier study of teachers' online information-seeking behaviors using online survey and interview methods, four themes emerged: currency of information, sparking of ideas and gaining personal knowledge, resource management and the role of time, and webs of sharing. However, although teachers were using the Internet widely, they were underusing the online digital tools specifically designed for educational use. An information ecology framework would enhance the study of collaboration between teachers and library media specialists and of how this collaboration might affect desired outcomes of teachers' information use such as student achievement. This research might have implications related to supporting enhanced teaching and learning practices and informing preservice education and professional development initiatives.

Introduction

Schools are inherently information-rich environments with converging and overlapping multi-streams of incoming and outgoing information. Information is represented in myriad formats including state learning standards, district mandates, curricula, lesson plans, student rosters, individual education plans, policy and procedures, textbooks, online resources, budgets, and schedules. These examples of information come in a variety of multimodal formats and are accessed, produced, and distributed through both low- and high-tech means. Yet we must remember that humans "ultimately decide what it all means and why it matters" (Brown & Duguid, 2000, p. 18) and that it is "social forces that shape the development of information networks" (p. 33).

Information Ecologies and Schools

A school may be considered an information ecology, that is, "a system of people, practices, values, and technologies in a particular local environment. In information ecologies, the spotlight is not on technology, but on human activities that are served by technology" (Nardi & O'Day, 1999, p. 49). Constituents of a school's information network, or information ecology, include teachers, library media specialists, students, administrators,

office and custodial staff, and parents. They act simultaneously as consumers and producers of information. Using the concept of the school as an information ecology can provide researchers with a framework for investigating the dynamics of information use by teachers and library media specialists in teaching and learning.

The scale of an ecology, assert Nardi and O'Day (1999), "allows us to find individual points of leverage, ways into the system, and avenues of intervention" (p. 50). Study of a school's ecology may uncover potential zones of intervention and avenues to leverage them that could be used in supporting the diffusion of innovations such as advanced information-seeking behavior and its sustainability.

An information ecology is similar to a biological ecology in that it is marked by "strong interrelationships and dependencies among its different parts" (Nardi & O'Day, 1999, p. 51). In addition, any change in the ecology is systemic. Nardi and O'Day point out that: "When one element is changed, effects can be felt throughout the whole system. Local changes can disappear without a trace if they are incompatible with the rest of the system" (p. 51). An emphasis on understanding the role of locality and context is a central feature of studying information ecologies, and this focus distinguishes it from a typical systems view.

Copy shops and libraries are two examples cited by Nardi and O'Day (1999) of "systems of people, practices, values, and technologies in a particular local environment" p. 49). They note that a self-service copy shop comprises paper, copy machines, scissors, a computer expert, and so forth, whereas a library comprises humans and multimodal (print and nonprint) resources, and in each of these venues, "humans help other humans use technology" (p. 50). In laying the groundwork for discussing their conceptualization of an information ecology, Nardi and O'Day consider the metaphors of technology as tool, text, and system, crafting a broad, although critical perspective, and frame technologies as ranging from a pencil to the Roman alphabet to computers. These technological tools and artifacts are considered to carry "social meaning … social understandings, values, and practices become *integral aspects* [italics in original] of the tool itself" (p. 21).

In the past decade, research has been conducted on technology in schools as a tool for both teaching and learning activities, as well as a tool to assist in tasks such as data management and school operations (Becker, 2000; Levin & Arafeh, 2002). Certainly although any discussion of schools as information ecologies necessarily and inherently includes aspects of technology and technology use, in this article I focus primarily on the human activities related to online information-seeking practices by educators, specifically the study of the interrelationship of people, practices, values, and the Internet.

Online information-seeking behaviors and their influences on teaching and learning activities are rapidly taking on increasing relevance as teachers and library media specialists are expected to serve as models and

mentors for students in this area. Yet they may lack their own efficient and effective information-seeking practices (Levin & Arafeh, 2002; Perrault, 2005; Recker, Dorward, & Nelson, 2004). Advanced online information-seeking practices by educators are not widespread and thus can be considered an innovation. Conceptualizing schools as ecologies where people, ideas, and technologies interact may help us make sense of the consequences of such innovations.

In this article, I propose the use of the ecology framework for investigating the dynamics of information use in school and the use of Rogers' (2003) Diffusion of Innovation theory as a guide for data collection and analysis. The primary focus and the innovation of concern for the proposed research would be the online information-seeking behaviors of the study participants. Focusing on the Consequences of the Innovation category of Diffusion of Innovation theory, a multi-method research approach would be used to explore the dynamics of information ecologies in two secondary schools. The research, using case study methodology, would seek to examine the perceived influences (i.e., the consequences) of library media specialists' and biology teachers' online information-seeking skills (i.e., the innovation) and this innovation's relationship to the school's information ecology.

Background Context of the Proposed Research

The need for the proposed research emerged from my doctoral research, which investigated biology teachers' perceptions of their online information-seeking practices and how these practices influenced their instructional planning activities (Perrault, 2005, 2007). Quantitative and qualitative analyses of the results of an online survey of 70 teachers and in-depth interviews of 10 teachers measuring the use of specific online tools (i.e., search engines, specific Web sites, digital libraries, online periodical databases, and electronic discussion lists) were conducted. Key findings showed that the teachers were using a greater number and wider range of current and multimodal resources than pre-Internet and perceived this as an advantage in creating authentic, inquiry-based learning experiences. However, the study also revealed that teachers were underusing educational online resources specifically designed to support teaching and learning activities (e.g., digital libraries, online periodical databases, and electronic discussion lists). Four themes reflecting the consequences of teachers' information-seeking practices emerged from the data analysis: currency of information, sparking of ideas and gaining personal knowledge, resource management and the role of time, and webs of sharing. Each theme encompassed both the purposeful and the indirect actions by teachers to access knowledge and resources to refine and improve their instructional planning.

For example, in the interviews, the teachers acknowledged the value of books and print resources, but noted that the Internet offered them immediate access to current and authentic information about new scientific developments and research. Participants commented on how this allowed

them to continue to develop their personal knowledge, which they then integrated into their planning activities. One participant, in explaining what the currency of online information brought to her instructional planning, said, "I like online because there are so many resources, so many concepts that are new and evolving … I use them to encourage my students to look up and gather new information." Teachers also described how useful access to current scientific information was for obtaining background information and for fostering personal knowledge. One teacher noted that she used it "for supplementary information above and beyond what the textbooks have. It's mostly even more for my background more than what I would present to the students, but also for more current research."

Information-seeking is a purposeful process undertaken to change knowledge (Marchionini, 1995). Findings from my dissertation research showed how both the purposeful and the indirect information-seeking practices of biology teachers served to spark ideas and create new knowledge. The teachers recognized their online practices as a benefit that influenced their instructional planning and described getting ideas from others' work, creating new knowledge, and becoming better informed on scientific concepts. Teachers reported that the online information resources for labs fostered new ideas and allowed them to modify existing labs into more inquiry-based learning experiences for students. They also reported that they regularly passed on and received online resources not only from their immediate colleagues in their school, but also from colleagues in the virtual world. Numerous webs of sharing were shaped as a result of their information-seeking behaviors.

The pedagogical changes that science teachers are making to create authentic and active learning environments require access to more resources, but this need, coupled with a lack of time to be able to find and use them, creates a tension for teachers. In both the study's survey and interview responses, teachers' repeatedly cited lack of time as a critical influence on their online information-seeking practices. The Internet with its seemingly endless array of educational resources potentially exacerbates the situation. Coupled with lack of time is the concern for how to manage the resources found for both the short and long term. Interview participants described the challenges of how to organize and retain the online resources from year to year and their frustration with managing all the sites they found.

Although my study brought to light important new understandings about teachers' online information-seeking behaviour, it also prompted new questions about the dynamics of information use in schools related to collaborative relationships between school library media specialists and teachers and also to their ongoing professional development. Before carrying out my dissertation research, my experiences as a library media specialist and a district administrator fostered my interest in considering from an organizational dynamics perspective how the flows, interplay, and disruptions of information influence a spectrum of activities related to

teaching and learning activities. Examining the school as an information ecology offers one approach to examining these new questions. However, the inherent complexities of the interrelationships of systems make it problematic to study a phenomenon such as the information-seeking behaviors of the ecology members without considering the context in which they develop and are used. Case study research is described by Yin (2003) as the "method of choice when the phenomenon under study is not readily distinguishable from its context" (p. 4) and offers an appropriate research methodology to study the information ecology of a school.

Information-Seeking Practices of Educators

Educators face a barrage of change, and the diffusion of the Internet in schools has coincided with significant changes in local and state curriculum standards, federal mandates, and the publication of learning and program standards by national education associations. Educators are involved with information whenever they plan lessons, examine new pedagogical practices, or build resource collections. Individuals who can efficiently and effectively locate, access, and make use of information have an advantage in their professional work over those who do not possess these skills (Hargittai, 2002). Educators who lack effective and efficient online information skills might be more likely to use existing resources rather than to seek out and adapt new resources and hence have fewer choices to tailor learning environments to their students' needs (Fitzgerald, Lovin, & Branch, 2003).

If educators are to find the teaching and learning materials they need from the vast and often unorganized collection of resources on the Internet, they must have mastery of online information literacy skills. Information literacy skills involve the ability to access, evaluate, and use information from multiple sources, and it is essential for teachers to develop these skills in order to find resources and materials to support the inquiry and project-based learning called for in, for example, the science reform efforts (Bruce, 2002; Carr, 1998; Doyle, 1998; Roberts & Foehr, 2002). Teachers who are proficient in online information-seeking skills also serve as models for their students in a world where the premium on information and the ability to find and use it continue to grow.

Curriculum reform efforts and technological advances influenced in part by the diffusion of computers in schools have the potential to transform for library media specialists and teachers both instructional goals and options in creating learning opportunities for their students. The Internet offers library media specialists and teachers a vast amount of current and authentic information to use in their instructional planning to create active, inquiry-based learning environments. However, a study that examined the information-seeking practices of science educators found significant underuse by science educators of online educational resources (i.e., digital libraries, online databases, etc.), those resources specifically intended to support teaching and learning activities (Perrault, 2005). Although the

Internet provides new resources, the question is whether and how teachers and school library media specialists can make use of these online resources and how they influence not only their teaching activities, but also the school ecology.

Research on human information behaviors is generally understood as the study of how in a context people seek, access, and use information. Although there is a strong body of research on children's information seeking practices (Bilal, 1999; Chelton & Cool, 2004; Cool, 2004; Kuhlthau, 1993; Neuman, 1995), there are currently limited numbers of studies that address educators' Web-searching behaviors. Of the two studies of note in this understudied area, one looked at the current state of digital reference service to elementary, middle, and secondary school educators (Lankes, 2003). This study analyzed question types and the user base. The second was a case study of eight middle and high school science teachers that examined how these teachers used and found online resources (Recker et al., 2004). Both Lankes and Recker et al. concluded that although digital libraries have received significant funding and research attention, there is a gap in understanding how teachers find, access, and use digital learning resources. Recker et al. argue that missing from initiatives to develop online resources is:

> a deep characterization and understanding of learning environments, and how digital learning resources may fit into such contexts. Developing this perspective requires adopting teacher and student perspectives, rather than simply focusing on technological concerns. Moreover, ignoring these perspectives risks hampering successful adoption of innovation (Moore, 1991), and the history of educational technology is replete with such omissions (Cuban, 1986, p. 125). (p. 9)

The Recker et al. (2004) study was one of few that examined how educators find, access, and use digital learning resources. However, it stopped short of examining the consequences of these actions on their instructional practices and the information ecology of the school. Recker et al. acknowledged this by calling for further study to "better understand the impact and adoption of emerging digital learning technologies and tools in educational contexts" (p. 123).

Differentiation of Online Search Skill Level

Increased access to the Internet in schools and at home, coupled with increasingly better organized educational online resources through sources such as digital libraries, provides educators with many choices for finding and locating resources and materials for instructional planning. Many have embraced this challenge and are in the process of developing a broad-based set of information literacy skills with online seeking skills comprising a key component. Notably, though, both teachers and students report a lack of proficiency by teachers to seek, access, and use Internet resources for teaching and learning (Becker, 2000; Levin & Arafeh, 2002). Teachers are not alone in not having the skills to find specific information online. A survey by the Pew Internet and American Life Project (Fallows, 2005) queried

Internet users on their practices with respect to search engines and found them generally positive about using search engines; 92% of respondents reported confidence in their searching abilities, and over half (52%) stated that they were "very confident" about their abilities. However, findings also revealed that many searchers were surprisingly unsophisticated about search engines and search results. For example, the study reported that only about one in six searchers could consistently distinguish between paid and unpaid search results. Disparities among teachers' levels of online information-seeking skills potentially affect their ability to take advantage of the Internet, and in turn affect their teaching, professional responsibilities, and personal learning and growth, all factors that influence the ecology of which they are members.

Educators must serve as models and mentors in the area of information literacy for their students. Studying a school as an information ecology and the local system of people, practices, values, and technologies that comprise it may reveal some of what we need to know about potential leverages to use in building and extending existing collaborations among teachers and library media specialists in order to foster advanced information-seeking practices. In viewing schools as information ecologies, it is valuable to consider how this integrated local system of people, practices, values, and technologies shapes and can be shaped by one's personal information infrastructure.

Personal Information Infrastructures

It is generally argued that *information* is anything that can change a person's knowledge. Information is also described as "any difference you perceive in your environment or within yourself; a recognition that your knowledge is inadequate to satisfy a goal that you have; a conscious effort to acquire information in response to a need or gap in your knowledge" (Case, 2003, p. 5). *Information-seeking* is a purposeful process undertaken to change knowledge (Kuhlthau, 1997; Marchionini, 1995). It involves searching for, obtaining, and using information, but goes beyond this to include the process of new understandings and knowledge construction arising from the information (Marchionini; Vakkari, 1999). The term *information behavior* is a broader definition of information-seeking and includes both active and passive information behaviors. Information behaviors are also referred to as *information practices*.

All individuals possess what researchers term a personal information infrastructure: an interactive repertoire of knowledge, skills, and attitudes that people employ to seek and to use information (Marchionini, 1995). Individual personal information infrastructures are broadened by the variety and number of information experiences in which people participate. For example, the information-seeking knowledge and skills of persons who challenge themselves to use resources and meet with success in doing so often become stronger (Hargittai, 2003; Marchionini, 1989).

Directions for the Proposed Study

This article begins with a discussion of the concept of understanding a school and the people who comprise it through an information ecology framework. The following part is a consideration of how research can be undertaken to inform the development of local interventions in the information ecology. In particular, the suggested research project focuses on collecting data with the intent of examining and shaping a culture in the ecology that will foster advanced online information-seeking practices by its educators so that they may serve as models and mentors to the students. Broadly, the study of the ecology for these purposes would focus on two elements: (a) understanding the nature of the information ecology and its members; and (b) understanding the current information-seeking practices of the educators in the group.

If we consider library media specialists' and teachers' online information-seeking practices critical to the ecology's mission and success, how might a study be designed to capture data on existing information practices, gaps in practice, potential zones of intervention, and so forth? A study of this nature could explore if the online practices of educators influence knowledge construction and knowledge management, and in turn how this influences the information culture of the organization in fostering student learning.

For example, in an initial pilot project, the study participants could be narrowed to a group comprising a high school library media specialist and biology teachers in two secondary schools. They would be studied as a knowledge cohort with the real-life context of the school and the information ecology of which they are members. In a multimethod research approach, the study participants could be narrowed to a group comprising the school's library media specialist and biology teacher(s). They would be studied as a knowledge cohort in the real-life context of the school and the information ecology of which they are members.

Potential research questions include:
1. Can an understanding of a school as an information ecology help to foster advanced information-seeking practice by educators?
2. In what online information-seeking practices are educators engaged?
3. What are the perceived consequences of the information-seeking behaviors? For example, what influence do these individuals' information behaviors have on each other's teaching, their students' learning, and the school community at large?"

Theoretical Framework

Rogers (2003), the preeminent scholar in diffusion of innovations research, defines innovation as an idea, practice, or object that is perceived as new by an individual or other unit of adoption. Diffusion, according to Rogers, is the process in which "an innovation is communicated through certain channels over time among the members of a social system" (p. 5). He further defines diffusion as "a kind of social change, defined as the process by which alter-

ation occurs in the structure and function of a social system" (p. 6). He includes both the spontaneous and unplanned spread of new ideas. Four key factors influence the adoption of an innovation: (a) the innovation itself; (b) the communication channels used to spread information about the innovation; (c) time; and (d) the nature of the society into which it is introduced.

The Diffusion of Innovation theory has been used extensively to study the adoption and spread of technological innovations in schools (Becker, 2000; Becker, Ravitz, & Wong, 1999; Frank, Zhao, & Borman, 2004; Jebeile & Reeve, 2003; Lankes, 2003; Levin & Arafeh, 2002; Ravitz, 1998; Smerdon et al., 2000). Diffusion of Innovation theory is grounded in the human aspects of the diffusion process (Rogers, 2003). This makes it a particularly appropriate framework in which to consider the information ecology of a school with a primary focus on the people and their exchanges and interactions.

In this project, the online information-seeking behaviors of the biology teachers and library media specialists are treated as the innovation. Of particular interest are the influences and consequences of this innovation on the teaching and learning practices of educators. To study this aspect, the category of research with Diffusion of Innovation theory, consequences of the innovation, are used.

Consequences of Innovations

Consequences are the "changes that occur [in] an individual or social system as a result of the adoption or rejection of an innovation" (Rogers, 2003, p. 436). Although understanding the consequences of the innovation for individuals and the social system is considered valuable, it is nonetheless a relatively understudied area of diffusion research. Rogers noted that past diffusion research frequently "stopped with an analysis of the decision to adopt a new idea, ignoring how this choice is implemented and with what consequences" (p. 440). Rogers argued, however, that future investigations needed to also ask, "What are the effects of adopting innovations?" Here a central future question might be, "What are the effects of online information seeking practices by educators on their teaching activities that occur in the context of the information ecology?"

Rogers (2003) pointed out that it is not possible to predict the how and when of the consequences, although in the long term, "the unpredictability of an innovation's consequences … is one important type of uncertainty in the diffusion process" (p. 436). Not being able to predict the effect of an innovation does not mean that one should neglect the study of its effect. Rogers himself notes that this is a valuable but understudied area. Other researchers also call for research into the consequences of innovations, particularly technology, in education (e.g., Recker et al., 2004). Rogers developed a classification scheme for the study of consequences that he believes minimizes the inherent challenges associated with this particular focus.

Rogers (2003) outlines three dimensions of a classification scheme he devised to help in the study of the consequences of innovations: (a) desir-

able versus undesirable; (b) direct versus indirect; and (c) anticipated versus unanticipated. This taxonomy can inform survey design as well as the choice of independent variables and data analysis methods. Direct consequences are

> the changes to an individual or a social system that occur in immediate response to adoption of an innovation. Indirect consequences are the changes to an individual or a social system that occur as a result of the direct consequences of an innovation. These are the consequences of consequences. (p. 445-446)

Rogers summarizes that the *"effects of an innovation usually cannot be managed so as to separate the desirable from the undesirable consequences"* (p. 445, emphasis in original). He describes this ripple effect as a "web of interrelations among the elements of a culture" (p. 445). For example, in studying a school as an information ecology, the findings could show that a strong proficiency with online information-seeking skills (the innovation) may cause the educator to have access to more learning resources for the students (the direct effect), which may in turn prompt the educator to share the new resources with colleagues and foster collegiality (the indirect consequence).

Some of the consequences of the innovation can be anticipated: changes that are "recognized and intended by the members of a social system" (p. 338). On the other hand, unanticipated consequences are neither expected nor recognized by the members of the group. Every innovation results in a consequence that affects the overall system, including the teacher, the students, the classroom, and the school, hence an imperative to study the ecology and its parts rather than studying parts in isolation. By using this theoretical framework and particularly Rogers' consequence classification system, we can start to understand the influence of teachers' and library media specialists' online information seeking skills not only on their own practice, but also on the information ecology of which they are a part.

Methodology

A multimethod research approach using case studies, user behavior software testing and analysis, and surveys could be used in this initial pilot project and extended to a larger multi-site project in future research.

Case studies of two school sites will be conducted using established multi-case study methodology (Yin, 1994), including: (a) the use of multiple sources of evidence; (b) the creation of a case study database; and (c) the maintenance of a chain of evidence. The library media specialist(s) and biology teacher(s) at the site will comprise a study cohort and will be studied in the real-life context of the school and the information ecology of which they are members. If we view information ecologies as defined by Nardi and O'Day (1999) as a system of people, practices, values, and technologies in a particular local environment, case study research offers a strong methodological framework to use in the study of them. Yin (2003) outlines several possibilities where this method is appropriate and relevant to the study of ecologies including: "(a) to define research topics defined broadly

and not narrowly; (b) to cover contextual or complex multivariate conditions and not just isolated variables, and (c) to rely on multiple and not singular sources of evidence" (p. xi).

Interviews are a key means of data collection in case study methodology. A partly structured interview format could be used to prompt the library media specialist and the biology teacher(s) who form the cohort to elaborate on aspects of their information-seeking process and their perceptions of the influences on their teaching and on their local environment. Rogers' (2003) classification scheme for the study of consequences (desirable versus undesirable, direct versus indirect, anticipated versus unanticipated) could inform the creation of the questions. Interviews would be audiotaped, transcribed, and then coded and analyzed using qualitative research methodology.

Rogers' taxonomy for the analysis of the consequences of an innovation might be a useful tool for data analysis. In addition, analytic methods could include: creation of a matrix of categories; data displays; use of mean, variances, and cross tabulations; and so forth (Miles & Huberman, 1994). Both cross-case analysis and pattern-matching analysis could be employed.

An online survey will be used to capture the educators' perceptions of their online search skill level, what they do with the resources they find, and how they perceive them influencing their teaching and their colleagues. A survey offers a means to collect baseline information on this underexamined area of research. To further round out an understanding of the online information-seeking behaviors of the study participants, Morae usability software will be used to capture and analyze aspects of the participants' online search skills. Study participants will be asked to complete several search tasks using Internet browsers and specific educational digital libraries such as the National Science Digital Library (NSDL). The software will capture for analysis keywords, time on task, keystrokes, and so forth.

Discussion

Study Limitations
Although statistical generalization of findings in case study research is limited, case studies offer opportunities for analytical generalization (Yin, 2003), and studying two sites in this pilot project instead of one expands this opportunity. Future research could involve multi-case sites.

Another important consideration of the project's potential limitations is the fact that the researcher is measuring perceptions and asking educators to self-report rather than making observations. Use of the usability software to capture actual search behaviors somewhat mitigates this concern.

Considering Schools as Information Ecologies
This article outlines a research approach for a pilot project to examine the concept of schools as information ecologies and the dynamics of online information-seeking behaviors of educators in that ecology. The concept of

an information ecology is particularly applicable to a school environment, as made apparent in Nardi and O'Day's (1999) description of an ecology:

> Information ecologies are filled with people who learn and adapt and create. Even when tools remain fixed for a time the craft of using tools with expertise and creativity continues to evolve. The social and technical aspects of an environment coevolve. People's activities and tools adjust and are adjusted in relation to each other, always attempting and never quite achieving a perfect fit. This is part of the dynamic balance achieved in healthy ecologies—a balance found in motion, not stillness. (p. 53)

Building from findings in this exploratory project, future research directions might include examining the following.

- What are the information flows and exchanges in the ecology of a school? Can they be leveraged to foster knowledge-construction and support teaching and learning practices?
- Can local environmental changes and local interventions in the information ecology exert influence on and foster the advanced information-seeking practices of educators?
- Does an understanding of a school's information ecology uncover "zones of intervention"? For example, are there zones of intervention in collaborative relationships that can help school library media specialists and teachers work together to design and implement authentic inquiry-based learning environments?
- Can an understanding of educators' information-seeking practices inform the knowledge base of both teachers' and library media specialists' practices in order to inform professional development offerings and preservice education?

Change in an ecology, assert Nardi and O'Day (1999), is systemic, and "when one element is changed, effects can be felt throughout the whole system" (p. 2). In the information ecology of a school, a collaborative synergistic relationship between teachers and library media specialists encompasses a fluid interplay of information and knowledge-construction. Understandings gained through close examination of the dynamics of the ecology may support more meaningful and sustainable collaborations and help identify key zones for interventions and training in the area of advanced online information-seeking behaviors. In the long run, this may help to ensure successful diffusion of the innovation (online information-seeking behaviors) and in turn positively influence student learning.

By recognizing, studying, and leveraging on the power of ecologies, we potentially gain understandings to be used in shaping the information culture and knowledge-construction activities in a school. The study of information ecologies in schools offers the opportunity to uncover points of intersection for collaboration among library media specialists and teachers. In an information ecology, a library media specialist who has a distinct repertoire of skills, knowledge, and expertise about information-seeking and information literacy is a keystone species—a species whose presence can be vital in fostering and supporting key ecology activities.

In addition, findings that come from the study of interrelationships of the system, its exchanges, and its myriad social networks can also be used to inform preservice and graduate education, as well as professional development in elementary, middle, and secondary schools.

References

Becker, H. (2000). *Findings from the teaching, learning, and computing survey: Is Larry Cuban right?* Paper presented at the School Technology Leadership conference of the Council of Chief State School Officers, Washington, DC.

Becker, H., Ravitz, J., & Wong, Y. (1999). *Teacher and teacher-directed use of computers and software*. Irvine, CA: Center for Research on Information Technology and Organizations, University of California, Irvine.

Bilal, D. (1999). Web search engines for children: A comparative study and performance evaluation of Yahooligans! Ask Jeeves for Kids, and Super Snooper. *Proceedings of the 62nd ASIS annual meeting* (pp. 70-82), Washington, D.C., October 31-November 4, 1999.

Brown, J.S., & Duguid, P. (2000). *The social life of information*. Boston, MA: Harvard Business School Press.

Bruce, C. (2002). *Information literacy as a catalyst for educational change: A background paper.* White Paper prepared for UNESCO, the US National Commission on Libraries and Information Science, and the National Forum on Information Literacy, for use at the Information Literacy Meeting of Experts, Prague, Czech Republic. Retrieved March 4, 2004, from: http://www.nclis.gov/libinter/infolitconf&meet/papers/bruce-fullpaper.pdf.

Carr, J. (1998). *Information literacy and teacher education.* Syracuse, NY: ERIC Clearinghouse on Teaching and Teacher Education.

Case, D.O. (2003). *Looking for information: A survey of research on information seeking, needs, and behavior.* New York: Academic Press.

Chelton, M.K., & Cool, C. (2004). *Youth information-seeking behavior: Theories, models, and issues*. Lanham, NJ: Scarecrow Press.

Cool, C. (2004). Information-seeking behaviors of children using electronic information services during the early years: 1980-1990. In M.K. Chelton & C. Cool (Eds.), *Youth information-seeking behavior: Theories, models, and issues* (pp. 1-35). Lanham, NJ: Scarecrow Press.

Doyle, C.S. (1994). *Information literacy in an Information Society: A concept for the information age.* Syracuse, NY: ERIC Clearinghouse on Information and Technology.

Fallows, D. (2005). Search engine users. Pew Internet and American Life Project. Retrieved February 12, 2005, from: www.pewinternet.org/PPF/r/146/report_display.asp.

Fitzgerald, M., Lovin, V., & Maribe Branch, R. (2003). The gateway to educational materials: An evaluation of an online resource for teachers and an exploration of user behavior. *Journal of Technology and Teacher Education, 11*(1), 21-51.

Frank, K., Zhao, Y., & Borman, K. (2004). Social capital and the diffusion of innovations within organizations: The case of computer technology in schools. *Sociology of Education, 77*, 148-171.

Hargittai, E. (2002). Second-level digital divide: Difference in people's online skills. *First Monday, 7*(4), 1-20.

Hargittai, E. (2003). The digital divide and what to do about it. In D. Jones (Ed.), *New economy handbook.* San Diego, CA: Academic Press.

Jebeile, S., & Reeve, R. (2003). The diffusion of E-learning innovations in an Australian secondary college: Strategies and tactics for educational leaders. *Innovation Journal, 8*(4), 1-21.

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

Kuhlthau, C.C. (1997). Learning in digital libraries: An information search process approach. *Library Trends, 45*(4), 708-724.

Lankes, R. (2003). Current state of digital reference in primary and secondary education. *D-Lib, 9*(2), 1-21.

Levin, D., & Arafeh, S. (2002). *The digital disconnect: The widening gap between Internet-savvy students and their schools*. Pew Internet and American Life Project. Retrieved March 4, 2004, from: http://www.pewinternet.org/pdfs/PIP_Schools_Internet_Report.pdf

Marchionini, G. (1995). *Information seeking in electronic environments.* Cambridge, UK: Cambridge University Press.

Marchionini, G. (1989). Information-seeking strategies of novices using a full-text electronic encyclopedia. *Journal of the American Society for Information Science, 40*(1), 54-66.

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

Nardi, B.A., & O'Day, V.L. (1999). *Information ecologies: Using technology with heart.* Cambridge, MA: MIT Press.

Neuman, D. (1995). High school students' use of databases: Results of a national Delphi. *Journal of the American Society for Information Science, 46*(4), 284-298.

Perrault, A.M. (2005). *Online information seeking practices of biology teachers and the perceived influences on instructional planning.* Unpublished doctoral dissertation, University of Rochester.

Perrault, A.M. (2007). An exploratory study of biology teachers' online information seeking practices. *School Library Media Research, 10*. Retrieved December 19, from: http://www.ala.org/ala/aasl/aaslpubsandjournals/slmrb/slmrcontents/volume10/biology.cfm

Ravitz, J. (1998, February). *Conditions that facilitate teachers' Internet use in schools with high connectivity: Preliminary findings.* Paper presented at the national convention of the Association for Educational Communications and Technology (AECT), St. Louis.

Recker, M., Dorward, J., & Nelson, L.M. (2004). Discovery and use of online learning resources: Case study findings. *Educational Technology and Society, 7*(2), 93-104.

Roberts, D., & Foehr, U. (2002). *Literacies at the end of the twentieth century.* Report for the Pacific Bell/UCLA Initiative. Retrieved August 10, 2004 from: http://www.newliteracies.gseis.ucla.edu/publications/index.html.

Rogers, E. (2003). *Diffusion of innovations*. New York: Free Press.

Smerdon, B., Cronen, S., Lanahan, L., Anderson, J., Iannotti, N., & Angeles, J. (2000). *Teachers' tools for the 21st century: A report on teachers' use of technology.* Washington, DC: National Center for Education Statistics.

Vakkari, P. (1999). Task complexity, problem structure and information actions. *Information Processing and Management, 35*(6), 819-837.

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

Yin, R.K. (2003). *Applications of case study research* (2nd ed.). Thousand Oaks, CA: Sage.

Author Note

Anne Marie Perrault is an assistant professor in the School of Library and Information Studies at the University of South Carolina. Her current research focuses on the information-seeking behaviors of educators and information literacy, and she is Co-Director with Marcia Mardis of Wayne State University, of the User Behavior and Assessment Lab. She previously worked for more than 10 years as a library media specialist and a district administrator.