Teaching and Learning in Digital Environments: The Resurgence of Resource-Based Learning

☐ Janette R. Hill
Michael J. Hannafin

The digital age has not simply changed the nature of resources and information; it has transformed several basic social and economic enterprises. Contemporary society—the settings where we live, work, and learn—has likewise changed dramatically. Both the amount of information and access to it have grown exponentially; a significant potential for using varied resources in numerous ways for instruction and learning has emerged. However, several issues related to the educational uses of varied resources (e.g., people, place, things, ideas) must be addressed if we are successfully to implement resource-based learning environments. In this paper, we trace the changing nature of resources and perspectives in their use for learning in the digital age, describe the overarching structures of resource-based learning environments, and identify key challenges to be addressed.

☐ During recent years, the role of educational resources has undergone a metamorphosis. The changes have not only transformed media, they have distributed production of and access to digital resources while altering fundamentally how, when, and for what purposes resources are created and used. The metamorphosis has been propelled by the exponential growth of information systems such as the Internet and the World Wide Web (the Web), and the ubiquitous presence of enabling technologies in classrooms, libraries, homes, businesses, and communities.

The digital age has both changed the nature of resources and information and transformed basic social and economic enterprises (Galbreath, 1997). Both the amount of information and access to it have grown exponentially:

> To get a glimmer of the impact of this growth, imagine that the total amount of information available in the world today is represented by a line 1 centimeter in length. By the time today's first-graders enter 12th grade, that line will be 64 centimeters long. (Thornburg, p. A 15, 1998)

Alvin Toffler (1993), a prominent technology futurist, predicted that individuals would have more information at their desktop than was available during an entire lifetime at the turn of the 20th century; this prediction may prove conservative.

The educational implications may prove more daunting. Technology capabilities hold considerable promise for teaching and learning, but current practices may prove insufficient in optimizing available resources and preparing individuals to learn in resource-rich environments. Schools and classrooms need to become resource intensive (Reigeluth, 1988), where digi-

ETR&D, Vol. 49, No. 3, 2001, pp. 37–52 ISSN 1042–1629

tal resources can be readily generated and accessed per specific goals of teachers or students.

The potential of resource-based learning environments (RBLEs) for instruction and learning is considerable. Whereas conventional instructional approaches address known learning goals using well-organized sequences, resources, and activities, methods for supporting context-specific, user-centered learning have been slow to develop. Increasingly, individuals evaluate vast numbers of digital resources located in expanding information repositories. Although tools and search engines that are provided typically (and in most cases only generally) help to locate potential resources, they do not help an individual to determine their meaning or relevance. Individuals must recognize and clarify learning needs, plan a strategy to address these needs, locate and access resources, evaluate their veracity and utility, modify approaches based on an assessment of learning progress, and otherwise manage their teaching or learning.

Digital information systems such as the Web continue to influence both the availability and use of resources (Quinlan, 1997). RBLEs enable teachers and learners to take advantage of these systems, expanding the resources they use to enhance the teaching and learning process. The purposes of this paper are to trace the changing nature of resources and perspectives on their use in the digital age, to describe the overarching structures of an approach to support diverse teaching-learning needs, and to identify key challenges to be addressed.

EVOLUTION OF RESOURCES FOR TEACHING AND LEARNING

Resources are media, people, places or ideas that have the *potential* to support learning. Resources are information assets—data points organized by an individual or individuals to convey a message (Allee, 1997). For learning, resources must be contextualized to determine situational relevance and meaning. Resources also need to be recontextualized to enable the use of information gleaned from various resources. Once contextual meaning has been established, information becomes organized as knowledge (Dewey, 1933), operating in a larger context of meaning encompassing relevant patterns, biases, and interpretations.

> I admire a painting and learn the name of the artist (a piece of *Data*). Later, I learn that the artist is one of a number who painted in a particular style, let's say I learn the artist is one of several French Impressionists (now I have some *Information*). I decide I like this style of painting and begin to learn about other French Impressionists, and some of the particulars about their lives and work (I now have *Knowledge* of French Impressionists). Then, I begin to learn about the period in which they worked and how they were making particular kinds of political and artistic statements, particularly relevant to their times and culture (I am exploring the *Meaning* of their art) . . . . (Allee, 1997, p. 63)

Resource-based learning involves the reuse of available assets to support varied learning needs (Beswick, 1990). While the concept of resource-based learning is not new, predigital environments have been constrained by how resources were created and distributed. Existing resources may be consistent with the needs and goals of designers, teachers, and learners, and can be used largely intact; in many instances, however, this is not the case. Individuals must find and adapt resources to meet learning needs unlike those for which it was initially created.

Predigital perspectives

Predigital educational resources conveyed meaning consistent with and supportive of established goals and standards. In addition to the boundaries defined by their initial design, predigital resources were constrained by their static nature. Pieces of a resource might be used, such as a particular chapter or video segment, but it proved difficult to use them to address different needs. Often, the resource was used intact, or not at all, because of its static nature.

While prevailing instructional materials often combined visual cues (words, pictures, etc) and aural cues (speech, sound, music, etc.), most were consolidated into a single medium such as text, video, or audio. For instance, most computer-based instruction features multiple symbol systems and media as a single learning resource. Access to and manipulation of individual components, such as text or video segments, have proven challenging (Ward & Tiessen, 1997). Thus, resources embedded within given instructional media have been used where and how they existed. They focused primarily on the purposes for which they were initially intended and provided little utility beyond those purposes.

Goals and objectives recognized by administration were typically created or chosen by a designer, teacher, or other external agent. Accountability was likewise external: teachers used resources incrementally and linearly to "convey" specific content; learners attempted to "acquire" specified knowledge or skills (Hannafin, Hill, & Land, 1997). Freire (1993) refers to this as a "banking" model, where the "educator's role is to regulate the way the world 'enter[s] into' the students" (p. 57).

Resources present information in ways that reflect given cultural perspectives and interpretations. History resources, such as textbooks, videotapes, and CD-ROMs, reflect the prevailing beliefs of the culture in which they were created. Wars, racial conflict, famine, and everyday events are captured in ways that formalize yet mask the biases inherent in them (Segall & Wilson, 1998).

Many ancillary educational materials were considered nonessential "add-ons" rather than integral learning resources (Doiron & Davies, 1998). Textbooks, for example, were adopted based on their congruence with established curriculum objectives (Breivik, 1996), tending to reinforce desired learning outcomes but limiting the availability of resources to pursue related interests or examine concepts from different perspectives. The emphasis on resources keyed to external standards has limited both the availability and use of resources that might support context-specific or individual learning needs. While some teacher educators have advocated curriculum approaches focusing on the use of multiple resources (see, for example, Beswick, 1990), this view is not widely reflected.

The typical physical location of a resource also presented significant challenges (Ray, 1995). Resources were generally distributed across different sites, such as libraries, classrooms, and county courthouses. In large measure, this situation evolved in response to pragmatic concerns (e.g., cost of duplication) and assumptions related to resource use (e.g., historical documents housed in county archives). However, wide-spread distribution without the benefit of a comprehensive retrieval system has complicated the locating and using of such resources for learning.

Packaging has also complicated resource use. For example, a videotape on famous composers might be created to address 7th grade music objectives. While some of the goals and objectives of the video may align with another subject area (e.g., history or language arts) or grade level (e.g., 4th or 12th grade), the packaging often limits both access to and use of its contents. That is, the constraints of the technology, both pedagogical techniques and the physical tape, make it difficult to use resource contents in other learning contexts.

The dominant educational perspective in the predigital age reflected an industrial model of production; indeed, this perspective continues to dominate many contemporary classrooms (Reigeluth & Squire, 1998). Accordingly, learning has been managed in controlled environments, with information divided into specific topics. Students demonstrate what they have learned from textbooks or teachers by passing tests and meeting performance criteria. In an effort to address external standards, teachers focus not only on what they present but how they present (Segall & Wilson, 1998). With some exceptions, such as when learners are preparing reports or writing papers and varied resources are used, resource use has been typically highly directed, focused, and, quite often, limited in scope.

A final challenge relates to how information was conveyed in predigital resources. Ideas were largely fixed and represented in a static fashion, providing neither links to additional resources nor capabilities to manipulate information. In the digital era, the duplication of identical or similar resources addressing the same concepts for different subjects or grade levels may no longer be feasible (Galbreath, 1997; Thornburg, 1998).

Emerging perspectives

The nature of a resource has now changed. Significant developments in knowledge-object technology, and the creation of standards for cataloging and classifying digital media (e.g., metadata), have transformed the very nature of resources. While there are certainly new challenges that arise with digital resources (e.g., lack of standardization; Web sites and addresses that change or disappear without notice), the opportunities afforded by these resources are considerable. As such, many are working toward making reliable and consistent access a reality. The Instructional Management System project (IMS) (http://www.imsproject.com/) is a joint academic-industry–government initiative begun in 1997 to standardize the technical specifications for management tools and educational content supporting distributed learning. This initiative holds significant promise for extending the utility of available Internet resources. IMS specifications and software are made publicly available at no cost to facilitate the exchange and usability of digital media. Using such standards, metadata are generated for individual media, which universally signify the nature of their contents and make explicit their attributes for other potential uses (Hannafin, Hill & McCarthy, in press).

While media may exist in a single package, the resources they contain are not inherently static. Digital resources can be as dynamic and malleable as their creators allow. Multiple resources may be aggregated within a single application, but can be reused in theoretically unlimited combinations by accessing their associated metadata. Metadata, typically a collection of object attribute tags in Web-based documents (Lemay & Tyler, 2000) or catalog records in print-based resources, provide data about a document to enable retrieval according to author, creation date, content, and the like. Digital video technologies such as QuickTime® make it possible to select and manipulate elements, such as segments within a scene or a single video frame, of a more inclusive video resource. Compilations of varied but related resources, such as text, video, audio, and graphics related to common learning themes, can be simultaneously gathered across multiple repositories. They can be combined to form new resources or examined from multiple perspectives as learners think critically and evaluate information (Fitzgerald, 1998; Kuhlthau, 1996; Ward & Tiessen, 1997).

Another aspect that differentiates digital from analog resources is the ability to isolate various components to meet specific needs within a particular context. While analog resources may contain metadata via library classifications and catalog indexes, this information assists librarians with resource administration, but rarely teaching or learning. Metadata are designed to assist everyday users with locating specific instances (e.g., a quote from Rosa Parks the day after her arrest, or a particular JPEG image) in a given resource or across multiple resources. Resources, in effect, become objects to think with and through as well as the vehicles for representing domain content; tagging a resource permits the most granular of attributes to be coded as metadata to extend dramatically its utility (Hannafin, Hill, & McCarthy, in press).

A resource does not simply "tell" in a singular or specific sense but provides candidate information to be engaged and interpreted. Meaning is influenced more by the diversity than the singularity of the perspectives taken. Multiple resources are accessed and interpreted for meaning, evaluated for veracity and utility, compared with competing perspectives, and acted upon. Peer, teacher, and expert resources continue to support the learning process, but their role is redefined. Teachers may direct students to view a particular segment of a video or to read a specific passage from a book, and then to write an essay addressing issues related to what they viewed and read. Teachers may also act as facilitators, guiding the process and assisting the learner in clarifying the kinds of information to be considered and in locating potentially useful learning resources (Belenky, Clinchy, Goldberger, & Tarule, 1997; Beswick, 1990; Freire, 1993).

The same resource may support vastly different learning needs. Resources created initially for a given purpose may be used in ways that seem to be inconsistent with subsequent uses. For example, personal letters sent to family members, as well as photographic images of the Civil War South, were enhanced using first-person narration and integrated into Ken Burns's award-winning Public Broadcasting System (PBS) television series, *Civil War*. The primary data resources were transformed in both medium and in meaning.

Intact resources (i.e., a single resource such as a book, videotape, etc.) are now viewed as a collection of knowledge objects rather than single entities. A biographical text on the life and accomplishments of Wolfgang Amadeus Mozart, as a text, is a single resource that contains numerous knowledge objects. Under differing circumstances, a learner may access a specific data point (e.g., Mozart's date of birth) or a semester-long course (e.g., Music History) to develop understanding, or access other resources that exist independently or as elements of comprehensive resources (e.g., encyclopedias, anthologies). The same set of resources may also be used to examine Mozart's influence on his contemporaries such as Salieri as a case study in the turbulent life of a child prodigy, or to compare the darkness of Mozartian funerial music with soothing, contemporary processional melodies.

The boundaries separating individuals from potential resources have diminished. Emerging systems enable educators and learners to access, evaluate, use and generate digital resources (Shotsberger, 1996; Sloane, 1997). The Web, for example, affords access to a wide array of multimedia resources across countless topics. Independent of time or location, individuals can retrieve, evaluate, and determine how (or if) to use information (Hill, 1999a).

Contemporary systems now provide ready access to historic, current, and dynamically changing information (Maddux & Johnson, 1997) where prior production and distribution cycles required extended lapses between the occurrence of an event and its published availability. We can now collect in a matter of seconds what formerly took weeks, months, or even years to amass (Tenopir & Lunin, 1998). Through digitization and distribution, resources can also be made available at various stages during their development. Teachers and learners seeking up-to-date information no longer need wait for finished products.

While resources represent information, the context of their deployment influences meaning. In resource-based learning, transactions between learners and resources are brokered by facilitating access to and interpretation of resources. Meaning can be explicitly guided where specific understandings are required, or uniquely constructed where individual meaning is valued (Ling, 1997). In highly engineered approaches, the learner may be directed to resources in which particular knowledge, beliefs, or skills are explicitly contained. In generative approaches, learning may be guided according to individual needs and purposes.

In each of the above, the same resources can be perceived differently by individuals to generate different understandings. While this can be accomplished to some extent with analog resources, digital resources both extend and enhance this process. The meaning of a resource is established within the context of its use (Chandler, 1999). To varying degrees, the teacher's efforts to teach and individual's efforts to learn are buttressed by activities that guide understanding. The "native" resources are accessed and assembled, but their meaning is transformed to accommodate different needs and learning goals.

TOWARD RESOURCE-BASED TEACHING AND LEARNING

Educators report pressure to guide and facilitate learning, creating a learning-centered environment using an integrated curriculum (see Boettcher, 1998; Cavalier, 1998; Fraser, 1998; Segall & Wilson, 1998). School reform proponents (e.g., Reigeluth, 1988), teacher educators (Beswick, 1990), and media specialists (e.g., Doiron & Davies, 1998) have advocated a shift to more flexible resource-based approaches that emphasize problem solving and critical thinking. Given the increased access to resources, and the flexibility in how these resources can be manipulated and used, the time seems ripe for a move to a more resource-based approach. In the remainder of this paper, we describe the characteristics and components of, as well as the challenges and opportunities associated with RBLEs.

AN RBLE PRIMER

RBLEs support the individual's effort to locate, analyze, interpret and otherwise adapt information to meet particular learning needs. RBLEs utilize resources by establishing interpretive contexts in concert with supporting tools and scaffolds. They exploit the potential of resources independent of specific hardware, software or epistemology. RBLE principles transcend particularized teaching-learning frames, provide varied tools for the learner, and offer support mechanisms to assist learners with their tasks.

RBLEs can be found across diverse systems and perspectives (see, for example, Bruce et al., 1997; Dennick & Exley, 1997; Hara, 1997; Hill, 1999b; Linn, 1995; Miller, 1995; Noesen, 1997; Quinlan, 1997; Ward & Tiessen, 1997; Yan, Torjman, & Clipsham, 1998). Diverse environments share common features: they are resource intensive; they emphasize intentional learning; and they engage the learner actively in the cognitive management processes of compilation, evaluation, manipulation and generation (Berryman, 1991; Cull, 1991). Intentional learning results from the learner's purposeful, effortful, self-regulated, and active engagement in the learning process (Palincsar & Klenk, 1992); learning is the principal goal rather than an incidental or accidental outcome (Bereiter & Scardamalia, 1989).

Resource-based learning does not imply either a particular form of learning or a specific learning process (Ling, 1997). RBLEs, as a design methodology, are pedagogically neutral. They can be implemented along a teaching-learning continuum ranging from directed (see, e.g., Doiron & Davies, 1998; Haycock, 1991) to open-ended (see, e.g., Breivik, 1996, 1998). However, RBLEs provide a foundation for design practices by aligning activities with the associated tenets and assumptions of the epistemological orientation they support (Hannafin, Hannafin, Land & Oliver, 1997; Hannafin, Hill, & Glazer, in press; Land & Hannafin, 2000).

Components of RBLEs

RBLEs are complex environments comprising multiple components: resources, contexts, tools, and scaffolds. The features of specific RBLEs change depending on how components are combined to address unique situational requirements.

Resources

Resources, static and dynamic, include the core information represented in RBLEs, ranging in format from electronic to print, and nonprint to human.

Static. Static resources, including print-based textbooks as well as encyclopedias magazine and newspaper articles, have stable contents. The information in these sources is captured at a particular moment in time. While useful for standardizing information, the data presented in static resources can quickly become obsolete or inaccurate, particularly in rapidly changing fields. Lengthy publication cycles complicate RBLE use of static resources, especially when seeking current information. On the other hand, the change of perspective across varied depictions of the same content can provide important and useful information.

Dynamic. Dynamic resources undergo frequent, sometimes continual, change. Many Web-based resources, for example, are updated continuously (e.g., temperature databases at the National Weather Service), several times a day (e.g., *New York Times*), or daily (e.g., *Newsweek, Time*). Some Web resources undergo cyclical or event-based change, such as the NASA Web site during phases of a shuttle flight.

Humans are also dynamic resources. The human resource may be an expert in a particular subject area or simply another learner. As the expert or peer continues to develop and enhance her or his understanding, her or his knowledge also evolves. This continual growth of understanding and knowledge frequently alters the nature of the information available when the expert or peer is consulted—making humans a resource that can be tapped on a regular basis for new information (Belenky et al., 1997).

Contexts

Contexts are the settings, real and virtual, in which learners develop understanding. Context plays a critical role in how affordances become operational by designers, and representations are developed by the teacher, the learner, or both. Contexts, characterized by situations and goals, can be externally directed, learner generated, or negotiated.

Externally directed. In externally directed contexts, an external agent (e.g., teacher, instructional designer) typically establishes the venue (real or virtual), meters the pace and sequence of resource use, facilitates the interactions and related learning activities, and establishes goals for the learner to achieve. The Great American History Machine (GAHM) (Miller, 1995), for instance, teaches learners to think like historians by creating a setting rich with information and problems similar to those that historians work to solve. To facilitate this transformation, GAHM incorporates varied resources, focuses on higher-order learning, and facilitates the generation of unique products. According to Miller, varied resources help learners to develop the fundamental skills of a historian, such as pattern identification in large bodies of data. GAHM is used in conjunction with other resources including census data, lectures, and published monographs to help learners develop both understanding of historical events and the analytic and interpretive skills of historians who document or challenge the veracity of historical events.

Learner generated. In learner-generated contexts, the individual defines goals based on unique needs, which in turn influence decisions related to where to seek resources, what is needed, and why it might be useful. Guidance may be sought from an external resource, but assistance is provided at the learner's request rather than being assumed necessary. Allee's (1997) art example begins with a piece of data: learning the name of the artist whose painting she admires. The need evolves until she questions how particular art connects within its historic culture (sense making). At any point, learners may determine that resources are needed to further their quest.

Negotiated. Negotiated contexts combine elements from externally directed and learner-generated settings, creating a partnership in the learning process. As with externally directed RBLEs, a context is established to meet predefined goals. Interpretation of the context is important, however, because this process assists the learner to establish individual meaning, define subproblems, and select and implement strategies. In determining which resources are best suited to the problem or need, the participants negotiate the relative value of the resources, generate additional questions to pursue, and consider alternative approaches.

Tools

Tools aid in locating, accessing, and manipulating resources, and in interpreting and evaluating their usefulness. Tools enable learners to organize and present their understanding in concrete ways (Jonassen & Reeves, 1996). Table 1 lists four types of RBLE tools: searching, processing, manipulating, and communicating.

Searching tools. Searching tools range from people, such as reference librarians or media specialists, to sophisticated search services that provide specialized search capabilities, to card catalogs providing author, title, and subject searching. Library catalogs, such as GIL (Georgia Integrated Libraries, http://www.gil.org), make it possible for teachers and learners to access local resources and to search for resources at libraries across the state of Georgia. Web search engines, such as Yahoo®, Google®, and AltaVista®, offer the learner links to a broad range of resources, enabling access to primary and secondary sources in a variety of formats. Sophisticated search tools continue to emerge that enable users to locate resources on local networks as well as the Web from a single interface.

Processing tools. Processing tools provide cognitive support to aid in collecting, organizing, integrating and generating information. For example, the copy-paste function in productivity tools (e.g., word processors, databases, Web browsers) allows the learner to capture information that can be stored and retrieved for subsequent use. As organizers, tools such as Spider® (Boland, Tenkasi, & Te'eni,1994) enable the user to represent conceptual understanding and to link together varied resources such as spreadsheets, cognitive maps, and graphs to clarify assumptions about relationships among documents. Using tools ranging from word processors to storyboarding to graphics programs, individuals can construct and revise representations of their knowledge and understanding.

Manipulating tools. Manipulation tools provide the means to test beliefs, ideas, and theories. Spreadsheets, for example, are exceptionally powerful tools used to test beliefs and theories (see, for example, Grabe & Grabe, 1998; Jonassen & Reeves, 1996, for an overview of spreadsheets as tools). ErgoMotion® allows learners to manipulate complex concepts directly, without complex computational demands, as they develop, test, and refine their personal theories (Land & Hannafin, 1997). Manipulating the features of a roller coaster, learners explore relationships among motion, force, speed, energy, and mass, engaging in "what-if" thinking as they analyze problems, and then propose and test potential solutions. Other tools such as MediaText (Hay, Guzdial, Jackson, Boyle, & Soloway, 1994) and MediaMatrix (Ray, 1995) simplify the generation of multimedia by enabling users to manipulate system features to meet specific needs.

Communicating tools. Communication tools enable the sharing of ideas in a variety of forms: text, audio, and video. By using asynchronous communication tools such as e-mail, listservs, threaded discussions, and bulletin boards, participants can readily exchange ideas independent of time and place (see, for example, Dehoney & Reeves, 1999; Francis, 1997; Gamas & Nordquist, 1997; Laffey, Tupper, Musser, & Wedman, 1998; Witmer, 1998). Communication tools such as videoconferencing afford opportu-

Table 1 ☐ RBLE tools and examples

Tools	*Functions*	*Examples*
Searching	Enable location of resources.	• Web-based tools (e.g., Yahoo, Altavista) enable location of digital resources. • More traditional tools (e.g., ERIC, PsychLit) enable the location of print-based resources.
Processing	Provide cognitive support.	• Copy/paste functions in productivity tools allow the learner to collect various pieces of information from varied resources. • Brainstorming or diagramming enables the learner to organize the information in ways that enable them to identify gaps. • Mental model representation tools can assist learners with making connections between and across areas. • Templates and programming applications allow learners to generate unique representations of their knowledge.
Manipulating	Testing beliefs/theories.	• Using spreadsheet to answer "how heavy would you be on the moon?" • Changing parameters (e.g., population explosion) in programs like SimCity to see how it would affect the long-term viability of the city infrastructure.
Communicating	Mechanisms for exchanging ideas.	• Using asynchronous communication tools (e.g., e-mail, listservs, bulletin boards) to enable the exchange of reflective ideas when convenient for the learner. • Using synchronous communication tools (e.g., videoconferencing, Web chat) when immediate answers are needed or when brainstorming ideas might be useful.

nities for exchanging ideas synchronously across geographic boundaries (Moore & Kearsley, 1995). Web-based communication tools such as chat rooms and CU-See Me® have further extended synchronous communication alternatives. Communication tools can also enhance interactions in face-to-face as well as distance classes, creating additional opportunities for community building (Palloff & Pratt, 1999; Parson, 1997; Weedman, 1999).

Scaffolds

Table 2 summarizes key RBLE scaffolding components: conceptual, metacognitive, procedural, and strategic.

Conceptual scaffolds. Conceptual scaffolds assist the learner in deciding what to consider or to prioritize what is important(Anderson-Inman & Zeitz, 1993). They may come in the form of outlines provided to guide information presentation and facilitate connection making among themes. Conceptual scaffolds can also be learner generated, such as a cognitive map showing relationships among various concepts. Scaffolds may simplify complex concepts, enabling the allocation of limited cognitive resources to other tasks (Rescher, 1989). Mapping tools such as Inspiration® can be used to represent and share emerging hierarchical relationships or conceptual connections between participants.

Metacognitive scaffolds. Metacognitive supports help learners assess what they know and what to do as they learn. Such supports may be as simple as a reminder to reflect on the goal or problem, or to consider alternative ways to address a goal or problem (Hill, 1999b). Metacognitive supports can also be more sophisticated, helping learners organize their knowledge. Linn's (1995) knowledge integration environment (KIE) scaffolds scientific inquiry, assisting learners in reflection and decision making and identifying where knowledge is well developed or deficient. Metacognitive scaffolds reduce cognitive load so learners can engage in more complex processes such as critical thinking and reflection (Chang & Rice, 1993).

Procedural scaffolds. Procedural scaffolds help learners use resources. Procedural scaffolds both clarify requirements and reduce cognitive load, permitting participants to focus on the task

Table 2 ☐ RBLE scaffolding mechanisms

Scaffolding Mechanism		*FunctionExamples*
Conceptual	Mechanism designed to assist with defining things to consider.	• Creating an outline of a paper before you start to write or examining a map of a location to determine best ways to reach your destination (either in a paper or a physical place).
Metacognitive	Assist with establishing what is known and how to think.	• Providing learners with structured "reflection reminders," which may come in the form of daily journal entries. • Enabling scaffolded inquiry so that as learners are engaging the process, they are assisted in ways that make the most sense for them.
Procedural	Assist with how to use a resource.	• Providing and encouraging the use of help functions in productivity tools to assist the learner with trouble-shooting and problem-solving. • Creating Web site maps so the learner can get a sense of the scope of the site, as well as indicators of how varied elements in the site are linked together.
Strategic	Alternative ways to do a task.	• Arranging for an expert consultant to demonstrate how to perform a task so learners can observe and ask questions while learning a new technique. • Creating "question pools" where learners can pose questions for others to provide responses, enabling multiple perspectives on a problem.

rather than to invest cognitive resources in the mechanics of procedures and navigation. The help system in Microsoft Word®, for example, allows the learner to search for context-sensitive information on a particular function and link to related areas, and provides "office assistants" that identify the steps required to execute program features. Navigational maps found on many Web pages also scaffold procedures. Site maps, ranging from simplistic textual organizational charts to complex graphical representations, guide the use of a particular site or resource (Grabe & Grabe, 1998).

Strategic scaffolds. Strategic scaffolds provide alternative approaches to engaging a task. They may come from an expert, such as a reference librarian, who suggests different keywords, search tools, or search limits. Strategic supports may also be embedded within a specific context. DOROTHIE, a Web-based electronic performance support system developed for NASA researchers to design instruction for astronauts, contains a strategic scaffold to assist designers in the creation of instruction. The WHAT DO I DO NEXT? function provides the user with additional suggestions on how to proceed or other perspectives to consider in performing a task (Hill & Cole, 1997).

CHALLENGES, OPPORTUNITIES, AND IMPLICATIONS

Increased resource availability and access are necessary but insufficient conditions to promote effective teaching or learning. In this section, we underscore several challenges and opportunities associated with the transition to resource-based teaching and learning.

Standards and conventions for creating and distributing digital resources remain inconsistent. While standards (e.g., IMS, Extensible Mark-up Language, Resource Reservation Protocol) and tools for sharing resources continue to emerge (Galbreath, 1997), the conventions are not currently systematically applied or adhered to. The software used to distribute the resources is frequently changed, creating a need to continually evaluate and revise information. We need flexible mechanisms to retrieve and use resources, while also encouraging continued advances in the technology.

The explosion of information also presents challenges. Maintaining pace with the growth of information has become impractical in many areas and impossible in others. To speed access, attempts have been made to change distribution mechanisms. Electronic journals are one example. Several publishers have made their publications accessible via the Web at no cost or for a nominal fee (e.g., the *Journal for the American Society for Information Science, New York Times*). However, electronic publications have not been widely accepted or acknowledged (Kling, Rosenbaum, & Hert, 1998). This has been especially true in the academic community where print journals continue to dominate even in technical, computer, and information-intensive fields. The current infrastructure and attitudes regarding electronic publishing restrict our ability to repackage information in ways needed to assist the individual teacher and learner.

The role and design of enabling contexts have not been well established. Context plays an important role in the implementation of any learning event (Shambaugh & Magliaro, 1997). Context becomes especially critical when implementing an RBLE, in terms of both the specific space in which the learning will occur and the larger system in which the RBLE is implemented. RBLEs need to work in the different settings where learning takes place, accounting for when it will occur and who will be involved. Settings in which "live" support is unlikely, for example, can require significant electronic scaffolding of both procedural and conceptual aspects of the learning task. Likewise, the enabling contexts must account for important learner differences if the framing is to be useful.

Resource credibility, content validity, and reliability are unregulated. The integrity of digitized resources is often questioned, particularly those on the largely unregulated Web. While open availability is an asset in enabling anyone to share anything, anytime, and from anyplace, it can also be a formidable liability. This liability extends to both the availability and the integrity of the resource. It is not unusual, for example, for entire Web sites to be altered, removed, or moved to another address, rendering access to their resources unreliable. For RBLE purposes, we also need to know the trustworthiness of source material. Some have proposed greater regulation and control of Web resources through sites and services that screen resources and endorse their validity; others have emphasized the honing of critical thinking skills (Kuhlthau, 1996), cultivating information literacy skills (ALA & AECT, 1998), and enhancing source evaluation techniques (Fitzgerald, 1998). Given the reliance on multiple resources in RBLEs, we need both to increase confidence in the resources used for educational purposes and to promote critical thinking and evaluation skills among teachers and learners who engage resources of all kinds.

Directed approaches tend to engender compliance and reliance over independent thinking. One unintended by-product of highly directed approaches is what McCaslin and Good (1992) termed *compliant cognition:* the tendency for students to simply comply with the standards and expectations of those who establish and implement instruction. Established teaching and learning strategies tend to work best when meeting prescribed goals, but are often ineffective where critical thinking and self-regulation are desired or needed. Students schooled using didactic, direct instruction methods can become compliant in their approach, expecting explicit guidance and support as to what should be studied, what kind of learning is required, and when something has been learned sufficiently. Indeed, they become successful due to their attention to external cues (cf. McCaslin & Good, 1992). RBLEs, in contrast, require greater learner autonomy, analysis, and decision-making—skills not honed via typical approaches (Land & Hannafin, 2000). Learners often express discomfort when the environment is not prescribed, especially when studying ill-defined domains in open learning environments. RBLEs need to provide more than access to resources. We need grounded approaches that support the intentions and needs of those who access resources for individual learning purposes (Hannafin, Hill, & Glazer, in press; Hannafin & Land, 2000).

Students lack sufficient metacognitive awareness and comprehension monitoring skill to make effective choices. Selecting and evaluating resources as well as scaffolding the learning process are not trivial tasks for designers, teachers, or learners. Information systems are increasingly user centered, requiring context-driven and individualized learning skills that are not well cultivated in our current educational system. Considerable evidence suggests that individuals frequently fail to identify accurately their learning needs, locate relevant resources, evaluate the utility of such resources, and evolve their strategies and understanding accordingly (see, e.g., Hill & Hannafin, 1997; Land & Hannafin, 1996). Yet these are precisely the skills needed to successfully engage many resource-based approaches, and for which prevailing approaches prove largely inadequate. Research is needed to establish the impact of metacognition limitations on learning and to define the scaffolding needed to overcome these limitations.

Contemporary school accountability standards typically emphasize breadth over depth, while open-learning RBLEs emphasize depth over breadth. Teachers frequently confront the need to cover all content in a given subject area or grade level. This phenomenon has two primary driving forces: (a) state- or locally defined curriculum goals; and (b) the scope and structure of available resources. Most states and school districts have defined a set of discrete goals and objectives for subjects by grade level. School systems must demonstrate that their students know the breadth of specified information and can do the tasks defined in the curriculum, usually by performing on tests that assess performance on the discrete skills. As a result, teaching and learning activities tend to address the scope of defined knowledge and skills across curriculum areas. Textbook structure and content tend to amplify the same knowledge and skill (Breivik, 1996, p. 65). Increasingly, school systems hold teachers accountable for their students' knowledge and skill. For RBLEs to be successful, we must find ways to convince and assure teachers, administrators, parents, and learners that the use of multiple and diverse resources does not lessen, but rather enhances, student learning and performance.

Generative learning goals require varied rather than singular learning strategies. Historically, learning goals were externally defined, as were the content and resources needed to achieve those goals. When goals are imposed rather than generated, varied resources may be neither necessary nor desired. Directed learning becomes the focus, with little attention to evaluating what is presented or generating individual interpretation. Perkins (1986) characterized this as "knowledge as information"; that is, "knowledge as data devoid of purpose" (p. 3) and disconnected from the individual learner needing or applying the knowledge. In other instances, however, learning needs are defined spontaneously by individual teachers or learners, yielding the so-called "teachable moment." Given the generative and individual nature of goals in these environments, one learning strategy (e.g., lecture) is likely to be insufficient. Multiple perspectives will be needed to provide varied strategies to meet individual needs.

Student-centered learning complicates identification and selection of appropriate resources. Resource selection and use for external goals are often determined by the teacher, guided by curriculum scope and sequence, state adoption lists, or both. Traditional search tools such as library catalogs or periodical indexes (e.g., ERIC, the Educational Resources Information Clearinghouse), or emerging information sources from the Web are used to identify candidate resources; that is, resources are selected prior to instruction. Where unique goals are assigned or determined by teachers seeking to match context-specific needs of individual learners, locating, identifying, and selecting resources become more complex. The requirement shifts from providing general information that might fit a variety of needs to providing a specific resource—even a component of an individual resource—to address a specific need. Efforts to simplify the location of context-specific resources have met with limited success. While the Internet and the Web provide a variety of mechanisms to assist in finding relevant information (e.g., dynamic indexing and hot link indexes), the relevance of the candidate resources is dependent on the learner's need and intent. Since media resources are not universally accessible electronically, the teacher or learner may need to search a wide range of databases and review multiple locations in order to identify a few simple resources. The needs may be small and well defined, but the resource universe is vast, and not well organized for specific learning needs.

Resources designed to support a given approach or perspective may not support different perspectives. Most resources are not inherently designed to support different contextual uses and purposes. Rather, they are created and selected to meet a particular goal or to deliver a particular message. Further, most educational resources are designed for use in a linear fashion to align with incremental steps in the instructional process (Dick & Carey, 1996). When learning goals are predetermined and learning is directed, the resources are useful; when learning goals are generative or contextually based, resources need to be interchangeable. A significant shift from finding the "perfect resource" to adapting existing resources is required (see Kuhlthau, 1996, and Stripling & Pitts, 1988, for discussions of multiple resources).

RBLEs may cultivate transferable skills critical for living and working in the digital era independent of the particular epistemological perspective underlying their use. It is now common for discussions of the skills needed by the 21st-century workforce to include critical thinking, problem solving, and self-direction—the same values espoused by leaders in education and learning (e.g., Breivik, 1998). RBLEs establish contexts in which these skills and processes can be acquired and enhanced. Independent of epistemological framework, at some point RBLE learners engage in critical examination, reflection on, and manipulation of various resources—processes linked to the development of critical thinking, problem-solving, and self-directed skills (Stripling & Pitts, 1988). Yet, the manner in which students engage RBLE scaffolding likely influences the extent to which these skills are internalized and transferable to related tasks. Research is needed to evaluate the high- and low-road transfer of RBLE contexts, tools, and scaffolds.

Given the ability of RBLEs to support varied epistemological perspectives, designers need to adhere to grounded practices that support individual needs and intentions. One of the appealing characteristics of RBLEs is the opportunity to support varied perspectives on teaching and learning. RBLEs are epistemologically neutral; that is, they can be implemented in highly regulated environments as well as in open-ended constructivist environments. While compelling, the opportunity for flexibility across various epistemologies heightens the responsibility of the designer. It is important that the environments are grounded in the theory and practice that correspond with the epistemological perspective adopted (Hannafin, Hill, & Glazer, in press). Different assumptions about the nature of learning and the meaning and utility of knowledge require different enabling contexts, tools, and scaffolds. That is, RBLE components should be differentiated based on factors such as (a) the extent to which learning demands are specific versus global, and (b) that the environment is designed to facilitate rapid detection and selection versus discovery and manipulation. The designer not only needs to be aware of the framework adopted, but also needs a clear understanding of how different frameworks influence how a learning environment is created and implemented (Hannafin, Hannafin, et al., 1997). By adhering to practices associated with grounded design, the designer can represent fairly the features and requirements associated with a given epistemological perspective.

The process used to integrate multiple resources into a coherent learning environment has not been well established. Learners and designers are accustomed to using resources for specific purposes. We are not generally accustomed to reusing resources developed for one purpose for other purposes (Doiron & Davies, 1998). The simultaneous use of several resources of this type involves a quilt-like approach to "stitching" resource parts into coherent and effective wholes. Research is needed to demonstrate how resources can be linked to meet varied needs. Strategies to assist learners with analyzing and interpreting resources in terms of their validity and reliability are also needed (Fitzgerald, 1998).

RBLE participants, including teachers as well as students, lack necessary skills to access, process, and use information and ideas. For most teachers and students, the transition to RBLEs will prove to be a significant shift in terms of prior experience, familiarity, and comfort. Information-seeking and literacy skills are increasingly important for both student and teacher success (Haycock, 1991). Management of the teaching-learning process is also quite different from that in didactic approaches featuring largely fixed resources. Assessment of teaching and learning activities and outcomes can be dramatically different. Yet, ample evidence suggests that students and teachers lack requisite skills in these areas. We need to explore mechanisms and techniques to assist both groups in developing the skills needed to implement successful RBLEs.

In addition to attending to issues related to practice, we also need to extend our research efforts. With few exceptions, research examining resource-based approaches was conducted prior to the digital explosion via the Internet and the Web (see, e.g., Beswick, 1990; Cull, 1991; Haycock, 1991). Given the substantial recent and ongoing developments in resource access; tools to find, process, and manipulate the resources; and alternative approaches to teaching and learning, we need to establish where the accumulated knowledge base supports RBLE design and use and where unique problems and issues such as those described in this paper have emerged.

CONCLUSION

RBLEs offer considerable promise for educators as we look for ways to enhance and extend existing approaches to meet the demands of the digital era. The physical infrastructure needed to implement these environments is already well developed and continues to expand and be refined. Our task is to find ways to consolidate and integrate cross-disciplinary practices into more comprehensive and grounded methods and models for the design and implementation of RBLEs. □

Janette R. Hill [janette@coe.uga.edu] is Assistant Professor of Instructional Technology and Michael J. Hannafin is the Director of the Learning and Performance Support Laboratory in the College of Education at the University of Georgia.

REFERENCES

Allee, V. (1997). *The knowledge evolution: Expanding organizational intelligence.* New York: Butterworth-Heinemann.

ALA & AECT (1998). *Information power: Building partnerships for learning.* Chicago, IL: American Library Association.

Anderson-Inman, L., & Zeitz, L. (1993). Computer-based concept mapping: Active studying for active learners. *The Computing Teacher, 21*(1), 6–11.

Belenky, M.F., Clinchy, B.M., Goldberger, N.R., & Tarule, J.M. (1997). *Women's ways of knowing: The development of self, voice, and mind.* New York: Basic.

Bereiter, C., & Scardamalia, M. (1989). Intentional learning as a goal of instruction. In L.B. Resnick (Ed.), *Knowing, learning, and instruction: Essays in honor of Robert Glaser* (pp. 361–392). Hillsdale, NJ: Erlbaum.

Berryman, S.E. (1991). *Designing effective learning environments: Cognitive apprenticeship models.* (ERIC Document Reproduction Service No. ED 337 689)

Beswick, N. (1990). *Resource-base learning.* London: Heinemann.

Boettcher, J.V. (1998). The turtle is moving . . . *Syllabus, 12*(2), 28, 44–45.

Boland, R.J., Tenkasi, R.V., & Te'eni, D. (1994). Designing information technology to support distributed cognition. *Organization science, 5*(3), 456–475.

Breivik, P.S. (1996). Information literacy: When computers aren't enough. *Learning and Leading with Technology, 23,* 65–67.

Breivik, P.S. (1998). *Student learning in the information age.* Phoenix, AZ: Oryx.

Bruce, B.C., Carragher, B.O., Damon, B.M., Dawson, M.J., Eurell, J.A., Gregory, C.D., Lauterbur, P.C., Marjanovic, M.M., Mason-Fossum, B., Morris, H.D., Potter, C.S., & Thakkar, U. (1997). *Chick*scope: An interactive MRI classroom curriculum innovation for K–12. *Computers and Education, 29*(2/3), 73–87.

Cavalier, R. (1998). Issues and trends. *Syllabus, 12*(2), 24, 26, 28.

Chandler, D. (1999). *Semiotics for beginners* [on-line]. Available: http://www.argyroneta.com/s4b/.

Chang, S.J., & Rice, R.E. (1993). Browsing: A multidimensional framework. *Annual Review of Information Science and Technology,* (28), 231–76.

Cull, P. (1991). *Resource-based learning: A strategy for rejuvenating Canadian history at the intermediate school level.* (ERIC Document Reproduction Service No. ED 343 829)

Dehoney, J., & Reeves, T.C. (1999). Instructional and social dimensions of class Web pages. *Journal of Computing in Higher Education, 10*(2), 19–41.

Dennick, R., & Exley, K. (1997). Tomorrow's doctors today: Innovations in medical teaching and learning—responding to the challenge of tomorrow's doctors. *Biochemical Education, 25,* 6–11.

Dewey, J. (1933). *How we think: A restatement of the relation of reflective thinking to the educative process.* New York: D.C. Heath.

Dick, W., & Carey, L. (1996). *The systematic design of instruction* (4th ed.). New York: Harper Collins.

Doiron, R., & Davies, J. (1998). *Partners in learning: Students, teachers, and the school library.* Englewood Cliffs, CO: Libraries Unlimited.

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

Francis, J.W. (1997, December/January). Technology enhanced research in the science classroom: Student track down proteins through the Internet maze. *JCST,* 192–196.

Fraser, A.B. (1998). Fraser's rule. *Syllabus, 12*(2), 45, 58–59.

Freire, P. (1993). *Pedagogy of the oppressed: New revised 20th anniversary edition.* New York: Continuum.

Galbreath, J. (1997). The Internet: Past, present, and future. *Educational Technology, 37*(6), 39–45.

Gamas, W., & Nordquist, N. (1997). Expanding learning opportunities through on-line technology. *NASSP Bulletin, 8*(592), 16–22.

Grabe, M., & Grabe, C. (1998). *Integrating technology for meaningful learning* (2nd ed.). Boston: Houghton Mifflin.

Hannafin, M.J., Hannafin, K.M., Land, S., & Oliver, K. (1997). Grounded practice and the design of constructivist learning environments. *Educational Technology Research and Development, 45*(3), 101–117.

Hannafin, M.J., Hill, J.R., & Glazer, E. (in press). Designing grounded learning environments: The value of multiple perspectives in design practice. In G. Anglin (Ed.), *Critical issues in instructional technology.* Englewood Cliffs, CO: Libraries Unlimited.

Hannafin, M.J., Hill, J.R., & Land, S.M. (1997). Student-centered learning and interactive multimedia: Status, issues, and implications. *Contemporary Education, 68*(2), 94–99.

Hannafin, M.J., Hill, J. R., & McCarthy, J. (in press). Designing resource-based learning and performance support systems. In D. Wiley (Ed.), *The instructional use of learning objects.* Bloomington, IN: Association for Educational Communications and Technology.

Hannafin, M.J., & Land, S. (2000). Technology and student-centered learning in higher education: Issues and practices. *Journal of Computing in Higher Education, 12*(2), 3–30.

Hara, K. (1997). A comparison of three methods of instruction for acquiring information skills. *Educational Researcher, 39,* 271–86.

Hay, K.E., Guzdial, M., Jackson, S., Boyle, R.A., Soloway, E. (1994). Students as multimedia composers. *Computers and Education, 23*(4), 301–317.

Haycock, C.A. (1991). Resource-based learning: A shift in the roles of teacher, learner. *NAASP Bulletin, 75*(535), 15–22.

Hill, J.R. (1999a). A conceptual framework for understanding information seeking in open-ended information systems. *Educational Technology Research and Development, 47*(1), 5–28.

Hill, J.R. (1999b). Teaching technology: Implementing a problem-centered, activity-based approach. *Journal of Computing Research in Education, 31*(3), 261–279.

Hill, J.R., & Cole, J.C. (1997). *DOROTHIE: An expert system for training development* [technical report]. Houston, TX: Johnson Space Center.

Hill, J.R., & Hannafin, M.J. (1997). Cognitive strategies and learning from the World Wide Web. *Educational Technology Research and Development, 45*(4), 37–64.

Jonassen, D., & Reeves, T. (1996). Learning with technology: Using computers as cognitive tools. In D.H. Jonassen (Ed.), *Handbook of research for educational communications and technology* (pp. 693–719). New York: Macmillan.

Kling, R., Rosenbaum, H., & Hert, C. (1998). Social informatics in information science: An introduction. *Journal of the American Society for Information Science, 49*(12), 1047–1052.

Kuhlthau, C.C. (1996). The process of learning from information. In C.C. Kuhlthau (Ed.), *The virtual school library: Gateway to the information superhighway* (pp. 95–104). Englewood, CO: Libraries Unlimited.

Laffy, J., Tupper, T., Musser, D., & Wedman, J. (1998). A computer-mediated support system for project-based learning. *Educational Technology Research and Development, 46*(1), 73–86.

Land, S.M., & Hannafin, M.J. (1996). A conceptual framework for the development of theories-in-action with open-ended learning environments. *Educational Technology Research and Development, 44*(3), 37–53.

Land, S., & Hannafin, M.J. (1997). Patterns of understanding with open-ended learning environments: A qualitative study. *Educational Technology Research and Development, 45*(2), 47–73.

Land, S., & Hannafin, M.J. (2000). Student-centered learning environments. In D.H. Jonassen, & S.M. Land (Eds.), *Theoretical Foundations of Learning Environments* (pp. 1–23). Mahwah, NJ: Erlbaum.

Lemay, L., & Tyler, D. (2000). *Teach yourself Web publishing with HTML 4 in 21 days* (2nd ed.). Indianapolis, IN: Sams.

Ling, P. (1997). Evaluating teaching initiatives which employ resource based learning. *UltiBASE* [online]. Available: http://ultibase.rmit.edu.au/develop/Articles/lingp2.html.

Linn, M. (1995). Designing computer learning environments for engineering and computer science: The Scaffolded Knowledge Integration Framework. *Journal of Science Education and Technology, 4*(20), 103–126.

Maddux, C., & Johnson, D.L. (1997). The World Wide Web: History, cultural context, and a manual for developers of educational information-based Web sites. *Educational Technology, 37*(5), 5–12.

McCaslin, M., & Good, T. (1992). Compliant cognition: The misalliance of management and instructional goals in current school reform. *Educational Researcher, 21*(3), 4–17.

Miller, D.W. (1995). Teaching students to think like historians—Great American History Machine. *Journal of Computing in Higher Education, 7*(1), 33–43.

Moore, M.G., & Kearsley, G. (1995). *Distance education: A systems view.* New York: Wadsworth.

Noesen, T.R. (1997). History comes alive. *Thrust for Educational Leadership, 26,* 30–31.

Palincscar, A.S., & Klenk, L. (1992). Fostering literacy learning in supportive contexts. *Journal of Learning Disabilities, 25*(4), 211–25.

Palloff, R.M., & Pratt, K. (1999). *Building learning communities in cyberspace: Effective strategies for the online classroom.* San Francisco, CA: Jossey-Bass.

Parson, P.T. (1997). Electronic mail: Creating a community of learners. *Journal of Adolescent & Adult Literacy, 40*(7), 560–565.

Perkins, D.N. (1986). *Knowledge as design.* Hillsdale, NJ: Erlbaum.

Quinlan, L. (1997). Creating a classroom kaleidoscope with the World Wide Web. *Educational Technology, 37*(3), 15–22.

Ray, R.D. (1995). *MediaMatrix:* An authoring system for adaptive hypermedia teaching-learning resource libraries. *Journal of Computing in Higher Education, 7*(1), 44–68.

Reigeluth, C.M. (1988). The search for meaningful reform: A third-wave educational system. *Journal of Instructional Development, 10*(4), 3–14.

Reigeluth, C.M., & Squire, K. (1998). Emerging work on the new paradigm of instructional theories. *Educational Technology, 38*(4), 41–47.

Rescher, N. (1989). *Cognitive economy: The economic dimension of the theory of knowledge.* Pittsburgh, Pa.: University of Pittsburgh.

Segall, W.E., & Wilson, A.E. (1998). Learning and teaching in the classroom. In W.E. Segall & A.E. Wilson, *Introduction to education: Teaching in a diverse society* (pp. 151–170). Upper Saddle River, NJ: Merrill.

Shambaugh, R.N., & Magliaro, S.G. (1997). *Mastering the possibilities: A process approach to instructional design.* Boston, MA: Allyn & Bacon.

Shotsberger, P. (1996). Instructional uses of the World

Wide Web: Exemplars and precautions. *Educational Technology, 36*(2), 47–50.

Sloane, A. (1997). Learning with the Web: Experience of using the World Wide Web in a learning environment. *Computers & Education, 28*(4), 207–212.

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

Tenopir, C., & Lunin, L.F. (1998). Introduction and overview. *Journal of the American Society of Information Science, 49*(11), 957–960.

Thornburg, D.D. (1998). Reading the future. *American School Board Journal: Electronic School, 185*(6), A 14–A 17.

Toffler, A. (1993, November). Shock wave (anti) warrior. *Wired.* Available on-line: http://www.wired.com/wired/1.5/features/toffler.html.

Ward, D.R., & Tiessen, E.L. (1997). Adding educational value to the Web: Active learning with AlivePages. *Educational Technology, 37*(5), 22–31.

Weedman, J. (1999). Conversation and community: The potential of electronic conferences for creating intellectual proximity in distributed learning environments. *Journal of the American Society for Information Science, 50*(10), 907–928.

Witmer, D.F. (1998). Introduction to computer-mediated communication: A master syllabus for teaching communication technology. *Communication Education, 47,* 162–173.

Yan, J., Torjman, P., & Clipsham, D. (1998). Successful resource-based learning strategies for the geography of Canada courses. *Canadian Social Studies, 32*(3), 85–88.