Learning in Digital Libraries: An Information Search Process Approach

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ABSTRACT

THIS ARTICLE DISCUSSES A CONSTRUCTIVIST approach to information age learning environments for children and teenagers, particularly as students in schools. An intervention role for librarians is described for guiding and coaching students in the stages of the information search process (ISP) using the abundant resources of digital libraries. Five strategies for coaching students in the ISP—collaborating, continuing, conversing, charting, and composing—are recommended for adaptation to electronic environments. A theory for creating learning environments in digital libraries is presented based on the concepts in the constructivist approach of acting and reflecting, feeling and formulating, predicting and choosing, and interpreting and creating.

INTRODUCTION

The National Information Infrastructure Taskforce's (1993) report identified schools and libraries as essential sites for Internet connection, recognizing children and young adults as primary users of digital libraries. Many schools and libraries are well on the way to establishing access to a wide range of resources through the National Information Infrastructure (NII) as well as the Global Information Infrastructure (GII). Unfortunately, some places still have little in the way of technology and meager prospects for development in the near future. This article, however, will not consider the serious equity issues related to unequal access to digital libraries but will assume that the technology for connecting to

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digital libraries is in place and concentrate on the equally serious issues related to the process of learning in the electronic environment of digital libraries. What are some of the main considerations for learning in digital libraries? What problems do learners encounter? How can librarians assist learners in their use of digital libraries for lasting meaningful learning? What are some of the theoretical underpinnings for guiding meaningful learning in digital libraries?

Digital Library Users as Learners

A recent workshop at the University of California at Los Angeles, sponsored by the National Science Foundation, addressed the "Social Aspects of Digital Libraries." The background paper for the workshop, prepared by a team led by Christine Borgman (1996), promoted the notion of digital library users as learners and raised some important issues related to developing digital libraries with learning as the goal. "Building digital libraries to exist on the NII/GII means creating information spaces that can serve the needs of novices in a subject domain, especially students of all ages" (pp. 2-3). The paper explained that this perspective introduces a range of new problems for system designers. "Placing the learner at the center recognizes special needs, such as understanding the goal, the motivation, the diversity, and the potential growth of the learner-user of digital libraries" (p. 3).

The common view of information seeking is that the goal is to answer a specific question or to locate specific information. Therefore, the goal of information seeking is seen as being achieved by the location of relevant or useful information. However, the goal of the learner cannot be met by merely locating relevant, or even useful, information. When the learner is placed at the center, the goal of information seeking is no longer merely getting the relevant information but getting information that leads to a new understanding in the process of learning. This aspect of information seeking is of particular concern for those striving to create enabling learning environments for children using digital libraries. Children and teenagers are engaged in expanding their knowledge base and actively constructing a view of the world. They are developing areas of personal expertise by building on what they already know. How can children and teenagers use digital libraries to enable the learning process? This question goes beyond the issue of how to design systems to accommodate learners, and becomes how to develop learning environments that make effective use of digital libraries.

This article addresses children and teenagers as students in school settings using digital libraries for learning. However, the issues, theories, and interventions discussed have broad application for that population in other situations, such as in public libraries, and even by extension for learners of all ages.

Information Age Learning Environments

Schools and libraries are being restructured for the information age. Online computers are transforming contained closed institutions into connected open communities. This has transformed the resources available for children and teenagers from a relatively small pool of materials consisting mostly of textbooks and contained library collections into vast, almost limitless, resources of the NII/GII. Robert McClintock (1996) calls this the new rule of abundance that is changing learning environments, particularly in schools, in very significant ways. Traditionally schools have been dependent upon knowledge presented in textbooks, relatively small library collections, and individual teacher's knowledge of a subject. Even the best designed text, the most well supported library, and the most highly skilled teacher cannot match the abundance and currency of the information available on the NII/GII. McClintock explains that schools have changed from being places where teachers and students were isolated from the general culture with a scarcity of resources to being connected by networks with unlimited access to the abundant resources of our culture. He warns, however, that: "Such a new rule is not without its pitfalls, but to cope with these we must recognize that it is a new rule, deeply different from the old. In our extended present, the educational problem changes profoundly, shifting from stratagems for disbursing scarce knowledge to finding ways to enable people to use unlimited access to the resources of our cultures" (McClintock, 1996, p. 2).

A Constructivist Approach

Educators are recognizing the need for new approaches to learning. Many successful restructuring efforts have been based on a constructivist view of learning rather than a transmission approach to schooling. A constructivist approach has a long tradition in American education with John Dewey laying much of the foundation for its implementation. When learning is viewed as a process of construction, each student is actively involved in building on what he or she already knows to come to a new understanding of the subject under study. In contrast, a transmission approach is based on transferring facts about the subject from the teacher or the text without requiring any reconstruction on the part of the child. An example of a transmission approach is copying word for word from a text or lecture and then reporting back, usually in the form of a test. An example of a constructivist approach is reading, listening, or viewing a text and reflecting on the content, noting what is remembered as important and interesting, perhaps in the form of a chart depicting the connection of ideas and then explaining to a peer study group what was noted. The approach draws on something previously read or learned and raises new questions to pursue. The constructivist approach seeks to foster deep learning that goes beyond the ability to respond to a test, to

application in daily living.

Constructivism is particularly well suited to the new environment of abundance of digital libraries. Living in the information age requires people to go beyond the ability to locate information and requires competence in seeking meaning and understanding. Students need to internalize the process of learning from information. They need to develop competency in deciding what is the best information for them and what is enough information for their ongoing process.

Constructivist learning takes students out of the predigested edited format of the textbook into the use of the abundant resources in digital libraries. The constructivist type of learning is transferable and enables learners to develop skills and strategies that transfer to situations in the real world. Students learn to think through issues that do not have prescribed responses or preset solutions. Students learn to identify what is important to them, to construct new meanings, and to explain their new understanding to others in some way that is authentic to the topic.

Problem-initiated learning is a way to organize the learning situation around a constructivist approach. Problem-initiated learning is centered on a major undertaking within an authentic learning experience. Problems are presented to students that require extensive investigation and research. When these problems are truly authentic to real world situations, they commonly cross subject lines and require interdisciplinary involvement. Students are encouraged to become actively engaged in constructing their own learning over an extended period of time under the direction of a team of skilled teachers that include librarians.

Roles for Librarians

Librarians and teachers play a central role in facilitating learning in the constructivist approach. While transmission learning may rely on textbooks and packaged materials, guiding the process of construction calls for expertise that only skillful sensitive professionals can provide.

They formulate the overall direction and underlying principles to be developed during the learning experience. They guide and coach learners through the learning experience (Sizer, 1992). Coaching has been used as an example of a way of offering enabling intervention into the learning of students. The coach organizes the learning situation and steps in when students need direction and guidance. Students are provided opportunities to take the initiative for their own learning and to gain a sense of accomplishment and success resulting from their own work.

Teachers and librarians working as a team can play an important role in enabling the process of construction in information-rich environments. Both the teacher's role and that of the librarian in the constructivist approach to learning need to continue to be redefined within the new

environment of abundant resources in digital libraries.

The concept of a zone of intervention (Kuhlthau, 1994) suggests some ways that librarians can provide essential assistance and guidance in learning in digital libraries. Vygotsky (1978), the Russian psychologist, developed the concept of an area or zone in which intervention would be most useful to a learner, called the *zone of proximal development.* The zone of proximal development is "the distance between actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers" (Vygotsky, 1978, p. 131). The zone of intervention for librarians, introduced in an earlier work by the author (Kuhlthau, 1993), is that area in which a user can do with guidance and assistance what he or she could not do alone. Help within this zone moves the student along in the information search process. Intervention outside of this zone is intrusive on the one side or overwhelming on the other. Intervention on both sides of the zone of intervention is inefficient and unnecessary. Timely intervention within this zone is efficient and enabling.

There are important roles for librarians in enabling learning in digital libraries. They have responsibility to create the learning environment consisting of a problem that initiates the learning and the resources for studying the problem. They also have a role in guiding and coaching students in the ISP when a zone of intervention occurs.

Six Stages in the Information Search Process

The information search process is based on a constructivist view of learning. The ISP, initially developed in more traditional library environments, reveals the holistic dimensions of learning from a variety of sources (Kuhlthau, 1988a). While this research suggests much about learning in digital environments, further study is called for within electronic environments to examine how the basic learning experience in the ISP may be affected by digital libraries. A number of studies in progress are investigating different aspects of this issue, but much more work is needed in this area of research.

A model of the ISP, developed from the findings of five studies (Kuhlthau, 1989), serves as a guide for coaching students in the research process. The ISP may be thought of as occurring in six stages: initiation, selection, exploration, formulation, collection, and presentation. The stages are named for the primary task to be accomplished at each point in the process. Thoughts, actions, and feelings commonly experienced in the six stages of the process are described in the model.

The studies underlying the development of this model were conducted with teenagers. Some further studies suggest that younger children experience the search process in similar holistic ways but with some

important differences (Harada, 1996; Kuhlthau, 1988b). Younger children under the ages of eleven or twelve experience formulation less intentionally than teenagers. This would seem to be in keeping with developmental theories related to concrete and abstract thinking. While younger children do experience the stages of the ISP, they may be more involved in building their general knowledge than formulating a personal perspective. This knowledge base lays the foundation for more personal formulations of young adult years and beyond.

The following description of the six-stage model of the ISP is adapted from "The Process of Learning from Information" (Kuhlthau, 1995, pp. 1-12). Initiation marks the beginning of the process when a problem is first introduced. Students are frequently puzzled by a task and uncertain as to how to proceed. Thoughts are commonly centered externally on "What does the teacher want?" and need to be turned internally on "What do I know?" and "What do I want to know and learn?"

The second stage, selection, is a time for identifying a general area for investigation that is accompanied by a sense of optimism at accomplishing the task at hand. Some students may take more time than others in this task. Those who do not select quickly can become anxious at being behind the group. Pace of the ISP varies greatly from person to person and from problem to problem. The only time a whole group of students will be together is at the initiation and presentation stages. Otherwise, pace will vary individually. It is helpful to point this out to students because this is not the norm for school learning but it is for learning in real world settings.

The third stage, exploration, is unexpectedly the most difficult of the entire process. After the general topic has been selected, students expect to be able to move on to collecting information and preparing to present. However, exploration, as the name indicates, requires a more varied and complex task. At this point, their task is to explore information to form a focus for their research. They need to read and reflect in order to learn enough about the general topic or problem to form a personal perspective or focus for their work. Confidence can be expected to drop sharply during this stage before increasing gradually. As students encounter inconsistent incompatible information that does not match their expectations, they commonly begin to doubt the appropriateness of the topic, the adequacy of the information sources, and their own ability to accomplish the assignment. This is to be expected, and they need to attend to the task of exploring information to form a focus for their research rather than collecting information to support a thesis. One of the most common mistakes in library research is to confuse the stage of exploration with that of collection and to apply collecting strategies to the task of exploring. Completely different strategies are called for during exploration than are used in the collection stage. For example, at

exploration, students find it helpful to list ideas and questions while skimming a wide range of materials rather than taking copious notes from one text. When these two stages are confused, students run into difficult problems in the presentation stage, including writing blocks because they have not formed a personal perspective to write about, or plagiarism because they have copied word for word with little sense of meaning.

The fourth stage, formulation, is conceptually the most important in the information search process. During this stage, the central cognitive task of the process is accomplished. A personal perspective or sense of meaning of the information encountered is formed. At this time the student begins to move from uncertainty to understanding. The focus provides a guiding idea, a theme, or a thread (student's own words) on which to base the collection of information. The focus provides the frame for constructing a story or narrative using the information that is gathered. The concept of focus formulation gives the student a strategy for choosing information from an information-rich environment and is the underlying concept in using information rather than merely locating it. During formulation, students are actively engaged in using information to create meaning that involves thinking, reflecting, interpreting, connecting, and extending.

In the fifth stage, collection, the task is to gather information that defines and supports the focus formed in the prior stage. The focus is further shaped and clarified during this stage as connections and extensions are made from the information gathered. The narrative begins to take shape. Many of the strategies used in traditional library searching are helpful at this point and may be adapted to the technological environment, such as subject searching and detailed notetaking.

In the sixth stage, presentation, the task is to complete the narrative describing the focused perspective of the topic and to prepare to present the new learning to the intended audience. This can be a difficult stage if little formulation has taken place during the ISP.

Coaching the Information Search Process in Digital Libraries

Studies of the ISP show that students use certain activities to help them work through the process of information seeking. Students find it helpful to: (1) work with others and not be required to work alone on a project; (2) have a clear concept of their own process; (3) talk to other people as they go along; (4) describe their ideas in some pictorial form; and (5) write short pieces along the way. These useful activities have been developed into five strategies for coaching students in the ISP: collaborating, continuing, conversing, charting, and composing (Kuhlthau, 1993). These can be readily adapted to digital libraries.

Collaborating

In studies of the information search process, one of the strategies students used to work through the more difficult stages in the process was to work with other students. They would confer on what they were planning to do. They would let each other know if they came across some source that they thought might be of use in the other's investigation. Although collaborating seems to be a natural strategy students use for moving along in the ISP, most traditional research assignments have been set up as isolated work to be accomplished independently and often outside of the school setting. Recently group projects have become a more common practice in schools. Many of these projects, however, lose much of their effectiveness because each student does not share equally in the work. Too often one student in the group takes charge and does most of the work because the organization of the project does not promote true collaboration. True collaboration enables each person to construct his or her own understanding of the problem at hand. The collaboration advances each individual's constructive learning. Collaborative strategies such as brainstorming, delegating, networking, and integrating are activities for promoting construction in the ISP.

In the best situations, collaboration neutralizes competition to a large degree. Students are placed in a position of cooperating with one another rather than competing against each other. They are attuned to helping each other in the process of construction. The purpose of collaboration is to facilitate construction. An individual is better able to think through a problem and to move along through rough spots with the assistance and support of other students. Students can explain and model what they have learned in ways that their peers can readily understand. In these collaborative situations, both parties benefit. A team approach to research more closely matches real-world information-seeking tasks where people often work together to address situations that require more information for a broader understanding of a problem.

The central task of the information search process for each student is to construct a personal perspective from the information encountered in the process of information seeking. If students are not constructing for themselves then they are not engaging in the ISP. Teachers and librarians are responsible for designing and implementing collaborative learning situations in which each student has an opportunity to construct and reconstruct his or her understanding of the problem at hand.

Collaboration is particularly helpful in technological environments. Librarians are reporting that students are instrumental in teaching each other to use computer technology and to help each other when they encounter the inevitable glitches that are endemic in the use of technology. Students also help each other considerably in sharing sources that they come across in their searching that might fit in with another student's

aspect of the problem or topic. Collaboration can prove helpful for students using digital libraries by providing assistance in the use of technology, in the location of sources, and in the process of learning.

Continuing

The strategy of continuing is based on an understanding of the information search process as a constructive process rather than as a single incident of information seeking. Students with a clear understanding of their involvement in a continuing process are likely to press on beyond a single search to reading and reflecting that leads to further searching and ultimately to forming a focused perspective that provides a base for an extensive collection of information. The process of information seeking involves construction in which students actively pursue understanding and meaning from the information encountered over a period of time. The strategy of continuing responds to this dynamic learning process. Coaching that continues throughout the duration of the ISP not only guides students in one specific research assignment but also establishes an awareness of the process itself. Librarians can introduce strategies and skills for each stage in the process that may be transferred to other situations of information seeking and construction. Students learn that exploring for a focus is essential for moving out of the uncertainty they feel toward gaining a personal understanding.

A basic principle for learning from digital libraries is to take charge of your own constructive process. In the digital library environment, it is important for students to actively seek to formulate a focused perspective that will guide their choices of what is pertinent and useful to them from the vast resources that may be generally relevant to the overall problem.

Continuing addresses the concept of enough, which is a critical issue in using digital libraries. In the environment of abundance of the NII/GII, an understanding of what is enough is essential in order not to become overwhelmed by the sheer number of sources available. What is enough was a simple notion, or at least a manageable one, when a person could gather all there was on a topic in a contained collection. The concept of enough is quite a different matter in the present abundant information environment. Knowing what is enough is important for making sense of the abundance of information available in digital libraries. Enough relates to seeking meaning in a quantity of information by formulating a perspective on which to build and determining what one needs to know. Within the ISP, the question of enough is addressed by what is enough to make sense for oneself.

Librarians can coach students in deciding what is enough for them to advance their understanding in each stage in the ISP. The concept of enough may be applied to the tasks in each stage of the ISP. Continuing strategies enable students to decide what is enough at initiation, to

recognize a problem that needs information; at selection, to select a general area to initiate their investigation; at exploration, to explore a general topic for an aspect to pursue; at formulation, to form a focused perspective on which to build; at collection, to collect information to build an understanding; and at presentation, to present a focused perspective of the chosen aspect of the general problem. Continuing strategies support students throughout the ISP by enabling them to use information for learning in each stage of the process.

Conversing

Talking was found to be an important strategy for students in the studies of the information search process in every stage in the process. As one individual put it: "I talk to everyone who will listen—my friends, my mother and father, my sister, and even my girlfriend." Coaching in the earliest stage of the ISP can take the form of offering an invitation to research that engages students in conversations about what they already know about the problem and what they might be interested in finding out. After an assignment is first announced, students often ask each other, What are we supposed to do? What does she want us to do? Such external questions need to be turned internally, What do I want to do? What am I interested in? Librarians can encourage dialogue by drawing from students' dynamic process through invitational exploratory questions that get them to discuss their knowledge, ideas, and questions about the problem.

Talking that enables thinking is an important strategy throughout the information search process but is especially helpful at those more difficult points where students are attempting to sort out inconsistent and incompatible ideas they encounter as they gather information. Conversations enable students to identify ideas that do not fit in with what they know and to decide what they need to learn more about. Conversing during exploration helps students to try out different formulations for the focus of their research and to articulate the narrative that is developing in the ISP.

Conversing is an important form of collaboration. Students can provide a sounding board for each other that challenges them to think more deeply and to engage in thoughtful discourse through each stage of the information search process. Peer groups can be organized with time set aside for conversation under the guidance of the librarian or teacher as coach.

Conversing gives the librarian an opportunity to listen to the student, to identify the stage in the process he or she is experiencing, and to determine if there is a zone of intervention evident where the student needs some help.

Charting

Charting is depicting an idea or a set of ideas in the pictorial form of a drawing or a chart. Organizing ideas graphically is an important strategy for developing thoughts as they are emerging as well as for identifying what is not known and needs to be investigated further in order to be explained. A chart provides a picture of a set of ideas and addresses the connection between the ideas. This type of charting has been given a number of different names, most commonly used are webbing and graphic organizers. The most traditional kind of chart is an outline. An outline borders between written discourse and a pictorial depiction of an idea. Charting in all of its forms is an excellent strategy for enabling students to summarize a large quantity of information.

Charting requires students to create a picture of their thinking. Most young children will readily draw their ideas as a natural expression of their thinking, but as they get older they seem less and less inclined to present their ideas in a pictorial form. It is important to use all of the strategies we have at our disposal to formulate meaning from the abundance of information in digital libraries. Charting is a good strategy for coaching students in expressing their ideas in the various stages of the ISP.

In addition, charting may be used to demonstrate the information search process itself and to make students more aware of the process as they experience it. The model of the ISP may be thought of as a chart in the form of a timeline that can be adapted as an instrument for illustrating the process to students. The diagram is a coaching tool that enables students to visualize a sequence of stages in information seeking. The chart may be used as a basis for identifying the stage that the student is experiencing and to describe the overall process to the student. The model may simply be drawn on a piece of paper in front of the student or prepared more formally as a handout. The objective of using the chart is for students to understand the process and to determine what stage they occupy in the process.

Charts in the form of simple timelines and flowcharts may be adapted for coaching students in charting their own searches. These charts are most effective for reviewing a recently completed search with a student and reflecting on what went well and what might be improved. Charts of this type can also be used as planning instruments. Personal computers can be used for charting in all of its applications.

Composing

Composing in the electronic environment means more than writing. Writing implies putting pen to paper in a traditional sense. Personal computers have changed significantly the ways people approach writing. Composing is an appropriate term for the activity of formulating thoughts

on paper. The act of composing facilitates thinking. People compose not only for others to read but to formulate, organize, and express their own developing thoughts.

Composing is an excellent strategy for advancing formulation in the information search process. Research journals can provide an ongoing vehicle for composing throughout the research project. Journal keeping can be easily adapted to the use of personal computers. Librarians may recommend that students keep research journals for recording ideas, questions, and connections as they progress through the ISP. Composing in a research journal is much more comprehensive than merely taking notes. The journal may be started when the project is first initiated and continued throughout the process with the purpose changing as the search progresses and the narrative emerges. Students may be asked to set aside a minimum of ten to fifteen minutes each day to write about their problem or topic. These short pieces of writing build the story and enable the constructive process. The main objective of composing is to serve as a tool for formulating thoughts and developing constructs.

Composing is a most efficient way for presenting a personal perspective on the information gathered on a problem. The traditional research paper or term paper can be recast to make the presentation authentic to the problem. Composing as a culminating activity should foster creativity in presenting a new understanding of the problem that has been formulated in the ISP.

Creating Learning Environments in Digital Libraries

Learning begins with an area of uncertainty. Something is not known, understood, or able to be performed. The student is unable to do something, does not understand something, and needs to know more. This uncertainty initiates a learning situation. Learning is moving from uncertainty to understanding.

Learning through information seeking promotes a change in a way of thinking about something. Learning is measured by this change. The student thought about something one way before and now he or she thinks about it in a different way. In some instances, a change is sudden, radically altering the way something is viewed or the way something is done. Such occasions of new insight are referred to as "aha" experiences or gestalt. Other learning is reflected in a more subtle change over time, but nonetheless a significant increase in understanding takes place. Learning is active, individual, and holistic. Under the best conditions, learning opens up new worlds to discover and construct that motivate and inspire the learner.

The constructive process of learning involves: acting and reflecting; feeling and formulating; predicting and choosing; interpreting and creating. These attributes of learning may be considered within the infor-

mation search process in digital libraries to reveal important ways to guide and coach students. Taken together they suggest an emerging theory for creating environments for learning in digital libraries.

Acting and Reflecting

Dewey (1933) explained that action and reflection are necessary elements in order for learning to take place. Activity without reflection rarely leads to new learning. Action that is followed by reflection enables students to construct a new understanding from the activity situation. By reflecting on the result of an action, students discover new insight into their former perspective.

Librarians can guide students to reflect on their action throughout the stages in the information search process. Opportunities for reflection need to be introduced into the use of digital libraries. The nature of the digital environment, with its abundant fast-paced information, can mislead students into thinking that much is being accomplished where little actual learning is taking place. Librarians can encourage reflective approaches such as suggesting that students stop to read and reflect before rushing on.

Acting and reflecting are important for learning in each stage of the ISP but particularly in the early stages to get the process going. At the initiation stage, taking some action is essential for getting started. Many students experience a tendency toward "procrastination" at initiation and need urging to begin. They can be assured that by taking an initial action they are not making an irrevocable commitment but only giving themselves something to reflect on in order to begin the process. They can be given advice on searching digital libraries to survey the topic to discover if there is "too much" or "too little." They can search for ideas, terms, events, and people that are associated with the general topic. Students can be guided through a series of actions and reflections that help them to move through the stages of the ISP. They can be helped in the selection stage by reflecting on information gathered in their initial preliminary action. In a similar way, reflecting on action taken in the exploration stage enables students to form a focused perspective in the formulation stage.

Feeling and Formulating

Formulation is the primary task of the information search process. Formulating is making some kind of meaning from the information gathered that fits with other constructs the student holds. Formulation follows reflection, not in a strictly linear sense but in a reiterative way that moves the student toward construction. Through formulating, the student's thoughts change from uncertainty to understanding. Formulation involves reconstructing a new understanding. First the students have to identify what they already know, then reflect on their former knowl-

edge and add to it, change it, or discard the new idea. It is not an easy process, and it is emotional as well as cognitive. Formulating is not just thinking about something but is a holistic experience accompanied by deep feelings and emotions.

Students often misinterpret their feelings in the information search process. Rather than recognizing feelings of uncertainty as natural and essential to the early stages of the process, they often mistake these feelings for a lack of ability to do the task or a lack of resources available to gather sufficient information. Librarians can help students understand the holistic experience of the ISP and to recognize the feelings they commonly experience in each stage of the process.

Digital libraries do not accommodate feelings in the ISP any better than traditional libraries and probably not as well. The emphasis is on locating the "right stuff" and not on formulating ideas and gaining a personal perspective. Students using digital libraries can become so absorbed with locating and gathering that they overlook the essential task of formulating. Librarians can help students attend to the primary task of the ISP. Uncertain feelings in the exploration stage of the ISP is an indication of a zone of intervention where students may need guidance in working to form a focus on which to concentrate their learning.

Predicting and Choosing

All throughout the information search process, students have to make choices. They choose general areas to investigate, specific aspects to learn about, and a focus to understand on a deep level. They choose the sources that they will read and the ideas they will develop. They choose the strategies they will apply for locating information and for formulating a focused perspective. Kelly (1963) explains that choices in the process of construction are based on prediction of consequences. Prediction plays an essential role in the constructive theory of learning. Although Kelly's explanation of prediction seems overly systematic and structured at times, when he describes an individual's experience within the process of construction, a dynamic uncertain process is revealed. He depicts people working through the process by a series of choices from a range of alternatives, and these choices are anything but obvious and straightforward.

Librarians can give students opportunities to explain their predictions by openly discussing the choices before they make them and the probable results of such choices. Some predictions are obviously off track, but many predictions will need to be followed through to fully divulge the result of that particular choice. Results lead to further predictions and choices and so on throughout the ISP. Students can be guided through the process by asking what they think will happen and what they would like to happen.

The ability to predict and to choose is important for selecting sources

from the abundance of information available in digital libraries. Students need guidance in how to choose from a large number of sources. Being aware of the range of sources available, as well as a variety of different strategies for accomplishing the tasks in the ISP, enables students to make productive choices. Predictions about sources and strategies that are useful for getting started, or for exploring for a focus, or for collecting for presenting a point of view promote a sequence of choices that lead to learning. In this way students can learn to diminish the deadening impact of overload on their efforts to learn in digital libraries.

Interpreting and Creating

Interpreting information and creating a new understanding is the overarching goal of the information search process. Interpreting is central to the constructive process. It is not enough merely to gather information. Bruner (1986) explains that: "If we are to understand it (new information), it will not be by means of a positivist archaeology in which everything particular about it and everything leading up to it are finally dug up, labeled, and collated. However much we dig and delve, there is still an interpretive task" (p. 53).

Interpreting involves creating. The interpretive task of "going beyond the information given" is a central concept in Bruner's work. Information is interpreted to create what Bruner calls "products of mind." This mysterious capacity to interpret and create is at the core of what it means to be human. Interpreting is based on personal constructs built from past experience. In this highly individual process, students make connections between information in various sources, extend their own ideas, and create something new for themselves.

Librarians play an important role in encouraging students to go beyond the information they collect to create their own understandings. In the presentation stage, students should be expected to go beyond basic documentation of telling what they have located and where it was found to presenting their own narrative about what they learned. They need to develop confidence in their own interpretations and be encouraged in their original creations, no matter how seemingly simple or rudimentary. Students learn from their interpretations and creations in the ISP. In the information age, this learning must be able to be accomplished using digital libraries.

Challenges for Librarians

The future holds great promise for learning in digital libraries but seeking meaning in information rich environments is not an easy process. Connection to the digital libraries in the National Information Infrastructure/Global Information Infrastructure offers access to an abundance of resources. However, mere connection to the resources in digi-

tal libraries does not automatically provide a better learning environment for students. More is not necessarily better without skillful guidance from an insightful professional. The call for designing systems for accommodating learners as users of digital libraries is timely and important. However, even the best designed system may fall far short of enabling learners to achieve their goal. The central goal of information seeking for the learner is to move from uncertainty to understanding. Librarians play an important part in facilitating that goal.

Librarians play a critical role in creating environments that foster meaningful and lasting learning in digital libraries. The constructivist approach to learning is well suited to the new environment of abundant resources. The approach calls for students to formulate their own focused perspective within the stages of the information search process that enables them to sort through the vast resources of digital libraries for those pieces that make sense to them. Librarians who are cognizant of the holistic experience of the ISP encompassing thoughts, actions, and feelings can identify a critical zone of intervention where students may be provided with essential guidance. Librarians can develop new strategies for guiding and coaching students in the process of learning in digital libraries. The vision for the future calls for restructuring librarianship to enable children and teenagers to engage in the process of meaningful learning in the vast resources of digital libraries.

In summary, this article has discussed a constructivist approach to information age learning environments for children and teenagers, particularly as students in schools. An intervention role for librarians has been described for guiding and coaching students in the stages of the information search process using the abundant resources of digital libraries. Five strategies for coaching students in the ISP—collaborating, continuing, conversing, charting, and composing—have been recommended for adaptation in electronic environments. A theory for creating environments for learning in digital libraries has been presented, building on the basic concepts in the constructivist approach of acting and reflecting, feeling and formulating, predicting and choosing, interpreting and creating. The challenge for librarians, particularly those who work with children, is to create environments for learning within the digital libraries.

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