

Mental Models of Information: The 1993-94 AASL/Highsmith Research Award Study

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The purpose of this study was to investigate the following broad question: When students are seeking and using information, why do they make the decisions they make? The study examined the decisions made by twenty-six students as they completed a classroom assignment that required them to seek and use information. The study found that a learning experience is composed of a variety of intertwined "learning strands." When differences existed between student understandings on any strand and the understandings required by the task, students were likely to try skills from other strands to overcome the problem.

Students based many of their decisions on understandings they had constructed prior to the unit. Because in many cases their prior experience had been limited, students' mental models related to information were not adequate to provide support for their learning. Educators who are planning a learning experience should view it holistically, recognizing that learning on one strand can support learning on other strands. This study was funded in 1993 by the Highsmith Corporation under an AASL/Highsmith Research Award.

How many seconds are there in a year? To answer this question, most people would immediately try to multiply seconds by minutes by hours by days. Though unaware of the thinking involved, they would be doing several things to reach an answer. One cognitive activity would be to access prior learning. Rummaging in the cognitive attic cobwebs and pulling out some previous understandings would be necessary to solve the current problem.

But it is important to remember that the brain is not one big, dusty room stuffed with a jumble of prior learning. Instead, it resembles an attic that has been partitioned into many little rooms, in which much of the prior learning is stored in a somewhat organized fashion. To locate knowledge to solve the problem above, one must first find the right little room to enter, or choose a category of prior learning to consult, and then use that prior learning.

In the above problem, the category would likely be mathematics. But what if the prior learning in that domain is inadequate? For example, suppose the problem solver does not know how to multiply. What steps would be required then, if the problem is still to be solved? Three obvious alternatives exist: to choose a different approach, to arrange to learn what is needed, or to give up. If a different approach is chosen, some technological skills might be accessed and a calculator used. Or a nearby person might be enlisted to provide a quick multiplication lesson. With no assistance or other skills available, some problem solvers might simply give up.

How is this related to the research to be discussed in this article? This study was conducted to find out how students would solve an information problem. Specifically, the researcher wanted

to know what prior learning students had about information seeking and use, and how they used that prior learning to help them with their task.

The Problem

The focus in this research was on the information-related problems of teenagers, given that teenagers have access to a lot of information and that they have to make many important, information-based decisions related to school or life issues.(1) Are students able to make thoughtful decisions as they search for and use information? Experience and the writings of such educators as Howard Gardner indicate that the answer is probably “no.”(2) Many teenagers do not have the prior learning needed to seek, find, use, and communicate information to solve problems they face. To investigate this problem and learn other things about the information skills of adolescents, a study question was asked: When students seek and use information, why do they make the decisions they make?

The following framework questions guided the work:

1. What prior learning do students have that influences the decisions they make while seeking and using information?
2. How is that prior learning the same as or different from what they need to address their task?
3. If differences exist between what they need to know and what they do know, how do they cope?

Mental model theory was the framework used to support thinking about the students’ prior learning.(3) Prior learning was envisioned as being understandings of two types: single, isolated ideas and connected, interrelated ideas. The connected, inter-related ideas are often referred to as schema, or mental models. Some cognitive psychologists think that novices in a field have unorganized and fragmented understandings, while experts have more complex and organized sets of understandings. This concept is illustrated in figure 1.

Figure 1. Novice-to-Expert Knowledge-Base Continuum

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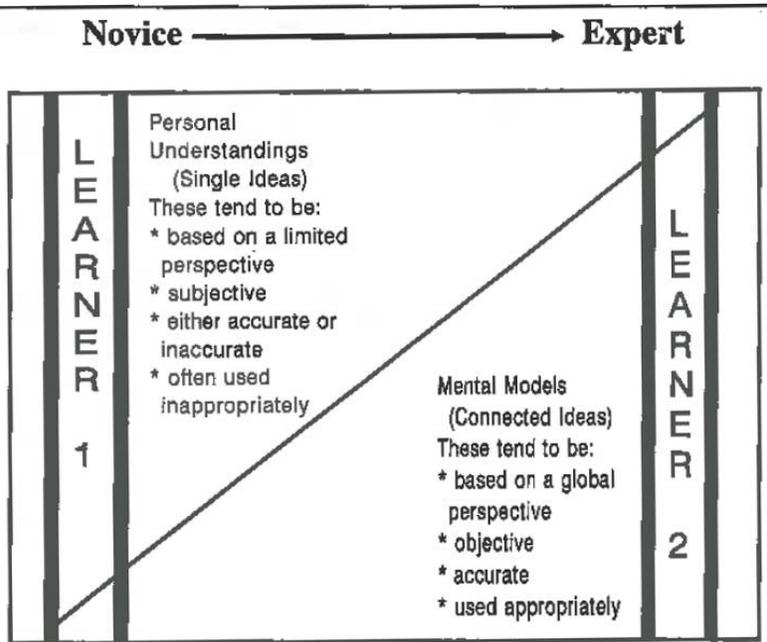


Figure 1 shows two learners. Learner 1—the novice—does not have much prior learning in the field under consideration. His or her personal understandings are fragmentary, based on a limited perspective, subjective, often accessed and used inappropriately, and either accurate or inaccurate. Learner 2—the expert—has more connected understandings or mental models. These ideas tend to be based on a global perspective, objective, accurate, and used appropriately. Movement from novice to expert brings about a change in the organizational nature of the prior learning.

During data collection, patterns emerged that had not been anticipated when the original framework questions were devised. One new pattern was related to the cognitive domains the students were using. They used understandings from subject matter, information seeking and use, life skills, and video production. All four domains were so essential to the unit that they were envisioned as being strands that were inseparably entwined. It was impossible to examine the students' use of the information-seeking-and-use domain without paying attention to all the domains. Since a naturalistic researcher must be sensitive to patterns emerging from the data, an additional question was added to reflect this idea that had emerged:

What do the decisions students make reveal about their prior learning on each learning strand?

Not just prior learning could be examined, however; new learning on all the strands had to be considered. Two additional questions reflected that concern:

1. How do specific activities, events, and circumstances support or interfere with student expansion of prior learning on each strand?
2. How do mediating activities performed by adults support expansion of prior learning on each strand?

Methodology

In order to answer the research questions, it was necessary to look at behavior and thoughts in a natural setting. Setting up an artificial information problem would result in obtaining information only about that artificial situation and not about the decisions students make in real life. The study was structured as a naturalistic or qualitative case study, the goals of which are to understand human behavior and to examine processes as well as outcomes.(4) The researcher maintained a “participant perspective” throughout the study, which meant that she wanted to know the students’ interpretations of the events in which they were participating. Specifically, their explanations of the processes they went through to make decisions were extremely important, and their decisions were assumed to be logical, even if their logic could not be perceived at first.

The researcher spent about nine weeks with a class of twenty-six eleventh- and twelfth-grade science students who had been assigned to work in groups to produce a video documentary on some topic related to marine biology. She had no input into the planning or the carrying out of the assignment. The unit was essentially unstructured-i.e., the teacher did not provide or arrange for instruction in the skills students might need to acquire in order to complete the task. The researcher observed the class twelve times before the video documentary was assigned.

During those visits she became acquainted with the students so that by the time the assignment was made, she knew them by name and they knew her. She had explained her purpose in visiting their class, and they soon began to respond positively as she talked to them about their class work.

Although students were the primary focus for data collection, other data sources were used. The teacher of the marine biology class was an important source. Halfway through the study, he received permission to work on a special project to develop computer material, and a permanent substitute teacher took over, who also provided important data. Additional sources were several teachers in the school, the school library media specialists, and the school principal. Several adults outside the school, contacted by the students as they worked on their projects, were also interviewed.

Data were collected through observation, interviews, and the examination of documents. Thirty-four observations were conducted using interactive observation techniques in which the researcher talked with and questioned students as they worked, enabling her to determine students’ perceptions of their experiences. Data were recorded either through field notes or via audiotape recorder.

The fact that students worked in groups proved to be a valuable aspect of the research situation. As they planned, collected information, and struggled to work with the ideas, they had to

verbalize their thoughts and understandings for others in the group. Thus, many of their thoughts were available for capture simply by listening to them work together. Probing for individual perceptions was usually not necessary, because those perceptions became obvious as the students talked with other members of the group. The researcher accompanied many groups on various trips to gather information—to the school library media center, to two university libraries, and to various filming locations.

In addition to the interactive, on-the-spot interviews that were part of the observations, the researcher conducted twenty-eight structured interviews, following interview protocols based on data obtained during observations. Several of these interviews were with the video groups and were conducted during the final week and a half of the unit to obtain their assessment of most of the project.

The documents collected fell into two categories. Documents that were a natural part of the process included student notes, outlines, storyboards, calendars, and evaluation sheets completed by the teacher. Other documents were solicited. Five times during the study, students were asked to respond to a written request for information, called a “prompt.” Preliminary prompts were developed before the study began, but revisions were made based on events in the field as the study progressed.

Discussion of Findings

Data analysis consisted of coding, sorting, and looking for patterns or themes. Qualitative researchers strive to go beyond this first layer of analysis and look for some broader theory that interlocks the themes. This broader concept is called grounded theory, because it is grounded in the actual data. The grounded theory developed here must be considered preliminary, but it provides a focus for future research and practice.

Grounded theory: Students who are involved in a learning experience are not aware that the whole of the learning event is composed of a variety of intertwined learning strands. While they are involved in the learning task, they assess situations and make decisions by using previously constructed understandings from whichever learning strand (or combination of strands) seems to provide the most direct approach to solving each particular problem they face.

The way in which this grounded theory works is shown through some specific problems students addressed during their work on the videotapes. Students’ approaches to this assignment somewhat resembled processes that have been recommended in the literature in the last several years. In no way, however, were the actual processes neat and tidy and linear. Instead, students performed or repeated steps recursively throughout the assignment.

Approaching the Task

Students chose broad topics—not research questions or problems—to pursue. Topics included beach pollution, Lake Jackson, manatees, marine biologist as a career, oysters, St. Marks River,

alligators, science camp, and sinkholes. Two patterns were clear in the data on topic selection. First, there were similarities in the reasons students gave for the choices they made. Some said they chose an “easy” topic. By this, they seemed to mean that they knew the information they needed (print, oral, or visual) was easily available. As one student said, “The lake’s not too far from here, and there’s a lot of information on it so we can use it.” Another, referring to the alligator topic, said, “I mean, you know, we could get a lot of footage of them.”

Another explanation for topic selection seemed to involve intellectual access; they chose topics with which they were already familiar. One student said, “I chose this project because I kind of knew about it some before.” Another commented, “When I was in the fifth grade, our class made the alligator the state reptile, and we learned all kinds of stuff about it.”

Finally, students wanted a topic to be interesting. One explained patiently, “If it doesn’t interest you, you’re bored. I mean, why do something that’s not interesting to you?” In a written comment, one person suggested, “[You should] think of a subject that you would enjoy doing and that you would not want to slack off on.”

The second pattern in the data had to do with the process of topic selection. Students all chose their topics quickly. In fact, all but two of the topics had been chosen by the end of the first day of the assignment. The only tactic employed to identify a topic was brainstorming; students sat in their groups and suggested topics until one seemed to appeal to nearly everyone in the group. Almost instantly, that topic would be adopted. Thus, because students did not have mental models of any alternative topic-selection processes, they limited themselves to topics about which they already knew.

The teacher provided little support for the process of topic selection. He did suggest four sample topics, two of which were selected by the groups. Other teachers who had many of the same students commented that they too nearly always provided students with a list of topics from which to choose. Only one described having students choose five preliminary topics from a list and then select from those alternatives. Neither the teacher involved in this study nor the other teachers discussed using any tactics to help students choose topics thoughtfully, and this was corroborated by the students.

An overall pattern that had an impact on every activity emerged during analysis. That pattern showed that the learning strands were intertwined throughout the unit and that students switched from one strand to another as they experienced difficulty. This pattern of interwoven strands can be illustrated by the data related to topic selection.

During this unit, the teacher focused on the development of life skills, such as decision making and problem solving. His perception was that the only way students could develop those skills was for them to figure everything out on their own. This emphasis on the life-skills strand and his perception of how students learn those life skills meant that students were not given any support for the information-seeking-and-use skill of topic selection (see a, figure 2). But the pattern that emerged was that one strand affected the other. Because students did not have the necessary information-seeking-and-use skills for this step (see b, figure 2), they fell back on their

life skills and chose from what they already knew about the subject matter—an eminently logical approach.

Figure 2. Strand Interaction During Topic Selection

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	Student's Limited Mental Models In ...				
		Life Skills	Information Seeking and Use	Subject Matter	Video Production
Affected Their Decisions In ...	Life Skills		x (b)		
	Information Seeking and Use	x (a)		x (e)	x (d)
	Subject Matter		x (c)		
	Video Production		x (f)		

Student understandings about the topics they chose (i.e., on the subject-matter strand) were, for the most part, novice-like. As they began, they had various isolated, individual understandings but did not seem to have complex mental models associated with their topics. Later in the unit, it became obvious that their limited prior learning on the information-seeking-and-use strand (see c, figure 2) kept most of them from developing more complex, subject-related mental models.

On the production strand, students understood that they should choose a topic that would lend itself to visual footage. Interestingly, they all assumed this meant there should be a physical site accessible to them. At this point, none of them had a mental model that let them envision obtaining video footage by filming from print and electronic sources readily available in nearby libraries. So in a way, their limited understandings of both production (see d, figure 2) and subject matter (see e, figure 2) influenced the choices they made on the information-seeking-and-use strand. Conversely, their limited understandings about visual information affected their production decisions (see f, figure 2).

These patterns show that the information-seeking-and use understandings could not be isolated. Each strand influenced the others, and students moved like expert tightrope walkers from one to the other whenever the situation warranted it.

Information-Seeking Activities

Table 1 describes the information students actually used rather than the information sought. Students used visual information to link with commentary or music that they later dubbed onto tapes. Sometimes they used both the sound and the visual of a videotape; that is labeled “combined visual & oral information.” In two cases, students converted information they had obtained orally into a script that one of them read. Similarly, in two other cases, they converted printed information into a script. Finally, they used musical information as background for various segments of their videotapes.

Table 1. Information Used in the Videotapes

Table 1

Information Used in the Videotapes

Types of Information	Source of Information
<i>Visual Information</i>	
Local scenery (8)	Student taped
Slides converted to video by students (1)	Teacher
Maps (2)	Adult friends
<i>Combined Visual and Oral Information</i>	
Commercial video (1)	School library
Interviews (9)	Student taped
<i>Oral Information Converted to Script</i>	
Interview (2)	Student obtained
<i>Printed Information Converted to Script</i>	
Children's books (1)	School library
University departmental brochure (1)	University dept.
<i>Musical Information</i>	
Rock music audiotapes (3+)	Student owned
Commerical videotape (1)	Video rental

Even though this assignment might be classified as a resource-based unit in which students would use a variety of library sources, students used surprisingly little information that they obtained in libraries. That does not mean they did not try to use libraries; they did. They simply did not find information there that they could use. The situation was even worse than it appears in table 1. In the two cases in which information from the school library media center was used, it was found by chance and not as a result of using bibliographic aids such as the electronic catalog. In both cases, the information was located by a student who worked as a student aide in the library media center. In one case, he knew where the books about alligators were shelved and

went directly to the shelf to look for information. In the other case, the same student was shelving videotapes and quite by accident came across a commercial videotape about alligators.

Why this lack of library resources? Why did students not locate information they could use either in their school library media center or in the nearby university libraries? The data showed clear patterns, and those patterns can be interpreted in terms of mental model theory.

Reasons for Unsuccessful Use of Libraries

Incomplete Subject-Matter Mental Models. Incomplete subject-matter mental models led to incomplete identification of information need. The analysis of the students' information-seeking activities shows that most were driven by very general information needs. When asked what kind of information they were seeking, students frequently responded by restating their topic or with a shrug and phrases such as "I don't know," "Anything we can put on the video," and "Whatever."

It is probably true that most people who begin a new research project are at first novices in the subject matter involved. If those people have expert information-seeking and-use understandings, however, they know how to use the information skills to strengthen the subject understandings. They might, for example, know how to find general, overview information as a first step and thus obtain the expertise necessary to identify clearly the information needs. This idea can be expressed in the following equation:

novice subject understandings + expert information skills = students who may use information skills to find information necessary to strengthen subject understandings.

In the opposite case (people with expert subject understandings but novice information skills), students know enough about their topics to articulate their information needs clearly to an information professional. This situation can be represented by another equation:

expert subject understandings + novice information skills = students who may articulate information needs clearly to those who can help.

But if subject understandings and information skills are both weak (as was the case with most of the students in this study), students have little chance of being able to progress on either strand. One strand cannot support the other. A third equation represents this dilemma:

novice subject understandings + novice information skills = students who are not likely to make progress on either strand.

Limited Mental Models of Information-Seeking-and Use Systems. A second reason for unsuccessful use of libraries was the students' limited mental models of information-seeking-and-use systems. In other words, they lacked framework understandings of the organization and types of information in libraries. Nearly always they looked in only one place—the electronic catalog. When that source failed to lead them to useful information, they assumed the information they needed did not exist in that particular library. This was not a matter of their "giving up easily." They did not give up; instead, they nearly always pursued an alternative plan

that involved searching outside the library. They might, for example, decide to set up an interview.

Another example of this problem involved searching for journal articles, a logical source of information for the topics the students were researching. Students simply did not know how to access journal articles, however. One student who was trying to find information in magazines explained to the researcher that he had just looked in the SIRS printed volumes held by the library. The exchange continued:

Researcher: Why did you choose to look there?

Student: Well, because magazine articles usually have statistics on different things, but I didn't find any.

Researcher: And you knew those were magazine articles. Have you used those before?

Student: Yeah, I've used the SIRS. A long time ago, but I used them.

Researcher: And is there any other way you're going to try to look for a magazine article, or do you know? *Student:* Not at this point in time.

Researcher: If you decided to, is there another way to approach it?

Student: I don't know. I'll probably ask some people.

Researcher: Yeah.

Student: And find out some other ways of finding statistics.

Researcher: Who would you ask? Do you know?

Student: I don't know.

Ultimately, the researcher asked nearly every student in the class to describe how he or she would locate a journal article at the nearby university science library, which the teacher indicated they had all used during the previous semester. Some students described going directly to the shelves holding the marine biology journals, pulling bound volumes at random, and browsing the tables of contents of the various issues. Others described wandering the aisles of the current journals, stopping to check tables of contents. Still others described a convoluted process in which they used the monograph database of the university's electronic catalog to locate journals about their subject. As one student said:

It's time-consuming with the computer, because you have to sit there and brainstorm and say, "OK, let me think of a title that I can type in that might have to do with stingrays." Last time, we had to look up stingrays. I went there many nights. You just have to sit there and type up stuff, type up stuff, and type up stuff. You had to keep on thinking of different subjects that the computer would know. I mean, you had to be specific.

The sad irony of the students' struggles was that there was a science index mounted on the university's electronic catalog system. There were many terminals in the science library and even one in the school library media center. In addition, the school library media center contained much useful information, such as the print volumes of the *Readers' Guide* and the full-text CD-ROM of the SIRS volumes.

These students were not overwhelmed by too much information. Instead, they were floating in a sea of information but did not know how to access more than a few useful drops. The journal

situation was caused in part by the limited mental models of both teachers involved in the unit. One had just completed a master's degree in science education; the other was currently in the program. Yet neither knew how to access information in journals. One teacher had taught his techniques to the students, which was why so many tried to use the monograph database for access to journal articles.

The substitute teacher used a different approach in her research. She described browsing copies of magazines she liked (such as *Nature*), finding an interesting article, and then following up on the bibliographic citations in that article.

Inaccurate Adult Mental Models. A final problem that interfered with students' using libraries successfully was the inaccurate mental models that adults had either of the students' subject-matter expertise or of their information-seeking-and-use skills. This problem occurred consistently when students tried to use the university libraries.

Students seldom asked for help, but when they did, the adults provided locational advice only, sometimes even taking the student to the correct shelf. But the information to which they led the students frequently was not appropriate for that student's information needs. In other words, the adults met the students where they thought the students were rather than where they actually were on a particular strand, and provided physical access to information when intellectual access was needed.

Sometimes the problem was the subject-matter strand, and the adult assumed students were more expert than they were in their subject understandings. Other times, the problem was on the information-seeking-and-use strand, and the adult assumed the student had asked for the most appropriate type of resource. This finding seems to support some of Kuhlthau's work, which describes a "bibliographic paradigm" that focuses on sources of information rather than on the people using them.(5)

Using the Information

As the marine biology students chose information for their videotapes, organized it, and created the final product, they completed a number of complex activities. In most cases, their understandings and mental models (either those from their prior learning or those constructed during the unit) were adequate to allow them to fulfill the minimum requirements of the project; nevertheless, these understandings were, for the most part, novicelike. The teacher's perception of how to foster life skills meant that students had to channel their energies into finding their own way through the task.

During activities that involved choosing information, students established their own criteria. In most cases, those criteria related to the students' visions of the final videotape (e.g., Was the information interesting? Did the ideas fit their refined topic?). Most students did not show an inclination to use the project as a way to expand their subject-matter understandings. In addition, little questioning of the information occurred. Plagiarizing a source was seen as a reasonable and accepted way to add information to the final videotape.

Organizing the information seemed to be a difficult task for many of the students, although some organized merely by using the information in the order they found it. Those students who used the structure provided by the teacher or created a new organization had to make many difficult decisions about what information went where.

The technical aspects of the unit, especially the video editing, absorbed much student time and effort during the unit. Most began the unit with no experience in video editing and ended with new understandings and skills related to editing. Some acquired complex new abilities; others began to see new possibilities. For much of the unit, activities on the production strand (especially the editing) dominated students' efforts.

Conclusions

The major finding in this study was that students did, in fact, depend on their prior learning to help them solve the problem. It is important to note, however, that the information seeking-and-use knowledge was never accessed in isolation. In other words, students always used their information-seeking-and-use knowledge in conjunction with a subject matter. If this finding can be applied beyond this study, it means that every unit in which students will be using information-seeking-and-use understandings involves, of necessity, at least one other knowledge domain. In this study, students used four major categories or domains of knowledge: subject matter, information seeking and use, life skills (e.g., decision making, problem solving, taking responsibility, planning, and communicating), and video production. When students faced a problem embedded within their assignment (e.g., when they had to choose a topic, locate information, or organize their information for the video format), they first had to categorize that problem as being a part of a specific domain and then check for helpful prior learning. If their prior learning in that domain was not adequate to help them solve the problem, one of three things happened: They used learning from another domain; they tried to acquire or construct the necessary new learning; or they did an inadequate job. For example, if they tried to locate necessary information using library resources but did not have the skills to do so, they might switch knowledge categories and use life skills to locate a person to interview for information. Sometimes there was no way to “finesse” the problem by using another domain, and then the students either had to acquire new learning in some way or do an amateurish, poor job. Both occurred among the students observed.

Throughout the project, students faced serious problems. Even though information was readily available in libraries in their immediate environment, students did not have the skills needed to access it. They did want to succeed, and they did have the skills to gather some information from sources other than libraries, combine it with what they already knew about their topic, and complete the assignment. But not much learning took place on any of the strands except, for some students, on the production strand. Partly because of the students' limited information-seeking-and-use skills, their growth in subject-matter understandings was restricted. Because no adult was systematically supporting the information processes, the students' subject matter learning was constrained.

Perhaps instead of conceptualizing the learning strands as being inextricably entwined, the strands should be viewed as woven together to form a web that supports new learning. If one or

more of the strands are weak, students' abilities to construct new learning on the prior learning network will be severely limited unless they receive some type of support to strengthen the weak strand or strands.

Implications

What are the implications of these findings for professionals? Related to the grounded theory discussed previously is an educator corollary. To plan and conduct a successful learning experience, educators must view the experience holistically; that is, they must emphasize the construction or development of new understandings within the context of the whole task. The whole of this learning event will be composed of a variety of intertwined learning strands, each of which influences and is influenced by all others.

Though the study was conducted with a small group of students and cannot be applied to every situation, the depth of understanding provided by these findings should lead professionals to examine their own situations in a new way. The implications of this study will be examined in three parts:

those that have meaning for school library media specialists and classroom teachers, those that are important to professional preparation programs, and those that researchers should consider.

For School Library Media and Classroom Professionals

Complex resource-based units should always be viewed as a whole—i.e., as based on a system of interrelated learning domains. At a minimum, these units will contain one subject-matter strand and several process strands, such as information seeking and use, decision making, and problem solving. Multidisciplinary units will have two or more subject-matter strands. If the background of the whole is lost, students are likely to develop only fragmented, isolated new understandings rather than the complex mental models necessary to support learning on all the strands.

Because such units are so complex, a team of experts should be involved in the planning, teaching, and evaluation. The school library media specialist is an essential member of this team. Obviously, the classroom teacher will most often serve as subject expert and the school library media specialist as the expert in a variety of other strands, such as information seeking and use, production, and planning. Other experts who might be involved include the school counselor to support group processes and a reading specialist to help with the construction of meaning from written text.

Careful consideration should be given to the understandings and mental models students have in place as they enter a unit of study. These understandings will be the basis of all new learning. They can be assessed by talking with and observing students as they work. Simply considering the past activities in which students have participated probably will not provide effective information about the understandings attained, because the expected construction of understanding may very well not have taken place in previous units.

School library media professionals should act as “bridge builders” who connect and provide essential support for both content and process learning by frequently proposing collaborative units to individual faculty members or teams. The collaborative approach to teaching represents a new paradigm for most educators, and helping to ease the transition into this mode is perhaps the school library media specialist’s most important role in a restructuring school.

For Professional Preparation Programs

Professional preparation programs, for both school library media specialists and classroom teachers, should enable pre-professionals to develop the skills necessary to identify all the learning strands that are a part of any unit. Units or other learning activities should be viewed as a complex web of interrelated learning strands. In the example of this study, four learning strands were interacting: subject matter, information seeking and use, life skills, and video production. Significant new learning will be far more likely to occur on any one strand when all of the strands are supported.

Professional preparation programs should help pre-professionals develop the mental models necessary to support collaborative planning, teaching, and evaluation. ‘Mis development of new mental models should be supported with opportunities to practice the skills both in education classroom settings and in internships. Pre-professionals should be encouraged to recognize the strengths they can bring to a planning/teaching team and the support they can expect from other educators.

For Researchers

Information seeking and use should frequently be studied in a natural context rather than in an artificial situation. The natural situation provides the opportunity to see the situation from the perspective of the participants rather than from a pre-imposed perspective, and allows researchers to examine the underlying understandings of people involved in natural, information-rich situations. Within this context, information-seeking-and-use skills should not be separated from other skills and understandings that are part of the learning situation. The realm of content and process interactions should be more thoroughly investigated. The role of specialists in the areas of content and process, the way in which they support these learning strands, and the most effective combinations of content and process learning strands are of great interest.

Both novice and expert understandings about information seeking and use and the nature of the movement from one to the other within real-world contexts should be investigated. How do the behaviors and mental models of novices and experts in both subject areas and content areas differ? How do mediation strategies affect a student’s movement on the novice-to-expert continuum of each learning strand?

A Final Word

This study has added a significant new understanding to the theoretical knowledge of how students make decisions during information-seeking-and-use activities: These activities are an inseparable part of a whole context. In this study, the whole context was a learning experience

that involved a variety of both content and process learning strands. Information-seeking-and-use behavior could not be entirely divorced from that context, because the context affected, and perhaps even determined, the behavior.

Understanding information seeking and use within its various contexts must continue to be extremely important to educators and library professionals. Today's students face an increasing flood of information; they must somehow turn that flood into ideas and knowledge that they can use to better their own lives. Young people who are dealing with these complex tasks deserve to have their behavior studied and analyzed as they make their first tentative attempts to become expert information seekers and users.

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