

# Constructing Mental Model Paradigms for Teaching Electronic Resources

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*Library media specialists activate numerous mental models when teaching electronic information literacy database access, research, and retrieval in the context of authentic school assignments. The paper identifies these models and examines what occurred when the mental models in a study sample interconnected in the complex changing environment of a lesson. Discussion focuses on the changes to the mental models the library media specialists held with respect to the electronic database, the role of the library media specialist, the lesson goals, and their teaching strategies. Findings suggest that (a) most of the library media specialists' mental models of teaching with electronic databases were influenced by their models of teaching access, research, and retrieval with print resources and (b) even though many library media specialists identified the necessity to incorporate mental model changes for more effective teaching, these were not sufficient to counteract their habituated teaching behaviors.*

New policy thrusts in education are increasing the range of electronic learning technologies for use by students, placing them as central to the core curriculum, and calling for equitable access to information via these technologies (Tallman 1998). Part of this equity includes individualized instruction to help students “develop a systematic mode of inquiry to gain physical and intellectual access to information and ideas that reflect diversity of experiences, opinions, and social and cultural perspectives” (American Association of School Librarians and Association for Educational Communications and Technology 1988, 29). Effective teaching of computer-based electronic resources requires library media specialists to have appropriate mental models of the characteristics and protocols of these resources and strategies to teach competent problem-solving access, research, and retrieval skills to meet the needs of individual students. One method for constructing mental-model profiles of library media specialists is to explore their mental models in situ. This involves identifying changes to the mental models during and after teaching episodes. This paper demonstrates that constructing a representative teaching paradigm for the library media specialists in the study sample involved examining the relationship between various mental models. It reports the study of the interconnected relationships of various mental models utilized by ten American and Australian library media specialists when involved in one-on-one teaching-learning episodes with students using electronic resources in the context of information-seeking for authentic school assignments.

## Mental Models

Mental models “are deeply ingrained assumptions, generalizations, or even pictures or images that influence how we understand the world and how we take action” (Senge 1990, 8). They can be defined as a schema or internal domain-specific representation of an object, system, or event that may be incomplete. Through the mental model, the individual can explain, infer, predict, and understand phenomena in order to decide what action to take to control its execution (Johnson-Laird 1983; Bliss and Ogborn 1989; Renk, Branch, and Chang 1993). Thus, mental models are created for a purpose; they are not optional extras (Green 1990). They act like tools to allow individuals to understand problem situations, choose potential solutions, and predict outcomes as a consequence of their actions. Students and library media specialists are continuously processing their schemata for each situation as a “runable” event. This concept of “runability” is a core defining characteristic of a mental model. As a processing mechanism, runability is a process rather than a product (Jih and Reeves 1992; Randell 1993; Rogers and Rutherford 1992). When mental models are run, they are constantly in a state of change in a teaching-learning situation as new information is attached to them or context-irrelevant information is deleted.

“Mental models” is an accepted concept in the human-computer interaction literature (Staggers and Norcio 1993). Even so, the research literature dealing with mental models and use of electronic information literacy databases tends to have a narrow focus. First, it concentrates on the learner, user, or instructional designer rather than the library media specialist, librarian, or teacher (for example, Stine and Wildemuth 1992; White 1994). Second, information literacy database research usually attempts to establish whether there was a transition in the user’s mental model conceptualization of the information literacy database from naive to expert, and proceeds to explain why this did or did not occur (Carmel, Crawford, and Chen 1992; Doomen and Leuven 1997; Jacobson and Jacobson 1993; Moray 1986). Third, electronic information literacy database literature devotes little attention to the multiplicity and interactions of the mental models simultaneously held by the participants and, significantly, how these various mental models interact when they are being run (Randell 1993). Thus, this paper does not concentrate on the student as user or on a comparison of the library media specialists’ initial and final mental models (cf. Carley and Palmquist 1992; Randell 1993). Rather, it examines what occurred during the running of various interconnected mental models held by the library media specialists in the complex changing environment of a lesson.

## Methodology

### Sample

The researchers employed a purposeful sample in the United States of one elementary, one middle school, and four secondary media specialists, each with two student participants. These library media specialists, located in Georgia, were selected by the differences in experience and teaching background. The study was replicated in Queensland, Australia, with library media specialists chosen to correspond as closely as possible to the United States sample. The students were chosen by the classroom teacher at the request of the library media specialists and had an authentic assignment that required the use of an electronic database resource.

## Data Collection

According to researchers (Mevorach and Strauss 1995; Rowe and Cooke 1995; Sasse 1990), mental models are not directly observable; they must be inferred from performance on some measures. There is no agreed-upon method, but the following, including combinations, have been found useful: interviews, think-aloud protocols, stimulated recall interviews, videotaping, computer tracking of the user's interactions, and multivariate statistical techniques. A qualitative study with the following data collection instruments was utilized. The variety allowed necessary triangulation of the data in order to obtain before, in-action (Mevorach and Strauss 1995), and after mental model paradigms.

### Individual Pre-Episode Interviews

Audiotaped interviews using structured, open-ended questionnaires were conducted with each participant at the beginning of each teaching-learning episode. These interviews asked "big picture" questions, such as "Tell me your mental image of this database." The open-ended questions were grounded in the data, that is, they were based on a pilot interview with an experienced library media specialist and the work of researchers who had previously investigated mental models.

### Video- and Audiotaping of the Teaching-Learning Episode

Each teaching-learning episode, which was conducted in situ in the library, was video- and audiotaped. In order to obtain a realistic situation (Reeves 1995), the library media specialists were asked to replicate their normal teaching practice. Thus, the sessions varied in length, lasting as long as the library media specialists maintained the instructional interaction. Special videotaping apparatus was required to create a split-screen effect for the stimulated recall sessions. To provide the best stimulated recall, participants needed to see both what was on the computer screen and their own verbal and nonverbal reactions. To achieve this dual image, the video portrayed a picture within a picture. The researchers used a mixer to pair images from a video camera focused on the participant with the digital signals from the computer screen showing the database content and keystroke and mouse responses.

### Process-Tracing Stimulated Recall Interviews

Individual process-tracing stimulated recall interviews based on the videotaped episode were then conducted. The methodology adhered to the strict protocol developed in Australia for text and interactive multimedia qualitative studies (Marland, Patching, and Putt 1992; Putt, Henderson, and Patching 1996). Each videotape was replayed to the library media specialists to stimulate their recall of their thinking during the episode. The researchers took each library media specialist individually back through their interactions during the episode. The researchers asked the library media specialist to volunteer their own statements about their thoughts at the time of various verbal or nonverbal incidents depicted in the video replay or respond to the researchers' questions asking them what they were thinking during those incidents. These videotape-replay interviews were audiotaped and conducted as soon as possible after each video session in order to diminish intervening distractions. Both researchers jointly interviewed each library media specialist to strengthen internal research validity.

## Post-Interviews

Two individual post-interviews containing a set of open-ended questions were administered and audiotaped. One was conducted immediately after each stimulated recall interview while the final, smaller post-interview was administered to each library media specialist at the conclusion of all previous data collection sessions. The purpose of both post-interviews was to increase detection of any changes in the library media specialist's mental models. The post-stimulated recall interview gave the library media specialist a place to explain the relationship between the mental models they held prior and after each teaching-learning episode. Importantly, it also allowed the library media specialists to comment on any perceived changes to their mental models during each lesson. Besides providing a last opportunity for reflection, the final post-interview permitted the library media specialists to identify any changes they in the second teaching-learning episode as a consequence of the first lesson or the research itself. Thus, by having the library media specialists each teach two students, the researchers could identify any adjustments in the library media specialists' mental models in response to each student's needs and the library media specialists' reflections.

## Findings and Discussion

From analysis of the data, the researchers identified various mental models utilized by the library media specialists during the teaching-learning episodes. By triangulating the data, it was possible to construct a "before," "in-action," and "after" profile of the mental models of the library media specialists' as teachers of electronic information literacy databases. Those selected for discussion are mental models of: (a) the electronic data base, (b) the role of the library media specialist, (c) their lesson goals, and (d) their teaching strategies. This paper is concerned with examining the runability of these mental models in the in-action stage of the teaching-learning episode. Hence, the before and after profiles are summaries of the findings that, nevertheless, help provide a contextual overview.

### The "Before" Profile

The before profile contained [several] the following types of mental models. All media specialists held perceptions that their mental model of the database was satisfactory. Their mental models of the role of teachers contained samples of teacher-as-expert, teacher-as-director-of-events, teacher-as-colearner, and teacher-as-facilitator. Their teaching strategy mental models advocated a hands-on approach with the student in control of the keyboard and mouse. Their mental models of what constituted appropriate planning resulted in the following sorts of preparation: only a couple had one or more practice sessions on the database; none developed pencil-paper lesson plans; most reactivated their schema to massage certain teaching strategies into some sort of mental procedural list and some relied on their years of experience to allow them to utilize their mental model "on the fly." There was variation in the teachers' mental models of their lesson goals: some saw student procedural understanding as the outcome; a few aimed for a conceptual framework in which were located the procedural steps of access, research, and retrieval; many saw a tangible outcome—a printout of a list of references or information—as the appropriate goal. Teachers employed additional mental models, but this summary nevertheless illustrates the number of mental models that library media specialists use in any teaching-learning episode and the range that occurred within the research sample.

## The In-Action Profile

An examination of the in-action library media specialist profile highlights the effect that changes in one mental model had on other mental models.

### Mental Models of the Electronic Information Databases

Not surprisingly, all the library media specialists perceived they had an adequate mental model of the electronic database for the lesson they chose to meet the students' assignment needs. The teaching-learning episodes exposed discrepancies with these perceptions. Analysis revealed that the mental models ranged from flawed to reliable depending upon the level of working knowledge of the database that the teachers possessed. Significantly, understanding of the complexities of the databases fluctuated within several of the inadequate models. Such inconsistencies in their mental models of the database had repercussions for the library media specialists' mental models of (a) the role of the library media specialist and (b) the teaching strategies utilized during the lesson. The following example helps clarify what happened due to inconsistencies.

Two media specialists experienced nearly identical "technical nightmares," that is, breakdowns in their mental model conceptualization of the database protocols when attempting to establish dial-up access through the Internet to a university and a public library, respectively. Certain of their other mental models impacted the inadequate mental model in practice to produce different scenarios. One media specialist's mental model of herself as a library media specialist of electronic databases was that of co-learner with the student. Putting her mental model into practice, she openly discussed her bewildered lack of success with the student and ensured that the student was co-solver of the library media specialist's predicament. During the stimulated-recall interview, the library media specialist stopped the video and pointed to the TV screen:

. . . I was thinking there, I see it as valuable, the fact that they see their teachers learning too, that I don't know everything. I've never ever claimed to know everything and I don't hide that. I see that as a valuable part of their learning.

The library media specialist stressed that she consciously thought that her teaching strategy demonstrated her mental model of the library media specialist as co-learner and that it would help the student create a new (or reinforce her existing) mental model of the legitimacy of the library media specialist as a continuing learner. In contrast, another media specialist's mental model of herself as library media specialist permitted ambiguity: it allowed her to admit errors while still maintaining the role of director-of-events:

The modem is actually dialing out . . . We're waiting. I heard somebody talking but I don't know why. It didn't connect. Maybe [I] forgot the number! [She did and told the student the correct number to dial.] Now enter. Did you mash enter? . . . I don't hear it dialing. Mash enter again. Back up. It's not letting us escape out either. Let's start over . . . I don't know what happened. It's connected now.

She reported that her overriding consideration during technological "moments of panic and discomfort because of unfamiliarity with the database," involved a mental model of the role of library media specialist as expert: "I was concerned a little bit about my own image . . . I didn't

want to come across as if I didn't know what I was doing." Her mental model involved her normal immediate preference for "abandoning ship" and asking the student to come back later. Time-out would allow her to develop a more consistently near-expert mental model of the database that, in turn, would reestablish her mental model of herself as library media specialist-as-expert with electronic information databases in both her own and, ipso facto, the students' eyes. Because of her mental model of the appropriate role for a media specialist, she overlooked the possibility of inviting her student's involvement in finding solutions.

### **Mental Models of Lesson Goals**

Most library media specialists' mental model of the lesson goal were for the students to (a) acquire procedural understanding, that is, be able to repeat the procedures for access to the database and location of appropriate content and (b) obtain the best immediate resources for their assignments. These objectives dovetailed nicely. For these, the goal was that the session be useful for the students. "Useful" was interpreted as having a resource of value, a printout of reference call-numbers of books located in the public library or printouts of articles from the World Wide Web. Thus, the library media specialists had a mental model of the electronic database as a tool to be used by the students when finding resources for assignments. Their aim was that the students follow and be able to repeat the procedures necessary for access to, searching, and retrieval from, the database.

A few of the media specialists helped their students form a mental model or image of the resource itself in its broader dimensions. According to researchers (Borgman 1984; Brown, Collins, and Duguid 1989; Schmalhofer and Kuhn 1990), in order for students to acquire a reliable mental model they need to be exposed to the use of a domain's conceptual tools through how-it-works-instructions in an authentic activity. Teaching with the goal of obtaining a successful product, such as a list of appropriate resources, has been a traditional approach for text-based resource location and access. The approach concentrated on imparting a set of procedures for the student to follow. Its transferability to teaching with electronic resources, as demonstrated by some of the media specialists, is problematic. When confronted with electronic resources, users do not have the opportunity to see everything that the database contains or how the content is structured, which they can easily do by flicking pages of print resources. They are confronted with one computer screen with one page of information. It is therefore difficult to create a reliable mental model of the database, its type of information, and the role of hypertext and hypermedia linkages to the information necessary for successful information literacy searches.

### **Mental Models of Teaching Strategies**

All the media specialists held mental models of how to teach database access, research, and retrieval that reflected an important tenet in Piaget and Bruner's learning theories, that of direct experience. Students were to have hands-on experience with the computers: "You need hands-on if you're dealing with a computer . . . if a learner does not have that concrete touching interaction that's personal, then the retention is just minimal." Some library media specialists shared this mental model with their students, thereby making the rationale visible in terms of student learning outcomes: ". . . you will remember more if you do it yourself instead of my just telling you how to do it." Most initially had an image of sitting beside the student who had control of the keyboard; some did not succeed because their mental model in-action was affected by their

assessment of the student's ability: "The temptation to touch the keyboard was too much given the student's hesitancy, and I sort of jumped in." Others encompassed a show-and-tell-then-copy-me strategy whereby the students took control during the latter half of the lesson in order to demonstrate their ability to replicate the library media specialist's procedures.

Although all allowed hands-on, many library media specialists used directive statements or questions; only a few adopted a questioning technique that involved procedures, predictions, and consequences of the database's navigational and hypermedia features. An examination of the interconnectivity of two library media specialists' mental models with respect to their lesson goals, teaching strategies, and role of the library media specialist helps clarify these points.

One media specialist concentrated on the student's acquisition of procedural skills while the other saw conceptual as well as procedural understanding as the important learning outcome. Both used questioning strategies. A simple tally of the number and types of questions from the transcriptions of the videotaped lessons revealed significant differences. The first library media specialist asked 79 questions, of which 30 (38 percent) required a yes/no answer and a further 34 (43 percent) were also of the closure type needing the correct answer. The second library media specialist asked 54 questions, of which 11 (20 percent) required yes/no answers with a further seven (13 percent) being closed-answer questions. For the first library media specialist that left a mere 15 (19 percent) questions that demanded higher level thinking from the student; for the latter, a substantial 36 (67 percent). Both sought answers requiring deduction, prediction, and interpretation; however, the teacher whose goal was for the learner to be able to conceptualize the relevance of the hypermedia and navigational features of the database also required the student to compare, explain, synthesize, and extrapolate. Not surprisingly, the former teacher's mental model held the teacher-as-director-of-events whilst the latter depicted the teacher-as-facilitator. Analysis of the data revealed that there was no conflict among the media specialists' mental models of their teaching strategies, their lesson goals, and their role as the teacher.

## **The After Profile**

The profile of the teachers' mental models at the conclusion of the study revealed that some media specialists made dramatic changes to some of their mental models, for the better, in their perception; others made modifications to counteract weaknesses; and some maintained the status quo. This last group retained a mental model that essentially held that there was one way to teach electronic database skills regardless of the student's age, learning style, level of computer and database expertise, student outcome needs, and, indeed, the database itself. Data suggested that they did not recognize the inappropriateness of these mental models, particularly when teaching the lessons. Data also revealed that the "status quo" group and a few of the other media specialists had no perception that their mental models as carried out in practice (the in-action stage) did not reflect their "before" mental model. Interestingly, some media specialists did perceive this, and acknowledged this verbally in their first post-stimulated recall interview. However, the mental models evidenced during their second teaching-learning episode did not reflect their earlier statements and belief that they had now, indeed, incorporated the changes to their mental models.

## Conclusion

The purpose of the study was to delineate the implicit in-action mental models of library media specialists when teaching information literacy access, research, and retrieval with electronic databases. The before, in-action, and after mental model paradigm highlighted how different mental models influenced the library media specialists' teaching when rescuing an inadequate mental model (in this instance, the database dial-up protocols), how the mental models interacted, and how questioning was affected. Findings indicated that the in-action mental models of their conceptualization of the database, role as library media specialist, lesson goals, and teaching strategies directed the library media specialists' teaching. Indeed, their mental models acted as a controlling element, defining the library media specialists' responses to situations occurring in the teaching-learning episode.

Our study suggests that mental models are ingrained during initial experience with print resources and the procedures used to teach access to information in print resources. Thus, transition to electronic resources requires changing some mental models to incorporate a reliable conceptualization of electronic databases into their mental models. Acknowledgment of flawed mental models after a teaching-learning episode appears to be inadequate for change to occur in subsequent teaching-learning sessions.

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