DOCUMENT RESUME

ED 249 925 IR 011 344

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TITLE	Information Management Tools for Classrooms: Exploring Database Management Systems. Technical Report No. 28.
INSTITUTION	Bank Street Coll. of Education, New York, NY. Center for Children and Technology.
PUB DATE	Jul 84
NOTE	33p.; For related document, see IR 011 340.
PUB TYPE	Reports - Research/Technical (143) -- Tests/Evaluation Instruments (160)
EDRS PRICE	MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS	Case Studies; Computers; *Computer Software; *Databases; Elementary Secondary Education; *Information Retrieval; *Information Seeking; Interviews; Observation; Online Systems; Problems; Research Methodology
IDENTIFIERS	Computer Uses in Education; *Database Management Systems

ABSTRACT

In order to understand how the database software or online database functioned in the overall curricula, the use of database management (DBMs) systems was studied at eight elementary and middle schools through classroom observation and interviews with teachers and administrators, librarians, and students. Three overall areas were addressed: teachers' backgrounds in teaching and computers, the information-seeking activities that teachers required of their students and the curriculum context in which they occurred, and the use of the specific database system and its relationship to students' information-management skills. Results indicated that the DBMs were implemented in varied ways depending on software selection, schools' philosophies about computers, teacher selection and training, type of database activities, and problems in classroom use. Problems noted relate to the rigid information format required by software, inability of the software to allow for definition changes, limited hardware access, math and programming as exclusive domains for computer use, insufficient teacher training, limited classroom information-based activities, and students' math and reading skills. This report includes in-depth case study reports of two of the schools, a summary, conclusions, and the teacher interview guide. (LMM)

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ED249925

Information Management Tools for Classrooms: Exploring Database Management Systems

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Technical Report No. 28

July 1984

IR011344

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INFORMATION MANAGEMENT TOOLS FOR CLASSROOMS: EXPLORING DATABASE MANAGEMENT SYSTEMS

Carla Freeman, Jan Hawkins, and Cynthia Char

The present decade is commonly referred to as the "information age." Children and adults have greater access to computer-based information technology (e.g., personal computers, videotext, interactive videodiscs, information networking, electronic mail). The ability to flexibly organize, manipulate, and communicate information is becoming an increasingly important skill for students to acquire. But technology alone, no matter how pervasive, cannot be simply imposed on people; its potential must be adapted to functions required in particular contexts. Some segments of society--most notably the business and communications industries--have been actively engaged in applying the unique features of computers to their needs, and in making these tools available to nonspecialists. However, the potential of computer technology has not yet been systematically adapted to educational settings, nor has the impact of the information "revolution" been effectively incorporated into the learning experiences of children. One junior high school teacher expressed this concern in the following way:

> We keep hearing about how we're moving into an information-based society and how information is really a currency, so to speak...that people who have information have some kind of power. But [how does this fit into the activities that kids in school are involved with], that's a good question.

Information organization and management are skills required of students, often beginning in elementary school. Formulating and answering questions, reading, and summarizing bodies of content material are frequently a large part of students' assignments across subject areas (e.g., social studies, English, science). In this paper, we are concerned with the ways in which children learn how to access and use information. We are interested in exploring the potential of computer technology to contribute to this learning. As part of this work, we have been examining one category of information-handling software--database management (DBM) systems. DBMs are generally used as business and office tools to help people do a variety of information-handling functions (e.g., to organize, integrate, store,

query, and retrieve bodies of information), but they also present possibilities for educational applications.

Unlike CAI (computer-assisted instruction) software, which commonly drills students on particular content matter (e.g., vocabulary and mathematical computation) DBMs are tools. Rather than presenting specific material or information, this software has the potential for facilitating the process of organizing, manipulating, and accessing information. Like word processors, DBMs may be thought of as computer tools rather than as delivery systems for prepackaged material. They are used extensively in such settings as hospitals, libraries, and businesses in which large quantities of information are utilized and retrieved for solving problems and answering questions. By creating files, the DBM user not only has ready access to specific information in a format which s/he has created, but can sort the information by particular categories within that overall structure.

Because of the rapid introduction of computers into schools all over the country, it is important that we examine ways in which they may be integrated smoothly and effectively into existing curricula. The computer need not be viewed as a discipline per se (i.e., "computer literacy" as a separate curriculum area), but as a unique tool for encouraging activities and skills already stressed in the established subject areas. As part of our program of research in this area, we wanted to know how this type of software tool is currently being used in schools.

We made contact with many school districts around the country to locate elementary and middle schools which are making use of DBMs. We found that, as yet, relatively few schools are integrating DBMs into the classroom context; much more common is the use of database software for such administrative purposes as keeping records of student grades or attendance. However, eight sites that seemed to be actively using DBMs with students in interesting ways were located and selected for investigation and analysis. In each site, classrooms were observed and teachers, students, and administrators were interviewed.

In this paper, we will discuss: (1) the goals and ideas which led teachers to use DBMs; (2) the content and context of these activities; and (3) some interpretations of their impact on children and the classroom. Since our approach to this phase of the research was largely ethnographic, more complete descriptions of two classrooms, in case-study form, will follow this overview.

Sample

The schools and teachers for this study were selected on the basis of their involvement with DBMs. We contacted both public and private schools located in the northeast, although all of the schools we found to be involved with DBMs were public. These elementary and middle schools ranged in size and setting from wealthy suburban districts in New Jersey and Massachusetts and a small alternative school in Pennsylvania, to large inner-city Manhattan schools (see Table 1).

Method

Teachers, and in some cases, administrators, librarians, and students were interviewed in order to understand how the database software or on-line database functioned in the overall curricula. We discussed issues relating to the benefits and problems encountered (or anticipated), as well as the content and context of implementation. We were interested in finding out not only about how databases are being used, but also how information in general is thought about by teachers, and how teachers convey these ideas to students. Using structured interviews (see Appendix), we addressed three overall areas:

1. Teachers' backgrounds in teaching and computers, the information and software resources they used, and the circumstances that led them to begin using DBMs with students.

2. The information-seeking activities that teachers required of their students, and the curriculum context in which they occurred (e.g., the times/occasions they asked students to find out about something, and the process by which a student would find the answer to a question or "research" a topic).

3. The use of the specific database system and its relationship to students' information-management skills (i.e., what they did with the software, what skills appeared necessary to use a database system well, what skills might be facilitated through using the DBMs, students' problems with using DBMs and whether these problems varied across students). Teachers' conceptions about research skills, and the ways in which they were taught to students were considered critical features of our interest in the use of DBMs.

Results

We observed a wide range of ways that DBMs were implemented in schools. A number of factors appeared to influence the form and direction of a classroom database activity:

Table 1

School Sample

School	Grade(s)	Programs Using Tool Software	Software	Activity System	Goals for Use
1. Belmont Elementary*	5th	No specific subject	Window: "Notebook"	Personal interest file, book reports	Summarizing, notetaking
2. Lincoln Elementary	5-6th	Gifted program	Telecommunication system	Share essays, compositions	Brainstorming, sharing information
3. William Penn Junior High (Alternative)	6-8th	Computer literacy	Public domain DBMs, PFS file	Create DB geography/interest project	Organize, integrate, relate information
4. Cedarbrook Junior High	7-8th	Social studies, U.S. history	Dow Jones online DB	Research, relation questions, encyclopedia searches, data analysis	Being specific, logic: conditional reasoning
5. Ravenswood Junior High	7-9th	Computer science	PFS file	Business activities: ties; payroll, phone list, etc.	Organizing, notetaking, speed, accuracy, introduction to business
6. Jefferson Junior High	8th	Business education	PFS file	Business tasks	Job preparation
7. Washington Junior High	9th	Not being implemented	PFS file, Easywriter	No specific activity, some word processing	
8. Ramsdale Junior High	9th	Law, World history	PFS file	Create and use historical DBMs for research	Organize information, promote "schematic thinking"

*The names of the schools have been changed.

1. The selection of software. Did teachers choose software on the basis of their classroom/curricular needs? Was it selected by an outside group and then introduced to teachers?

2. Schools' philosophies about computers. What was the context for DBM use? Were the computer programs already rooted in any particular direction (e.g., business and programming)?

3. Teacher selection and training. Which teachers had access to the software, and which subjects did they teach? Was the database used across disciplines, or only in the math/computer science areas?

4. Types of database activities. How and why were DBMs used in these schools? What activities did teachers construct for students and what were the (pragmatic/cognitive) reasons for using them?

5. Problems in classroom use of DBMs. What were the problems encountered by students and teachers involved with DBMs?

Selection of software. The source of funding for computer hardware and software in schools appeared to be a key factor in how software was selected. In some schools, software was obtained free of charge and initiated through donations by large corporations; in others, computer coordinators or teachers actively initiated software purchases. Two of the schools in our study--Washington and Jefferson junior highs--were participants in the large demonstration project of a major computer hardware corporation. They were supplied with 15 microcomputers and a variety of software, and project staff conducted training sessions for the teachers. Similarly, the Cedarbrook school district received free access to the on-line Dow Jones system (a news and financial database that supplies stock market information and the latest news published by Dow Jones, e.g., The Wall Street Journal, Barron's, and several Canadian newspapers). Access to this service for an indefinite period was made possible through a private source. The educators whom we interviewed said that without this free access they would not be using this on-line system. Although they found the system to be interesting for student use, its current cost is prohibitive for many classrooms. Thus, these three schools had not made any firm decisions about obtaining these particular software and data systems.

In three other schools--William Penn, Belmont, and Ramsdale--the computer coordinators, with parental support, actively sought funding through the school districts and obtained hardware and software which they had personally selected. In each of these schools, one dynamic teacher or administrator focused the program on using the

computer as a tool, and had several ideas for application that extended beyond the realm of computer science and math.

Schools' philosophies about the educational value of computers. The context of DBM use in the schools was very much affected by their philosophies about where computers belonged in the school curricula (e.g., programming or computer literacy vs. curricular applications).

Among the eight schools selected for our research, five were heavily steeped in programming. Several of them offered Logo at the elementary level, and BASIC in the junior high schools. These schools often taught computers as an independent discipline. This emphasis on programming seemed to limit the amount of computer use in other areas. In contrast, other schools used computers for English, social studies, business education, and/or math. Such contexts will be discussed in detail in a later section.

In other sites, teachers were not able to offer a clear rationale for having chosen particular directions for the use of computers. Lincoln Elementary School was involved with a teleconferencing system which provided a communications link-up among all the schools in the district, and computers were available only to children in the "gifted and talented program." In Ravenswood Junior High, the emphasis was largely on programming, while some database and other tool software were incorporated as part of computer science or computer literacy courses. These schools seemed to involve students in database activities for no other reason than to familiarize them with computer use and expose them to different types of software. Interviews revealed that teachers did not have specific goals for what students might gain from the experience.

Teacher selection and training. Noting which teachers were involved with the computers in each school proved to be a revealing index of the overall computer scene. More specifically, the subject area expertise of these teachers often reflected the schools' biases of what the role of computers should be. There appeared to be a striking contrast between schools which focused on the areas of math and computer science, and those which focused on such subject areas as social studies and English. In four schools--Ravenswood, William Penn, Jefferson, and Washington--the teachers involved in administering the majority of computer activities were math and/or computer teachers, and computer activities tended to reside exclusively in those departments and classes. Only at William Penn did other teachers (e.g., art and English) become involved.

In contrast, in two of the junior high schools (Cedarbrook and Ramsdale) much of the database work was being done by social studies

teachers, largely because of their personal interest and initiative and the support of others in their schools. These teachers spent a good deal of time devising curricular-related activities for their students, while at the same time teaching them how to use databases as information tools.

Thus, in addition to the overall philosophies of the schools, the specific computer applications adopted by each school depended on the motivation and focus of interested teachers. While most of the schools provided some degree of teacher training (ranging from informal support and demonstrations of specific computer activities, to workshops and inservice courses lasting for several weeks), these programs did not play an apparent role in the preparedness or success of teachers in implementing DBMs. Some teachers who received little or no training from their schools showed ingenuity and creativity in working with DBMs, while others who participated in extensive formal training (funded schools) were unsuccessful in involving their students in database activities. Personal interest and motivation, as well as the general support of school administrators and other teachers, appeared to be more important to the effectiveness of database implementation than the amount of training teachers received.

Types of database activities and teacher views of the information-handling process. Equally as varied as the teachers involved with the computers were the activities going on in the eight sites, and the degree to which the DBMs were incorporated as flexible information tools. While the coordinators in each school claimed to be actively involved in database work with their students, the contexts and extent of time devoted to its use differed considerably. DBMs can be used as tools for a variety of functions ranging from simple storage of information, searching, and sorting, to probing and integrating the information more extensively. Some schools were effective in teaching students not only to enter data and search for particular information, but to manipulate that information in order to elicit new and different ideas; others exhibited varying degrees of success in touching on each of these phases of information handling. Six of the schools that used DBMs outside the math and computer science areas were quite distinct from one another in the extent to which they probed and utilized the systems.

Business uses. In Jefferson and Ravenswood junior high schools, computer activities were focused largely on computers in the math and business areas. These schools taught students to use a database through business-related tasks. Students were assigned projects that required them to use a DBM in the creation of a payroll or to keep track of credit card accounts. They focused on the ability of the DBMs to alphabetize quickly, make phone lists, and create large

grids of information that would otherwise be too cumbersome. They felt that these applications were "real-life experiences" which would be useful in the students' future work lives. In both of these schools, the computer science curriculum emphasized the teaching of data processing and word processing as topics in order to prepare students for jobs. Teachers in both schools had some notion that computers needed to be incorporated across subject areas as tools rather than presented as a separate topic. However, in spite of the teachers' apparent desire to implement computers in this way, the computer activities in these two schools resided almost exclusively in programming and the business curriculum.

Personal interest files and reporting. At Belmont Elementary School, fifth graders worked with the district computer coordinator, Mrs. Mancini,* and constructed a personal-interest database which they called "Whiz Kids." The class brainstormed with the coordinator and came up with a list of things they were interested in knowing about each other. They learned how to define the fields of a database with questions that required specific kinds of information (e.g., numbers vs. letters). When the forms were filled in by each child in the class, the group learned how to search for a particular entry and sort it alphabetically (by name) or numerically (by birthdate). Students learned to enter, retrieve, and even to sort information, but no effort was made to introduce them to the idea that information can be integrated, creatively organized, and retrieved somewhat differently from the way in which it is entered.

The teacher responsible for introducing such DBM activities at Belmont felt that the interest file was an ideal introduction to databases because of its personal meaning for children of this age (10-11). "Seeing their names in print or on the computer screen, and dealing with topics which they have chosen is exciting for them."

Another way in which these classes used DBMs was to create book report files. The format, established by Mrs. Mancini, dealt with both straightforward information (e.g., title and author), and interpretive input (a 4-line summary of the plot). She felt that this summary was especially important for giving students practice in condensing a large body of information into concise form, so necessary for data entry. She felt that "the lure of the computer" made this "usually boring and tedious task appealing to kids." Brainstorming, summarizing, and notetaking were the skills she hoped to promote with database work: "Organization is the greatest problem

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*The names of the teachers have been changed.

for kids. Outlining and formulating key words are hard." Mrs. Mancini hoped that by using the DBM as a tool for managing and manipulating information, the children might grasp these skills more easily. She also envisioned the database as a tool which could encourage social interaction and support communication among students, and between students and teachers.

Research with a large on-line database. In the Cedarbrook district, great effort was made to utilize the available Dow Jones on-line database in teaching social studies, history, and economics. The social studies teachers in these schools concentrated on lessons in these domains because of the primarily financial and economic content of this database. The sample activities required students to locate, gather, and analyze information from the database, drawing on such research skills as making inferences and discriminating between relevant and irrelevant information.

The context of these database assignments rested within what the social studies teacher, Mr. Foreman, described as "the historical method" of research--a problem-solving process utilizing the following steps:

1. posing a research question;

2. doing preliminary research by accessing information from the database;

3. forming a hypothesis and checking with sources (the database and others);

4. categorizing the information with the computer database;

5. analyzing and drawing conclusions from these categories.

Mr. Foreman felt that the logical statements within the structure of the database promoted skills of abstract thinking (e.g., conditional reasoning). For example, such practice encourages specificity in defining questions, often a difficult step for students. When reporting on a subject, students tend to take a topical approach rather than to ask the kinds of questions that would lead them to research activities and other information-seeking tasks They are more likely, for example, to report on an African country's government, agriculture, and political structure than to ask questions about how the agriculture and subsistence methods might influence the social structure of the family, or how the climate affects the livelihood of the people. In this classroom, the database fit within the teacher's established social studies curriculum, and enabled him to expand his

usual classroom activities to support and extend students' research skills. He devised activities to support the concepts and skills necessary for understanding the "historical method," which he hoped his students would gain in the research process. "We need to change the kinds of questions we ask kids, and the kinds of assignments, now that information is easily accessible...and fast." In his view, the DBM could be an effective tool in effecting this change.

DBMs and information-gathering processes. At William Penn, sixth through eighth graders in several elective computer classes were involved in individual DBM projects. They used File Cabinet, a public-domain DBM, as well as a program called PFS to create files (usually on sports teams) from newspapers, or information gathered from other sources of interest to them. A math teacher who became the computer teacher/coordinator made the DBM a central computer activity for his students. A key component in teaching children about information here and at Belmont was to have them work with material which personally interested them. For example, the teacher had his computer awareness class look through newspapers and "find a database" from which they could cull significant facts. He believed that students in this age range would glean more from sports-related or personal-interest information than from topics that were less relevant to their daily lives, such as stocks or financial trends.

Another DBM activity at William Penn involved gathering personal information about each student for a joint map-making and computer project. A map of the city subdivided into neighborhoods became the basis for a personal interest/habitation database. Students listed the kinds of information they wanted to know about their fellow students (e.g., special interests, hobbies, involvement in community activities), and entered these data for each student, along with such information as street address, city, and state. The class was then able to search for and sort information about class members in different ways (e.g., geographically, by interest, by hobbies). Students could interpret the database in order to see the categories of information in different relationships.

Students also worked on research assignments, and entered data about their individual topics into a DBM format they themselves designed. Rather than composing a structured essay, each student wrote a report in the form of a sorted list, which included a description of how the information was sorted, why it was done in this way, and what this organization scheme showed. These lists were shared and discussed with the rest of the class. Mr. Halpren felt that this task was an important part of the research process and that, through such database activities, students became more organized in their ability to handle and understand various forms of information.

This teacher saw the potential applications for DBMs lying largely within the social and natural sciences since, in general, these are the subject areas that require information gathering. He, too, spoke of the particular problems students seemed to have when asked to deal with information:

> The hardest thing for kids to do is to look at a list of information and pick out what is important or significant.... Even when there's numerical data that really stands out, they can tell how it's ordered (ascending or descending order) but they have a hard time picking out significant facts.

He felt that as a teacher he could help to promote these skills

> by asking leading and open-ended questions, and not questions for which everyone in the classroom is going to answer the same way.

While Mr. Halpren viewed computer education as a curricular area in itself, he felt that the skills learned in working with the technology (e.g., the ability to pick out, organize, and relate pieces of information) overlapped with those required in such subject areas as social studies and science. For the database work, information from other teachers' courses was used, and students collected information from encyclopedias and numeric charts. By using this approach, Mr. Halpren hoped to expose his students to the interdisciplinary nature of information gathering and, hence, to the utility of a DBM.

Interestingly, an eighth grade student at William Penn, who was very much involved with and interested in computers and DBMs, believed that a database management system

> mostly just keeps information in different columns....It's good for keeping records--for easier output...just to keep files like the file cabinet; it's the same thing. Like, if you wanted to keep different files, you could keep them in here [the database]. There's nothing really different it can do....It might help to study a foreign language. It could tell you a word...but mostly it's just for listing information.

For this student, DBMs did not imply research activities, skills of organization, or the manipulation of information. They were simply listing devices and storage banks for facts. The familiar analogy of the DBM as a file cabinet (that being both the name of the software used in this school, and the way the student used the software to

construct a national hockey league database and a database of the computer facilities available in Philadelphia schools) became his way of conceptualizing what a DBM was all about. Unfortunately, this conception of the database seemed to be more common among students than Mr. Halpren's or Mr. Richards' more flexible and innovative models.

DBMs for historical and legal research. A dynamic social studies teacher at another school (Ramsdale) involved students in DBM activities that extended beyond this notion of promoting summarizing and organizational skills in the context of information gathering. Going beyond the activities of structuring their own material into lists, students began to use the DBM to creatively manipulate relationships among pieces of information.

Mr. Richards, a ninth-grade world history and law teacher, began to use PFS database software as part of his assigned research activity. From a system of schematic notetaking, students individually devised the format for a database that would accommodate the information they gathered. The process involved several steps: defining the fields and general layout of the database, entering information for several records to "pilot test" the adequacy of the designated categories, revising those categories based on new or different types of information that had not been accounted for, searching the database for specific pieces of information and, finally, sorting the information according to particular relationships within the database that were of interest to the student.

In conceptualizing a model of information in this way, Mr. Richards hoped that his students would begin to take a critical look at information. He felt that, since all the social sciences require analysis of data and the skills to manipulate and use information, teachers must address and promote these skills in the activities they construct. He believed that a problem-solving approach was fundamental to the skillful use of a DBM:

> The importance of using a database is not simply the retrieval of information, but seeing the relationships between different pieces of information and drawing inferences from it. They need to recognize that, when dealing with information, there is not one right answer; that the process is not linear, but schematic.

Therefore, DBMs might be helpful in encouraging students to ask probing questions and in forcing them to organize their thoughts and information effectively.

Mr. Richards' sense of the educational potential of DBMs as information tools grew out of his awareness of the stumbling blocks often encountered by children in the research process, particularly in conceptualizing and designing structures for organizing their information:

> The idea that one needs to organize one's questions and develop a structure for research is difficult. While it is necessary to organize information, one also needs to work within a flexible framework which will allow for modification and manipulation.

Mr. Richards felt that the traditional organizing convention, the outline--in its linear form with headings, subheadings, and Roman numerals--was restricting. He believed that this format prevented the more natural schematic thought process.

Summary: Goals for DBM use. It would appear that there were several information-handling skills which teachers, collectively, hoped to engender through the use of DBMs. Various teachers mentioned as important parts of the research process: brainstorming, notetaking, categorizing, learning both to generalize and to be more specific, analyzing data, reading and organizing information critically and effectively and, finally, asking probing questions that relate pieces of information in interesting and unique ways. In a few of the schools, it appeared that DBMs might be appropriate tools for promoting these skills. Perhaps DBMs allow some teachers to isolate and articulate for their students different steps in the information-handling process. At Ramsdale, and certainly in Cedarbrook, the teachers had fused the application of this novel tool with research activities that were appropriate for and integral to their curricula. In several of the schools, the DBM activities addressed specific problems that students commonly encountered when dealing with information. However, as discussed below, DBM activities sometimes became an extension (or reflection) of such problems.

Problems in classroom use of DBMs. Practice with DBMs did not necessarily lead to the development of research and information-handling skills. Some of the problems in implementing such systems in classrooms were:

1. Rigid information format required by software. The structure of data entry and querying in available software can make DBMs difficult and inflexible tools for novices. For example, the formats for entering information are often rigidly defined (e.g., the amount of space for each field, the number of fields, and the number of records). In some packages, only one file can be entered on each

floppy disk, so that a teacher cannot store all students' work together, and children aren't able to share and integrate information from their personal files.

2. Inability of the software to allow for definition changes. A tool requiring fixed definitions of information as the initial step in entering data may exacerbate the problems novices encounter in the research process (e.g., defining questions, deciding which information is most important, organizing pieces of information in a coherent framework). For example, Mr. Richards noted that the PFS software, like many other DBMs, forces the user to conform to predefined configurations of information. Often, decisions about the format for entering information must be made before the student has determined how the material can best be organized. Because changes in format are difficult to execute, naive decisions at this stage often control the remainder of the work. According to Mr. Richards, it can become a "tail wagging the dog" syndrome. Since teachers agree that conceptualizing a form is generally a very hard step for students, it is important that a DBM allow for, and even encourage, revisions of both content and form. As Mr. Foreman remarked:

> Kids use the database to fit with their original research question, but then must be creative in branching off if they are to gain rich information from the database. This is often a problematic step. The idea that one may not find information which will exactly fit the question one originally posed, and that it becomes necessary to develop new questions from the information available, is a new and difficult concept for most seventh graders.

3. Limited hardware access. Limited hardware resources and time in the school day influenced the level of effectiveness of DBMs in classrooms. In most of the schools we visited, teachers complained about having too few computers for an entire class to use as a group, and too little time. As with most other computer activities, working with a DBM takes time, and students need the opportunity to experiment with and explore the organizational options available to them.

4. Math and programming as exclusive domains for computer use. In many schools, computers are located in the math department, often for learning about programming. This orientation emphasizes a particular way of thinking about computers in education which is different from that required for the effective use of DBMs, as well as other tool software, as information-handling tools. Even at Washington Junior High School, where a grant provided hardware, software, and teacher training for implementing tool uses of the computer, the emphasis was deeply rooted in computer programming. Serious con-

sideration of tool uses of the computer seemed to be difficult to promote.

5. Insufficient teacher training. The extent of teachers' exposure to tool uses of the computer and the degree to which they were comfortable with this software influenced their ability to use the DBMs in creative ways. Effective teacher training for this type of implementation of computers was relatively rare. Often, teachers learned one or two applications of the software, rather than getting a thorough grounding that might have enabled them to incorporate DBMs into their existing curricula in innovative ways. In addition, the business-oriented nature of the DBM software itself often prevented teachers from recognizing appropriate classroom applications.

6. Limited classroom information-based activities. Some teachers lacked a clear perspective or agenda for teaching research and information-handling skills. Often they had rigid notions of a required sequence of steps (finding a topic, notetaking, outlining) which constitute research, but little sense of how students learn the skills of acquiring, critically analyzing, and manipulating information. A number of the teachers, either less familiar with DBM possibilities or less thoughtful about the general topic of information gathering and manipulation, tended to treat the software merely as a filing system. They saw it primarily for storing information, rather than as a device for relating or restructuring information for the discovery of new ideas. The more computer-experienced and generally dynamic teachers tended to be more creative with the DBM as a classroom tool. For example, at Belmont, students were taught to search and sort merely to elicit the same information that they had entered into the system, whereas at William Penn, students were shown that by relating categories of information (geography and personal likes/dislikes), they could discover new relationships among pieces of information.

7. Students' math and reading skills. Teachers' opinions differed about the value of DBMs for those students with less facility in reading and writing. For example, a teacher at Belmont thought that these students had more difficulty with DBMs specifically, and computer activities in general. On the other hand, Mr. Halpren felt that DBMs encouraged these students to develop their skills, provided the activity concerned information that was meaningful to them:

> We have some real low-level readers and low-level math students who will search through data related to topics of interest, and then be able to draw conclusions about what they're interested in. They may not want to look at a database that I make up or that they find in the newspaper, but if they can search through data that has social

significance to them, then they'll be able to find what it is that they want.

It may be that the skills and concepts necessary for using a DBM effectively make it a difficult tool for low-level readers or students who have trouble with logical analysis. On the other hand, a DBM may in fact be a tool that encourages the development of such abilities.

These seven problems, ranging from the limitations of the software itself and the availability of computer hardware and adequate software, to the abilities of teachers to be creative and perceptive about DBMs as flexible research tools, seem to be partly responsible for the limited attention to databases in the educational community today.

Case Studies of Individual Schools

In order to give a more indepth account of the factors that influenced the use of DBMs, we will describe two of the schools in greater detail. These case studies provide a more complete account of the historical backdrop of the schools and their respective computer involvement, and a fuller picture of their actual activities. Ravenswood and Ramsdale were strikingly similar in many ways. They were both suburban junior high schools in predominantly white, middle- and upper-middle-class areas. Both schools have had a commitment to computer use for many years, with an emphasis on programming and computer literacy, and both have become interested in other computer applications, such as tools. The teachers whom we interviewed were interested in and articulate about the incorporation of the technology into their schools--in particular, the adoption of the technology by certain disciplines, and the educational value of DBMs.

Ravenswood

The school's computer history and current functions will be described as a context for the discussion of the use of DBMs.

History. According to Mr. Morris, a math teacher and the computer coordinator at the time of our research, Ravenswood has been involved with computers for 17 years. Financed by the school district, they began with a minicomputer. From the start, they had computer literate teachers who wrote their own software to conform to their curricular needs with, according to Morris, "the emphasis always being to integrate the computer into the curriculum." The school district acquired microcomputers in 1977 and introduced them into the elementary schools with a variety of drill-and-practice software. As more and more students became interested in learning programming,

microcomputers were acquired for the two junior high schools and the senior high for "computer science." Thus, the computer emphasis expanded to accommodate the perceived need for a programming curriculum. The district continued to purchase microcomputers for elementary and junior high schools (PETs and Apples) for use in subject areas other than computer science.

Training was available in the junior high schools in each of the subject areas for department chairs and selected "influential faculty members" who were particularly interested in using computers. School principals were also given training for the purpose of making software and hardware purchasing decisions. The aim of the training was a "grass-roots approach" to educating these staff members and enabling them to make broad curricular decisions for implementing computers in all disciplines. In the training process, great emphasis was placed on helping teachers use computers to develop their materials (e.g., records, files) more quickly and easily, whether or not students were directly involved. The rationale for this approach was that before computers could be functionally incorporated into classrooms, the teachers had to see how the machines could serve their personal needs; once they realized that computers could speed up and facilitate their own work, the teachers could integrate the technology into the classroom curriculum. Mr. Morris described this as a process of "getting teachers hooked so they would incorporate computers into their classrooms."

Context of computer applications. At Ravenswood Junior High School, we visited the three microcomputer laboratories. Each was equipped with eight computers and served a different set of teachers and students. One lab was used for computer science classes, another for teaching study skills to "special needs" classes, and the third was available for classroom teachers (social studies, English, math, etc.) to use at will. Each lab was intended to accommodate approximately 25 children.

Thus, at Ravenswood the technology functioned in several subject areas and as a separate computer science discipline. Computers were used as classroom management tools by the teachers, and by some students for various extracurricular activities. With respect to particular subject areas, computers were used in foreign language classes where drill-and-practice software was designed both by teachers and students for vocabulary and grammar lessons. Similarly, drill-and-practice software was used in math and English classes for computation, spelling, and vocabulary. In the social studies curriculum, the most common computer activities were drill-and-practice and simulations (e.g., population models, states, election procedures). Simulations were also used in some science classes (e.g., to supple-

ment units about genetics, minerals, and mining). A physical education teacher learned to use VisiCalc for keeping statistics on his students.

All teachers were encouraged to use computers in ways that they saw as comfortable for themselves and appropriate for their classes. In addition, in reviewing computer activities for their particular areas, the department heads could make suggestions to teachers about computer applications.

> Every curricular area is going to be affected by the microcomputer. It is now a challenge for the staff to identify the best practice for using that technology to make it a part of their classroom.

Mr. Morris had a strong sense of pride and enthusiasm about the extent to which the Ravenswood schools were steeped in and committed to various computer applications, and alluded several times to their emphasis on curricular integration of the computer, primarily with simulations. Teachers were encouraged to support such activities with print materials and group discussion in order to promote cooperative learning and avoid a solely game-like approach. It was up to the teachers to determine how frequently, in what ways, and for whom such activities were best suited.

Database management activities. A variety of topics were taught in the computer science and personal computing classes: Logo, BASIC, word processing, and database management. The DBM work in this school was primarily a business computer application in the programming curriculum, rather than an information-handling tool for different subject areas. As Mr. Morris said:

> In junior high schools, we have some staff members who understand the computer science of database management software....They could sit down and write a program something like PFS. They could do it in such a way that they could make it very specific [to their class demands] ....Since we have a staff that's able to do that, it's now a part of the computer science curriculum where students have to design databases. They do not use pre-canned software; they write their own software to perform database [tasks].

Mrs. Wright, a personal computing teacher (an elective course for ninth graders), was selected from the math department to teach programming and other computer uses. The math departments in the junior high schools were the best staffed, and several teachers were

moved into these positions because of the demand of the computer curriculum. Mrs. Wright's math background was reflected in the activities she presented to the personal computing class. The content of the DBM work was largely mathematics- and business-related. Students participated in two projects whose goal was to introduce the structure and purposes of DBMs. The students' first assignment was to design a program to accommodate a simple payroll. Given data about individuals' financial status and assessed taxes, students were to write a program to handle the information. The second assignment, more difficult and time consuming, was to create a VISA (major credit card) program. Students created a purchase-discount report and set up a master record for each person entered in the files.

Mrs. Wright saw these activities as practical exposure to some of the ways in which computers are used in the business world:

> These are business-type examples that aren't too mathematical...many of the students who are poor at math really have a hard time when they have to use the computer because they have to know what they're doing themselves first, to tell the computer what to do...their ability in math is major...and their ability to think logically...are paramount [to success in using a DBM].

There was some recognition on the part of Mr. Morris that the concept of a DBM as an information tool was not being addressed through such activities. "Classifying information and having students be able to identify what kind of information they want, and what kind of form they want it in, and then to put it all together and display it" was a process he wanted students eventually to engage in. The notion of retrieving data and classifying information, however, were talked about primarily in the context of business, along with phone lists, filing programs, and electronic mail. Nonbusiness examples that had been considered included recipe files, paper route records, and a file of students' record collections. The goals of these activities, while more personal in subject matter and perhaps more interesting to students, were similar to those of the business functions--record keeping and listing, entering information, and retrieving it in the same form at another time.

In general, at Ravenswood DBMs were seen as important and advantageous because of the speed with which users could access information, and the capability for storing large chunks of information that would otherwise be too cumbersome to manage. In this school DBMs were used primarily for business, and instruction was geared toward practice in using the tool itself, rather than incorporating it into other domains.

Ramsdale

History. Ramsdale Junior High was originally designed as an open classroom school, but has since become more traditional, with permanent classrooms and more structured curricula. The school's educational approach to computers reflected this traditional structure, focusing largely on programming and some computer literacy courses. One semester of BASIC programming was required in the seventh grade, and additional computer courses could be taken as electives.

At Ramsdale, there was one computer lab with five Apples and nine Commodore PETs. Some teachers acquired computers through independent grants or brought their own from home. For example, the district gave the special education teacher an Apple computer to use with her students. However, access to a sufficient number of computers remained a problem for those teachers who used them with their students.

Database management activities. Despite the traditional tone of the school's computer curriculum, one teacher at Ramsdale was a striking example of ingenuity and creativity in using the computer as a classroom tool beyond the areas of programming and computer science. Mr. Richards, a social studies teacher of long standing, spent his sabbatical in 1980-81 at the University of Oregon to research the possible uses of computers in junior and senior high school social studies and history curricula. He believed that an analytical, problem-solving environment was most conducive to children's learning. His model included an emphasis on the ability to manage and manipulate information:

> The widespread use of the computer will be database management and information retrieval, and it is the most logical application in the social studies curriculum....All of the disciplines in the social sciences deal with the analysis of data and evidence, the ability to manipulate evidence, the ability to retrieve, look at, and question it. So...there's something common to all of these disciplines, and I think this is a fundamental skill that everyone should have.

In addition, Mr. Richards felt that

> as we become more and more math- and science-oriented, we become less problem solving-oriented. Kids begin to feel that there's one right answer. This makes forming probing questions difficult.

Mr. Richards had reservations about how effective computers could be in today's public schools, largely because of the rigid constraints of time, and set curricula that teachers must conform to. He felt that students needed to work at their own pace in developing the skills of problem solving, analyzing, hypothesizing, and synthesizing. However, he was experimenting with DBMs in two of his classes. Recognizing some of the problems his students had in dealing with information, he introduced the DBM in the hope that it could become an effective tool in the process of notetaking and research: "The idea that one needs to organize one's questions and develop a structure for research is difficult." He felt that only by trying out such tools as database systems could we understand their value for students. Hence, in two ninth grade classes--world history and law--Richards had his students use the PFS file software. He hoped that, by defining fields and learning to search for and sort information, they would begin to think about and relate information in new ways.

We observed two classes in which students had taken notes about legal cases and historical characters, and were in the process of entering data into the formats they had designed for this task. Mr. Richards' unusual method of teaching notetaking was based on the "schematic" way in which he believed people think. Students were taught to map out their notes graphically (with self-selected symbols, colors, and underlining) in a way that displayed the relative importance and relationships between and among individual items. For example, a student taking notes about a particular legal case might develop a schematic structure that would connect specific evidence to historical data with arrows or lines. He might color code all information related to a particular event or person, circle especially important information, or simply place related data next to, above, or below each other depending on his view of their relationships. The students decided which symbols best fit the material they were dealing with, and were encouraged to avoid the rigidity of a formal outline. According to Mr. Richards, the idea behind this process was that "the mind processes information very schematically and, ideally, we should do the same as we gather information and do research."

Using their schematic notes, students designed the "form" they thought would most effectively incorporate the information they had gathered. Students often found that after completing their format, a case or an historical figure did not fit the scheme they had devised, and it then became necessary to revise the format in order to incorporate this piece of information. Inadequate formats and the resulting revisions were frequent stumbling blocks for students. They learned the importance of being specific and also the value of general categories which allowed for more flexibility in including "unusual" pieces of information.

In his world history class, Richards began the database experience by comparing the research process to the way in which an historian asks about a particular period or figure. Students identified the ideas they felt to be important in analyzing historical data: the institutions that might have had an influence in that time period; the significant people who played a major role; the environmental influences; and physical, technical, and economic factors. These categories provided the starting point from which the students branched out according to their individual research needs. None of the formats were exactly alike since they had been created from each student's schematic notes. Richards felt that in this way his students were able to make an information system which made sense to them, and thus were better able to probe the resulting database with interesting questions since they had created the organizing framework. The ultimate transfer of skills and conceptualization, he believed, would occur when they sorted information from the database.

> There is transfer just in plugging their information in, categorizing etc., but when they sort, they need to think even more about what they want to know. This step is often ignored in regular research; kids have a topic and they gather details and facts about that topic often without thinking about how these relate to the overall questions.

Although DBMs seemed to make sense as a tool for encouraging these concepts of relating information and organizing it, Richards didn't claim that it was a magical key or panacea for solving students' information-handling problems:

> The research process is hard. Developing probing questions and manipulating information is not easy for them. The database is a simple way to organize data. As a research source for drawing out information, it can be somewhat flat compared with books and other resources. Some kids may find it a useful tool and others may not, just as some find historical fiction to be a better source for researching an historical period and some prefer pure "fact."

While the database didn't eliminate the problematic steps for students of posing questions and being thoughtful about what they wanted to know, experience with the tool may have brought these issues to their attention in new ways. Similarly, teachers like Mr. Richards may have begun to see information gathering and manipulation in a new light, as well as the problems and needs students faced in various research tasks.

While there were many similarities between Ravenswood and Ramsdale (e.g., student populations, ongoing history of computer use, involvement with databases), they also exhibited significant differences. In their database work, Ravenswood focused on business applications of the tools, whereas Ramsdale gave more attention to social science. Each school also saw the educational value of DBMs for students quite differently. Mr. Morris and Mrs. Wright described database work as a chance to introduce students to the real-life applications of the computer in the workplace, while Mr. Richards saw its value in terms of the general thinking and organizational skills so necessary in both academic and work contexts. It is apparent, then, that in addition to the resources (hardware and software) of the schools and the general emphases of the district administration, the individual personalities and backgrounds of the teachers played a determining role in what value was ascribed to the DBMs and how they were applied.

Summary and Conclusions

From our study, it is apparent that the use of DBMs as flexible information tools has not been thought about in depth by many teachers and school administrators. Schools are largely committed to computer programming and computer literacy, and are just beginning to consider tool software applications in the larger curriculum. The goals which led the teachers in this study to use databases, the content and context of the activities, and the problems they encountered were as varied as the teachers themselves. Since educators are just beginning to think about the use of this technology for information management, it is important for researchers to carefully examine the classroom context and the needs of teachers and students that might be addressed by the tool.

The question of how children learn to use, manipulate, and relate information in order to discover new things is a critical backdrop for considering the use of a such a tool. Despite the school problems noted thus far and the present limitations of available software, it is our belief that the tool uses of the computer will play a role in education well beyond that of programming or computer-assisted instruction. Database management systems do not offer a simple solution to the problems of learning to access and use information effectively, but with creative design and greater attention to the whole information management learning process, DBMs may become an important member of a whole family of tool software for classroom use.

APPENDIX

TEACHER INTERVIEW: PART I
(Re Information Gathering)

Overview of Interview

Typical Assignment
Information Sources
Concepts and Skills
Students' Developmental Differences

Teacher Background information

1. First, can you tell me which subject areas you currently teach? How long have you been teaching?

2. (If s/he teaches social studies, science, or anything to do with thinking/study/critical reading skills) What is your social studies/science/_____ curriculum like? How does it develop over the course of the year? What kinds of projects or assignments do the kids do?

Information Gathering and Organizing

Nature of Activity/Place in Curriculum (Typical Assignment)

3. What are the times/occasions when you ask kids to find the answer to something, find out about something? In what subject areas? What types of assignments? Explore whether:

   - answer particular question vs. researching topic;

   - more structured assignment (finding or organizing information for a test, science experiment, or homework assignment) vs. writing report or doing research project;

   - addressing topic (Eskimos' clothing) vs. research question or hypothesis (how does the type of fabric used in clothing relate to climate);

   - teacher-generated question vs. student-generated question or topic;

   - individual vs. joint/group projects;

- interrelatedness of students' topics (question to get at feasibility of common database, or are students' projects "all over the place").

4. What do you call this sort of thing--this kind of information gathering activity? Is it different for different subjects?

Steps in Process

5. Can you take me through the process one of your students would go through in order to find an answer to a (social studies) question, or to write a report?

   Probe: How is topic/question generated?

   What are the steps of the research process (e.g., generate question, seek out sources, take notes, make outline, revise question, meet with teacher or other kids)?

   What do you do to help kids through this process? (How explicit are these steps to the teacher? How explicitly are they taught to the kids? Are the steps delineated into different activities?)

   Do you use structured devices, such as specific types of notecards to fill out or outline formats to follow? Is the rationale for these steps and the "bigger picture" of the research process conveyed to the students?

6. Is there any difference in the types of assignments or projects you have students do at the beginning of the year vs. the spring term? If so, what are the differences? (Get specific examples of types of assignments.)

   That's interesting. Why do you feel it's important to change over the course of the year in this way?

Sources

7. What kinds of information resources or tools do you use in teaching? (Probe to see what kinds of printed materials are used: e.g., particular books [encyclopedias, dictionaries, atlases, newspapers]; pictures; other media [films, TV]; people; places [museums, aquariums].)

8. Do you talk with your students about sources, and if so, how?

   - For an assignment, is the number of sources they use important? Are the types or variety of sources they use important?

- Are they taught about the "special role" of different sources (encyclopedia as preliminary research source; text vs. pictures; fact vs. opinion; media vs. people vs. places; datedness of source)?

9. What kinds of sources do kids seem to find valuable--how do they work with them, and with peers?

10. Are there other kinds of things (books, tools) you would like to have available to help kids find and use information? Describe (even if not specific or concrete).

Concepts and Skills

11. What do you think kids might get out of going through this type of information-gathering activity?

12. What kinds of skills are needed to do it well?

13. How important do you think these skills are relative to other things? What do you think is important for kids to learn about in their year with you?

14. Why do you think it's important for kids to learn these things? (Pragmatic: important for them to able to find out information for themselves; cognitive: helps them to develop analytical thinking skills.)

15. (If not addressed) What should kids be taught about developing questions and finding information?

16. How did you learn about/arrive at this model of teaching about information gathering? Did you learn yourself? Were you taught in teacher's training? Is it the way you were taught as a child?

Developmental Differences

(For the following questions, probe what seems to be conceptually hard for kids, what seems to enable some kids to understand these things better than other kids)

17. Are there certain things about this research process which seem hard for students? (Explore different ability levels within class.)

18. What do you expect your students to know or be able to handle this year that they might not have been able to tackle last year? How is what you ask students to do different from what they might be asked to do next year?

19. What seems to distinguish those kids who can handle this research process better from those who cannot? What are they able to do (cognitively) that other kids have trouble with?

Other People Involved in the Research Process

20. (Optional) What do you think parents think of this type of research activity? What is the value for their kids? What seem to be the most important features of process to them (e.g., surface features--length, use of footnotes; worked hard on project; have concrete product to show; analytical/thinking process; writing skills)?

21. (Optional) How much research work do the children do in the library? Do you accompany them or send them off to work by themselves? Do they receive any help from the librarian? If so, what kinds of help? Do you have any contact with the librarian about your students' research needs (types of resources or help they need)? (Probe extent of contact and communication.)

TEACHER INTERVIEW: PART II
(Re Computers and Databases)

General Background of Computer Use

1. How do you use computers with your students? (Probe for types of software [CAI, tools, programming], where they fit in the curriculum [as part of computer curriculum vs. other subject areas], physical setting [how many computers; student/computer ratio]; used in classroom vs. lab.)

2. What is your background in computers (how got started; extent of training; used at home in free time or only at school for student lessons):

   Why did you decide to use computers with your students? What did you hope they would be good for?

3. How do you use tool software in your classroom? (Probe what use and where it fits in the curriculum.)

   Why did you want your students to use computers in this way? (Probe teacher's attitude toward computer tools; possible value of tools for kids.)

4. Ideally, what other kinds of software and computer uses would you like to have for your students?

Databases

Nature of Specific Database Activity

5. What sort of database do you use? Describe (on-line vs. software).

6. What times/occasions do you have kids use the database? Can you describe a typical assignment where your kids use the database? Probe:

   - place in curriculum;
   - type of assignment;
   - on-line or "already packaged" database vs. create your own database;
   - teacher-generated database vs. student-generated database;

- if teacher-created database, what is content of DBM. Why was this selected?

- teacher-generated research questions vs. student-generated;

- ways/steps go through to teach kids to use database;

- how independent are kids to search database on own vs. closely supervised;

- address how related to other sources, noncomputer means (e.g., physical sorting by hand, running around the library).

7. Do students seem to like to use the database? What do they seem to like about it? What do they seem to get out of it?

Concepts and Skills

8. What do you think students get out of using databases?

9. What sorts of understandings or skills are needed in order to use a database well? (Probe)

10. Is what's required from the children different when they're using the DB and retrieving information from when they are creating their own databases?

11. How important do you think these skills are relative to other things which are taught in school? Why do you think it's important for kids to learn these things?

12. Are there any stumbling blocks that kids encounter when trying to use a DBM? What seems to be hard about using them? Are the difficulties different between using vs. creating databases?

Developmental Differences

13. Do some of your kids seem to take more readily to using the databases than others? What are those kids like? What is their interest level? What are those kids able to handle better than other kids?

14. Has your way of using the DBM changed since you started? Describe.

    In what ways did things go as "expected"? What kinds of modifications were needed? Were different explanations/help/structure needed for different kids?

Were there any things which disappointed you about how the DBM was used?

Comparison with other DBMs

15. Did you see any other DBMs before deciding to use this one? Which ones?

16. Why did you like this DBM better? (Probe for the features that made it better.)

17. If you could change this DBM in some way, what kinds of suggestions would you have (e.g., change size of fields, numbers of fields, vocabulary, structure of program, ability to change records, number of records)? What other things would you like it to do that it can't do now?

18. What other kinds of content areas or topics would you like to put on the DBM?

19. How do you think databases compare to other, more traditional, noncomputer information sources? Advantages? Disadvantages?

20. How do you think DBMs compare to other computer tools (e.g., word processors, graphics tablets)?