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ABSTRACT

This report discusses the design of the Macintosh version of INQUIRE, a software package developed to support the processes and activities of inquiry learning and teaching. It is noted that the design challenge was to encourage students to consider information from a variety of perspectives, to make and articulate conceptual connections between the ideas and facts they encounter, to enable them to play with information while learning to evaluate its validity and relevance, and to help them reflect about their own questions and learn something about the assumptions underlying their ideas and opinions. Included in the report are descriptions of the central metaphor guiding the design process; the software's basic structure; navigation and housekeeping tools; and procedures for researching students' own questions, writing text, drawing, recording numerical information, noting the sources of information, linking INQUIRE to a videodisk, analyzing information, and tracking student progress through the software. (GL)

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Designing INQUIRE

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DESIGNING *INQUIRE*

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The Purpose of INQUIRE

INQUIRE was designed to help children investigate and to help teachers guide them. Its main purpose is to support the processes and activities of inquiry learning and teaching; that is, to facilitate children's active construction and transformation of understanding, and to foster the development of their awareness of what knowledge is. Using the tools and activities provided in the program, children can investigate information sources systematically. The program helps them by making it easier to identify and keep track of their purpose, to take notes and organize them in useful ways, and to think about and interpret the information. The program neither coaches nor tutors; rather, it provides procedural support for carrying out the complex, recursive processes of inquiry.

The original design goals for INQUIRE were to create tools that help students to: (1) juxtapose their current understanding of an issue or phenomenon with new information; (2) orient investigation and focus comprehension; (3) provide support for managing all parts of the information-gathering and interpretation task; (4) divide complex questions into component parts or subquestions; (5) review, evaluate, and revise questions and understanding throughout the inquiry; (6) supply procedures for querying and transforming new information as students record and work with it; (7) identify and build relations through flexible categorizing (since relations change as one learns more), and linking items with each other in ways that can be easily examined and changed; (8) query and interpret multiple (including both qualitative and quantitative) representations; (9) compose top-level ideas in complex problem solving as well as in generating hypotheses and alternatives; and (10) consider consequences of solutions, alternatives, and constraints in relation to information and evidence.

The design challenge for INQUIRE, then, was to find ways to encourage students to consider information from a variety of perspectives, to make and articulate conceptual connections between the ideas and facts they encounter, to enable them to play with information while learning to evaluate its validity and relevance, and to help them reflect about their own questions and learn something about the assumptions underlying their ideas and opinions.

INQUIRE presently exists in two versions. The original version was written for MS-DOS machines. A Macintosh™ version, written in HyperTalk™, was created specifically for research purposes. The HyperCard™ environment permits the design of a graphic interface and instant, on-the-spot revision. Design features can thus be added, altered, or customized during usage and testing in schools. This report discusses the design of the Macintosh version of INQUIRE.

The Design of INQUIRE

INQUIRE is designed like an adventure game. It is intended to be familiar to kids who play computer games. There are tools, commands, inventories, maps, and decisions to be made and a maze to be navigated—everything but the story. The story is constructed interactively by the child and the content material. INQUIRE never contains the story. At most, it holds documentation for a proposal or evidence for an argument. It is not a report writer (since the goal of an inquiry is understanding, not a report) but it can be

used as a report composition tool.

The Central Metaphor

The opening animation of INQUIRE is intended as an allusion to "Star Trek" (Figure 1). It is meant to suggest discovery, adventure, exploration. Star Trek, in film and on television, is primarily a story about a journey of exploration. In keeping with the Bank Street perspective on education, we consider guided exploration the central process of inquiry. As creators of educational technology, we also wanted to demystify computers, to portray them as tools for investigation rather than as carriers of knowledge.

Figure 1

In Star Trek, the computer is an almost limitless source of fascinating and useful information about distant times and places. It can also analyze the chemistry of planets, diagnose disease, and run the ship, but it never challenges the crew's power to interpret the information it furnishes or the commander's power to make decisions. When attached to rich information bases, INQUIRE can function like a modest version of the Star Trek computer. It can help analyze information and facilitate learning. The screen becomes a window into the universe, in which people, objects, and planets can be brought into close focus.

The futuristic Star Trek computer knows about every aspect of life on innumerable planets throughout recorded history. It can put the relevant information together and analyze it to come up with answers to complex questions. Children accept computers as magical and mysterious creatures. They know as little about how computers come up with answers as they do about how scientists arrive at conclusions. In INQUIRE, the computer facilitates but does none of the thinking, none of the coming up with answers. It merely provides a set of analytic schemes that can help solve conceptual problems. Whether the data banks from which answers are constructed are accessible through the computer screen or through another medium, the students have to designate information as relevant, collect it in sets of notes, and analyze it in the light of their own questions about the topic. The answers, for better or worse, are the children's own.

The Basic Structure of INQUIRE

INQUIRE consists of three modules (Figure 2), which can be used independently or in any relation to each other. The activities provided in the Brainstormer are intended as a kind of fuel. Either at the beginning of an inquiry or at any point during it when there is a need for new strategies or new approaches, these brainstorming activities might help to point investigators in new directions. The tools available in the Note-Taker are designed to assist in recording and organizing different kinds of information. The activities in the Analyzer are intended to facilitate a different kind of stepping away from the data. They are meant to help children get an overview, to construct a bigger picture in order to gain better understanding. These activities can be used to summarize or to generate new ideas, to diagnose or to revise, to evaluate or to conclude.

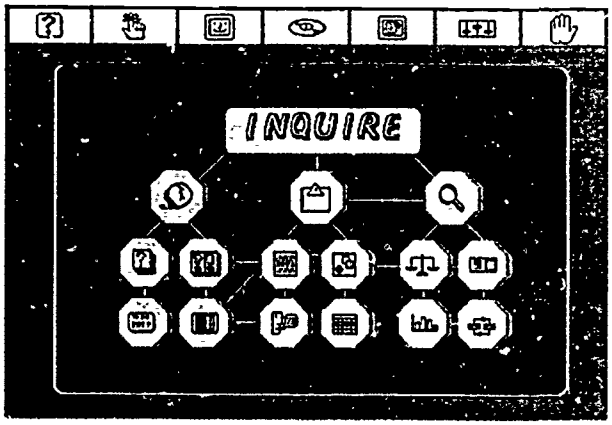

Figure 2

All three sets of tools and activities can be used in a variety of ways and for a range of purposes. Creative teachers can find interesting uses, and students may find that some activities suit their style of thinking better than others. Formative research about how they

are being used may add templates for activities that are unanticipated in this design and alter the interface so that better use can be made of them. Because INQUIRE was designed for science inquiry, the activities of scientists are modeled in it. Uses of the program in social studies, art, or literature might require additional or different thinking tools.

Basic Navigation and Housekeeping Tools

The menu bar across the top of the screen consists of graphic buttons that either produce direct action or pop-up hierarchical menus (Figure 3). Clicking in a menu button produces a distinct sound effect to signal the user to wait to release the mouse until the pop-up menu appears.

The Travel menus are identical throughout INQUIRE. The left and right arrows take the user to the previous or next card within the same activity. The right-angled arrow takes the user back to the last card s/he came from, regardless of the activity. The Helicopter menu makes travel among all the parts of the program possible. The Text menu ("A") permits changing the size of the font from 9 to 14 points. Each change is accompanied by a distinct sound effect.

The Apple and Copy menus are designed to fulfill the same function whenever they appear, but the specific menu items they contain may differ depending on the activity (Figure 4).

The Copy menu allows the user to copy and paste text within and across cards and activities. The Collect item facilitates collecting text segments from multiple cards before pasting them all into an Evidence field in the Analyzer. (See the description of the Evidence activity below.).

The Apple menu is designed to take care of "housekeeping" chores in each activity, analogous to the File and Edit menus in the standard Macintosh interface. In the Brainstorming activities, the only tasks needed are to create new cards, delete unwanted ones, and turn the Video Controller on or off. There is no Print function provided, primarily because we want to stress that Brainstorming is an activity in which the outcomes are far less tangible than the process. There is no technical obstacle to providing a Print function that allows the user to print out a list of all questions with or without their tentative answers. (See the description of the Questions activity below.) Formative research will determine whether that would be a useful addition to the program.

In the Note-Taker, the Apple menu includes a number of additional features. The user can get a new, empty card (New Card) or a new card in which the bibliographical information from the previous card is already entered (Same Source). The user can also enter that bibliographical information into special Source Cards (Enter Source). (See the description of "Source" cards below.) There is also a feature that allows the user to find specific words or phrases in any card of the program (Find Word), to print any number or combination of cards (Print), to use the Macintosh DA calculator (Calculator), or to see the student's own conceptual guide through the inquiry (Guide). (See the description of the Summary activity below.)

In the Analyzer, the Apple menu differs in each activity. It always contains the tools to perform the activity itself.

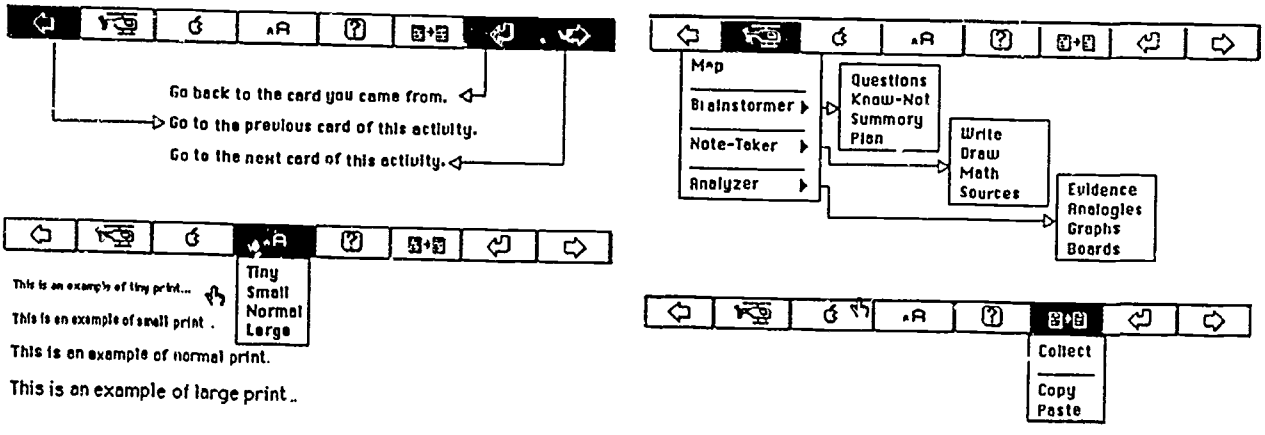

Figure 3

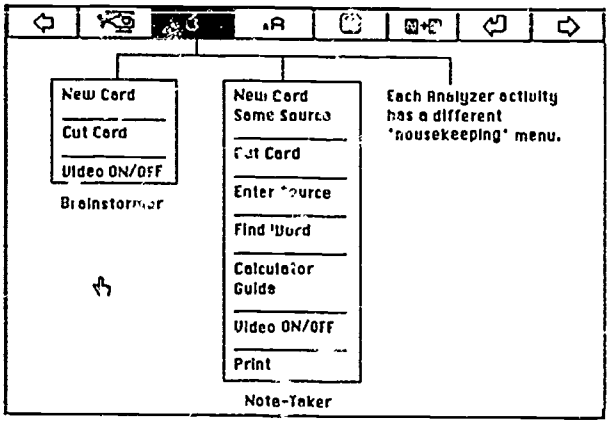

Figure 4

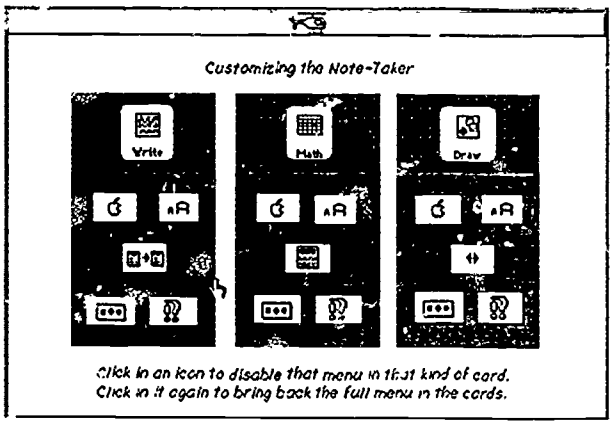

Figure 6

The Help feature in INQUIRE is not in its final form (Figure 5). Since the program itself is being revised all the time, the Help screens are undergoing constant revision. In the present version, Help consists of separate text fields for each menu in each screen. When users click in the Help button ("?"), that button is highlighted and, for as long as the highlight is on, clicking in each of the other menu buttons produces a text field explaining each menu item rather than the pop-up menu itself. We need more formative research about the difficulties students and teachers encounter in trying to use the program. We plan to enlist students who use the program as co-designers of the Help section.

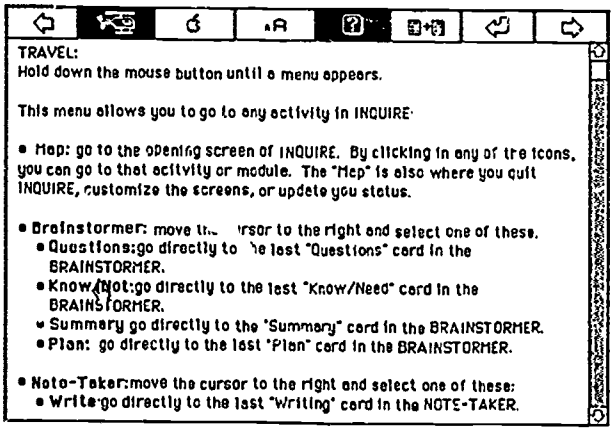

Figure 5

Customizing

There are a number of housekeeping tools built into INQUIRE to make life easier for teachers and students. There is a special screen for customizing the menus available in the Note-Taker (Figure 6).

Teachers (or students) can disable or enable menus simply by clicking on it in this screen. If all menus have been disabled, there will still be a sufficient number of options available to make INQUIRE workable and navigable. But, especially in the beginning, too many options might make the program seem more complicated and harder to master than it needs to be. This feature allows for a gradual introduction of options.

Status Cards

The Status screen allows students to keep track of their work (Figure 7). We included this feature because we believe that self-assessment is an important skill, and in this activity students are invited to assess how much of their own projected inquiry they have accomplished, rather than how well they are doing or how much effort they have expended. As with most other parts of the program, a creative teacher can use this activity to start interesting discussions about how one estimates progress, what criteria might be relevant, and how estimations change over time as students learn more and realize that finding the answers to their own questions is both more complex and simpler than expected.

Students enter the date by clicking in the date fields below the three sliders. They estimate the amount of work they have done in any module by dragging a vertical sliding bar up from "0 %—not yet started—to 100 %—finished." The part names can be changed to reflect any part of the work. Since there can be any number of Status cards, the number of parts of an inquiry that can be evaluated in this nonthreatening way is unlimited. Students who are working in a group can also keep separate track of their status on

individual cards.

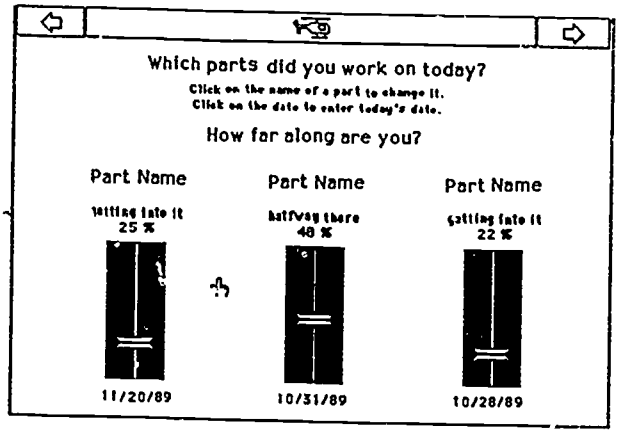

Figure 7

Reminder

INQUIRE is designed to prevent leaving the program without going through a "next step" planning process. This is an example of the kinds of classroom management issues we try to address in designing the program. The bell invariably rings when students are right in the middle of some process. It might be many days before they come back to the program. They are likely to forget what they had started and to lose track of what they were planning to do next. On leaving INQUIRE, a field asking "What were you planning to do next?" appears. One can leave the program without writing anything in this field, but one has to do it deliberately by clicking in an "OK" button. This feature is likely to encourage jotting down at least a key word or two, however. On restarting INQUIRE, the opening screen will contain the reminder field headed by the words "What you were planning to do next...!"

The Brainstormer

Ideally, students will use INQUIRE to research their own questions. This may be done in the context of independent projects or as part of some topic area defined by the teacher or the curriculum. Knowing how to phrase fruitful questions—how to define the problem in such a way that answerable questions can be asked—is a major aspect of inquiry learning. INQUIRE thus contains a Questions activity designed to help students arrive at a set of questions that can guide their inquiry.

Question Cards

This activity consists of an unlimited number of question boxes into which students can write any question that occurs to them (Figure 8). There are eight question boxes per screen. This limitation can be used to organize the question boxes into sets. Questions written into boxes in no particular order can be cut and pasted into new question screens, now containing related sets of questions, such as a main question and up to seven subquestions. Question sets can thus become the first organizing principle for the inquiry.

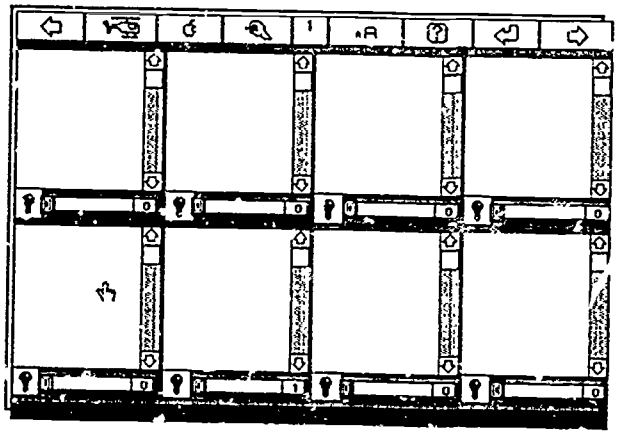

Figure 8

Students are invited to try to answer their own questions (clicking in the light bulb icon brings up a hidden answer field) This is intended to encourage them to reflect on their questions and their current ideas. They are invited to determine whether their questions can be answered by thinking about what a possible answer might be. Formative research has demonstrated that children find this difficult, not because of a lack of interest in imagining possible answers, but because they are used to having to come up with what the teacher considers the "right answer." We decided on two design features to facilitate this reflective process for them: The answers can be hidden behind the questions so that nobody looking over a student's shoulder can evaluate or comment on the possible answer without the student's permission; the children can "hedge their bets" about the answer by rating their degree of certainty about their answer(s).

The rating scale is a sliding bar below each question box, indicating how sure the student is of the

answer on a scale from 0 to 10. It invites additional reflection about the process of arriving at answers. Students can become increasingly uncertain as they gather information, for instance, while learning something about what makes for adequate criteria for evaluating the validity of an answer. They can also become increasingly certain as they gather evidence to support what was originally only a hunch. A good teacher can use these activities to teach about thinking as well as about subject matter

Know/Not Cards

Starting from what students know can promote confidence by demonstrating that they already know quite a lot. It also puts unanswered questions into a meaningful context, thereby making them less overwhelming.

The Know/Not activity invites students to write down what they know and to answer three questions about it: (1) How certain am I of this information or idea? (2) What else do I need to know about it? (3) How important is the missing information to my goal? The known "clue" and the yet-to-be-discovered one are written side by side, underlining the implication that there is something else still to be discovered about everything known, and that the basis for every question is some idea or piece of knowledge (Figure 9).

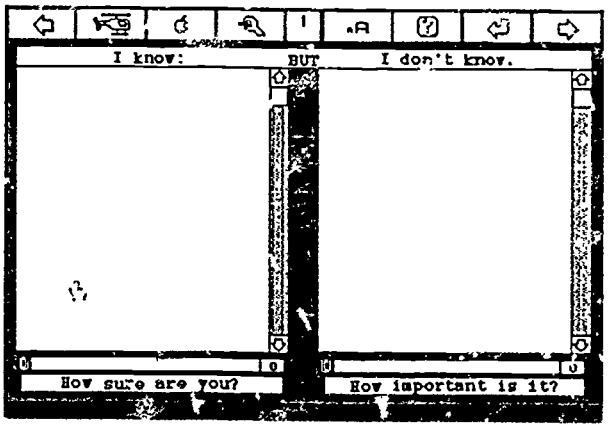

Figure 9

There is room for quite a lot of information in the "I know" or "I don't know" fields. There are many ways in which these parallel fields can be used. Evidence can be added to a "known" fact and puzzling findings can be added to the "unknown" information. A single card can end up being a record of the investigation of a single clue, with all the inferences drawn and related leads added over time. Keeping track of the inquiry itself by periodic assessments of this kind can help teachers diagnose students' progress and can help students become more aware of their own learning and thinking processes.

The sliding bar on the bottom of each field permits a 100 point rating (rather than a ten point rating, as in the Questions activity). The rationale for this is that deciding how sure one is of known information might require a more sensitive measure than hedging one's bet on a hunch about a possible answer to an early question. This might well turn out to be an unnecessary distinction. We decided to keep the rating scales different, however, to underline the fact that different kinds of evaluations are being asked for in each of these activities. If the main purpose of the rating scale in the Questions activity is to allow students to even consider what a possible answer might look like, the point of the scale in the Know/Not activity is to think seriously about the kind of evidence on which the known fact is based and to make considered decisions about priorities in pursuing unknowns.

Summary Card

As part of the cyclical revision process, each important question or statement of needed information can be imported to a scrapbook. Novice investigators—and, occasionally, experts– have difficulty moving back and forth between the specifics of the information they are gathering and an overview of the main concepts and directions of their inquiry. They need a guide to remember why they are taking certain approaches, how specific facts might be relevant, and what questions they are trying to answer. In INQUIRE, the Brainstormer activities can be used to develop such a guide, based on the students' own concerns and assumptions.

Both the Questions and the Know/Not activities have a button that allows the student to "grab" text and store it in the Scrapbook field of the Summary screen (Figure 10). The Scrapbook is a scrolling field and can hold a great deal of text, whereas the Summary field can only hold a limited amount of text. In this activity, students are invited to go through all the questions or ideas they considered important enough to include in the Scrapbook and weed them out further. The most important ones can be listed in the Summary field. Because the Summary is available in

every part of INQUIRE, students can use this field to develop an overview for themselves—a kind of guide to what's important, what they are really after—against which they can periodically measure their information-gathering processes.

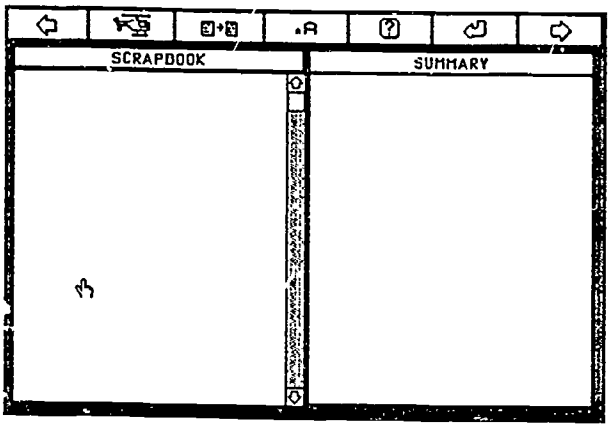

Figure 10

multiple planning cards, the number of separate lists is unlimited. The list fields can take up a quarter of the screen or extend over the entire screen. Each field also has a place to check off items, either because they are finished or because they are particularly important.

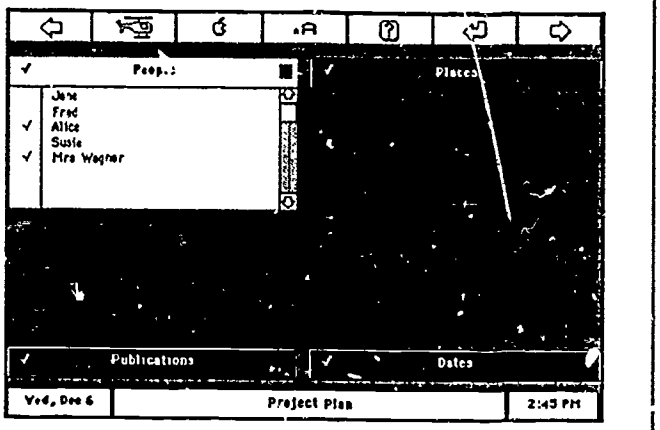

Figure 11

Planning Cards

There is one other tool available in the Brainstormer—the Planner (Figure 11). Students can write down a simple plan of action for gathering information and dividing the work. The Planner is intended to serve as a kind of bridge between brainstorming and gathering data. The process of figuring out how to organize the search for information—from understanding how a library works or how to establish contacts with experts—probably needs a lot more support than INQUIRE is presently providing. More research into what strategies help students think productively about the logistical, administrative, and organizational tasks involved in starting and completing an inquiry is needed. Refining this activity may be particularly important since genuine group work, in which students take different roles and assign different tasks to themselves, seems to be one of the major benefits of INQUIRE in the classroom. The computer serves as an organizer, a logistics manager, leaving the teacher more time for substantive discussion with groups of students.

At present, the activity consists of four separate fields that invite the user to keep track of various aspects of the inquiry. The rubrics provided in the program are People, Places, Publications and Dates. These names can be altered by the user, however, to reflect any aspect of the inquiry. Since there can be

Clicking in the large Project Plan button on the bottom of the screen brings up a fifth field in which the students can plan their inquiry strategy. It is another list field, in which they can combine or prioritize the information contained in the other lists.

One of the items in the Apple menu of this activity allows the user to find a particular word or date in a specific field without having to open up the field and scroll through all the entries.

The Note-Taker

The main module of INQUIRE is the Note-Taker. It consists of four kinds of note cards to keep track of different kinds of information. There are cards for writing text, cards for drawing, cards for recording numerical information, and cards for noting the sources of the information.

Writing Cards

The Writing card consists of three separate fields (Figure 12). The Title field can be used in a number of ways, from identifying the content of the card to creating a system of subcategories. INQUIRE comes with all the searching and sorting capabilities of HyperCard. The entire stack of cards can thus be sorted according to the Title field, either numerically, alphabetically, or by date depending on what has been entered into the title field. All three fields can be

searched for key words or phrases. These sorting and searching capacities have been downplayed in the design of INQUIRE, even though they are familiar from other programs, in favor of an emphasis on making meaningful connections between cards (see Tags below).

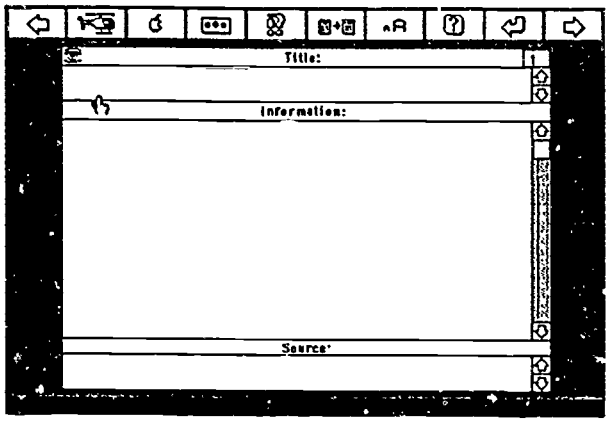

Figure 12

Once information has been entered, whether painstakingly by transcribing important sections of audiotapes or typing in scraps of handwritten notes from the library, or magically by scanning text and images into a card or by linking note cards to video sequences, the real problem for the student lies in figuring out how to organize this undigested information. To the extent that INQUIRE is a database for children, it needs to be intuitive and flexible far more than it needs to be fast or powerful (i.e., include sophisticated search and sort features).

Most children haven't the time, the opportunity, or the inclination to become compulsive collectors of data. On the contrary, early research findings indicate that the "bottleneck" created by asking groups of collaborating students to type their notes on the computer serves a very important function: They have to discuss which pieces of the information they have collected from various sources warrant entry into the INQUIRE database. Since only one person sits at the keyboard and the others discuss and dictate, they also have to discuss how to phrase the entries. This not only permits genuine role differences (e.g., the most articulate is not necessarily the best typist), but also fosters reflection about the information being entered.

Most conventional databases permit some kind of key phrase or title search and sort, as does INQUIRE. Large stacks of cards can be searched through rather quickly, either by asking for cards containing a specific word or phrase or by sorting the cards according to information in the title area. But we know from previous research that those kinds of searches and sorts are difficult and often not useful for children. They require having understood what concepts are key at the time the information was first encountered—and they also require reliable spelling.

A system is needed that allows children to sort their card collection into piles without at first knowing what the cards in any pile have in common, just an intuition that there is something that relates them. Eventually, as they sift through the piles and examine them from different perspectives, using a variety of brainstorming and analyzing tools to do so, a category system should evolve. Once students can name the factor(s) a pile has in common, they should be able to label the pile, annotate the name, change it at any time, and cross-reference cards by assigning them to multiple piles. Children have to be invited to think about the fact that any given piece of information may be relevant to a number of different issues, may belong to a number of different piles for a variety of reasons. We want them to become as conscious as possible of the kind of intellectual decision making involved in categorizing, while making the actual implementation of the categorizing activity as intuitive and simple as possible.

The system we decided on consists of a set of eight graphic Tags that can be "stamped" on any card (Figure 13). Each card can have any or all (or none) of the tags. The child can search for all the cards containing any combination of tags. Once a particular combination of tags has been selected, clicking in the little eye button in the upper left corner of the title field will bring up the next card with the same set of tags.

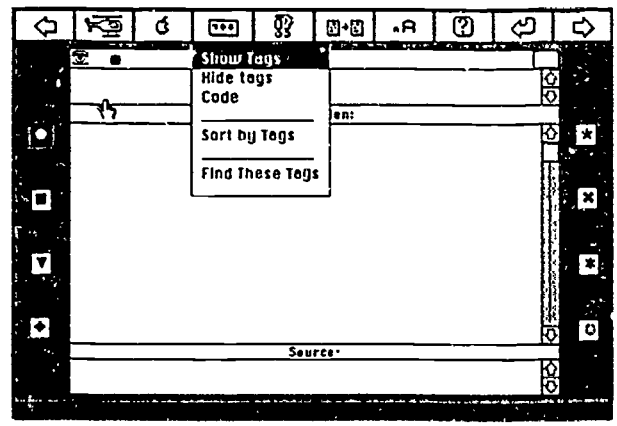

Figure 13

Code Card

The Code card is where tag combinations are selected for retrieval by clicking in any combination of the eight tags (Figure 14). This card is designed to allow students to think about their category system. There is plenty of room to comment on the category labels or to make them as elaborate as needed. By using the title field in conjunction with the tags, a complex system of subcategories can be developed by more sophisticated students. The two schemes permit different and not necessarily related ways to organize the information. One system could be used to label the cards by topic category, while the other one is used to mark the cards for such things as looking up missing facts, doubtful spelling, or even evaluating the importance of the information. As with all the INQUIRE tools and features, a good teacher can invent or model appropriate and interesting uses. Our intention is to support such efforts, not to prescribe them.

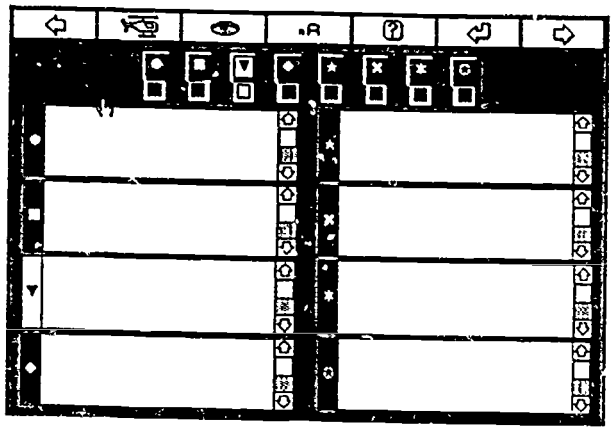

Figure 14

If the information contained in the card is in a rather raw state (i.e., if there are a number of unrelated ideas or facts included), tagging the card and thereby placing it into a category system might be quite difficult for students. Some in-between step is probably needed to facilitate abstracting the raw information in the body of the card and connecting it to a central theme. Two tools are included in INQUIRE to help with that process.

Students can summarize what they consider to be the essential import of the information on the card in the Main Point field (Figure 15). This also helps students go further in their note-taking than merely making a verbatim copy of sentences found in some textbook or encyclopedia. They can still make a copy, not being sure what parts of the text that seem relevant actually contain important information, but now they are invited to summarize and paraphrase that information in notes to themselves. As a next step in the process of categorizing the information in a card, students can try to relate it to the central question of the inquiry in another hidden field.

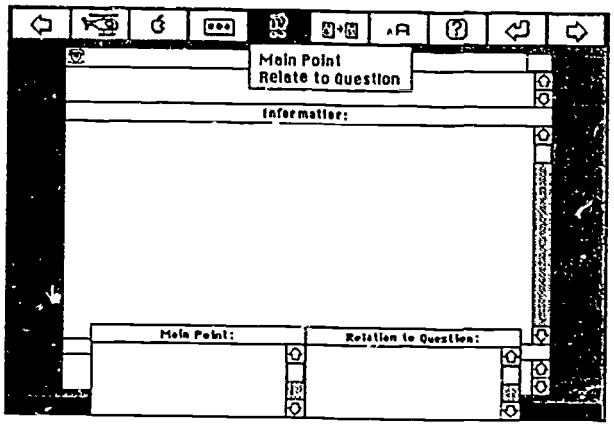

Figure 15

Drawing Cards

Not all information comes in the form of text. INQUIRE's Drawing cards are intended for keeping track of graphic information (Figure 16). Anyone familiar with MacPaint will know how to use the tools provided with these cards. They can be used to draw anything from expressive doodles to precise blueprints.

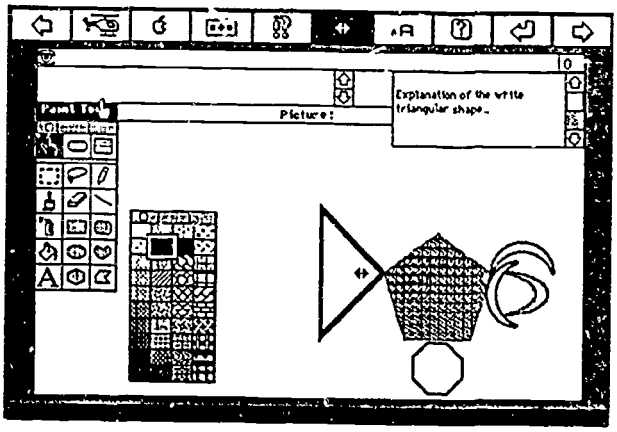

Figure 16

These cards are intended for any graphic, whether created by the student, imported from other electronic media, or scanned in from print media. A feature is provided to allow children to annotate these images by placing movable arrow buttons linked to explanatory fields on any part of the graphic. Only the little arrow is visible until it is clicked, when the pop-up field containing the explanation or comment becomes visible for as long as the mouse button is held down.

Math Cards

INQUIRE provides Math cards to keep track of and play around with quantitative information (Figure 17). These cards consist of six separate scrolling fields which can be linked together. The extreme right field is used for row totals. The function buttons across the bottom of the card are used to perform calculations. Various tools in the math menu allow children to do such things as switch columns of data around, sort entries in a field in numerical or alphabetical order, rank-order entries in any or all fields, and export data to a graph card.

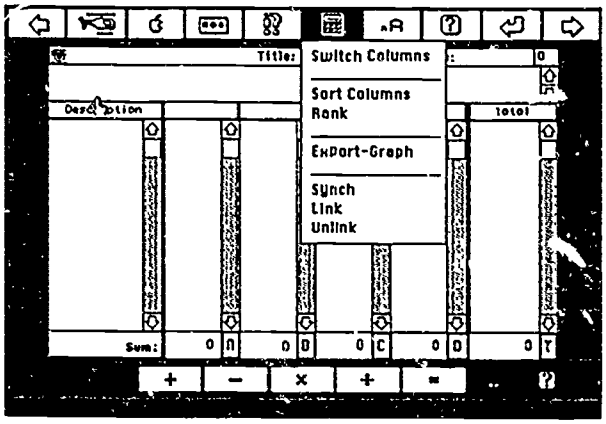

Figure 17

It is also possible to link or synchronize the four scrolling data fields, and thus to create a simple matrix for certain statistical calculations involving row and column entries. But the emphasis is on the kinds of quantitative manipulations children actually need to do to interpret their own data. The design of some of the math features, for instance, is based on our long-term observation of students in a junior high school science class. We noticed that they tended to perform science experiments in pairs and then get together as a class to share their results. The usual way in which they wrote down each other's results was by seating order. When it came to interpreting these data, it turned out that seating order was not a meaningful variable and that all those numbers had to be rearranged and rewritten, which often resulted in errors. The Sort and Rank features were included to make it possible for students to rearrange any single column and to rearrange all columns in accordance with the rank order of any one column.

Video Controller

INQUIRE is a multimedia tool. The Brainstormer and the Note-Taker modules each contain Video menus that allow students to control any videodisc through INQUIRE and to link video images or segments directly to note cards (Figure 18).

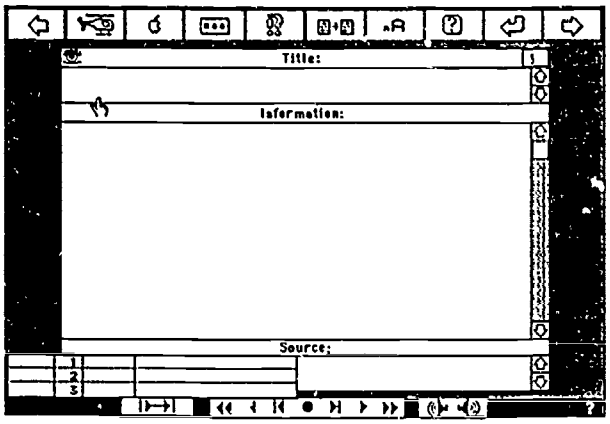

Figure 18

The video controller pops up across the bottom of the screen. The central buttons allow the user to play the videodisc forward or backward at three speeds, to stop the video, and to step and scan through the disc in both directions. The two buttons to the right control the audio, turning either, both, or neither of the two audio tracks on or off. The longer arrow button to the left is a pop-up menu that allows the user to show frame numbers on the video screen, search for chapters or frames, turn the video off, eject the disc, or get a video logger.

The video logger consists of four parallel fields. It can be stretched from a single line up to 25 lines that take up the entire height of the screen. When the student clicks in the first or the third field on each line, the logger notes down the current video frame number. When the student clicks in the little field in the middle (containing the line number), the videodisc plays from the frame number in the first field to the

frame number in the third field. The fourth field is an open field in which the student can name or annotate video segments.

Since the video controller is available on each note card, student-generated text or images or calculations can be linked directly to video segments on any commercially available videodisc. This allows for greater flexibility in the use of these videodiscs than is usually provided in the software that comes with them. Since much of the commercial videodisc software is HyperCard based, however, entire cards containing explanatory text or additional images from those programs can also be copied and pasted into INQUIRE.

Source Cards

With information coming from multimedia sources, it becomes particularly important to help students keep track of and evaluate these sources. The Source cards are intended as more than a simple bibliographical listing (Figure 19).

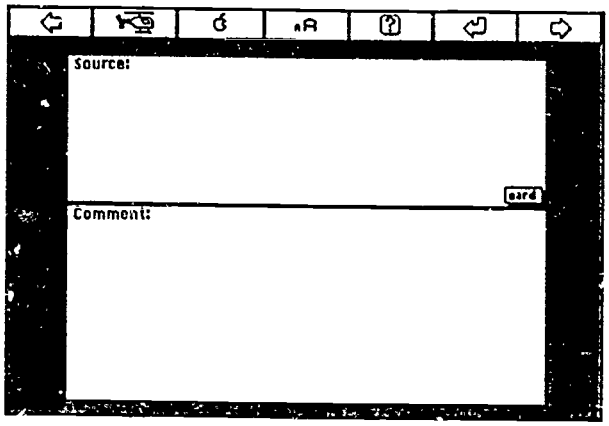

Figure 19

INQUIRE does not automate the process of entering references. Writing formally correct bibliographical information may occur to more experienced inquirers, since they will have experienced the hard work entailed in going back over all the information and trying to remember where it came from. If a student does not enter complete source information, however, the activity of sifting back through the collected nuggets of information and identifying their origins can be a helpful revisionary process. It can lead to new questions, to new sorting schemes, and to new evaluation of the value of the information.

Since we are trying to encourage the use of diverse sources, from interviews with experts to videodiscs, the format for entering source information should be kept flexible. A set of dialog boxes could be designed that ask the students where the information comes from, who made it available, and when it was produced, but additional formative research is needed to ascertain how to ask these questions in a way that illuminates their purpose.

At present, when the student selects Enter Source from the Apple menu, the description in the source field of the note card is entered into the upper field as a new source card (after a check to see if a source card with the identical information already exists). That field is closed; that is, one cannot alter the information in the Source card but has to go back to the note card to change it. This is intended as a precaution against accidental erasure or altering of source information. The bottom field is open. Its function is to invite students to comment on the source listed in the card. The little field on the right contains the identification number of the card from which the source information was imported. Clicking in it takes the student back to that card.

The Analyzer

The activities in the Analyzer are designed to be useful throughout an inquiry. Students can use them to think about the information they have collected. Knowing how to make sense of a large collection of vaguely related facts is particularly hard for children. The activities provided in the Analyzer can be likened to a gold digger's sieve. They allow students, under the creative guidance of a good teacher, to sift the evidence. They learn about theory building and to look at the same set of facts through a variety of lenses, to consider alternatives, and to change perspectives. This module could contain many more thinking schemes or strategies. The present version of INQUIRE includes a sample, designed to represent a range of activities from the linear to the topological, appropriate to different tasks and individual preferences.

Evidence Cards

The most linear and, in a sense, the most conventional of these analytic schemes is represented in a set of Evidence cards. Students write an outcome of their inquiry or a question into the Hypothesis field (Figure

20). They then look through all their relevant note cards and collect what they consider supporting evidence in the "Evidence for:" field. This part of the process is familiar to students. The next part, where they go back over the same information in their note cards and collect evidence that contradicts their hypothesis to put into the "Evidence against:" field, is generally less familiar to them. In the formative research we have conducted, students found this an interesting exercise, though not easy, since it requires switching perspectives.

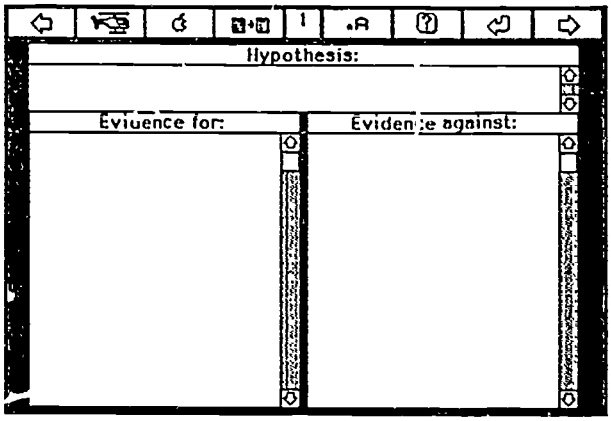

Figure 20

Students are then asked to summarize the evidence they have collected in two separate summary statements, one conclusion based on the evidence supporting their hypothesis, and a different conclusion based on the contradictory evidence (Figure 21). They are, in effect, developing an argument and a counter-argument, even if each point in their argument is not necessarily dealt with in their counter-argument. When students have finished stating their conclusions, INQUIRE asks them which of the two conclusions persuades them (Figure 22).

This question appeals to students, probably because it asks them what they think rather than what they know, and it models a process of theory building they generally know little about. They tend to think that the answers to scientific or intellectual questions are "found" in the course of research, either in books or among the facts, like a shell on the beach. This process demonstrates something about how experts develop theory by interpreting facts, by turning them over in their minds, and then fitting them into a conceptual picture.

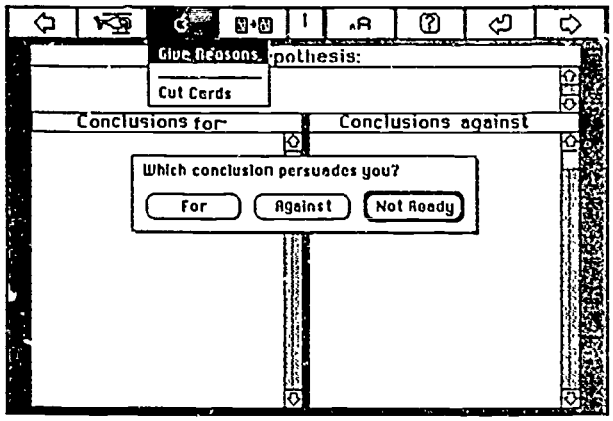

Figure 21

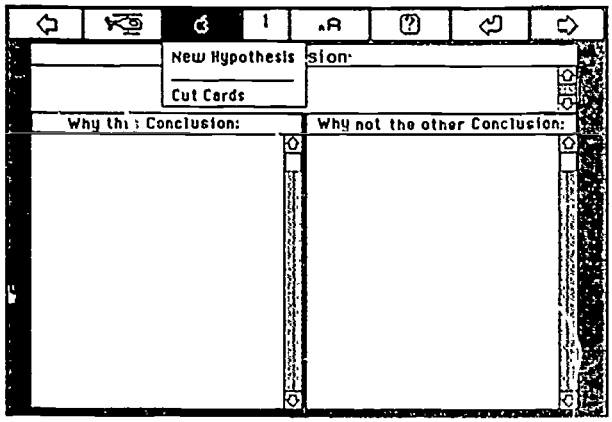

Figure 22

In the final step in this activity, students are asked to explain why they were persuaded by the conclusion of their choice and why they were not persuaded by the other conclusion. A creative teacher can use this rationalization activity as the beginning of an important discussion of the nature of interpretation, of what makes evidence valid, and what criteria can be justified in deciding between alternatives. There can be any number of such sets of linked hypothesis/evidence/conclusion cards. The same evidence can be used to support or contradict any number of different hypotheses, of course, either developed by different students on the same basic topic or by the same student(s) or different aspects of the topic.

Analogy Cards

The Analogy activity also consists of three text fields (Figure 23). The top field is designed to contain the basic statement of the analogy. One field holds the student's description of what the two elements of the

analogy have in common, while the other asks students to describe where the analogy breaks down or is misleading. Formative research has shown that when students make analogies, they tend to list all the ways in which the two parts of the analogy are the same and all the ways in which they are different, which is often a trivial enterprise. Asking them to point out where the analogy is misleading is intended to help them leave out trivial differences and concentrate on the important characteristics of the two concepts. Without a teacher's supervision, however, students might well interpret the title question "What is misleading?" to mean "How are they different?"

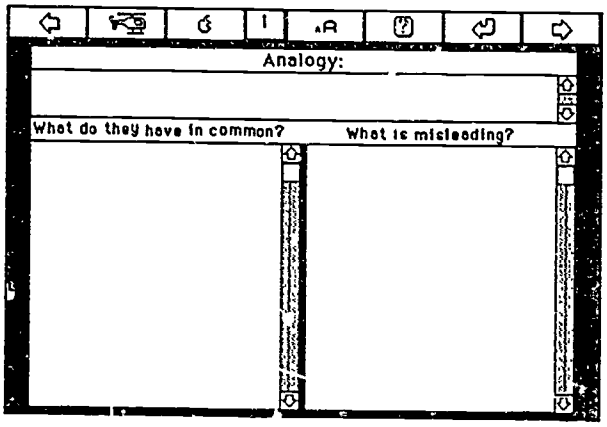

Figure 23

Electronic Blackboards

The Electronic Blackboards are intended for drawing concept maps or flow-charts (Figure 24). They allow students to write a number of key concepts into idea boxes, which can be moved all around the screen, and to connect these boxes with lines. The pedagogical import lies in the fact that each idea box is automatically linked with a small explanation field in which students are invited to summarize their current understanding of the concept (or evidence for their conclusion). When playing around with these ideas, arranging them into meaningful groups, or linking them, it is easy for students to forget how they defined the idea and what they were thinking about when they included it on the board. The explanation field, accessible by clicking in the idea box, will remind them. They can revise the explanation as their thinking progresses. In addition, the links themselves are accompanied by a similar explanation field. This allows students to write down what relationship between concepts they had in mind when they linked them by drawing a line.

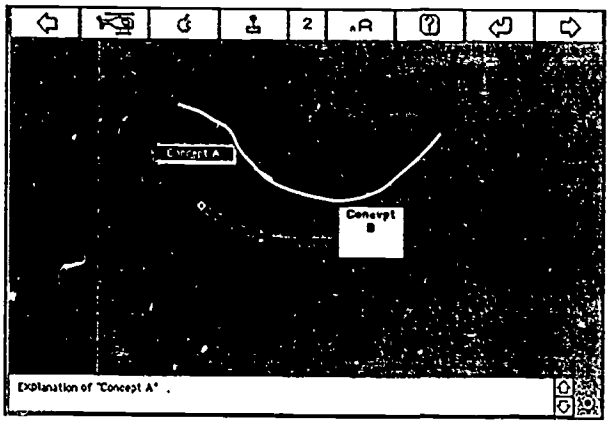

Figure 24

The special concept box menu allows for a great many options in the size and shape of the boxes, the text, the lines and even the color of the background of the board (Figure 25). This allows students to draw highly sophisticated, differentiated concept maps. When examining one's own (or another student's) map, for instance, one can add layers of interpretation by highlighting related ideas through giving them the same size or shape, without altering any of the explanations or links. One can also copy a board with all its boxes, links, and explanations so that different students can write explanations for the same concept map or create different arrangements of the same ideas. The wealth of graphic options also permits a kind of pleasant, expressive fooling around that, we hope, makes the somewhat abstract activity of concept mapping inviting and fun for a greater number of students.

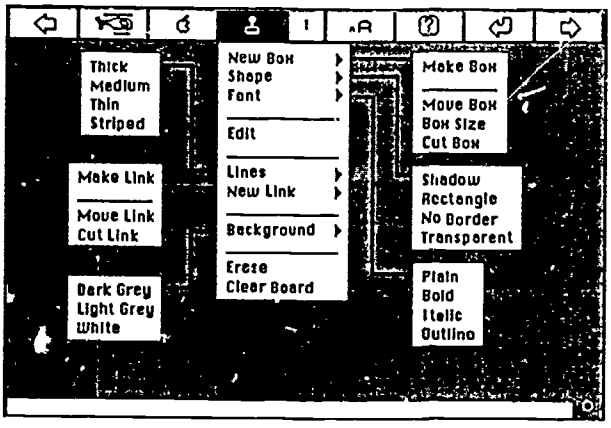

Figure 25

Graph Cards

The Graph Cards are designed to help students analyze and think about graphic representations of quantitative information (Figure 26). The program lets students graph anything—any set of numbers and any two variables—whether or not it makes sense. We know from the research literature that understanding graphs is particularly difficult for students. INQUIRE is not intended to teach graphing but to facilitate graph interpretation. The data to be graphed can either be imported from Math Cards or entered directly into a Graph Card into one or two data columns on the right side of the card. The student can then select a kind of graph for either one or two variables and watch the graph appear.

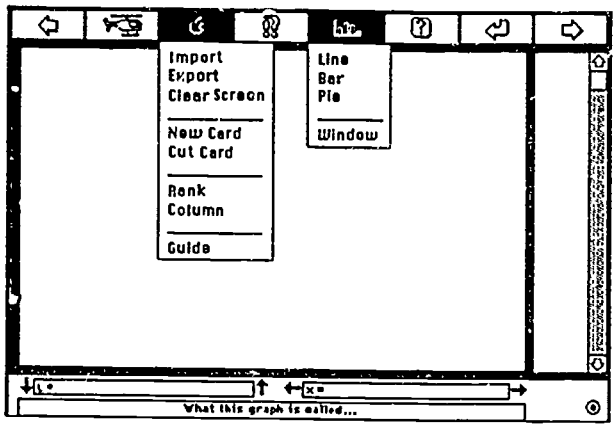

Figure 26

The most interesting feature of the Graph Card is the window. A student can select any part of a graph by stretching a window across it and then move the window containing a piece of the graph all over the screen for comparison. These windows can be flipped or rotated, making another set of comparisons possible.

The Graph Cards also contain two explanation fields, one asking the child to state what this graph shows and the other to decide how this graph relates to the question the inquiry is trying to answer. For the teacher who is concerned with letting students discover what a graphic representation can tell them about their own data, these kinds of summary fields can be useful tools.

Game Cards

Finally, there is an example of a kind of analytic Game included in this version of INQUIRE (Figure 27). This particular game asks students to write a declaratory sentence, ideally a major conclusion they arrived at in the course of their investigation. It then invites a second player to "challenge" any word in that sentence by selecting it and then asking one of three questions about it. The game requires that players elaborate on their statements by articulating their definitions of the terms they are using. We include it primarily as an example of the kinds of game-like activities many teachers have developed for their own uses. A program like INQUIRE might make it possible to share (with appropriate credit) some of these interesting activities among teachers and students across schools.

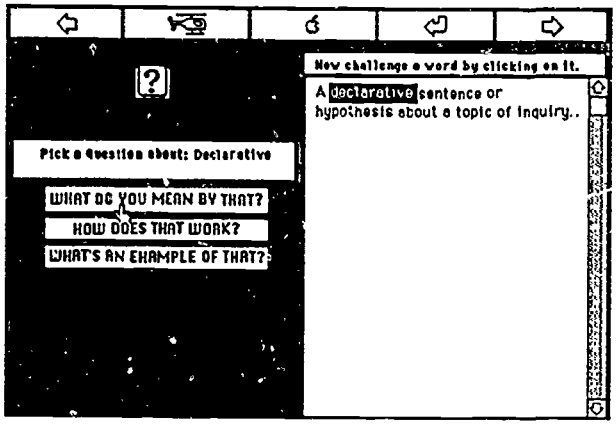

Figure 27

Author's Note

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