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ABSTRACT

This paper describes the experiences of first grade students as they are introduced to inquiry experiences and begin to develop skills and dispositions conducive to the practice of scientific literacy. The Guided Inquiry Instruction on light was the culmination of seven months of the teacher's professional development experiences in an orientation to teaching called Guided Inquiry supporting Multiple Literacies (GIsML), (Magnusson and Palincsar, 1995). The class consisted of 24 students, ages ranging from 5 years and 10 months to 7 years and 2 months, attending first grade in a school in a small farming community south of Ann Arbor, Michigan. The paper describes the unfolding of GIsML instruction illustrating different phases of the heuristic. It gives directions for construction of the light box used, made by the teacher from an ordinary corrugated cardboard box, with a white rectangular piece of posterboard for a screen. The paper details the four cycles of instruction and the resulting achievement of the content goals specific to light by the students. (Contains seven figures and seven references; a list of disk contents is appended.) (CR)

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Knowledge Through Communication: Guided Inquiry About Light In A First Grade Class

Knowledge Through Communication

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Guided Inquiry About Light In A First Grade Class

INTRODUCTION

Increasingly, there is interest in how literacy learning is a process of enculturation into various discourse communities (Gee, 1992; Wells & Chang-Wells, 1992). In the domain of science, this interest encompasses how students learn the linguistic norms as well as the syntactic conventions that enable children to engage in problem solving in a scientific way (Palincsar, Anderson, & David, 1993). While there is burgeoning research studying how children in classroom communities are supported in acquiring the "discourses of the literacies" (e.g., Gayford, 1989; Richmond & Striley, 1996), little of this work has been conducted in primary grade classrooms.

In this paper, a reflection on the first Guided Inquiry program of study I conducted in my first grade class, I describe, from my perspective, the experiences of my first-grade students as they are introduced to inquiry experiences and begin to develop the skills and dispositions conducive to the practice of scientific literacy. The Guided Inquiry Instruction on light was the culmination of seven months of professional development experiences in an orientation to teaching called Guided Inquiry supporting Multiple Literacies (GIsML), (Magnusson & Palincsar, 1995). Figure 1 illustrates the important features of this social constructivist orientation. The arrows indicate the recursive nature of the different phases of the heuristic. There are numerous literacy opportunities in this instructions. Children must negotiate orally with their partners, engage in written documentation, interpret the written documentation of others and explain through dialogue the significance of their data.

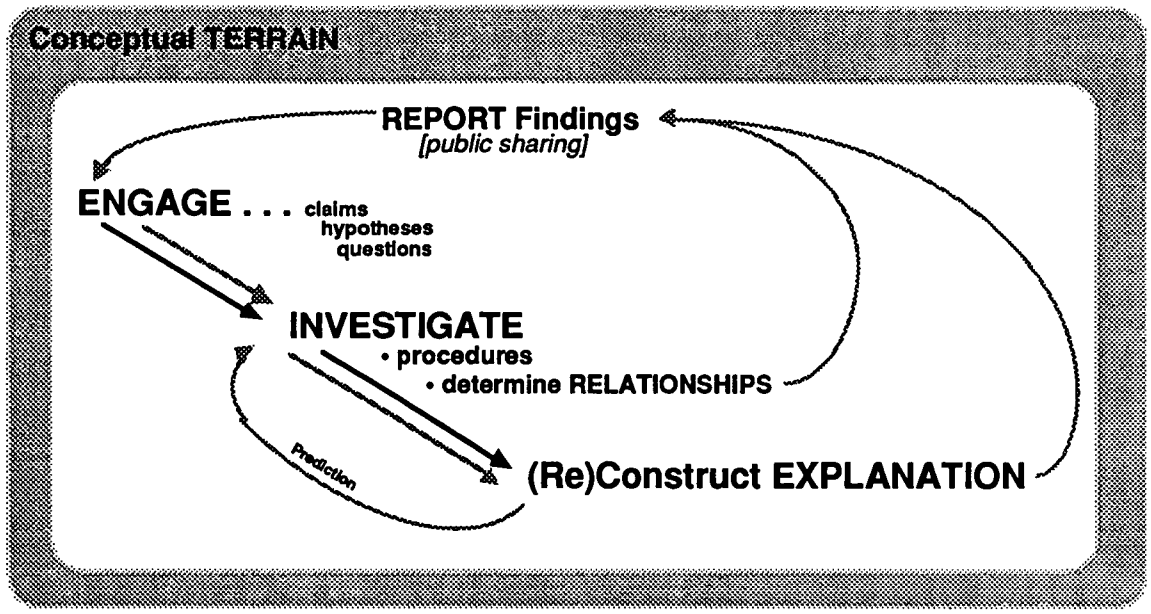

figure 1, the GIsML Heuristic

CONTEXT

My class of first graders included 24 children who entered school in September at ages ranging from 5 years and 10 months to 7 years and 2 months. Our school is located at a very small farming town 18 miles south of Ann Arbor, Michigan. Most of the families in the town derive income from farming, working in automobile factories or working at any of the three prisons located in the area. There is also the occasional professional family that likes the rural setting and chooses to live there.

The subject of the Guided Inquiry Study was Light. The conceptual goals for the children were: light radiates from its source; light travels in a straight line; objects can stop light and; light can be reflected and directed with a mirror.

After several weeks and several investigations of my own, I designed and constructed a light box from an ordinary corrugated cardboard box. One end (bottom) of the box was cut open. A square opening was cut at the opposite end (top) to allow a light bulb to hang and also to serve as a vent. A rectangular opening was cut out at one side of the box to function as a "window". The

window had 2 cardboard panels. The students could slide the panels close together or apart like window panes. This was an essential feature of the box because it permitted a 6-year old to control, with considerable ease, the amount of light coming from the light box. This facility with the equipment allowed the child to focus on the investigation of light rather than on manipulating the equipment.

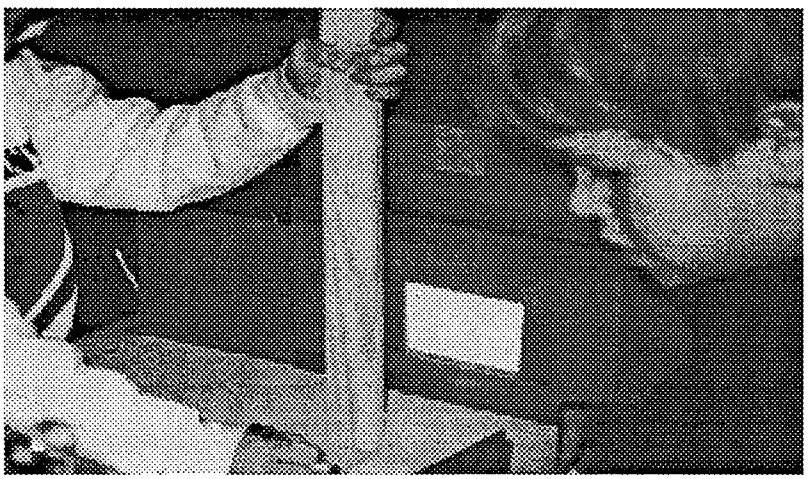

figure 2, a picture of the light box

In addition to the light box, I made a screen consisting of a white rectangular piece of posterboard. The pictures of a baseball, a basketball, a football and a soccer ball were drawn equidistant from each other at the bottom of the screen. During the investigation, the screen was to be placed about 2 feet in front of the window of the light box.

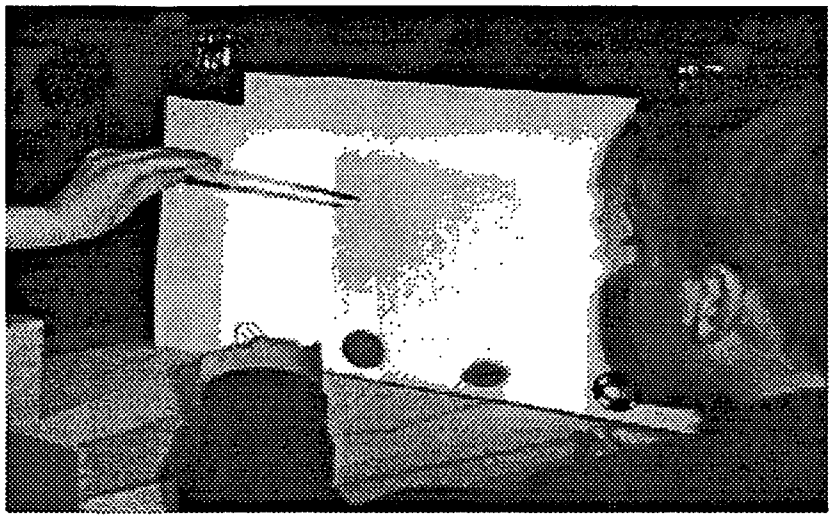

figure 3, picture of the screen

The task for the children would be to find out how much light to allow from the light box to reach a target, which would be one or any combination of the balls on the screen. This task was to be the context for the children's investigations on light. In this context the conceptual goals would become natural consequences of the investigations. The context would provoke and sustain curiosity as well as accommodate individual differences.

THE INSTRUCTION

This section describes the unfolding of GIsML instruction illustrating the different phases of the heuristic. The cycles of instruction typically start with the engagement phase, proceed with investigation and are followed by public sharing. Each cycle will demonstrate the increasing level of thinking over time especially as illustrated by the children's documentation.

CYCLE 1

ENGAGE . I introduced the children to the light box and the screen and how they were set up on the investigation tables. I gave them a task to do with their partners. One child would choose a target on the screen. The other would manipulate the window panes so that light would shine on or hit only the chosen target. The partners would switch roles in an agreed upon manner. They could choose one ball or any number of balls as targets.

INVESTIGATE. The children posed a variety of targets which they called challenges. Initially, the challenges were simple. They would choose one ball as a target. Then some chose 2 balls that were next to each other.

Eddie[1] thought of a challenge that he believed would be impossible. His challenge was to hit the baseball and the soccer ball, the two end balls, but not the basketball and the football, the two middle balls. Eddie's partner, Jeff, covered the 2 middle balls with his hand. That way, the light went only to the designated target. The other children heard about this very "tricky" challenge. They began thinking of their own targets to trick their partners. It was in this context that the children discovered that shadows are helpful in meeting "tricky" challenges. They also discovered that there were many things they could use to create shadows. They could use their fingers, their hands, rulers, and wooden blocks. At the end of the lesson, the children had become familiar with the context in which they would be investigating light for the next several days.

REPORT Findings. The first public sharing was mostly done orally. A few children made illustrations on the chalkboard. I started by posing a question: "How wide would you open the window of the lightbox to hit the basketball and the football (the 2 middle balls on the screen)?" The children gave varying responses. Seth claimed the window opening would be as wide as the space occupied by the 2 middle balls on the screen. He was asked to illustrate his idea on the chalk board.

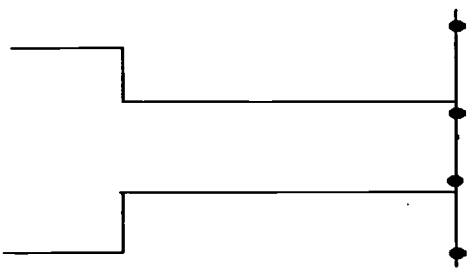

figure 4, Seth's illustration[2]

1 All student names are pseudonyms.

2 Figures 3, 4, and 5 are reproductions of students' drawings on the chalkboard.

Seth's illustration prompted an animated debate as many of the children did not agree with his idea regarding the width of the window or with the shape of the light as it left the light box. Betsy illustrated her own idea.

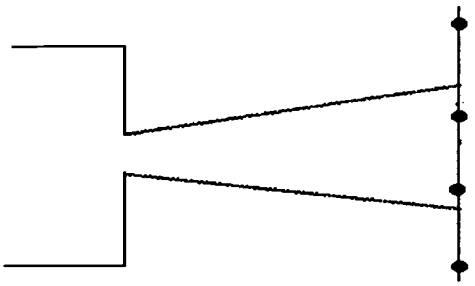

figure 5, Betsy's illustration

Stephanie agreed with Betsy that the opening of the window is smaller but she had a different idea about the shape of the light. She claimed that the light came out the same size as the opening of the window but then got big as it got close to the target.

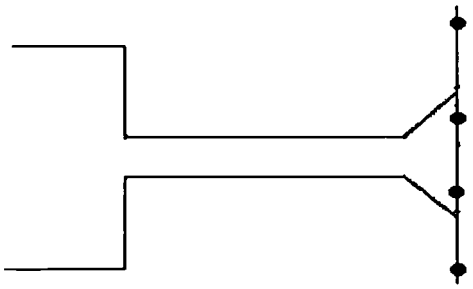

figure 6, Stephanie's illustration

CYCLE 2

ENGAGE. I asked the children how we might resolve the disagreement regarding the size of the window opening and the shape of the light. During the discussion that ensued, I pointed out that there were large sheets of paper on the investigation tables. One child suggested, "We could trace the light when it goes to the target". The children realized that a visual record was necessary as evidence of the claims they were making.

INVESTIGATE. Documenting the observations was added as a new activity during the second cycle of investigations. In our specific context, the children were essentially tracing the path

of light on the paper as it left the light box. Some of the children decided to color in "their pictures of light." Pretty soon all of them were coloring their pictures of light.

REPORT Findings I began the lesson by displaying all the children's documentation on the chalkboard. I called attention to the "pictures of the light" they had made from their investigations. I asked the question, "What can you tell me about the pictures of light that you made." The children gave variations of the following responses:

They all have colors

They have different colors.

There are lines and there are colors.

I then asked the question, "What is the same in all these pictures?" The responses were more variations of the same.

I wanted the children to tell me the shape of the light from the pictures. I was not sure they saw it and if they did, they were not articulating what they saw. I made other suggestions to help the children see that the pattern of light on their documentation all had the same shape. I asked them to trace the light from the documentation with their fingers. They were asked to trace someone else's instead of their own. Surprisingly, they had no trouble tracing the outline of the light beams with their fingers. They demonstrated an understanding of the shape of the light but they were not articulating the similarity across the documentation. Finally, I asked the children to use scissors to cut out the drawing of the light from their documentation.

I displayed the light shapes on the chalkboard as they were cut. When all the pictures were displayed on the chalkboard I asked again, "Can you see anything that is the same in all these pictures?" The only new response was: "They are all cut." Not one response addressed the shape of the light.

Ironically, this was a class with considerable experience with patterns in other contexts. They had read pattern books, found patterns in the way books are formatted, found patterns in illustrations in books. They had created their own patterns with pattern blocks. They had skipped

in patterns, had clapped in patterns, had counted in patterns. They had added and subtracted numbers in patterns. They had identified patterns in a variety of situations. They had identified patterns in a variety of places. We had already spent half an hour looking for the shape of light. I was beginning to feel frustrated.

I then began to turn the shapes over one by one so that the white side of the paper showed. Before all of the documentation had been turned, someone exclaimed, "They all look like a V!" Then someone else added, "They look like a V without the point." The eyes and the faces began to light up. Indeed, no matter what the target had been, the shape of the light was the same! Some were "fat" and some were "skinny". But all were like a "V without the point". EUREKA! The children had finally noticed the pattern of the light as it left the light box. Pedagogically, this was the most challenging time during the inquiry.

CYCLE 3

ENGAGE. As had become customary each day of our investigations, we started by gathering in an open area of the room to recall the experiences of the previous day. After a brief conversation, I asked the children to think about why it took us so long to find the pattern of the light. The children thought that the different colors representing light and shadow were confusing. Alex suggested that we should make a plan so that we would not be confused when we do our documentation. He added that we could use one color to represent light and another color to represent dark. If we all used the same colors, then we would not be confused. The children agreed that the suggestion was a very good one. They decided on a color to represent areas on the paper where there was light and another color to represent areas on the paper where there was darkness. Other suggestions were added to facilitate documentation including using something with a straight edge to trace lines, and writing labels where appropriate. The difficulty of finding the pattern of light illustrated the need to use a shared way of recording for better communication.

INVESTIGATE/Construct EXPLANATION. As the children proceeded with the second round of investigations, they used the conventions they had generated. Their comments revealed

their increased attention to the shape of the light on the paper. They were careful to indicate the areas of light and dark. While doing so, they discovered the relationship between the shape of shadows and the shape of the light from the light box to the screen. They also discovered the relationship between the size of the shadows and the distance of the object causing the shadow from the light source. The actions they took in manipulating their materials enabled them to generate explanations regarding the relationships they discovered.

REPORT Findings/ENGAGE. This time, individual teams shared their observations with the aid of the documentation they had generated. Robert's team was the first to volunteer. Robert was the designated presenter. Displaying his team's data sheet before the class, Robert outlined where the light was and where the shadow was. He explained that a block (of wood) had been used to create a shadow so that the light would not go to the basketball and the football. The rest of the class listened and when Robert was finished with his presentation, he asked if anyone had a question. Some children asked questions to clarify portions of the documentation. When something I considered important was not addressed, I asked a question. Most of the time, Robert answered the questions. When he was not sure, he referred the questions to his partner, Alex.

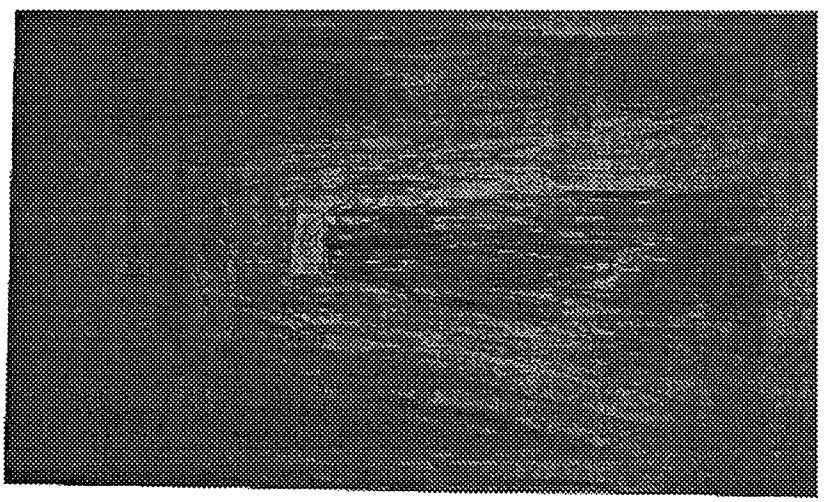

figure 6, Robert's documentation

Part of the dialogue follows:

Question: "What was your challenge?

Answer: "The challenge was to shine light on the softball and the soccer ball but not on the basketball and the football."

Question: Why is there no light on the baseball?

Answer: There really was. We messed up. The baseball should be here (points to an area above inside the light).

Question: Why was the shadow on the soccer ball?

Answer: It (the shadow) is not supposed to be there. I think the stick (straight edge) moved when we were tracing the light. But the shadow wasn't really there.

Question: What is that dark block inside the shadow?

Answer: That is where we put the block the first time but the shadow did not cover the basketball and the football so we moved it back and then the shadow got bigger.

Two other teams shared their data. After the public sharing, some of the children went to the light boxes for more investigation. Others decided to take a look at their documentation to see if there was something that needed "fixing." I suspect this was a result of the children's dialogue during public sharing.

It was interesting to notice that a few of the children made additional marks on their documentation. One child whose documentation showed only light began to make a shadow in the middle of the light. When I asked why he was doing that, he responded that the shadow was supposed to be there. Actually, his original documentation was accurate. The shadow on Robert's data might have given him the idea that a shadow is supposed to be included in the documentation.

CYCLE 4

INVESTIGATE. The children who were at the light boxes became very conscientious about accuracy in tracing the lines to show light and shadow. They began to label not only the objects on the paper, but also the areas of light and shadow. The discussion during public sharing taught the children the importance of accuracy in recording observations. They began to label not

only the objects on the paper, but also the areas of light and shadow. They were not only thinking about tracing the areas of light and shadow, they were also thinking about how accurately they could communicate their observations to the rest of the class using their documentation.

Construct EXPLANATION. In addition to careful representations, the children's dialogue during the investigations revealed that they were formulating explanations regarding the phenomena they were discovering. The previous public sharing demonstrated to the children that they should anticipate the need to explain what their drawings represented. They made sure that they had answers to possible questions.

The public sharing became a driving force in raising the level of observation, documentation and public sharing. The questions asked by the listeners and the responses they received motivated the children to manipulate the materials in different ways to achieve other possible results. In addition, the questions prompted the children to review and refine their documents and prepare more seriously for public sharing. The public sharing also became an opportunity to introduce new challenges to extend their understanding of light.

An example of the introduction of a new challenge occurred using Robert's old data (see figure 6). It showed light on the two outside balls and shadow on the 2 middle balls. I asked the children if they could put light back on the basketball and on the football (the 2 middle balls in the shadow) without moving anything, not the block, not the screen, or the light box. It was the context for introducing mirrors to reflect and re-direct light.

INVESTIGATE. I casually put mirrors on the tables and told the children who were investigating that they were there in case they wanted to use them. The mirrors created new excitement in the investigations. The children discovered many possibilities for using the mirrors to direct light onto objects on the screen that were in the shadows. While the children were very excited about the many ways they could put light in the shadows using mirrors, they began to realize the difficulty of documenting their discoveries. There were now more lines to draw and more objects to label. At one point one child said, "Why don't we just take a picture?" Two

children asked if they could write descriptions on their paper simply because there were too many lines. Writing a description of what they were observing, they explained, would allow them to trace only a few lines, which would be less confusing.

As the lesson continued, the children were making more and more discoveries about directing light. They made statements that expressed what they know to be true about light. We called these statements "claims" and listed them on a chart. The list included: *The light gets big as it gets to the target. The box blocks the light. The sides of the light are straight. We can stop light. The mirror steals light from the box and shoots it some place.* The list grew as the children made new discoveries and made additional statements.

The children showed continued interest on the subject of light even after the first hand investigations have been concluded. I directed the ongoing interest to the production of a book about light. I kept the list of claims on display for 2 more weeks. As part of their language arts activities, the children were given the task of choosing a claim to write and to illustrate. They could choose the claims they made or they could choose someone else's. They could also write about something they knew about light that was not on the list. They prepared their writing for "publication" which meant typing and printing their writing on the computer and making final illustrations. Some of the children typed or helped someone type the pages that they were preparing for publication .When all the materials were prepared, I mounted each page on construction paper, laminated each and bound them into a class book. Four copies were made of the book and the children took turns sharing a copy with their families. The children were also asked to write any other questions they had about light. Many of the questions the children wrote were similar. One child filled her paper with several questions about light. The questions included: Why does light travel so fast? Why does light get bigger when it leaves the light box? How can sooo much light come from so little bead (holding the filament) in a light bulb?

ROLE OF TEACHER/ROLE OF STUDENTS

To understand the opportunities that unfolded during the cycles of inquiry, it is helpful to consider the role of the teacher in the instruction and the classroom culture that allowed the students to participate comfortably in their roles. .

During the Guided Inquiry on Light, I saw my role as primarily that of a facilitator. My activities could be grouped as those I undertook in preparation for the Inquiry and those I engaged in during the Inquiry.

As part of my planning, I conducted my own investigations about light. That activity led me to determine the context of the investigation which included the design and construction of the light box and the initial task for the children. I anticipated possible sources of distractions and did my best to minimize them. I chose a physical set-up that allowed free and unhampered movement by the students as well as effective monitoring and supervision of their activities. I made sure all the materials were ready and easily accessible.

In addition to the physical set up of the classroom, I decided that the children would work in pairs. As customary in our class, the children would chose their partners initially.

A very important activity I undertook prior to the Inquiry was shaping a classroom culture that would allow the children to benefit fully from Guided Inquiry instruction. In order that they would be actively engaged in the investigations, the children would have to be self directed so that they would pursue their investigations with very little help from adults. They would need the ability to focus on assigned tasks for sufficiently long periods of time and a level of self-confidence that would permit them to take on new challenges. They would also need to have the ability to ask relevant questions and have the facility to engage in productive dialogue. They would have to be comfortable in participating fully in making classroom decisions and plans. I strove to achieve this particular classroom culture from the very beginning of the school year. By January, we were ready to benefit from a Guided Inquiry on light.

During the investigations, I walked around and asked questions at opportune moments to advance the children's thinking. I assisted with materials when necessary. I allowed for flexible pairings when appropriate. The length and pace of the investigations were determined by the children's interest and abilities. In a few cases, I stopped some children to allow others to take their turn.

During public sharing. I helped the children display their data on the chalkboard. I re-phrased the children's questions and answers for clarification. At times, I asked questions that I felt were important, but that the children failed to ask. When I sensed that the class was becoming restless, I stopped the discussions and went back to the investigations. Through the duration of our Guided Inquiry on Light, public sharing and investigations were interwoven in a manner that sustained the interest of the students.

The children had 3 primary roles: to investigate, to record, and to share. These roles generated the bulk of the activities during the 10-day period it took for the Inquiry. During the investigations, the children posed target challenges for each other. They made discoveries as they manipulated the light boxes. In many cases, the solutions to the challenges became sources of new and more difficult challenges. There was considerable dialogue among the children during their investigations. They challenged each other's solutions, they verbalized their observations and they consulted each other for solutions.

Recording their discoveries consisted mainly of tracing the paths of light from the light box to the targets. Initially, the children experienced some difficulties. Over time, the children became more comfortable with the activity and their documentation increased in clarity and sophistication. Public sharing was a big factor in refining the children's documentation. Each pair collaborated on ways to document their observations well.

The children not only shared their discoveries; they listened to others present theirs. They asked questions for clarification and for further explanation. The discussions generated ideas for new investigations, new challenges and other directions to pursue.

CONCLUSION

Guided Inquiry is a very dynamic approach to teaching. The flexibility of the heuristic allows time to cycle back to a phase when necessary before going to a new phase. The public sharing that was interwoven with other phases of the heuristic was an opportunity for the children to clarify their discoveries and collaborate on ways of sharing their knowledge. The dialogue during public sharing challenged the children to become more attentive to details of their investigation for accurate documentation and reporting. The investigations required active thinking on the part of the students to formulate explanations for their discoveries.

The children demonstrated that they achieved the content goals specific to light. Beyond that and perhaps more importantly, they engaged in activities that gave them syntactic knowledge of documentation, interpretation of evidence and collaboration through problem solving.

The success of Guided Inquiry demands an enormous amount of preparation from the teacher. It requires shaping a classroom culture that is predisposed to the activities of this kind of study. It demands critical thinking during planning to provide a rich context for investigation. It also demands active thinking during the actual investigations to ask the appropriate questions at critical moments. The demands, however, result in learning that is very satisfying for both the children and the teacher.

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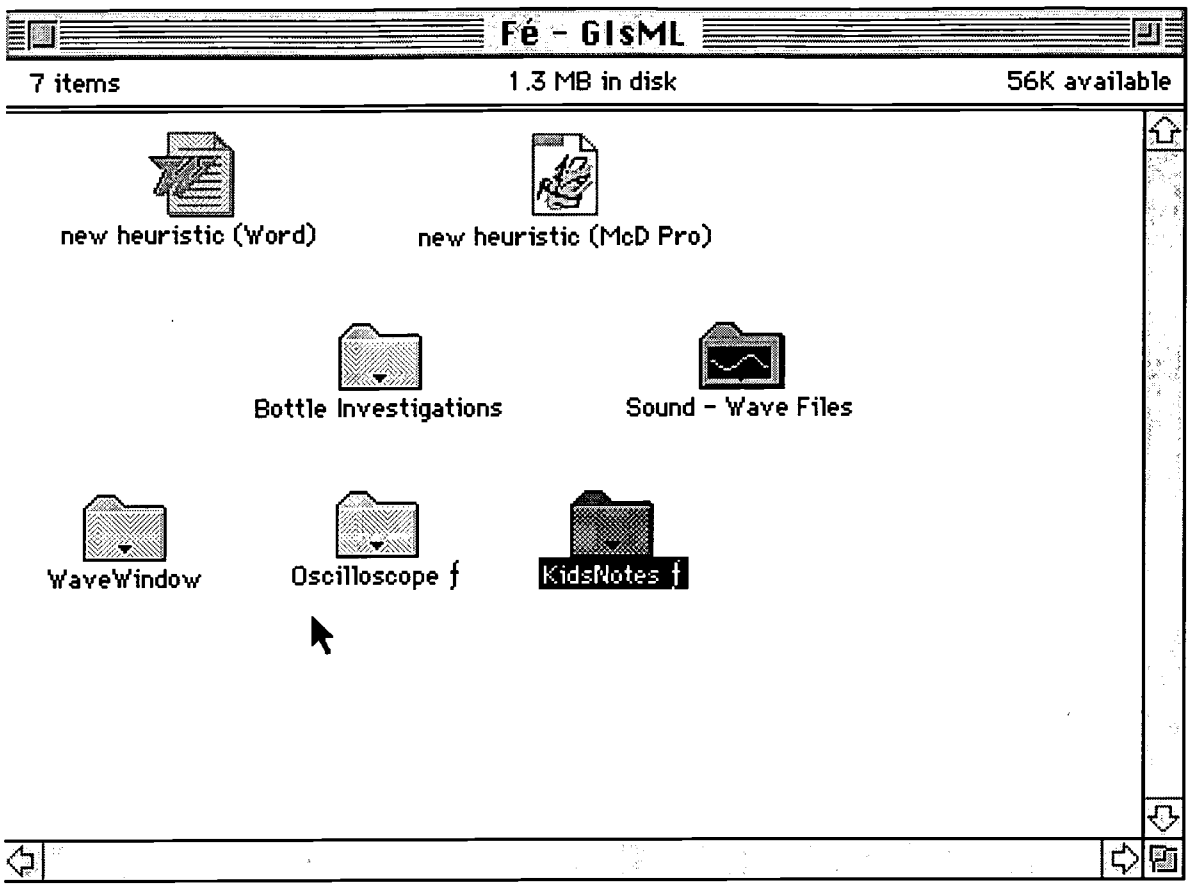
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6/96)