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ABSTRACT

When children are curious they are willing to investigate the less self-evident properties of matter. It is hoped as deeper explanations and relationships are explored, children learn analytic, critical, and creative skills for later application to phenomena encountered in life. A concern of elementary science teaching is motivating learning or discovery of scientific concepts. The instructional issue is getting school children to apply systematic thinking. The theoretical issue deals with what becomes defined as a problem realm for students as they interact with authoritative sources. This study was conducted on three classroom lessons on detecting problems that centered around a videotape stimulus. The object was to gain insight into ways teachers could organize the conjunction of everyday experience and the scientific and how that integration may have served to define what a problem is and what a solution is for the children. The investigation showed different types of systematicity being introduced that appeared to convey different definitions of what constituted a science problem. Children need to go beyond surface explanations of events to develop adequate understandings of concepts for use in problem solving. Related diagrams are included. (RT)

Teaching Problem Structure from Video and Everyday Life

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Teaching Problem Structure from Video and Everyday Life

Abstract

In this study, three elementary school lessons in science problem detection were studied, that centered around a videotape stimulus. The object was to get a sense about the ways in which teachers could organize the conjunction of everyday experience and the scientific in discussion and how that integration may have served to define what a problem is and what a solution is for the children. The connection teachers made between abstract properties of problems, video narrative, and personal experience did not depend on formal problem content. The investigation showed different types of systematicity being introduced that seemed to convey different definitions of what constitutes a science problem. Encouraging children's need to go beyond surface explanations of events is argued to be an issue of socialization. The work has implications for how the structure of video narrative may utilized to that end.

Teaching Problem Structure from Video and Everyday Life

According to many educators, the main concern of teaching elementary science is how to maintain children's curiousity in how the world works (Rowe, 1978; NSTA, 1982; Hawkins, 1983). When they are curious, children are willing to go below the surface of events and learn about the less self-evident properties of matter. It is hoped that as they explore deeper explanations and relationships, children learn analytic, critical, and creative skills to later apply to new phenomena they encounter, in school and out.

Related to this central concern is one of motivating learning or discovery of scientific concepts when the school environment functionally doesn't demand a higher level of predictability (Horton, 1967), except for the purpose of getting a passing grade. The instructional issue is one of getting school children to apply systematic thinking where there was previously a unreflective set of strong responses to particular situations. The theoretical issue concerns discussing what becomes defined as a problem realm for students as they interact with authoritative sources (Goodnow, 1987). Both work at the juncture of what Vygotsky (1988) called the everyday and the scientific, or, conceptually systematic.

The process of learning systematicity and what is to be "systematic" according to the culture, involves socialization of a particular kind. Like all development of "higher psychological functions" (Vygotsky, 1978) it involves a selection process in which interindividual transactions will be transformed into inner thought processes. In addition, it involves the particular lesson of approaching the world as a specific kind of problem text. This approach aspect is value-laden in that certain practices or problem realms are not defined as legitimate. For instance, in the lessons we examined, the affective side of science problems that was presented was not taken up.

In the current study, classroom lessons on detecting problems that centered around a videotape stimulus were studied to get a sense of the ways in which teachers could organize the conjunction of the everyday and the scientific and how that integration may have served to define what a problem is and what a solution is at the new plateau of information from the students' points of view (see Engestrom, 1987). Such a focus may eventually help us address the problem of a collective version of science getting construed and transmitted in ways that may not encourage continuing curiousity among many children.

The Study

Three teachers and their students in three elementary schools in the New York area were involved in the present work. Each school served an ethnically mixed and predominantly lower middle class population. Carol, a teacher for six years, taught fifth grade; Scott, a fifteen year veteran, taught fourth grade; and Charlie, in his fourth year of teaching, worked with a fifth grade.

The teachers had each participated in a teacher education program in mathematics, science, and technology carried out by Bank Street College. A multi-media science and mathematics package, The Voyage of the "Mimi", served as a vehicle for conveying the training ideas and methods. The package includes a 13-episode video drama concerning scientists studying whales. The "Mimi" is their boat.

In the study, teachers were asked to conduct a discussion around an episode of the Mimi during which the following questions would be addressed:

1. What problems did the "Mimi" crew have to solve?
2. What did the crew have to know in order to solve their problems?
3. What problems have you encountered in your experience that may be like the ones you saw in the show?
4. What possible problems might be anticipated for the crew in the future?

The discussions were videotaped and transcribed.

Information relating to the scientific nature of remarks--that is, their inferential, descriptive, etc. qualities--was not immediately useful in capturing the differences between the lessons and will not be discussed. Rather, differences emerged as the properties of the video material were matched with the structures of the lessons and with the teachers' strategies for introducing information to the children.

Figure 1 diagrams the science-related events that occur during Episode 3, and indicates their chronological sequence. The central dilemma is that the instruments have been misreading because of an electrical problem on board. Three modes of utilizing evidence, formulating hypotheses, and resolving problems are modelled in the show. That is, children see examples of inductive, causal, and deductive reasoning.

Carol's Class

Carol began her discussion of the episode by asking the children to identify problems encountered by the "Mimi" crew. [Figure 2 shows the sequence in which problems were mentioned overlaid onto the narrative structure of the videotape.]

The circled numbers represent the order in which the crew's dilemmas were discussed. Numbers that are slashed indicate that Carol refused the bid for that topic of conversation.

Rather than remembering incidents chronologically as they took place with the narrative frame, children instead seemed to remember salient visual events such as sparks coming out of the fuse box. It can be seen that, with two exceptions, Carol directed the flow of discussion topics to match the narrative sequence.

Carol proceeded by offering an open invitation for children to volunteer their observations. This technique mostly failed so she solicited ideas with leading references to the narrative content [Figure 3]. If a child responded by naming a problem, some additional information was elicited and the problem-detection cycle then would begin again. Most often, however, the child's response provided an occasion for Carol to then elaborate with a lot of factual information. Children's statements in this portion of the lesson were succinct, averaging 4.2 words per turn.

After that discussion segment, Carol asked for ideas about "what can they do to take care of these problems." Carol at that point maintained the viewpoint of the television viewer. The students responded as Carol named the problems in turn. The structure and nature of the questionning sequence are the same as in the problem detection segment [TV].

As Carol's lesson moved to a discussion of the children's personal experiences [PE] and of hypothetical problems [HTV], the dialogic structure shifted. Although the teacher continued to solicit the students' comments with leading information about the drama she also mentioned other sources of information. In this part of the lesson, a child's response could be followed by another child's. At a couple of points, there was evidence of one child having been reminded of something by another.

In recounting the stories of their own past--being lost, blowing fuses, a motor dying--children's expressions expanded to 31.3 words on the average. Their stories were well-formed, detailed, humerous, and dramatic. For example:

> Child: Once I was going down the basement to get something and I opened the lights and I saw water all over the floor. And then I called my father and he came down and was trying to look where the water was coming from but it wasn't coming from those tubes.

> And then my baby brother, we found out that my baby brother had opened the pump from outside and the window is right next to that and the window was open and all the water came in.

Carol offered no elaborations of the content of the children's experiences.

When no more personal stories were forthcoming, Carol asked the children to think of problems the "Mimi" crew might have. In short statements, they generated a list of mishaps and disasters (without solutions), for example: "a mouse might eat the wires," "a hurricane blowing in the other direction," "maybe they'd run out of food," The ideas are imaginative and pertinant, although they focussed on disasters rather than resolutions.

Carol's decision to address, point by point, the questions of the experimenter, lead to a partitioned discussion and, perhaps, reinforced the distinction of two domains of thinking, everyday and schooled.

Scott's Class

Before showing Episode 3, Scott asked the class if there had been any problems for the scientists in accomplishing their tasks. He then wrote three problems mentioned by students on the board, and told them this was to "get our mind on the whole idea of problem." Continuing from that viewpoint, he told them they should look for and think about "the problems and what you have to know to solve them."

After the viewing, Scott created a table on the board saying:

Look at this. Problems. Solutions... We don't want to be all with a list of problems nobody can solve.

And he wrote down the solutions that correspond to the problems based on the children's responses [Figure 4].

If we map out the sequence of topics discussed in Scott's class with respect to the drama narrative we can see several striking differences compared to Carol's map [Figure 5]. First, problems are discussed in the order in which they are generated, not in chronological order of the story. The children generated all but one of the problem topics. This structure seems to legitimize what the children find salient. [Boxed numbers on the extreme right indicate topics arising from personal experiences.] While the children's utterances were short, comparable in length to the non-personal statements made in Carol's class, the problem/solution framework they filled in is based on content shared between the children and the characters. This content actually represents the structural commonality between the personal, video, and hypothetical instances.

Because the problems were introduced in conjunction with their possible solutions, the meaning of "problem" became something-to-be-solved, rather than as dilemma per se. The problems, in other words, were presented and treated as conceptual action-based wholes. Even solutions to particular problems were cast and discussed as general principles, for example, as "emergency procedures."

Third, seasickness is included as a problem for which emergency actions may be necessary. This crosses an important conceptual boundary, to which the children are very likely to relate easily: getting sick versus needing to fix a computer.

Looking at the sequence of instructional dialogue during the lesson, a recursive pattern emerges wherein children's responses are consistently related back to an abstract framework [Figure 6].

Scott's organization did not teach the logic of inductive or deductive inference. Instead, getting students to think about what the crew did using what they themselves know resulted in a perhaps necessary prior awareness: that problems have structure in the first place.

Charlie's Class

Charlie's intent was to organize children to work within a scientific system: the formal problem of calculating rate of travel from distance and time.

Charlie began the discussion by trying to get the students to reconstruct the context of the rate problem, asking them, "What's the first thing you know that went wrong? That caused everything else?" This is a difficult question since many of the causal elements of the problems become known by the characters through induction and so initial cause is not the first thing that is seen to go wrong [Figure 7].

Since the children didn't answer, he made the questions simpler. Carefully verifying selected responses of the children's, he gradually laid out a set of problem elements so that the class arrived at the fact that the knotmeter was malfunctioning.

When Charlie asked the class what the captain replaces the knotmeter with, one children answered, "a piece of bread." What else did the captain use, he asked. "Stopwatch," was the answer. But there was one more thing Charlie wanted them to say. The classes responses began by being reasonable. As Charlie continued to elicit guesses, the children volunteered "steering wheel," "multiplication," "speed," with the answers becoming less reasonable, less associated figuratively with the video event, and more random. The answer turned out to be "the length of the boat," which no one guessed.

In the second segment of the lesson, Charlie went over the formula for rate problems, writing them on the board, and had the children do some sample calculations. Incidentally, Charlie confused the term "knot" as a distance and speed measure throughout the lesson.

Charlie did not organize the discussion around the questions. He elicited what the captain's worries were, what tools the captain usually used and what he had to replace them with, and finally, how the rate of the boat was measured. Charlie selected the topics to be developed in discussion by negating the various contributions of the students.

Charlie attempted to define the legitimate problem under discussion so that the children could apply this concept to mathematical calculations. No personal information about the children's experiences emerged during the lesson. The children's utterances averaged 2.2 words overall. The net effect of guessing what the acceptable answer is teaches a lesson that "problems" are defined outside the student's perceptions and responses to the world.

Conclusions

From these examples, we see that introducing systematicity is not a simple issue: each teacher worked systematically in his/her own way, either by following the narrative chronology and experimenter's directions, by creating a problem/solution chart, or by presenting variations on rate problems.

In what ways, then, are the regularities of the everyday and the scientific mediated to allow an abstract structure to become internalized as part of the child's reference system? Here, the nature of the connection itself between ordinary and "scientific" experience seemed to lie in the teachers' own sense of the connectedness of the two rather than in the overlap of formal content. The teacher's conceptualization is critical to the development of scientific meaning among children because the dynamic is essentially socialization not merely development.

Carol might be said to have encouraged interaction that "taught" that problems exist in particular contexts, that they may or may not have solutions that can be figured out, and that the everyday and the more delineated co-exist. The rich set of hypothetical disasters generated by Carol's students remained a list of images.

Scott selected a different version of "problem" from among his students' responses. Juxtaposing everyday experience with the video examples allowed him to logically pull meta-structure into the foreground of the discussion and to integrate the familiar with the novel. Scott seemed to create a framework of systematicity from which one can generalize to new problem sets and to new instances.

Finally, Charlie developed the steps in his lesson based on answers from the children that corresponded to what he and the mathematical problem defined as problem elements. The "scientific," such as it was, predominated. Charlie's use of notation seemed to underscore that invoking the fact of the rate formula was the object of the lesson, rather than having the students achieve understanding of the formula. The students' approximations of answers were not acknowledged. Their contributions became more restricted and they lost coherence. Those students probably learned that one is told how the world works.

Among the children, we saw that unguided expression of the everyday is richer in form and content than expressiveness concerning formally structured concepts. Children's recall was most often of visually salient events. They had difficulty organizing their recall along logical lines of causation or inference. Finally, all the children worked to construct logical connections between the teacher's questions and their answers. This responsiveness is what, one may suppose, ultimately teaches the particular model of problem structure they encounter in class because the children engage with the teacher who organizes the use of examples, instances, and generalities.

The fate of the children's "curiousity" here is not known, but what is alive and well in Carol's disaster discussion, can be said to be harnessed in Scott's exploration of solutions. In Charlie's class, unfortunately, probing the fathoms of the teacher's mind became the object of curiousity.

To make principles of systematicity detectable, the lesson material--in this case the chronological narrative--must, like our own experiences, be divorced from one sort of everyday logic and dubbed into a formal, culturally-derived framework that lies in some sense apart from exposition and unfolding. At the same time, symbolic notation (such as RxT=D), and the structure of such frameworks, unmanifest in narrative and in our everyday doings, needs to be tied to an unfolding experience (see Lampert, 1986) so that it can become acted upon and thereby acquire an identity in the problem/solution detecting process.

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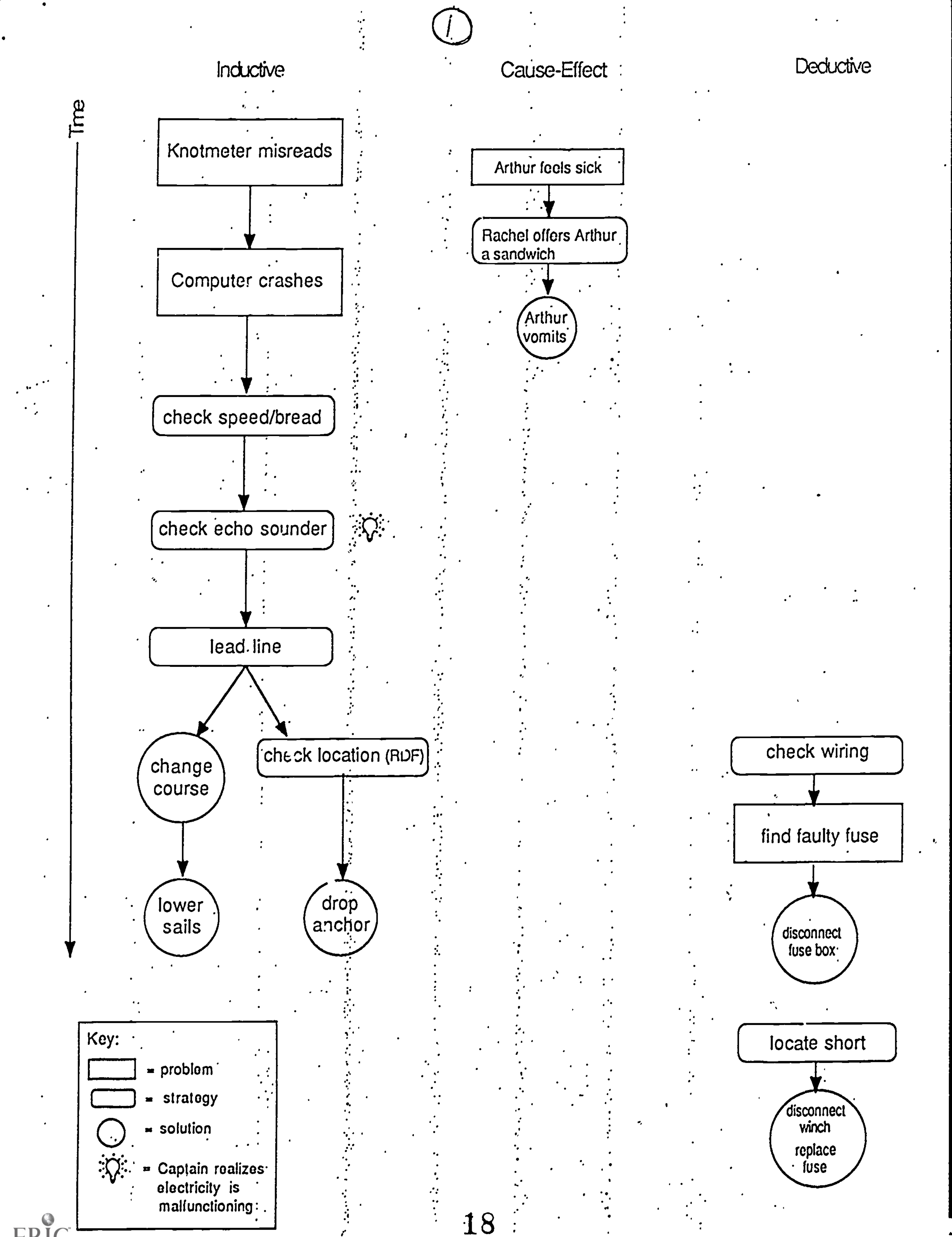
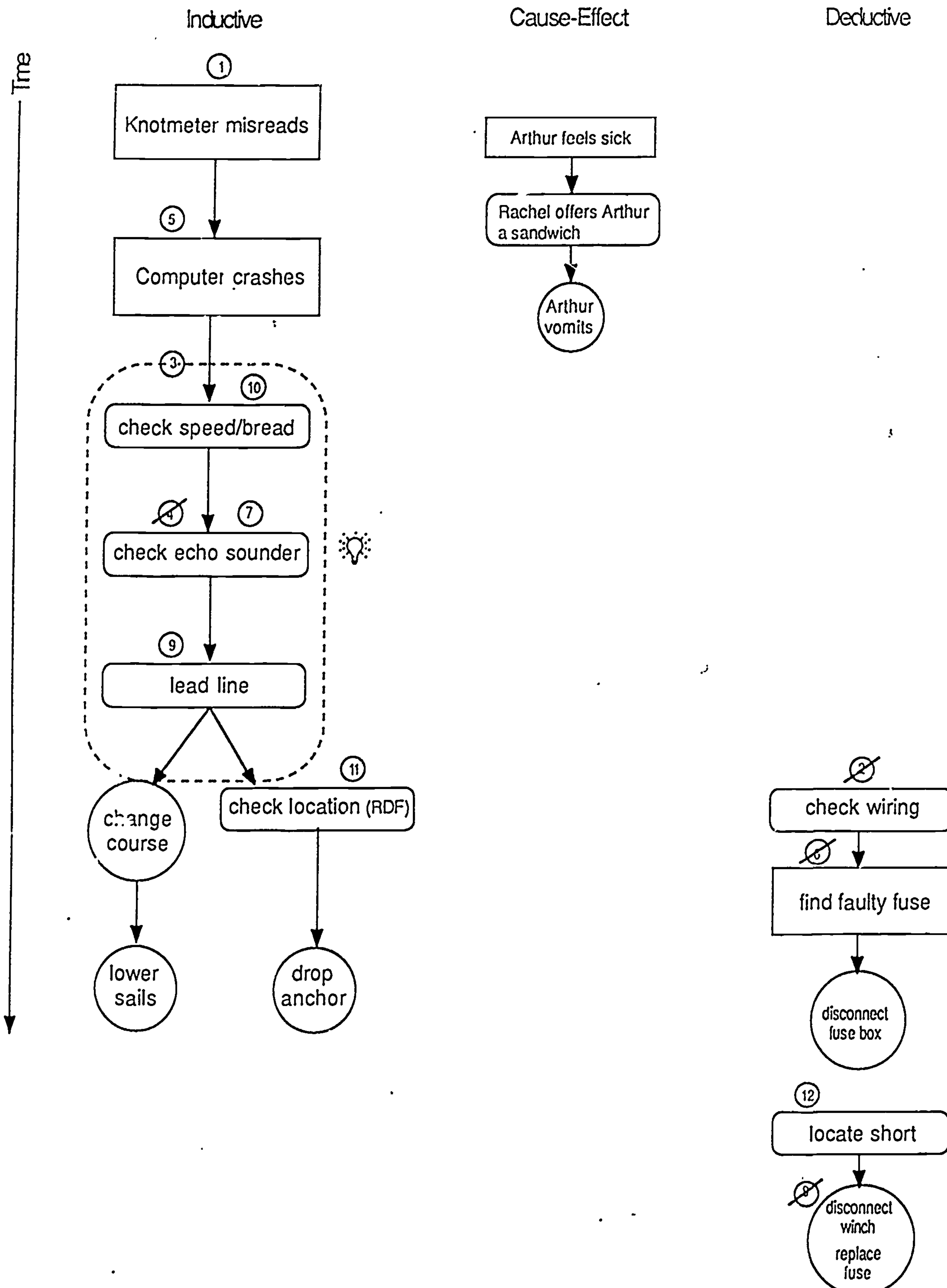

1
Inductive
Cause-Effect
Deductive
Time
Knotmeter misreads
Computer crashes
check speed/bread
check echo sounder
lead line
change course
check location (RDF)
lower sails
drop anchor
Arthur feels sick
Rachel offers Arthur a sandwich
Arthur vomits
check wiring
find faulty fuse
disconnect fuse box
locate short
disconnect winch replace fuse
Key:
= problem
= strategy
= solution
= Captain realizes electricity is malfunctioning

2



Inductive
Cause-Effect
Deductive
Time
1
Knotmeter misreads
5
Computer crashes
3
10
check speed/bread
4
7
check echo sounder
9
lead line
11
change course
check location (RDF)
lower sails
drop anchor
Arthur feels sick
Rachel offers Arthur a sandwich
Arthur vomits
2
check wiring
6
find faulty fuse
disconnect fuse box
12
locate short
8
disconnect winch
replace fuse

3

Structure (implicit):
problems and solutions

↓

Structuring Information (Teacher):
sequential ordering of events

↓

Soliciting Questions (Teacher):
leading information

↓

Response (Child)

↓

Overexpansion (Teacher):

TV

Soliciting Questions (Teacher):
leading information; information children
learned from other sources

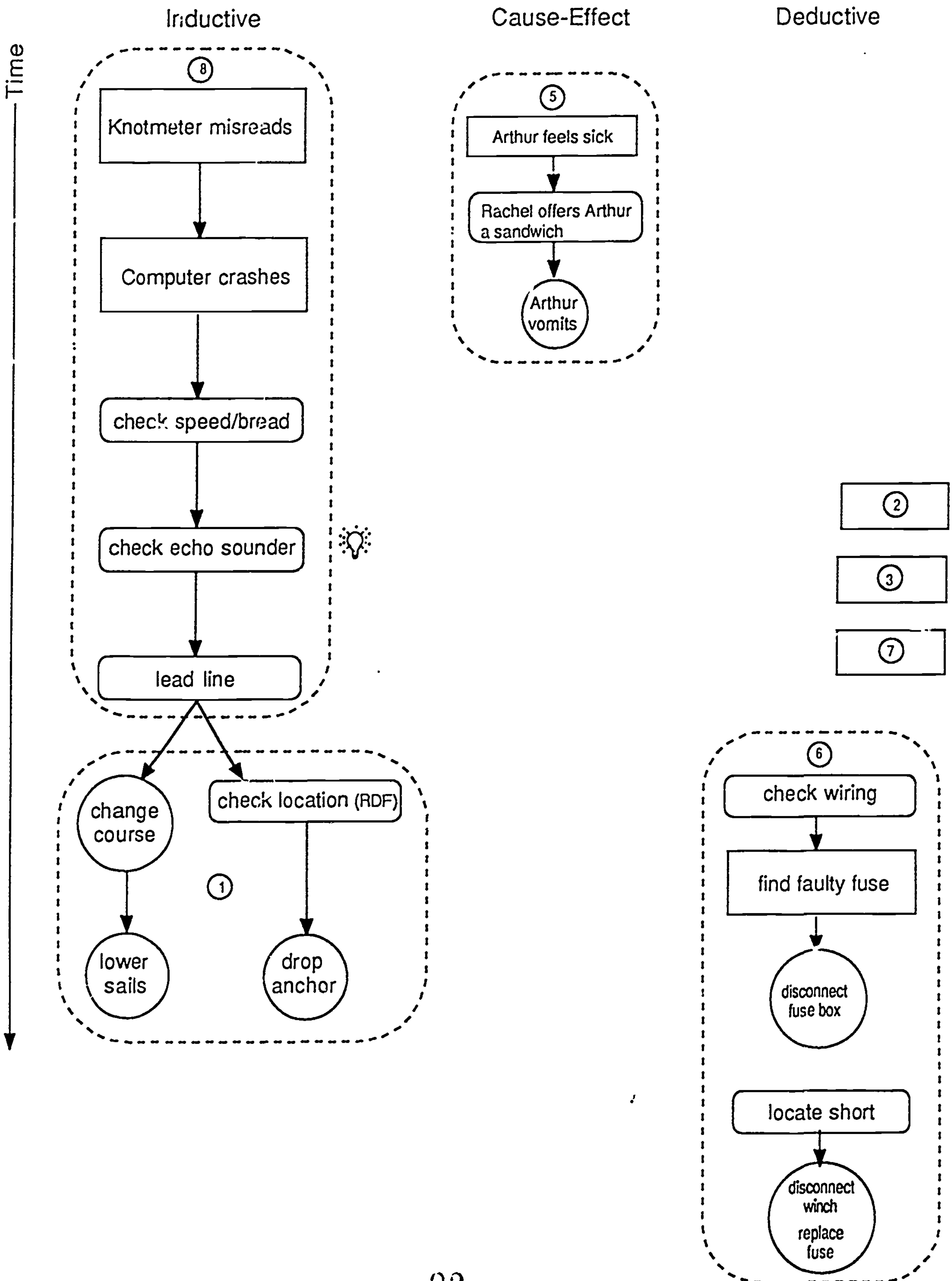
Response
Child 1 → T → Child 2 → T → Child 3

HTV & PE

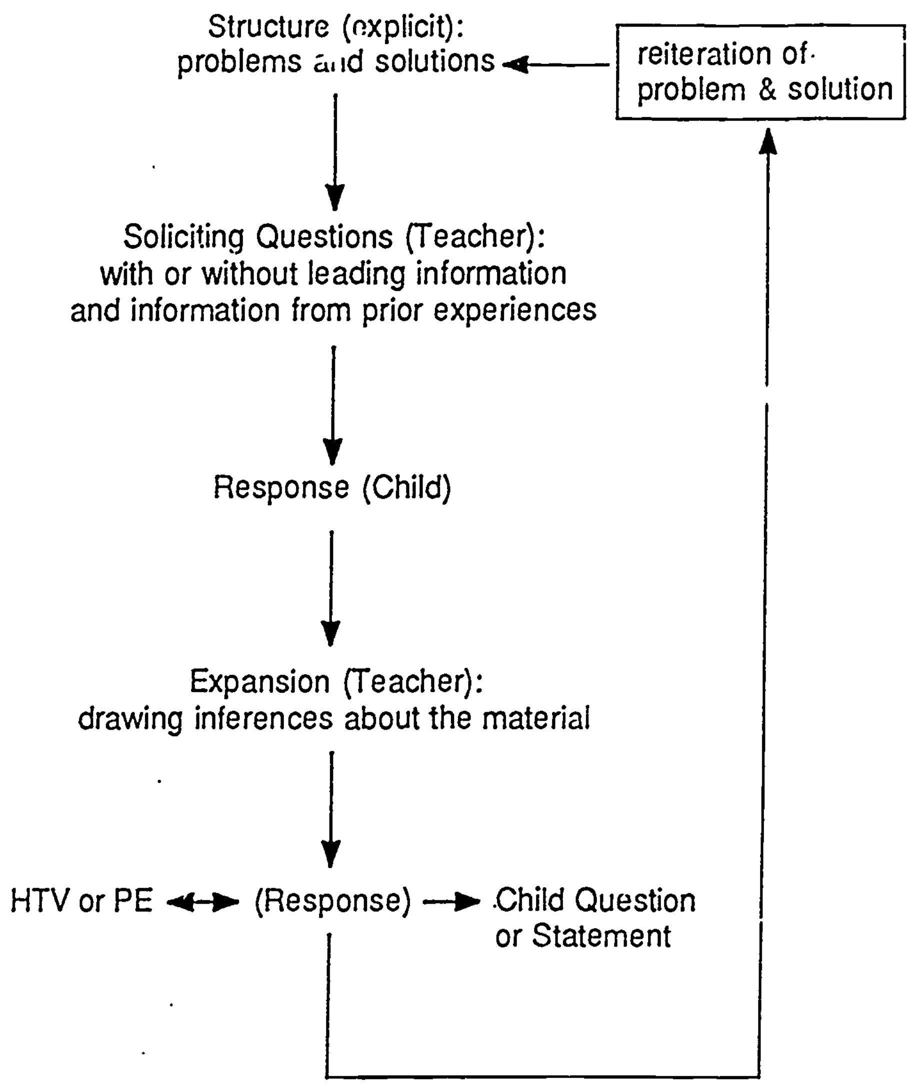
(4)

PROBLEM	SOLUTION
Knowing where to go	Map reading, compass reading: navigation
Storm	Emergency procedures
Getting back	Navigation
Seasickness	Medical equipment, walking around, going on deck, to vomit
Electrical	Knowing about electricity, tools, wires, and fuses
Boat sinking	Lifeboats
Instruments don't work	Fix power supply, use other equipment that works without electricity

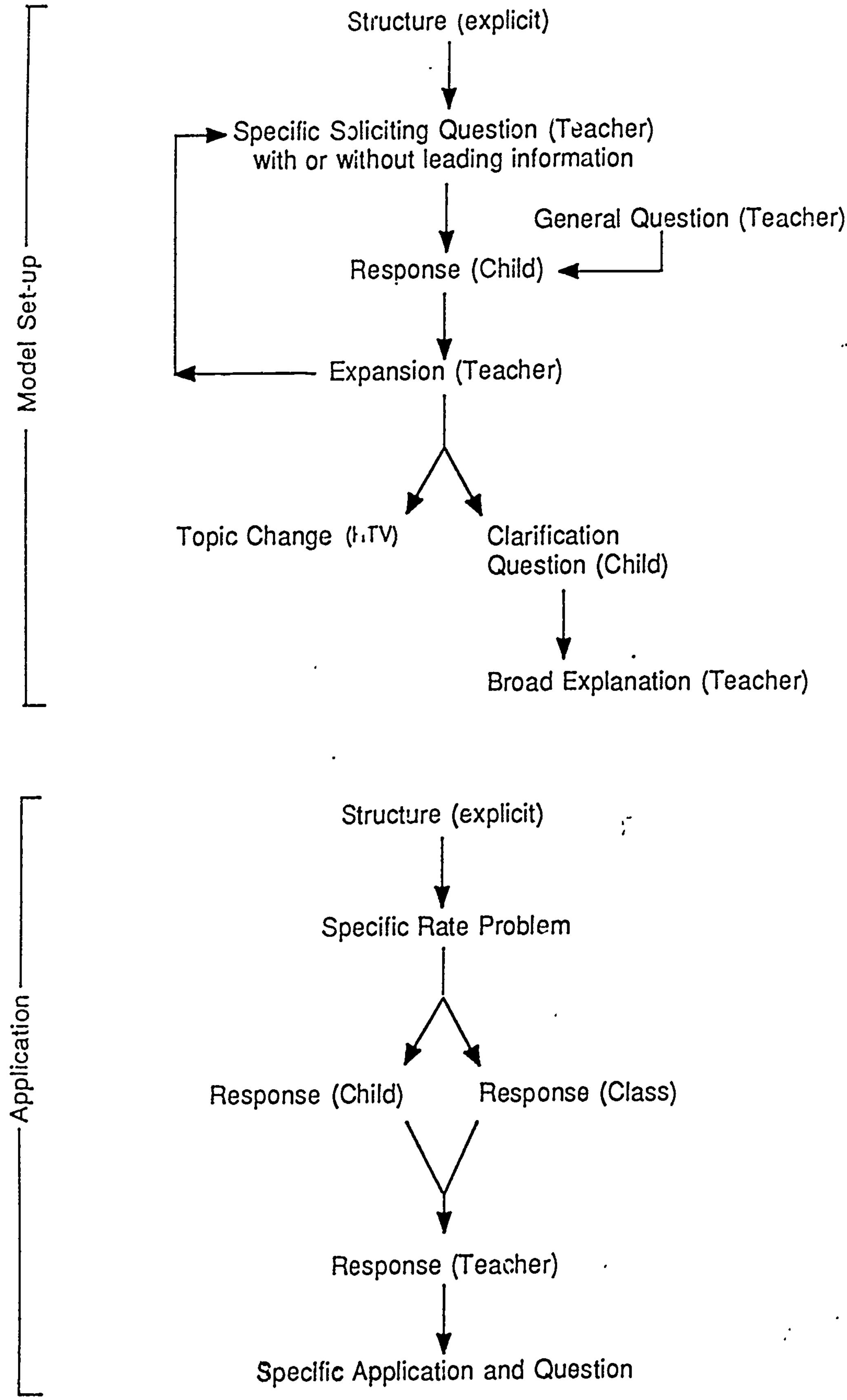
5


Inductive
Cause-Effect
Deductive
Time
8
Knotmeter misreads
Computer crashes
check speed/bread
check echo sounder
lead line
change course
check location (RDF)
1
lower sails
drop anchor
5
Arthur feels sick
Rachel offers Arthur a sandwich
Arthur vomits
2
3
7
6
check wiring
find faulty fuse
disconnect fuse box
locate short
disconnect winch
replace fuse

6


Structure (explicit):
problems and solutions
reiteration of
problem & solution
Soliciting Questions (Teacher):
with or without leading information
and information from prior experiences
Response (Child)
Expansion (Teacher):
drawing inferences about the material
HTV or PE
(Response)
Child Question
or Statement

7


Model Set-up
Structure (explicit)
Specific Soliciting Question (Teacher)
with or without leading information
General Question (Teacher)
Response (Child)
Expansion (Teacher)
Topic Change (HTV)
Clarification
Question (Child)
Broad Explanation (Teacher)
Application
Structure (explicit)
Specific Rate Problem
Response (Child)
Response (Class)
Response (Teacher)
Specific Application and Question