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ABSTRACT

This case study explored how social interaction during science lessons leads to the development of planning skills in students. An analysis of group discussions was conducted. Questions addressed were: (1) What is the nature of planning discourse during science problem-solving activities with young children?; and (2) How is collaborative planning during science problem-solving encouraged by the teacher to help a student structure problem-solving attempts? An urban elementary school located in a transient, low-income, predominately Latino neighborhood was selected. The class tended to be bilingual, but the analysis focused on activities where English was used primarily. The classroom population was 30 children, and one-third were fluent English speakers. Participant observation notes and unstructured interviews were conducted. Classroom documents and video and audio tapes of 1-2 hour durations were analyzed. Discourse and conversation analytic methods were used to complete both macro and micro analysis of classroom discourse. Results suggest that the teacher's general framing of learning as problem-solving opportunities for all participants profoundly affected the nature of instructional talk, and contributed to an emphasis on learning about planning during social interaction. In this case study, the teacher was in the process of building a classroom environment that engendered group problem solving by creating opportunities in which students could actively participate in planning activities. The social organization, shaped by a complex integration of linguistic, visual, and kinesic texts, provided students with a means to make sense of practical activity as forms of problem solving that require planning. Active participation in social interaction around planning had the consequence of shifting students' roles from receivers of knowledge to producers of knowledge. (Contains 37 references.) (WP)

Issues in Problem Solving Discourse: A Preliminary Study of the Socialization of Planning Skills During Science Lessons in a Kindergarten Classroom

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Abstract

This research study explored how social interaction during science lessons lead to the development of planning skills in students. To this end, teacher led discussions during kindergarten science were analyzed through discourse and conversation analytic approaches. Results revealed that when learning is framed as a problem-solving activity in general, students have multiple opportunities to participate in group planning.

This research project is a preliminary investigation into the role that social activity and discourse play in the development of planning skills during science problem-solving lessons in an elementary classroom. Planning is the expression of goal-directed behavior and the ensuing solution strategies (Scholnick & Friedman, 1987; Suchman, 1987). As students and teachers coordinate their classroom discourse around science lessons, students participate in problem-solving activities in which they learn what it means to plan, how to use plans, and when to use plans. In other words, social interaction during science activities provides the location where children are socialized into the linguistic, cognitive, and social skills of planning. It is in the moment-to-moment interactions that the process of learning how to plan can be captured *in vivo* through an analysis of problem-solving discourse.

It is commonly recognized that planning is a fundamental and essential aspect of problem solving, a goal directed behavior (cf. Hayes-Roth & Hayes-Roth, 1979; Smith 1992). However, a close examination of expert-novice problem-solving discourse in classroom contexts has remained relatively unexplored. Limited research into social interaction in studies of planning by cognitive psychologists and educational psychologist grows out of a generally shared theory of knowledge (epistemology) that views knowledge construction as an internal phenomenon (cf. Piaget, 1954; von Glaserfeld, 1984). When internal, cognitive phenomena are privileged over social interaction, the relationship between psychological processes and the social context is treated as ancillary. It is for this reason that investigations into the nature of planning seldom give analytical preference to the language practices during planing (for an exception see Rogoff, Gauvain, & Gardner, 1987). Given the lack of relevant research into the language of planning during classroom problem solving activities, an investigation into

language practices during planning activities is in order. A better understanding of how children are socialized into the skills of planning offers the possibility of improving a commonly desired goal, problem solving instruction.

Currently, there is growing recognition that classroom activities and thus discourse not only shape students' opportunities to learn content knowledge but also socializes children into the process knowledge (i.e., reasoning) of content areas (Edwards & Mercer, 1987; Lemke 1990). Moreover, it is during classroom science activities that children learn what it means to do science in a formal setting. What is learned depends on the how and why of ongoing activity. The classroom provides the context for "situated practice" in which the doing and knowing of science creates valuable resources of experiences and artifacts that mediates present and future activities (Lave 1993). The history of experiences and ensuing relations among participants, meaningful actions and activity organization contributes to the complex development of classroom social norms. The culture of a classroom, i.e., taken-as-shared practices, comes into existence through the continual development of social norms. It is important to note that social norms are not static but are continually constructed and reconstructed during concrete activities of the classroom. The evolving classroom culture provides both a cognitive map (Goodenough 1957) and a means of making sense of talk, behaviors and symbol systems (Ochs 1988; Geertz 1973; Bloom 1993). In other words, the integration of linguistic text (talk), visual text (pictures, graphs) and kinesic text (gestures) makes sense as a result of ongoing practices. It follows that what is learned cannot be separated from the context. Consequently, the context contributes in essential ways to the intellectual development of planning skills. Moreover, the process by which children are socialized into process of planning during science lessons is a result of co-participation in the constitution of

classroom norms about when, where and how to plan during science problem solving activities. Since it is through social interaction that students have opportunities "to grow into the intellectual life around them" (Vygotsky, 1978: 88), participation in social activity is one of the principle means by which new knowledge is produced. Accordingly, the classroom represents a cognitive socializing environment where children are formally introduced to scientific knowledge and reasoning.

The crucial relationship between contexts in which children participate and the concepts they appropriate is elaborated in the sociohistorical school of psychology. From the sociohistorical perspective, Vygotsky(1978) argues that learning first occurs on a social plane between people (interpsychological) and later is transformed and internalized to an individual plane (intrapsychological). Interpsychological processes are social because they are socially mediated. From this view, cognition is a social construction where individual cognitive skills are promoted through joint activity. In other words, children's learning and subsequent development is best understood by examining both their active involvement in activities and interactions with more competent others and the broader sociocultural context that provides meaning. Since Vygotsky holds that the child is actively involved in a sense-making process with more competent others, the process is neither a unidirectional mapping of culture (simple socializing) or an individual construction of knowledge. Rather, it is a process of co-construction, i.e, collaborative construction. On this view, both the child and the environment are active. Consequently, children with the scaffolded assistance of socializing agents jointly construct and reconstruct their world together (Rogoff 1993; 1990; Ochs 1988; Valsiner 1988; Winegar 1988). Ochs (1988) claims that it is in this process of co-construction that "ways of thinking are both social and individual"

(p. 20).

In addition to the co-construction of the world, Vygotsky holds that semiotics (tools and signs) mediate development during social interaction. The semiotic tool given analyticai priority is language (oral and written). For Vygotsky, language mediates cognition among participants during social interaction. Since language provides the micro context for interactions, it is the primary mechanism for learning and cognitive development. By focusing on cultural constructs (e.g., language, mathematics) as mediators of psychological functioning, Vygotsky emphasizes the interdependence between social and cognitive factors in learning. In effect, the boundaries between the individual and social world are blurred. An analysis of the nature of this process is elaborated in research on language socialization. Ochs (1991) has shown that grammatical forms are used to socialize children into local theories of knowledge, i.e., what counts as knowledge, how knowledge is gained, and how it is applied. These findings point to how and why a study of discourse during problem-solving activities can contribute to our understandings of instructional practices. It is at the microgenetic level or moment-to-moment development of problem solving activities that the theories of knowledge and thus planning of the classroom community are evoked. Participants' views, beliefs, and practices about the how, when and why of planning are revealed through the integration of their language, visual and kinesic texts. It is for this reason that a micro- and macro-analysis are inextricably linked. Talk-in-interaction cannot be studied separate from the context since there is an interdependent relationship between individuals and their environment. Since this study focuses on the activities of planning during problem-solving, it is important to have a clear understanding of these terms.

Problem-solving is a form of goal directed behavior, i.e., there is an end

point or *telos* (Scholnick & Friedman 1987). Although not mandatory, an aspect of goal-directed action is planning. Plans are candidate solutions that function as resources for future action. Plans are focused on future action while problem-solving is the execution of plans. Plans represent complex cognitive and social activity that occur both before future action and on the fly during ongoing activity. Thus, plans, as Rogoff, Gauvain and Garner (1987) point out, are not "encapsulated" within the individual but rather involve a context of action. In order to understand how students develop planning skills during problem-solving activities in science lessons, it is important to look at the mutually informing contributions of the social and contextual aspects of instructional settings. Moreover, it is a close examination of the relationship of "situated action" that provides a means of studying the development of planning skills in children (Suchman 1987). Situated action in classroom planning activity involves semiotics. Semiotics or sign systems are communication systems that include the use of language (written, verbal and nonverbal), gestures (e.g., pointing, nodding), visual images (e.g., drawings and graphs), discourses, and proxemics (body positioning) during social interaction. This study will investigate how the multiple aspects of planning contribute to the development of planning skills in young children during whole group planning aspects of problem-solving activities.

Research Aims

To explore how social interaction during science leads to the development of planning skills in students, an analysis of teacher led group discussions was conducted. In particular, the following questions were addressed:

1. What is the nature of planning discourse during science problem-solving activities with young children?

2. How is collaborative planning during science problem-solving encouraged by the teacher to help students structure problem-solving attempts?

METHOD

The School Setting

To investigate how children learn to plan during science problem-solving activities, an urban elementary school located on the west coast of the United States was selected. The school is located in a transient, low-income neighborhood. While the population is predominately Latino, there are students of African-American and European descent. The administrators and teachers of this school openly state a commitment to changing instruction in science and mathematics to reflect current theories of learning. Many of the teachers are involved in collaborative efforts with universities and business to change instructional practices.

Participants

The teacher. The teacher, Mrs. Ferragher, who collaborated on this study taught a bilingual kindergarten classroom. Since Mrs. Ferragher is bilingual, the language of instruction in this classroom tended to shift between Spanish and English during lessons. However, for the purposes of this study, the analysis focused on activities where English was used primarily.

Mrs. Ferragher was involved in a science "partnership" between a university, a school district, and a business corporation. Involvement in this partnership entailed both reading about current educational research in science education and also attending regularly scheduled "dialogues" for teachers, students and working

scientists. Utilizing information gained from her involvement in the partnership, Mrs. Ferragher attempted to create a challenging environment in which students could explore and learn about science in small and whole group settings. Consequently, the improvement of science instruction was an important goal for this teacher. The criteria for the selection of this classroom was the teacher's commitment to improving instruction, the frequency of science lessons and the inclusion of instructional methodology that went beyond merely using a textbook to teach science.

The students. The classroom population consisted of thirty children. Twenty of these students were limited English speakers while ten were fluent English speakers. The selection of this classroom was based on the teacher's interest in science rather than on student characteristics.

Procedure

In this case study, participant observation (Jorgensen 1989) notes were collected over a six month period to gain an understanding of the development of classroom social norms. Ongoing unstructured interviews (Spradley 1979) were conducted with the teacher that focused on the nature of science, science teaching and learning in general. These interviews provided important information about how science learning was conceptualized and implemented. Classroom artifacts or documents were analyzed for contributions to the research questions. In addition to interviews and document analysis, eight video and audio tapes of one to two hour duration were collected over a two month period to record the face-to-face interactions among participants.

Discourse and conversation analytic methods were used to complete both a macro and micro analysis of classroom discourse. Note that discourse analysis

allows the researcher to unravel how the norms, preferences, and expectations of the participants are used "to relate language to both social and psychological contexts, including knowledge, beliefs, social acts, activities and identities" (Ochs 1990, p. 289). In this study classroom discourse is seen as "an integration of sentences that produces global meaning that is more than that contained in [individual] sentences" (White 1980). As a consequence, discourse and conversation analytic methods allows for the integration of the larger context and face-to-face interaction to reveal how moment-to-moment development of meaning during interaction is related to the larger context of practical activity.

Although this study focused on planning skills during science, recorded classroom activities included reading, math, science, social studies and daily organizational activities. The collection of data across instructional settings allowed the researcher to determine how social interaction was interrelated across events. It was found that the teacher's focus on the process knowledge of science (i.e, observing, collecting data, developing and testing hypotheses and drawing conclusions) was embedded in activities throughout the day. Influenced by current trends to integrate curriculum and her own beliefs about science, Mrs. Ferragher openly stated that she believed the process knowledge of science could be taught as a part of other curricular areas. It is for this reason that the data sets in this paper are taken from multiple instructional settings including classroom opening activities, mathematics and language arts lessons.

RESULTS

Preliminary data in this study reveal that the teacher's general and systematic framing of learning as a problem-solving event had profound implications for the moment-to-moment development of discourse around specific content activities, including planning activities during science instruction. How learning was consistently framed as problem-solving opportunities is found in an unexpected activity,

the organization of daily agendas.

Agenda Time: Group Planning as a Problem Solving Event

Although agendas are generally used as pre-announcements of scheduled events, that was not the case in this classroom. Here, the agenda functioned as both a general outline of daily activities and a tool used by the teacher and students to plan and anticipate possible strategies for those activities. Strategies are plans to the extent that they are maps of goal-oriented actions used to resolve problem circumstances. Consequently, the discussion of strategies during agenda time were simulations of past or future activities in which plans were either shared or developed in a whole group setting. In this activity, the teacher has the tendency to reformulate students "opportunistic" solutions to past problems as planful and therefore strategic (Hayes-Roth & Hayes-Roth 1979). Opportunistic plans are developed in the turbulence of ongoing activity rather than from a removed vantage point.

It is important to note that although Mrs. Ferragher accepted all agenda topics proffered by students, she would consistently refocus the function of agenda time on strategies, i.e., plans for future action or successful past plans. Thus, while agenda items tended to be teacher generated, students were encouraged to share strategies and topics for discussion. Consequently, as the school year progressed, the responsibility of producing agenda items tended to shift from teacher generated to student generated topics. The shift in responsibility for developing and discussing agenda items was consistent with shifts found in a range of classroom activities in which students were expected to take on the role of relative expert, not as all knowing but more knowing (Gutierrez, Larson, & Kreuter, in press; Jacoby and Gozalez 1991). The shift in responsibility for planning during social interaction was an ongoing activity that involved a subtle process in which the teacher initially

labeled and described activities as planful and thus strategic as students slowly appropriated the teachers language and views to interpret behavior and actions.

How children learned about planning skills during social interaction was facilitated through a study of daily agendas. Agendas were physically displayed on large sheets of easel paper made visible and accessible throughout the day. As a result of this practice, the agenda served as visual and linguistic texts on which the drawings and words of both teacher and students could be found. Since these texts were visible, they could be referred to at any time by participants. It is of interest to note that at the end of each month, daily agenda sheets were collected, bounded into a book, and made available to students in the class library. Students often spent their library time looking through the agenda "big books" discussing past activities. The topic of discussion generally involved one or more student contributions or "strategies." As a consequence, the process of agenda production with the emphasis on planning activities and the resulting artifacts appeared to be highly valued among students.

The valuing of student generated plans was not an accident in this classroom. From participation in the science "partnership," Mrs. Ferragher was attempting to implement a science curriculum in which learning was not conceived of as a transmission model in which knowledge is received by students. Instead, she was attempting to implement a "constructivist" model of learning in which knowledge is constructed by students during social activity (Tobin, 1994). Thus, her goal was to create situations in which children were actively contributing to ongoing activity.

The larger goal of encouraging children to engage in the "thinking of the classroom" explains the practice of returning to the agenda to begin each activity during the day. This practice had the consequence of framing content learning (e.g.,

science, math, language arts) as multiple forms of problem solving activities. This approach was accomplished through the sharing of candidate solutions (i.e., plans) for expected activity through simulations and discussions. As a result, the agenda provided a physical locus used to focus joint attention as the teacher socialized students into a critical dimension of planning, a deliberate search for a solution to problems found in ongoing activity. An example of how agenda time provided an activity in which the teacher socialized children into what counted as a strategy or action plan and how to use strategies is captured in the following excerpt.

Example 1: Agenda Time or Reformulating Student Actions as Cognitive

1	T:	I didn't ^e:ven sa:y it was agenda time and y.ou kn:ew it.
2		You're so: smart. (.) you ^moved up. Ya:sseni:a, thank
3		you.
4	A:	An everybody knew that:
5	T:	They ^di:d. hn. It's amazing. Le:o (.) could you
6		sc[oot on: up so you could hear:.
7	A:	[You: know: how: we knew:? Cuz in you're gonna
8		(inside hand) you were getting a marker.
9	T:	That's how you knew?
10	A:	^**Every**::one know: th::at cuz cuz markers you write on
11		that.
12	T:	^Good. You know what thou::gh every:one not may not
13		be a:ware: of that Anthony. So, that's why you're sharing a
14		sta^tegy right now with us. (.) You're saying that when you
15		see me get this marker, you know what we're gonna do.
16		

The above example illustrates a commonly occurring pattern in which the teacher uses face-to-face interaction to reformulate students' situated behavior (talk and actions) as planful, i.e., using a method to achieve a goal. In this instance, the teacher has recontextualized present actions and talk as a cognitive activity in which the student used past events of agenda activities to determine future actions

(i.e., planfulness) and move toward a large easel. Thus, through retrospective construction, the teacher formulates a child's movement toward the agenda as a positive action that was strategic or metacognitive in the sense that the child thought about past events to predict the teacher's future goals, i.e., action plans (Lines 1-2). Here, Anthony's movement toward the agenda is cast as utilizing his understanding of past activity to plan his future actions, getting ready to participate in agenda activity. Of interest is that the teacher's post hoc account of what constituted a strategy, utilizing a solution method (plan) based on reflection, contributed to a typification of behaviors that indexed planfulness. In this way, the teacher socialized children into what counted as plans or action plans.

Nonetheless, the reformulation of an individual child's actions into strategic behavior does not adequately explain the interaction in Example 1. A close examination of lines 5 and 6 revealed that not all students knew agenda time was about to begin. This explains why the teacher reformulated Anthony's explanation (Lines 10-11) as an example of "sharing" a strategy or action plan (Lines 12-16). Anthony's actions became a model for how other students could interpret activity as cognitive events, in this case, planful. In fact, the use of student activity during agenda time as a tool to model how present actions functioned as strategies or possible solution plans is consistently evidenced in this data set. Mrs. Ferragher's continual description of students' individual actions as motivated by underlying plans not only provided information about plans but also socialized children into thinking about planning. In effect, Mrs. Ferragher provided instructions about how to interpret events. A further consequence of explicitly labeling individual student's situated action as planful appeared to result in a classroom community pallet of behaviors and events that served as resources for future decisions on appropriate action plans.

Additionally, the instructional treatment of planning skills in Example 1 is a prototypical example of how planning was initially accomplished in relation to content area activities such as science. In the beginning, the teacher took primary responsibility for guiding and defining actions. However, over time it was noted that students successively took on greater responsibility in identifying themselves or other children as strategic. Toward the end of the school year, students would elaborate how others and their own activity was planful.

The talk-in-interaction in Example 1 also illustrates another aspect of the classroom being constructed here: role definition in relation to planning and problem-solving activities. In reformulating Anthony's explanation as an instance of planful or strategic behavior, the teacher is defining her role as a facilitator or someone who assists children in identifying how they are using cognitive strategies. In other words, by acknowledging the student as the source of strategies, the teacher is not only in the process of discursively constructing the role of student as a source of expertise but also in the process of attributing an agential role to the students, i.e., capable of planning and solving problems. While agency, exercising some influence over actions, is not achieved by mere assignment, it is achieved by participation in ongoing practical activity. Thus, the teacher's recurrent practice of asking students for examples of action plans for problems became part of the classroom community's "mutual knowledge" (Giddens 1987). In other words, the taken-as-shared norms of the classroom suggested that students had access to different roles, including the role of strategic planners. This explains why over time the students in this classroom expected to be the initiators of action plans across contexts. However, it will be demonstrated that commonly found classroom activities and interactions patterns makes the constitution of students as expert problematic.

Nonetheless, the general pattern of creating opportunities for students to take on the role of planner or problem-solver occurred frequently. One way Mrs. Ferragher worked to achieved the larger goal of shifting responsibility for planning to students was through reformulations, a restatement of a past response. Solitary answers became solution plans when the teacher reformulated a response as strategic and therefore planful. Further, by casting each student's answer as a one possible solution and not the only solution, students had the opportunity to select from a collection of group generated solutions. How this teacher tended to reformulate student answers during lessons is illustrated in the three following examples of reformulations taken from a reading lesson that integrates science content. In this lesson, the students are dictating labels to describe zoo animals that they expect to see on a field trip planned for the near future. The teacher asked for volunteers to select removable letters from an alphabet to match the "sounds" of the dictated names to append to animal pictures.

Example 2 Reformulations

201 T: Right there by *e*. John's giving you a strategy.

230 T: OK:::. Who has another strategy for Vanessa besides just
231 pointing to it?

280 T: No:::. We're looking for *k*. Let's use Jesus's strategy.
281 A::B::C::D::E::F::
282 *((Using Jesus's previously stated strategy, the teacher beginning to point to each letter and says it out loud.))*

In the above examples, the teacher is reformulating children's assistance to other

classmates as offering strategies or multiple plans (Line 201, 230) rather than single answers to a problem (finding the alphabet letter that corresponds to a sound). While it is possible that children in this study (five and six year olds) may not have an entirely accurate conceptual understanding of strategy as one possible solution plan to solve a problem of ongoing practical activity, the continual use of considering more than one way to solve a problem (Line 230-231) suggests that over time, they would expect and accept that action plans could encompass multiple solutions.

Another typical example commonly related to group planning in this classroom is found in Example 2, line 280. When the young students in this setting were not able to remember what the task entailed, the teacher used multiple resources (visual, linguistic, and gestural text) to assist children in remembering the goal structure of the task. Mrs. Ferragher uses linguistic text or utterances to help Tonisha recall what the task is, "We're looking for *k*." In addition, she points to (gestural text) the letters (visual text) to focus attention. It is in this way that linguistic, visual, and kinesic text become an interrelated system that reflects the larger context of practical activity, implementing solution plans to a problem circumstance (i.e., problem-solving).

The reformulations in example 2 point to other important historical resources used by Mrs. Ferragher during classroom activities. The continual and frequent use of students' names to indicate the origins of a strategy worked to create classroom social norms in which students expected to assist one another. Moreover, the practice of utilizing strategies of different students worked to shift who could proffer options and had the interesting effect of continually shifting novice and expert roles among students. The effect of this approach was to distribute sources of expertise among participants as a result of taking advantage of individ-

ual strengths of the group. It is in this way the distributed cognition of the group worked in an "intellectual partnership" with the strengths of individual students (Salmon 1993). As a consequent, planning activity in this classroom is actively distributed between individual cognitions and the mediational structures of the environment, e.g., linguistic (oral, written), visual (pictures, graphs), and kinesic text (gestures) (Simon 1981).

The practice of constructing students as planners and problem-solvers was revealed not only through discourse analysis but also through document analysis. Document analysis was made possible through the books of assembled agenda pages. In this classroom, strategies were authored, i.e., each student had his/her initials recorded next to the label or drawing of their strategies and planning attempts. Moreover, this instructional strategy appeared to account for the frequent use of student's names being associated with specific strategies. Further, both document and video analysis indicated that the agenda sheets acted as a tool where verbal planning was translated into images and words. Solution plans or strategies were not limited to any one academic area but represented cognitive (i.e., problem solving), behavioral (how to make friends), and procedural (how to use paints) strategies across classroom activities. The maintenance of a book essentially comprised of visual and linguists aspects of planning and problem-solving events underscored this teacher's emphasis on the process knowledge (thinking) in content areas. Moreover, the ways that problem-solving and planning were achieved through discussion, drawing, and gestures points to how collaborative problem-solving in this class was a multimodal event that included linguist, visual, and kinesic text.

Linguistic Text as Dimensions of Collaborative Planning During Problem Solving

The interactions analyzed in this data indicate that collaborative group plan-

ning and problem-solving during science activities were characterized by cycles of questions and answers. As a result, the organization of classroom questioning activities provided "opportunity spaces" in which children were socialized into the complex activities of planning and problem solving (Ochs 1991). It is in the sequential structure and grammatical features of the classroom discourse that provided students with sociocultural information about how to plan, what to plan, and when to plan for problem-solving activities. An examination of the data suggests that the teacher accomplished this activity through a set of linguistic features (e.g., modal auxiliaries) embedded in the sequential organization of talk. Note, while linguistic features tend to be characterized by regularity in form, their semantic functions are conte .t dependent (Wittgenstein, 1968). The implication is that linguistic forms embedded in utterances are tied to the communicative functions that serve goals during interaction.

In order to achieve the goal of inviting children to actively participate in classroom planning, teacher discourse around planning activities tended to be characterized by three common linguistic forms: WH-questions (e.g. who, what, when, where), questions with modal auxiliaries (e.g., could, should, would, might) and questions with the periphrasictic modal 'going to' (Quirk, Greenbaum, Leech, Svartvik 1972). Each of these devices provides important expressions of planfulness that can be used to indicate factual or theoretical possibility (could), hypothetical situations (might), and intentional stances (should). It is important to note that how the differing question types were used varied across activities. The use of these questions in different contexts had implications for the development of role expectations for teacher and students.

In the initial stages of an activity in which the teacher guided students atten-

tion to a specific topic, single WH-questions occurred regularly. Although WH-questions tend to be open-ended in nature, the expectation here was for responses that involved a single correct answer. How WH-questions can be used to elicit single correct answers is found in the following excerpt taken from an agenda time discussion of math in which the teacher posed the following questions:

Example 3 A Review Sequence

82	T:	Who kno:ws what the strategy is?
83	Ss:	One: hun::dred.
84	T:	*h What do we do with this strategy? (.) Jesus.
85	J:	Count to uh hun:dred.

Questioning that lead to single correct answers tended to be found in review and attention focusing activities. Since questions of this type were frequently found in this data set, they had implications for how the roles of teacher and student were mutually constituted as expert and novice, respectively. In single, correct answer questions, the teacher generally controls the topic, selects whose answer is accepted and whose answer is rejected. In other words, the teacher functions as the expert. The consequence of frequent interactional episodes that indexes the teacher as expert is captured in the following excerpt in which the teacher and the class are involved in a group planning activity to solve the problem of how to record data in observational logs for a science lesson.

Example 4 Teacher Recasts Students as "Experts"

311	T:	°Ok::sy. Okay°. S:o::, should one:: person do ^it should
312		we a:ll do it?
313	S:	No:oo

314	Ve:	The teach:er (°can).
315	Ss	Ye::^ah
316	T:	The te:acher, we:ll ^I co^uld do:: it but cu ^you guy:s
317		know how to write too:: don[cha?
318	S:	[I d:o::.
319	Vi	Yea^p.
320	T;	S::o, if (.) do you think if you ^a:ll:: had something to
321		write o:n.
322	Ss:	=Ye::ah
323	Ve:	Pa:^per::
324	T:	=then you could keep track of ^whe:re you: see it?
325	Ss	Ye::ah.

In this and in many other examples, the teacher poses a seemingly open question about what procedures or action plans to use or action plans (Lines 311-312) that results in the students' spontaneously assigning the role of expert to the teacher. Thus, while the primary theme in the entire interaction is one of student decision making about plans, the initial response by children is to interpret the teacher-posed question as a bid to ratify the teacher's expertise. It is likely that the regularly occurring pattern of treating open-ended questions as though they were closed in nature (i.,e.. leading to a single correct answer known by the teacher) indicates a strong orientation of the students to "correct answer" questioning activities.

Of further interest here is the manner in which the teacher responded to the children's ratification of her as "expert data recorder." In lines 316-317, Mrs. Ferragher accepts the students conclusion and then offers an alternative suggestion that recasts the students as writers capable of recording data. The verbal act of acknowledging the students candidate solution (Line 314) as one possible alternative signals their status as co-participants. That is, student solutions warrant consideration. Further, the positive redefining of students as writers was collaboratively achieved through the use of two linguistic tools, a tag-question (Line 317) and prosody. Tag-

questions or questions that tend to invite the hearer's verification have a conversational preference for a positive response, that is, agreement is expected (Pomerantz 1984; Quirk et. al. 1985). Further, the tag question combined with the teacher's prosody (i.e., stress and intonation pattern) had an overall positive affect. So that, the organization of the conversation had the general tendency of leading children to confirm the teacher's claim: they were writers. The social organization of this event is an example of how interaction contributed slowly to a growing definition of students as potential experts. Moreover, it is this pervasive pattern in which the teacher assigns potential agency and potential expert status to students that points to how this teacher used language to index students as competent (i.e., relative experts) and capable of using their competency (i.e., students as writers).

While the teacher uses interactions around planning to co-construct the role of students as experts or at least relative experts, it was hard for students to know when they had decision making autonomy and when they did not. The difficulty of interpreting role expectations appears to grow out of the tensions of the teachers' desire to facilitate children's contributions to planning and her sense of the overall end goal of the activity. The goal and content of science lessons appears to compel this teacher to explicitly guide students. In other words, the continual renegotiation of roles during ongoing activity is a constant tension found in these classroom lessons in which the teacher's instructional goal is to shift responsibility for activity to students over time yet provide explicit instruction.

In the initial stages of whole group planning, the teacher provided an overview of the problem (topic) and methods (action plans) for the problem solution. During these activities the teacher's discourse is characterized by an overall tentative nature. This is accomplished through the frequent use of the modals "might" and

"could" to indicate possibility. While the use of statements increased during this initiating activity, the data demonstrated no evidence of linguistic terms that indicated obligation or compulsion during planning activities. The tentative nature of planning discourse is demonstrated in the following excerpt in which the notion of collecting information is i ıtroduced.

Example 5 Solutions as Possibilities

254	T:	The ways: that we could collect (.) in:for:mation might be
255		in a book. We might write down things in a book like we
256		do in our journals.
257		*((Drawing on easel in front of class.))*
258	S:	°(We make pictures in our journal)°
259	T:	Unhum. Ok:ay.
260		*((Drawing on easel what a picture in a journal would look like.))*
261		Then after we've collected that information, you know
262		how ^else we could do: it?
264	Ss:	(inaudible response)
265	T:	Uhn uhm. We use th:is machine. (...)
266		*((Drawing on easel)).*
267	Ss:	Oh::::. Uh cam:[era::.
268	T:	[Uh cam:era could collect data.

One of the crucial features in this interaction sequence is the use of the modals "might" (Lines 255-256) and "could" (Lines 261-262) by the teacher to characterize her candidate solutions in terms of possibility. With few exceptions, the teacher in this study used modals to cc nvey the idea that the options she posited or those of students were only possible solutions. Thus, the development of planning exhibited in this setting suggested that planning involved participants generating multiple possible solutions before selection.

Related to the development of multiple solutions is the teacher's monitoring activity. It was a common occurrence that during the problem-solving activity the teacher would ask students which of the candidate solutions they were using. Questions about what solution the student was using appeared to function as an assessment activity that provided the teacher with opportunities to offer guidance or suggestions if students were having trouble. Since the teacher did not offer an evaluation indicating which strategy was preferred, it appeared that this practice contributed to children's growing expectations that more than one solution method could be applied.

Note that in Example 5, the teacher is the primary generator of candidate solutions (Lines 254-255). Further, the data suggest that this tends to occur only in two locations: at the beginning of units of study and at the completion of a unit or activity. During the initial stages, it appears that the candidate solutions offered by the teacher and elaborated by students (Line 258) are used as a point of departure from which children could generate ideas. Although students often made use of the solutions proffered during introductory activities, this was not necessarily the case. Student's candidate solutions to problems tended to be added to a list of solutions as the activity unfolded. It was found that the continual contributions of candidate solutions was encouraged and facilitated by public display of students solutions. Each new solution was added to a large chart often in the form of a concept map in which the problem became the center node and links were drawn from that node to possible solution plans.

Another interesting aspect in Example 5 is the teacher's activity of both writing and drawing images on the easel of her candidate solutions (e.g., a camera) and the students' elaborations (e.g., drawings) for recording data. As pointed out ear-

lier and evidenced here, there was a consistent use of images to represent problems, strategies and words (Lines 260, 266). The act of drawing, writing, and talking around planning and problem-solving activities reveals how linguistic, visual and gestural attributes of planning contributed to how the students in this class were socialized into planning skills and strategies.

The Interface of Linguistic, Visual and Kinesic Text

As noted earlier, when the activity changed, the nature of the discourse changed. As the initial introduction of the topic ended and the discussion turned toward actual problem solutions or plans, the use of WH-questions with modal auxiliaries occurred more consistently. Additionally, in these situations the teacher did not tend to offer candidate solutions. Instead, she utilized spates of questions, gestures and suggestions of how to use past experiences and the visual text in the classroom as resources for problem solutions. Further, there was a common practice of encouraging students to visually clarify for the class how a solution would look by drawing, pointing, or acting it out. The following video frame and excerpt of a teacher and student interaction on the procedures of recording data demonstrate how the visual, linguistic and kinesic text contribute to planning and problem solving in this setting.

Example 6 Modeling Data Entries

Creating Plans Through a Visual, Linguistic, and Kinesic Text

Frame A: Recording Data

820 T: When you go back and read this book again. (.) And you
821 go look at your data you collected, your information. How
822 are you gonna know that that was about an ^airplane *a*? (..)
823 How are you gonna know ?th:at (.) ^you (.) sa:w th:at on
824 an airplane? (...) Do you think you could ^do more on that
825 pa:ge that would help you remember that you s:aw it on an
826 airplane?
827 *((Moving her hands on surface of easel paper.))*
828 What could you do?
(..)

829 J: °(Write an airplane.)°

830 T: Write what?

831 J: (Write an airplane.)

832 T: *hh (.) Write an air^plane. Let's see how th::at would
833 look.

834 Ss (inaudible)

835 J: *((Jesus draws an airplane on the easel paper.))*

The above excerpt provides an interesting example of some of the activities that characterized the interface of linguistic, visual, and kinesic text during planning in this setting. First, lines 821-824 illustrate how a linguistic text through the periphrasictic modal "going to" is used by the teacher in attempts to create an immediate and hypothetical future for the child to act on. Moreover, this use of "going to" was commonly found in situations where students were expected to act out (kinesic text) or produce an example utilizing a drawing or a word (visual text). It appears that the linguistic construction of the periphrasictic modal "going to" was regularly used to help young children remember the goal of the planning activity (e.g., to demonstrate an entry into a log).

As seen previously, the teacher used the modal "could" in WH-questions to elicit candidate solutions (Lines 824-826). What is different in this excerpt is the use of multiple questions to prompt responses in a single turn at talk. In fact, lines 820-826 are illustrative of how this teacher tended to used multiple types of questions to prompt a response. This type of questioning tended to occur when a child hesitated. While the student in this interactional sequence did respond to this battery of questions, that was not always the case. On those occasions when children did not respond, it was common for the teacher to ask students if they would like to think more about the question. Of interest is that students are not attributed with not knowing but rather in the process of thinking. Mrs. Ferragher's pattern of casting wait time as reflection time and her pattern of continually accepting long intervals (three to eight seconds) between the elicitation of a response and the actual response worked to create an accepted classroom norm of students as thinkers. As a result, plans in this setting are seen as requiring time to reflect.

Another regular pattern found in this data is illustrated on lines 830-833. In

this instance, the student is being prompted by the teacher to illustrate how his entry in a data log might look. The image of this activity displayed in Frame A provides one example of how the easel as visual text functioned as a resource for both the teacher and students. The easel itself created a focal point for the students and the teacher. Further, the visual image that the students created became a model for the other members of the class to use. In this way, students were "peripheral participants" in the construction of model (Lave & Wenger 1991). Since the student in this activity used other images on the agenda as a resource and created an image, he provided other students with a model of how to record data and a model of how to make use of the visual text in the classroom. Moreover, in this example, both the teacher and the student functioned as sources of expertise.

Following is a model to visually clarify how the linguistic, visual, and kinesic text combine to create a socially scaffolded and artifact mediated environment for the socialization of planning in young children:

The Multi-modal Nature of Collaborative Planning During Problem-Solving Activities

visual and oral text

Frame A: Recording Data

linguistic text ⟷ **kinesic text**

Collaborative Planning Sequence

Initiation:	**T: When you go back and read this book again. (.) And you go look at your data you collected, your information. How are you gonna know th:at (.) ^you (.) sa:w th:at on uh airplane?**
Planning Stragegy:	**J: Write an airplaine.**
Response:	**T: **hh (.) Write an air^plane. Let's see how th::at would look.**
Execution:	**J: *((Drawing on chart paper in front of class.))***

Frame B: Data Gathering Resources

The above model is an example of a collaborative planning sequence. It displays how a teacher and students use visual, linguistic, and kinesic texts to participate in planning activities during joint activity. The integration of multiple communicative texts illustrated in this model of planning points to the important contributions of the environment during the socialization of planning skills and strategies. Classroom environments are not neutral but are "built" of social practices (e.g., shifting roles) and cultural tools (e.g., vocal /non vocal language, diagrams) that contribute to cognitive activity (Goodwin, personal communication). It follows that what children learn about planning is tied to how planning aspects of problem solving activity are shaped over time. Thus, a multi-model of planning reveals that planning is not an encapsulated activity but eventuates from the active contributions of both the individual and the social milieu. In this way, planning is constituted by participation in culturally organized settings where mind and activity are not separate but part of complex social phenomena. How planning activities are achieved in this classroom influences both students' growing understanding of planning and functions as a resource to guide future action. The implication is that instructional practices during whole-class discussions have the potential to contribute significantly to what children learn about planning skills.

When instruction is organized to include a variety of communication tools that encourage multiple social roles (i.e., novice, expert), students have access to rich resource of experiences for future activities. It is likely that frequent opportunities for students to be involved in the common practices of whole group classroom planning activities results in students' developing "typifications" of the how, when, and why of planning (Suchman, 1987). These typifications of situations include skills for using classroom contexts and thus provide resources for future demands of problem-solving events. Moreover, Rogoff et al.(1987) suggests that children

do develop more sophisticated planning skills as a result of planning assistance during interaction in typical situations. In this case, students learn how to plan for and execute data collection in classroom science activities. The teacher's general emphasis on planning strategies coupled with an emphasis on planning activities across contexts (e.g., planning during math, language arts, science) contributes to familiarity with situated planning actions and the development of in-action-planning skills (opportunistic) and heuristics.

Final Comments

The complexity of classroom contexts and social interaction frequently makes it difficult to determine which specific instructional interactions contribute to effective instructional practices. However, the results of this investigation suggest that the teacher's general framing of learning as problem-solving opportunities for all participants profoundly affected the nature of instructional talk, and contributed to an emphasis on learning about planning during social interaction. In this case study, the teacher was in the process of building a classroom environment that engendered group problem solving by creating opportunities in which students could actively participate in planning activities. One means by which the teacher's goal is realized obtains in the embodied practices of the classroom. The social organization, shaped by a complex integration of linguistic, visual and kinesic texts, provided students with a means to make sense of practical activity as forms of problem solving that required planning. The instructional technique of shifting responsibility encouraged greater participation so that students had many opportunities to participate in a range of planning strategies. Active participation in social interaction around planning had the consequences of shifting students' roles from receivers of knowledge to producers of knowledge.

Additionally, the pervasive use of language that reformulated single solutions to problematic situations into possible solution methods rather than correct answers lead to the framing of activities as planful. This approach had the consequence of creating social norms in which both students and teacher were expected to contribute to planning activities. The practice of expecting all students to participate created a classroom situation in which expertise and novice roles were fluid. This is, students had multiple opportunities to shift roles. It is in this way that the instructional strategies in this classroom created frequent opportunities for students to become full participants in the complex thinking characteristic of problem solving activities. Consequently, along with learning how to be "expert planner," the recurrent use of planning across curricular subjects created opportunities for students to develop situational knowledge about what, how and when to plan. What is not known from this case study of whole group planning is under what circumstances if any students used features of whole group planning in other multiple-party settings, e.g., small group activities. Future investigations into the effects of whole group planning on small group activities would be illuminating.

While it is generally recognized that planning is a necessary aspect of problem solving, how planning skills are appropriated during classroom instruction is rarely a topic of investigation. The means by which students are socialized to use planning skills has implications for instruction. All too often instructional approaches preclude the development of complex planning skills by emphasizing a teacher centered model. That is, the asymmetrical participation of teacher and students falls heavily on the side of the teacher who provides topical information and controls participation through discourse (cf. Carlsen, 1991, 1992; Gutierrez, 1993; Voigt 1989). The data in this study suggest that when more symmetrical participation patterns in whole group problem-solving activities are encouraged, students

have access to the complex thinking involved in situated planning (i.e., planning as part of ongoing practical activity).

The teacher in this setting, as with many others who are struggling with implementing new views of curriculum undergirded by constructivists notions of learning, is not yet sure what instructional strategies will work. Nonetheless, the understanding that children need to be active participants in learning and not just passive receivers is affecting this teacher's practices. Mrs. Ferragher is beginning to achieve her goal of having children actively participate in knowledge construction. The consequence is that she is starting to recognize when she is "funneling" children's responses in to single correct answers and when she is not (Voigt, 1989). While it is not always clearly understood when and where students need to have opportunities to participate equally and when and where they need not, it is likely that as Mrs. Ferragher continues in her own learning some of these issues will be resolved. However, when to explicitly direct students and when to guide or assist students will continue to be negotiated as our understandings about how to structure our classroom environments develop.

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