

Considering Conceptual Growth as Change in Discourse Practices*

James G. Greeno (greeno@csl.stanford.edu)
Gertraud Benke (gertraud@leland.stanford.edu)
Randi A. Engle (randi@csl.stanford.edu)
Cathy Lachapelle (aelin@leland.stanford.edu)
Muffie Wiebe (wiebe@leland.stanford.edu)

School of Education, 485 Lasuen Mall
Stanford University, Stanford, CA 94305 USA

Abstract

We present a view that conceives of conceptual learning as changes in discourse practices. This view focuses on interactions in which people construct understanding collaboratively, either as deliberate conceptual inquiry or to facilitate accomplishing something else. Our analysis combines concepts and methods from ethnography (e.g., Jordan & Henderson, 1995), linguistic discourse analysis (e.g., Lemke, 1990), cognitive analyses of conceptual growth (e.g., Keil, 1994), and theories of information structures in comprehension and reasoning (e.g., Kintsch & van Dijk, 1978). In this view, conceptual understanding is considered mainly as an interactional process. The view focuses on how concepts are created and built up when people engage in activity, especially when they communicate about the things they are doing and trying to understand. Participation in a community includes using its concepts according to practices in which members communicate, coordinate their action, and achieve mutual understanding. Our view of concepts is illustrated with examples drawn from a study of two FCL science classes.

Introduction

In this paper we present an alternative to considering concepts mainly as structures of information in individuals' memories. As in the standard view of conceptual understanding in cognitive psychology, developmental psychology, and artificial intelligence, we analyze structures of information in the ways that people describe and explain things. Unlike the standard view, however, we consider conceptual information structures mainly as aspects of social activities, and we consider that a community's concepts are patterns in social practices. This is not to say that we discount the idea of individual learning or of internal structures posited in the standard cognitive perspective. Rather, we seek to embed these more standard ideas of understanding and learning into an account of interaction focused on participation in and learning of social practices.

As the primary level of our analytic and theoretical focus, we choose communicative interactions. We argue that this perspective has the potential to provide a more successful scientific analysis than the cognitive perspective that focuses primarily on individual processes. In our study we obtained data of students interacting with teachers and each other, and of individual students interacting with an interviewer: events

which we view as communicative interactions. This does not deny the value of analyses which focus on one or more of the individuals in group interaction, treating the group as a context for those individuals' thinking and understanding.

Some Qualifications

To forestall misunderstanding, we make three points about what we do *not* assume.

First, we do not assume that the term "discourse" refers only to talk. We include both verbal and nonverbal interactional moves. We mean by "discourse" both these moves and the whole interactional event in which people are engaged.

Second, we do not assume conceptual understanding and learning occur only in face-to-face interaction. Although we consider interaction between people as the primary locus of conceptual understanding and learning, we recognize, of course, that individuals understand and learn to use concepts as they read and write texts, draw diagrams, or engage in contemplation by themselves. We note, however, that these solitary activities also can be conceptualized as special forms of discourse (e.g., between a reader and an author), and that these solitary activities are generally carried out as parts of an individual's participation in social practices.

Third, we do not assume that by participating in a group interaction in which the group arrived at some conceptual understanding, that all the individual members of the group reached the same understanding. In our analyses we take into account wide variations in the ways in which different individuals participate in the activity. Indeed, a major focus of our effort is to understand how individuals coordinate their activities of conceptual understanding and learning.

Theoretical Assumptions

Our analysis is a contribution to the situative perspective on cognition and learning (Greeno, Collins, & Resnick, 1996; Greeno & MMAP, 1998). In this paper we carry this situative perspective one step further and address conceptual learning. We examine not only the individual located and thinking in a situation, but also the developmental trajectory of the interaction and the developmental trajectory of the emerging conceptual structure in the discourse of a group of learners. Students working in a group, along with their teacher, other groups, and learning resources constitute each others' situation: they influence each other, and (as is well known in sociology) create their own particular interactional system. This tendency of particular communities to create

* This paper was written collaboratively, with all authors making substantial contributions.

their specific interactional and discursive styles or registers also has long been noted in socio- and text-linguistics (Biber & Finegan, 1994; Swales, 1990).

Levels of Learning

Viewed in the situative perspective, learning occurs at two levels (ca. Rogoff, 1995). At one level, learning pertains to individuals and involves becoming a competent participant of a community. An important aspect of this learning by individuals is coming to participate in discourse in ways that are aligned with the prevailing patterns in the community, including using concepts in ways consistent with the group's practices.

At another level, learning pertains to groups or communities. For a group, learning means developing practices that are more effective in realizing the community's purposes and functions. For example, discussions of changes in classroom discourse practices have been provided by numerous investigators (e.g., Cobb & Yackel, 1997; Lampert, 1990; Roth & Bowen, 1995; Rosebery, Warren, & Conant, 1992; see also a review of discourse and learning by Hicks, 1996).

Learning Conceptual Content

Our view of learning has been influenced strongly by the theoretical work of Vygotsky (1978, 1986), Lave and Wenger (1991), Rogoff (1990), and Wertsch (1991). In these perspectives on learning, however, there has been little consideration of conceptual understanding, especially the content involved in school learning. Given that we take learning to be participation in (one or more) discourse communities, we believe that it is in the discourse of these communities that we need to look for conceptual learning. Our goal is to account for learning of concepts, including their coming-into-being and their gradual refinement, in terms of discursive and interactional development.

In this view we take, concepts are treated dynamically. As proposed by Chi (e.g., Chi et al., 1994) and Keil (e.g., 1994), concepts are considered as ways of organizing more detailed information, thus supporting easier access to specific material. We contend that this process of organizing a domain can also be applied to discourse, where it is reflected in the coherence of the development of a topic.

Relevance as a Learning Mechanism

We consider it promising in analyzing conceptual change as change in discourse practices to use relevance theory (e.g., Sperber & Wilson, 1995). In a well organized discourse, ideas are only contributed if they are relevant. If a topic is taken up again later, although it was seemingly closed off before, there is generally good reason for it: new information may have been brought into the discourse, which is presuppositional for some new aspect of the topic. We believe that, as in language learning, people who are believed to be competent serve as models for others. They model what "things go together," and what are appropriate questions in a domain. Attentive listening allows an individual to become attuned to the relevance structure that underlies the discursive organization on the ideational as

well as on the interpersonal level (Halliday & Hasan, 1985). As in Hobbs' (1997) formal analysis, this can be modeled by readjusting weights in an evaluation function, which increases the likelihood that particular things are said, or not said, at the next occasion. This analysis provides a linguistic view on learning to participate more successfully in a community's discourse practices.

"Shared" Meaning and Learning

In our analyses of discourse, we focus on the participants' co-construction of a public understanding in common ground. This process rests on a mutually understood background of largely implicit norms. Of course, the public understanding is only shared to the extent that participants work for shared understanding (Clark, 1996), and despite how participants in discourse work to align their meanings, there is always some ambiguity and misalignment in shared meanings. This ambiguity can contribute importantly to the productivity of a conversation (Barnes & Todd, 1977; Wells, 1986) or derail it (Lemke, 1990).

Our analyses focus on the discourse of groups. Of course, we do not believe that any participating individual takes notice of the entirety of what is said and discussed.¹ Even so, we consider the information that is contributed (in Clark & Schaefer's, 1989 sense) to constitute a collective common ground that is taken as understood in the conversational group and is, in principle, accessible to all of the participants. The extent of engagement in, understanding of, and agreement with the information in the group's common ground varies between individuals and, from time to time, within any individual. These variations in an individual's relations to collective common ground, as well as differences in the opportunities afforded different individuals to participate actively in discourse, undoubtedly result in differences in what individuals learn.

Empirical Illustrations

To illustrate the use of these ideas in an empirical analysis, we present a few examples taken from a study of classroom learning. We observed students in two fifth-grade classrooms in Brown and Campione's (1994) *Fostering a Community of Learners (FCL)* project, during a 39-day unit on endangered species, held over 12 weeks. Key concepts in the unit were the survival needs of animal species and how these survival needs contribute to species endangerment. Students worked in research groups of 4-5 members to study a particular species, with each student in the group focusing on one of the survival needs concepts.

During the unit, students engaged in a variety of learning activities, including conducting scholarly research, discussing their findings and writing reports. To maximize effective use of resources, the lessons commonly were divided into rotations, during which groups would be engaged in different activities. In addition, there were

¹ While we have included measures of individual learning in this study, detailed analyses of individuals' learning in group discourse is problematic, because one is limited in what can be known about individuals' moment-to-moment intentions and understandings of specific items of information.

activities that took place outside of the classroom. These included reciprocal teaching sessions, breakout groups in which all students studying a given survival need met, and jigsaw groups formed for presenting the finished reports.

In collaboration with the two classroom teachers we developed pre- and post- unit assessments of the students' conceptual understanding. Each of these assessments included a videotaped 45-minute individual interview with each student, and a group assessment done by the research groups over three class periods. We chose two focal research groups in each class, videotaping their pre- and post-unit group assessments as well as most of their learning activities during the unit. Various episodes and interactions of the groups as well as of individual group members were chosen for detailed case analyses, based on having content especially relevant to conceptual learning that occurred.

First we provide two examples that illustrate what kinds of conceptual change occurred. Then we consider how these changes may have come about.

Increasing Complexity in Pre-Post Assessments

Over the course of the unit, students' discourse about survival needs changed. Statistical analysis of answers given in the pre- and post-interviews showed that students used more survival needs after the unit (from categorical coding for presence or absence of the six salient survival needs). To explore the quality of this and other changes, qualitative analyses of individual and group cases were performed.

More Linkages Between Key Concepts A major part of conceptual understanding and learning in the unit involved a relational structure between the survival needs that were salient in the classroom (food getting, reproduction, etc.), properties of the environment (i.e., the animal's habitat) and behavioral or physical adaptations of the animal which allow it to survive in its environment (Figure 1):

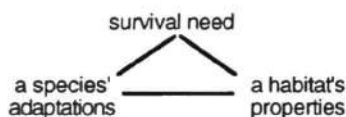


Figure 1: Conceptual links in endangered species unit.

More advanced conceptual understanding in this domain includes more integration between conceptual components (e.g., Brown & Campione, 1994), so more conceptually advanced discourse would include more elaborated and coherent relations between these three components.

The following analysis of conceptual learning by Jamal, one of the case study students, is based on comparing his pre- and post-interview answers to a problem of designing a new kind of animal, called Borogoves. Some details of the animal were prescribed (e.g., it eats tiny worms in the muddy bottom of the ocean). The discourse about this question, including the interviewer's moves, was divided into episodes focused on similar content. Each episode centers around the presentation of an adaptation of the designed animal along with any reasoning about it. For example, in the pre-interview episode below, Jamal

proposed the behavioral adaptation of hiding behind plants (segment 3). The segments about methods of eating food (1, by the interviewer) and plants existing under the sea (2, by Jamal) are also included in the episode because they function as initiation and elaboration of the adaptation:

- Interviewer: Okay, let's see if there's any other questions (?I need to) ask you about. (1s) um, okay, um, so
- 1 how would these animals go about eating these worms?
 - 2 Jamal: Just, uh like, if they- like the plants that w- under the sea?
 - Interviewer: Mhm.
 - 3 Jamal: They can hide behind 'em.

Segments that made reference to one or more of the three conceptual components shown in Figure 1 were identified. The sequencing of discourse (e.g., the question-answer pair represented by 1 followed by 2+3), co-reference relations (e.g., using the pronoun "em" in 3 to refer to the plants under the sea from 2), and other discourse patterns were then used to infer links between conceptual components. A network diagram was drawn for each episode to represent how (and if) identified conceptual segments and concepts were related to each other. Figure 2 shows the resulting network for the episode above:

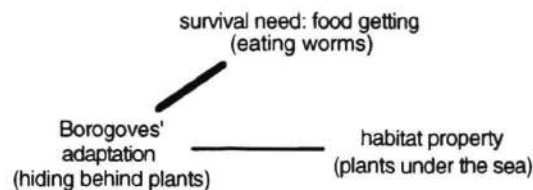


Figure 2: Conceptual links in the episode.

If a link was occasioned by a prompt of the interviewer, the link is bolded. In segment 1 the interviewer prompted for a relation between food-getting (a survival need) and a way of behaving (an adaptation of the Borogoves). In response, Jamal constructed an adaptation for food-getting (3 - hiding behind plants) which, without any prompting, considered a property of the deep sea environment (2 - it has plants). This results in two links, one prompted and one unprompted.

For the design-an-animal question of Jamal's pre and post-interview, the number of prompted and unprompted links made in each episode were added across all episodes and divided by the total number of episodes. This results in the mean number of links per episode, which is shown below:

Table 1: Mean number of links in Jamal's responses to the design-an-animal question.

	In Pre-interview	In Post-interview
Prompted	.8 (47%)	.2 (8.3%)
Unprompted	.9 (52%)	2.2 (91.6%)
Total Links	1.7	2.4

As the table shows, in the pre-interview the percentage of prompted links was much higher than in the post-interview. In the post-interview Jamal took more initiative; overall he

created 41% more links per episode, and the majority of those were unprompted. Thus, Jamal is an example of a student who became able to construct a discourse which linked together survival needs, adaptations, and habitat properties—the core concepts of the unit.

Increasing Multicausality Another aspect of conceptual learning was increased consideration of multiple causes. For example, when evaluating how a species would survive in a new habitat, one focal group considered more multicausal relationships in their post-discussion than in their pre-discussion. The features of the habitat (e.g., presence of other animals) were more often causally linked to more than one potential outcome for the species (e.g., having sufficient food and having too many predators); and any one outcome hypothesized by the group was more likely to be caused by more than one habitat feature (e.g., low tides and other animals contributed to insufficient water). Multicausality was evidenced using diagram and counting techniques similar to those demonstrated in the analysis of Jamal's interview.

Learning in Classroom Interactions

We examined episodes in the learning activities of the unit to identify ways in which observed changes in discourse practices in assessments could have been brought about by the students' participation in the unit. The following examples illustrate the workings of the relevance principle in bringing about conceptual change. As briefly explained earlier, a particular communicative event can be used by learners to influence how they determine what is an important thing to contribute to a particular topic and to structure possible future contributions. Learning can occur as students become better aligned with the discourse patterns of teachers or peers.

Adding Conceptual Relations Teachers helped bring students into the discourse practices of the unit through scaffolding and instruction, stressing to students what concepts and conceptual relations were important and relevant to discuss in their research. In the following two teacher-student consultation sessions from 19 days into the unit, the teacher encouraged students to include the conceptual links shown in Figure 1 in their research.

In the first example, Jamal showed the teacher his progress so far on eagles' food getting, a list of the food that eagles eat. In response, the teacher asked Jamal to address what adaptations allow eagles to eat their food:

Teacher 1: This is the list of things that they eat. Now you can tell me like, not what do eagles eat, but how? How do they get their food? What I- what kind of adaptations do they have? Like the talons (that you talked about), do the talons help? What kind of things do the eagles have to help them get that food, (xxx), ok?

In the second example, Ron, specializing in eagle habitat, had created a list of where eagles live. The teacher asked Ron to identify what habitat properties are needed in the places eagles can live:

Teacher 1: You can make a pretty good list of the places: they live in [she reads Ron's list] . . . But, so you've told me the names of the places they live. And I bet on a map you could point to all those places. But now I want you to start thinking about what are the things that they need to have in the places that they live? . . . And try to make a list of things you know eagles need to start to live somewhere.

Later, in a whole class wrap-up, the teacher used this interaction with Ron as an example for all students working on habitat, pointing out that their reports needed to include not only place names, but what kinds of things the animals need to have in their environments to live there.

Changing Prominence of Conceptual Components In the next example, a teacher (the school's science specialist) brought all students studying habitat in each research group together, and asked them to report on what they had discovered so far. This was the first breakout group session of the unit, so there was no pre-established discursive practice for students to use: thus, at the very least the first student speaker needed to draw on interactions outside this session to get an idea of what to do.

The first student, Ron, presented what he had found out about his animal, including 'where it lives' - something that certainly comes to mind if one has to study habitat. The teacher used this as a teachable moment and stressed, as did the teacher in the previous example, that 'place' is more than just a location:

Ron: Bald eagles.. (xxx) over all of California. With the exception of desert areas. and/

Teacher 2: So it doesn't live in a desert.

Ron: Mnh.

Teacher 2: Ok. [...] Ron has said a few sentences and it may not sound like much but what he has just said is really a lot. He has said that he found out the range. He knows where his animals lives. He said in California, right? He is saying, he said he found out that they need old trees to live. [...] Ok. The range. Ok. Now he said they didn't live in desert. That's another big part in the puzzle. Not the desert. Now why do you think that don't live in the desert? Ron.

Ron: Because they don't have any trees there just sand

Teacher 2: (laughs) Right. [...] What do you need to find out.

Jonah: More where they live. Like maybe some of them live in New York or something.

Teacher 2: So you are not sure exactly where their range is. Ok.

This discourse highlighted the importance of the concept of place before other students were asked to report on their animal. And 'range/place' started to be interpreted as an implicitly stated relevant fact, which had to be reported. We believe it is no coincidence that all subsequent student presentations (see transcript excerpts below) started with a report of the place where the animal could be found. A discursive expectation was set up, which was evidenced by

Daria's acknowledgment that she did not know about the Panda's range. There were many facts the students had not discovered yet, and which they knew they would need to find out. However, except for the range/place feature, none of those was reported as "don't know":

Andy: Ah, my animal is. It lives in (Florida) [...]

Bob: My animal is gorillas, and they live in Africa, and [...]

Daria: My animal is bears and I know that they live in mostly California in uh mountain ranges. I don't know where the Pandas live.

We believe that episodes like this are important for learning; however, no causal claim that permanent conceptual changes result from these interactions can be made, especially as important subject-matter concepts usually turn up in several interactions throughout the unit. Even so, we believe that interactions like these serve the same function: they model the underlying (discursive) relevance structure of the domain.

To see the status of the concept of range/place at the end of the unit, we analyzed the final reports students wrote. Students included discussions of range/place in the section of the reports on habitat. For example, in Ron's section on Eagle habitat, about 1/3 of his sentences presented where eagles are to be found.

Change in Participation in Research An important element of our theory is that conceptual change is not only change in a particular way of talking about a domain, but also a change in activities undertaken. The following example discusses such a change in the students' practices of doing research.

The research groups were the dominant structure of the unit: the students' work was organized around their membership within a particular group studying a particular endangered species. From our observations during the unit, and from our theoretical perspective of learning as transformation of participation, we expected to find changes in what the students did as research. Since one of the central goals of the FCL program is to create classroom environments in which children assume responsibility for their own learning (Brown & Campione, 1994), we hypothesized that students would take on a greater role in organizing their own research work. Such a change in the participation structures of the classroom would provide a case in which a group of students working collaboratively show progress in taking over control of its activity, moving through its zone of proximal development (Vygotsky, 1978). This is analogous to ways in which individual children have been shown to increase their self-control in interactions with adults (e.g., Wertsch & Stone, 1985). Such a change would also include conceptual growth, as students increased in their understanding of ways in which different conceptual contents are involved in subtasks that they can undertake.

A content analysis of one group's activity up to the midpoint of the unit has shown clearly observable differences in how it functioned in its research time. Early in

the unit, the group's activity was organized primarily by their classroom teacher, teacher 3. She began each lesson with an introduction, explaining what the students would be working on for that day. In the first days of the unit, these introductions generally included very brief, broad outlines of the unit as a whole, little about how the task for the day fit into the unit, but detailed instructions for completing the task. For their part, the students subscribed closely to the teacher's instructions for the task; they did not discuss the bigger purpose and concepts underlying the tasks in which they were engaged. For example, on Day 2 of the unit, the teacher briefly discussed the scope of the unit, then indicated that for that day the students would be cutting out questions and then sorting them into categories. When the group was handed the questions, they spent several minutes fervently attacking the job of cutting, but no one showed any interest in the content of the questions. Only when the cutting was almost completed did one of the group begin to read a question out loud. At this point, the group began talking about what categories they could think of. Their progression through the lesson followed quite literally the sequence suggested by the teacher's introduction.

Some days later in the unit, however, the shape of the lessons had changed. The teacher's introductions were less specific in their instructions and shorter in length, establishing the structure of the lesson's rotations, but leaving more to the discretion of the students regarding how to use that time. Students occasionally began their research time without consulting the teacher at all, with each member of the group organizing their own activities. Also, as the unit progressed the group discussed amongst themselves how to proceed with their work. For example, on Day 12 two members of the group suggested that another member look for information about his topic on the CD-ROMs, and one went with him to help him with his search.

By the middle of the unit, then, the overall structure of classtime was still largely set by the teacher, but the ways in which the students organized their time within that structure had shifted somewhat. The frequency and nature of the group's interactions with the teacher had changed: the students tended to address questions amongst themselves and to take responsibility for turning to the teacher for guidance. For her part, the teacher did not make reference to the larger context of the unit, spent less time each day establishing a detailed protocol for the lesson, and instead gave a quick orientation to the rotations.

Conclusion

Concepts are usually thought of as mental constructs that exist in individual people's minds. By relocating them in people's discursive interactions, we have a new way to look upon the development of symbolic action. This perspective facilitates the exploration of the interconnectedness of aspects of human life which have traditionally been isolated in a wide range of disciplines. We have used this perspective to interpret examples taken from a longitudinal study of conceptual learning as development of participation in (discursive) practices. These interpretations have allowed us to demonstrate the integrating power of our approach, which

incorporates social, interactional, and informational aspects of learning.

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