CHAPTER 6

Learning in Activity

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This chapter discusses a program of research in the learning sciences that I call "situative." The defining characteristic of a situative approach is that instead of focusing on individual learners, the main focus of analysis is on *activity systems*: complex social organizations containing learners, teachers, curriculum materials, software tools, and the physical environment. Over the decades, many psychologists have advocated a study of these larger systems (Dewey, 1896, 1929/1958; Lewin, 1935, 1946/1997; Mead, 1934; Vygotsky, 1987), although they remained outside the mainstream of psychology, which instead focused on individuals. Situative analyses include hypotheses about principles of coordination that support communication and reasoning in activity systems, including construction of meaning and understanding.

Other terms for the perspective I refer to as situative include sociocultural psychology (Cole, 1996; Rogoff, 1995), activity theory (Engeström, 1993; 1999), distributed cognition (Hutchins, 1995a), and ecological psychology (Gibson, 1979; Reed, 1996). I use the term "situative" because I was introduced to the perspective by scholars who referred to their perspective as situated action (Suchman, 1985), situated cognition (Lave, 1988), or situated learning (Lave & Wenger, 1991). I prefer the term "situative," a modifier of "perspective," "analysis," or "theory," to "situated," used to modify "action," "cognition," or "learning," because the latter adjective invites a misconception: that some instances of action, cognition, or learning are situated and others are not. During the 1980s and 1990s these scholars and others provided analyses in which concepts of cognition and learning are relocated at the level of activity systems. For example, Hutchins (1995b) studied remembering in the activity of flying commercial airplanes and gave an analysis of remembering to change the settings of flaps and slats during a descent as an accomplishment of the activity system of the cockpit, including the two pilots along with instruments and other informational resources. Goodwin (1996) studied perception and comprehension in the activity of managing ground operations at an airport and gave an analysis of perceiving and comprehending conditions at flight gates as an

accomplishment of the activity system of the ops room, including several human participants along with telemonitors that provided images of planes at their gates, with interpretation of the images on telemonitors organized by the relevance of information to their practice.

Studies of reasoning and problem solving have been especially influential. Lave, Murtaugh, and della Rosa (1984) analyzed reasoning by grocery shoppers as a process in which their decisions were shaped jointly by their initial goals and preferences along with the objects and symbols in the aisles of the supermarket. Scribner (1984) analyzed problem solving by workers in a dairy warehouse as a process in which their performance of placing requested numbers of items in containers for delivery was jointly determined by the workers' reading of forms showing the numbers needed and the visible numbers of items and open spaces in containers in the situation. The decisions and solutions produced in the shopping and the dairy product-loading systems were generally optimal; that is, the the shoppers generally chose products that had the best unit price, and the dairy product loaders generally filled orders by moving the minimum number of items. When mathematical problems equivalent to those solved by people in everyday activity are given to them in school-like tests, they generally perform poorly, which was documented particularly by Nunes, Schliemann, and Carraher (1993). The strong conclusion is that it is virtually meaningless to ask whether someone has learned a particular topic of mathematics, such as numerical multiplication, without taking into account the kind of activity system in which the person's "knowledge" is to be evaluated. Learning that occurs in one kind of activity system can influence what one does in a different kind of system, but explanations in terms of overlapping aspects of activities in practice are much more promising than explanations in terms of the transfer of knowledge structures that individuals have acquired (e.g., Beach, 1995; Greeno, Smith, & Moore, 1993; Saxe, 1990).

From the situative perspective, all socially organized activities provide opportunities for learning to occur, including learning that is different from what a teacher or designer might wish. We study learning when we choose to focus our observations and analyses on changes over time and experience in people's activities. The study of learning in activity requires us to develop concepts and principles that can explain how and why activities in a setting result in changes in what people can do. Use of the situative perspective in designing learning environments focuses on characteristics of activity systems that can result in learners increasing their capabilities for participation in ways that are valued.

The situative perspective builds on and synthesizes two large research programs in the study of human behavior, both of which emerged as alternatives to behaviorism in the 1960s and 1970s. The first is *cognitive science*; this research focuses on patterns of information that are hypothesized to be recognized or constructed in activity. Generally, this research focuses on individuals, although social interactions can be (and increasingly are) considered as contexts of individual cognition and learning. The second is *interactional studies*; this research focuses on patterns of coordination in groups of individuals engaged in joint action with material and informational systems in their environments. Each of these two research programs has developed a considerable body of empirical findings, theoretical concepts, and methods. Each of them has succeeded in developing concepts and principles that explain significant aspects of learning, and each has played a key role in the formation of the contemporary learning sciences.

Although these two lines of research both provide important scientific knowledge about learning, until very recently they developed mainly in isolation from one another. Research in the individual cognitive perspective has analyzed information structures but has had little to say about the interactions that people have with each other and with technological resources in practice. Research in the interactional approach has

analyzed patterns of coordination of activity but has had little to say about the information structures that are involved in the contents of joint activity, for example, what the conversations people have are about. There is much to be learned by continuing both programs energetically. At the same time, it is valuable to develop ways to bring concepts and methods from the two programs together.

I begin by summarizing the individual cognitive and the interactional approaches. They emphasize different aspects of learning, and all of these aspects need to be addressed in the learning sciences. I then sketch two approaches to increasing the connections between research in the individual cognitive and interactional approaches, one that extends the individual cognitive approach to include interaction, the other – the situative approach – that extends the interactional approach to include analyses of information structures. In the rest of the chapter I discuss aspects of situative research, including some key concepts in the analysis of practices in activity, and I present two illustrative examples.

The Individual Cognitive Approach: Focus on Information Structures and Processes

Cognitive scientists focus on the activities of individuals as they answer questions, solve problems, study texts, or respond to stimuli. Most often, they examine performance on experimental tasks or school assessments. Cognitive explanations are models of the processes that individuals use to construct, store, retrieve, and modify patterns of information. These patterns are generally referred to as *information structures*. Concepts and methods for analyzing information structures are the main focus of cognitive science, but have remained in the background in most interactional analyses.

Analyses in the individual cognitive approach study information structures that participants already have learned or comprehend in the situation, which are used to engage in the activity, as well as information structures that are constructed in the process of participating in an activity. The cognitivist study of problem solving is an example. Individual problem solvers are hypothesized to have cognitive structures called *problem spaces* that represent the task, including objects of the problem, arrangements of the objects in different states, operators, goals, and strategies. In their activity they construct additional structures of subgoals, evaluations of changes in the problem state, memories of past attempts, and so on (e.g., Newell & Simon, 1972).

The cognitivist study of reading is another example. Cognitive scientists examine reading as a process in which the reader generates mental information structures: inferences, plot connections, characterizations, and overall narrative structures are generated by readers as they read stories. These structures are guided by more general information structures involving grammatical forms and schemata that correspond to patterns of information that can be instantiated with information found in the text (e.g., Kintsch, 1998).

Educational practices informed by the individual cognitive approach emphasize the construction of information structures and procedures that support understanding and reasoning. These approaches include Piaget's work on how children advance by constructing general schemata; curriculum design and development efforts of the 1960s, when experts in mathematics and science designed curricula around the conceptual structures of their subject matter; and curricula and technologies that are based on information-processing models of cognition, such as computer-based tutoring systems (Koedinger & Corbett, this volume).

The Interactional Approach: Focus on Participation Structures and Processes

The study of social interaction includes several disciplinary strands: ethnomethodology,

discourse analysis, symbolic interactionism, and sociocultural psychology (compare to "interaction analysis" in Jordan & Henderson, 1995; Sawyer, this volume). This research focuses on how people talk to each other as they plan, evaluate, and coordinate their interactions with the material and technological systems in their environment. The goal is to identify patterns of interaction in which the several components (human and nonhuman) of systems coordinate their behaviors as they participate in their joint activity. Such patterns have been called *participation structures* or *participant structures* (Phillips, 1972).[1] A participation structure describes the distribution of the functional aspects of activity, including agency, authority, accountability, leading and following, initiating, attending, accepting, questioning or challenging, and so on. Participation structures that are characteristic of a community or group are aspects of the community's or group's *practices*, and learning to become more effective in one's participation corresponds to achieving fuller participation in a community's practices (Lave & Wenger, 1991).

The interactional approach focuses its study on the whole activity system, and it leads to conclusions about the principles of coordination of interactive systems. This means that the researcher has to analyze the whole activity system without yet having complete understanding of the individual components – particularly the individual human participants in the system. The tension between the individual cognitive and the interactional approaches thus represents a general difficulty facing scientists who study complex systems: whether to proceed by reduction to study of the components, or by holistic study of the entire system (Sawyer, 2005, Simon, 1969).

Interactional studies have identified important patterns of conversational interaction – patterns of turn taking, opening and closing of topics, and mechanisms of repair in response to apparent misunderstanding have been reported and discussed (Sawyer, this volume; Levinson, 1983). Patterns of differential participation by different individuals can be analyzed; for example, in some classroom settings, students' contributions almost always respond directly to a question by the teacher (e.g., Bellak et al., 1966; Cazden, 1986; Mehan, 1979), and in others, discourse is arranged so that students also respond to each other's presentations and ideas (e.g., O'Connor & Michaels, 1996; Phillips, 1972).

An important contribution of interactional studies relates to an intuition by many educators that goals for student learning can be informed by aspects of the practices of professional scholars. For example, science education can include goals for students to be able to engage in reasoning, problem solving, and argumentation in ways that reflect practices that scientists have developed – for example, distinguishing hypotheses from evidence (e.g., Kuhn, 1989), inferring specific implications of general principles, and recognizing relations between specific problems and general principles (e.g., Chi, Feltovich, & Glaser, 1981). In pursuing this approach to science education, learning scientists can use results of studies of scientific practice – how scientists do their work and what knowledge and practices are involved in conducting that work. Influential studies of scientific practice were published in the mid-1980s (Latour & Woolgar, 1986; Lynch, 1985). These early interactional studies did not examine information structures in the scientific subject-matter disciplines; in fact, Latour and Woolgar (1986) famously claimed that all of science could be explained in terms of sociocultural factors, with no appeal to cognition. More recent studies have included careful and detailed analyses of the conceptual and empirical contents of scientific practice and development (e.g., Fujimura, 1996; Kitcher, 1993; Nersessian, 1984; 2002).

Including Interaction in Cognitive Analyses

One strategy for unifying individual cognitive and interactional concepts and methods

is to work from the cognitive side and extend its reach to include situations involving interaction between more than one person. If an activity system can be decomposed into individuals and their tools, then we can analyze the activity system by reducing it to a study of the individuals and the tools, and then aggregating these explanations back together to form an explanation of the entire activity system. A strategic assumption of the individual cognitive approach is that groups can be explained by reduction to individual study in this way (Sawyer, 2005). However, to study individual learners, researchers create a new kind of activity structure – a laboratory experiment – and because we do not yet know how the properties of individuals depend on the social context, we have to make a *factoring assumption*: that the principles that characterize behavior of the individual research subject do not depend significantly on the rest of the activity system. Without analyzing the activity system as a whole, we risk arriving at conclusions that we think are about the individual, but in fact depend on broader features of the activity system, and thus would not readily generalize from the laboratory to real-world learning environments.

Some research by individual cognitive-science researchers has provided promising findings for the program of extending cognitive principles from individual to group activity. For example, Schwartz (1995), studying performance of middle- and high-school students on tasks involving understanding mechanical or biological systems, found that pairs of students working together included useful abstractions in their conversations more often than was the case for thinking-aloud protocols of individual students. Okada and Simon (1997), studying performance of college students in a simulation of scientific problem solving, also found that pairs of participants outperformed individual participants. The pairs had greater frequencies of generating productive hypotheses to test in the simulation. Dunbar (1995), studying the conversations of biology laboratory groups, found that the participants made productive use of analogies in their joint reasoning. These results indicate that some processes known to be important in reasoning and problem solving by individuals – attending to general features of problem situations, generating hypotheses, constructing analogies – are also significant in reasoning by groups. That some of these processes occur more frequently and, perhaps, more productively in group than in individual performance, could be explained as an effect of the presence of other people as a favorable aspect of the social context.

Other findings, however, indicate that analyses of activity by groups may involve significant processes that are less evident in individual activity. Barron (2003), studying mathematical problem solving by sixth-grade students, concluded that their management of joint attention was an important factor in their success. Sawyer (2003), studying performance by groups performing jazz music and improvisational theater, concluded "that both verbal and musical performance collectively emerge from interactional processes," and that "the analysis of group creativity requires a fundamentally interactional semiotics, one which emphasizes the indexical properties of sign usage" (2003, p. 95). That semiotic interpretation in these improvisational activities is fundamentally indexical has the consequence that understanding meanings and, therefore, the course of a performance requires analysis of the interactional system in a way that goes significantly beyond that of scripted performances and problems that have stable problem spaces.

A Situative Approach: Including Information Structures in Interactional Analyses

Studies in what I call the "situative perspective" use another strategy aimed to bring concepts and methods of cognitive and interactional studies together. In a situative study the main focus of analysis is on performance and learning by an activity system: a collection of people and other systems.

In a situative study, individual cognition is considered in relation to more general patterns of interaction. For example, in inquiry classrooms, students' understandings are shared as they formulate and evaluate questions, and propose and debate alternative meanings of concepts and explanations. Analyses can consider whether the actions of individual students contribute to the class's progress in achieving shared understanding, rather than simply being displays of the understandings they have already constructed cognitively in their prior interactions with textbooks, teachers, and computers.

Developing a situative explanation requires a simultaneous consideration of both the interactive principles of coordination, and the semiotic structures[2] of information that are used in the activity. Such studies include analyses of information structures that are understood, used, and generated by the participants in their joint activity. Those analyses can use many of the concepts and representations that are standard in cognitive science; they differ in that they are based on records of conversation between participants (instead of thinking-aloud protocols of individuals) and they are interpreted as hypotheses about information that is constructed in the participants' conversational common ground, with hypotheses about information that they already shared in their common ground in order to have the conversations we observe. These situative studies, then, bring the individual cognitive and interactional approaches together by providing analyses of interaction in activity systems that include hypotheses about semiotic structures that are the informational contents of the activity. These analyses include representing contributions of the material and technological tools and artifacts of the system. The goal is to understand cognition as the interaction among participants and tools in the context of an activity. For this reason, it is often said that the situative perspective studies *distributed cognition*: problem solving, planning, and reasoning are accomplished by a group of people, working together with complex technological artifacts and with material representations they generate during the task (diagrams, figures, and models).

There is nothing in the situative perspective that precludes analyses on multiple levels simultaneously. Analyses of thinking processes and information structures perceived and constructed by one or more of the individuals participating in a group can be conducted, as can analyses of the ways in which the activity in a system is supported and constrained by the institutional setting of which the activity system is a part. We aspire to progress toward analyses at all of these levels (and others, even studies of brain processes) that can be coordinated with each other, providing different understanding at their several levels of analysis, but also providing understanding of how the concepts and principles at different levels are related to each other.

I propose that analyses in the situative perspective depart from previous work in the cognitive and interactional approaches in three significant ways. I illustrate these with a brief discussion of an example, which comes from a three-minute conversation between a middle school teacher and a student about a draft report that the student had written on behalf of her project group. The class was working on a curriculum unit from the Middle-school Mathematics through Applications Project (MMAP) (Goldman & Moschkovich, 1995; Greeno & MMAP, 1998) called Antarctica, which has the students use a design program called ArchiTech that supports students in designing buildings. Groups of four to five students were working on designing living quarters for four scientists who would have to stay in Antarctica for two years. ArchiTech includes a graphics interface that students use to construct floor plans and to specify details such as the amount of insulation, and average monthly indoor and outdoor temperatures. The program calculates the total cost of the building that they have designed and the projected monthly cost of heating the building, based on their assumptions

about temperatures and the amount of insulation and its quality. Their design has to include spaces for work, sleeping, and recreation.

I discuss an episode that involves a special assignment that the teacher gave: find the value of insulation quality, called the "R value," that would minimize the total cost of construction and heating over two years. To solve the task, students kept their designs and temperature assumptions constant, and used the program to calculate the total cost of construction and the monthly heating cost for different R values. The student's group had constructed a table of values with each row showing the construction cost and the two-year heating cost for one R value. In their analysis, they focused on pairs of successive rows in the table, noting how much the construction cost increased and the monthly heating cost decreased from the lower to the higher R value. The R value that they selected as the one that would minimize the total two-year cost was 20 because between R = 10 and R = 20, the increase in construction cost was less than the decrease in heating cost, but between 20 and 30, the increase in construction cost was greater than the decrease in heating cost. The teacher had expected a different form of analysis, in which the total costs (construction plus two years heating) would be calculated for each R value, then allowing a quick identification of the R value that minimized total cost.

In the conversation, the teacher and student successfully constructed a shared understanding of the group's analysis and why it was correct even though it was not what the teacher was expecting. A situative analysis of this episode has two components: an interaction analysis of the conversation, including close attention to its turn taking, responses, and contributions (Sawyer, this volume); and the semiotic structures of information that they constructed in the conversation, which include structures of information represented in the students' table. This latter analysis identified references of symbols to different versions of the design, each of which had the numerical properties of R value, construction cost, and heating cost represented in a row in the students' table. The meanings of these symbols were constructed as information structures that the teacher and student generated jointly as they achieved a mutual understanding of the group's reasoning in their conversation.

The teacher and student were attuned to several interactional and semiotic practices as well as constraints in the task domain: turn taking conventions, including the expectation that the student would be given a chance to explain the group's reasoning; conventions of constructing and interpreting symbolic representations in numeric tables; regularities in the domain of building design, including the importance of cost; and arithmetic operations, which they used to compare R values. However, at least initially, the teacher was not attuned to the method that the group created to identify the optimal R value, although she followed the student's explanation and became attuned to this reasoning.

Data Are Records of Interaction, Rather Than "Verbal Reports"

One way the situative approach differs from individual cognitive research is in the kind of data that are typically used to infer properties of information structures. In individual cognitive research on problem solving, evidence about information structures is often in the form of thinking-aloud protocols provided by individual subjects. These protocols are then interpreted as providing evidence about the nature of the problem space as represented in the individual's mind, and the processes that the individual used to work in that problem space. A situative approach, in contrast, begins by noting that problem solving often occurs in group settings. When engaged in joint problem solving, participants talk, gesture, and create visible representations for each other as they interact. Using methods of interaction analysis, researchers transcribe the participants'

activity, and the transcript provides a group-level analog of the thinking-aloud protocols that are analyzed in studies of problem solving: collaborative discourse is group thinking made visible. The evidence that participants provide each other through their collaborative discourse informs them about their understandings, goals, intentions, and expectations, and it provides evidence to the researcher about semiotic structures that are being generated and used.

How Semiotic Structures Are Generated

The learning sciences are fundamentally concerned with identifying how structures of information are generated and used in learning activities, and with ways that information functions in activity. In an individual cognitive approach, these processes are analyzed at the level of individual mental activities; in the situative approach, they are analyzed at the level of activity systems. If there is more than one person in the system, their conversation is *joint action* that constructs shared information (Clark & Schaefer, 1989). Clark and Wilkes-Gibbs (1986) have shown that reference can be understood as an achievement of joint action, rather than being a property of a symbol itself; the meanings of symbols are often interpreted in relation to problems that emerge in ongoing activity (e.g., Goodwin 1995). Even the referential meaning of a single word is a collaborative achievement that results from representational practice (Clark & Wilkes-Gibbs, 1986).

Researchers in conversation analysis (e.g., Schegloff, 1991) and psycholinguistics (e.g., Clark, 1996) have analyzed ways in which participants in a conversation mutually construct meanings. The conventions whereby symbols are interpreted differ in different cultures. These interpretations are integral components of the ongoing activities that people are engaged in as they participate in activity systems. The situative perspective considers meaning to be a relation between these joint actions of achieving mutual understanding, and the states of affairs or ideas that the participants themselves interpret their statements to be referring to. Material and other informational resources also contribute to the construction of information, in ways investigated in research on distributed cognition (e.g., Hutchins, 1995a) and in social studies of science (e.g., Pickering, 1995).

When researchers shift the analysis of knowledge construction to the level of the activity system, they include explanations about the various participants in the activity, and they analyze ways that individuals are positioned in the participant structures of interaction and how that positioning contributes to generation of information structures.

From Representation to Representational Practice

In the individual cognitive approach, representations are thought to be structures of information that connect concepts with each other in a network of propositions. These networks and concepts are mental objects that are stored in people's memories. In contrast, situativity treats representation as a relation between signs and aspects of situations, resulting from interpretations by people in their activity. The focus shifts to include both representations and *representational practices*.

The emphasis on representation as both mental and socially distributed in practices is a synthesis of cognitive and interactional perspectives. The individual cognitive perspective emphasizes representations of information, and the interactional perspective emphasizes representational practices as distributed across groups of people and across material objects and systems in the environment.

The representations and representational practices analyzed in the situative approach extend the scope of the typical context-free semantic-network representations of cognitive science to include *indexical relations* between a symbol and the context of its use. In a situative analysis, mental states can be considered to be representations, but there should be evidence that

the hypothesized representations figure in a functional account of activity that attributes informational functions to those states. In the situative perspective, mental representations are only relevant to the extent that they refer indexically to ongoing activity. Most of the indexical relations that are represented in *semiotic networks* (Greeno & Engle, 1995) are functional in this sense, rather than having interpreted representations inside participant's minds. Researchers need not assume that these functional relations are actually represented in individual learner's minds unless there is evidence of an explicit representation.

Practices in Activity

Situative research focuses on properties of activity systems, especially on principles of coordination between the various components of such systems – the participants, the technological and material tools in the environment, and the informational structures and practices of the participants in the subject-matter domain of their activities.

The situative perspective inherits the assumption of interactional studies that activity is not usually scripted or planned in advance, but has to be negotiated and actively constructed by participants. Decades of research in the interactional tradition have documented that participants expend a great deal of effort coordinating their ongoing interactions, and have documented many cases where interaction breaks down when this coordination effort fails. Given that coordination is such hard work, a major theoretical problem facing situative researchers is to explain how it is that joint activity proceeds in a coherent way (on those occasions when it does, of course). Coordination or *alignment* between individuals depends on mutual understanding of communicative intentions (as in conversation), as well as coordination of actions (such as collaborating in moving a piece of furniture or performing in a dance). Alignment between one or more individuals and a system in the environment includes operating a machine (such as a car) or playing an instrument (such as a piano), or observing, appreciating, and understanding the behavior of an object or system (such as a forest or an episode of animal behavior).

Practices That Contribute to Alignment

Aspects of activity in subject-matter domains have been considered and analyzed extensively in cognitive science, and hypotheses about them have been represented in the form of symbolic structures: cognitive representations in individuals' memories. The situative approach explains alignment by examining the group's shared social practices and the ways in which individuals participate in an episode of activity. A group's shared social practices include conventions, such as patterns of turn taking in conversation, or appropriate ways to work together while accomplishing a task, or what kinds of products will provide evidence that the task has been accomplished. Conventions also include ways to use symbols and other representational practices in spoken communication, in written communication, and in interacting with information technologies and tools in the learning environment – books and computer software. Discourse conventions include guidelines for turn taking, and the participants' various positions of status in the social arrangement of the classroom. These patterns specify the ways that agency, competence, authority, accountability, and other aspects of participation are distributed among participants in an interaction.

Participating in a community includes understanding the conventions and practices that are significant in that community's discourse about its activities. Some of that discourse is about the explicit meaning of concepts; much successful practice, however, depends on a shared implicit understanding of concepts – even when people may not know the explicit representations that are used by other people to discuss the concepts' meanings (Greeno, 1995).

Alignment also depends on the participants' shared practices of constructing

contributions to their activity. A general schema of interaction in tasks is shown in Figure 6.1, adapted from Clark and Schaefer's (1989) schema for contributions to discourse. Working on a task involves performing actions that contribute to achieving the task goals. The results of action can just be an addition of information to the common ground – information about properties of the task or situation, or about evaluations, intentions, or goals. Or the results of action can also be a change in the material situation of the task, by moving or constructing an object or by writing or drawing some kind of representation.

The schema sketched in Figure 6.1 provides a way of thinking about and representing participatory aspects of interaction at a turn-by-turn level. In addition, general patterns in the ways contributions are made in a group's or community's practices can be identified. For example, classroom practices differ in the extent to which they encourage problematizing of ideas and issues (e.g., Engle & Conant, 2002) and in the ways that differences are resolved (Ball & Bass, 2000; Greeno, 2003). In Figure 6.1, these correspond to frequent occurrence of the NEGOTIATE nodes, with discussion about alternative ideas, actions, and approaches to understanding and working on tasks. In relation to Figure 6.1, problematizing and reconciling correspond to encouraging responses to students' contributions that consider alternative ideas, actions, and approaches.

Participant Structures

Practices vary in the ways that agency is distributed between the participants. In interaction, different individuals are positioned differently regarding the competence, authority, and accountability that are attributed to them by others and by themselves. These differences in positioning mean that individuals are differentially entitled and expected to initiate proposals for action or interpretation, to question or challenge other participants' proposals, and to indicate that an issue has been settled (as in the Initiation-Response-Evaluation sequence discussed in Sawyer, this volume, and in other patterns of classroom discourse interaction, such as revoicing, O'Connor & Michaels, 1996).

Positioning in relation to other participants involves entitlements and expectations of the individual for initiating topics or questions, making assertions and proposals for actions, questioning or challenging others' assertions and proposals, and so on. Positioning in relation to the subject-matter domain has been characterized by Pickering (1995) as a dance of agency, involving material agency, disciplinary agency, and conceptual agency. Conceptual agency is involved when an individual or group interacts with the subject-matter constructively – interpreting meanings, formulating questions, choosing and adapting a method, designing an apparatus, and so on. Material agency is involved when a system (such as an experimental apparatus) determines the outcome of an action. Disciplinary agency is involved when established methods such as algorithms or proof procedures determine the outcome of an action. School activities often position students with little conceptual agency, teaching them instead how to perform algorithms correctly (disciplinary agency) or to set up apparatus to obtain known empirical results (material agency). The emphasis by constructivist educators on knowledge construction in authentic practice is designed to grant students some conceptual agency.

Alignment among participants depends on how differences in ways that individuals participate are understood and incorporated into practice. Situative analyses include study of the participant structures of episodes of activity, particularly ways that individuals are positioned to take initiative or not, to question or challenge others' proposals and assertions or not, to engage in the group activity attentively or not, and so on.

In an individual's participation in a group or community over time, he or she generally has some ways of interacting that come to be characteristic and expected by her- or himself and others in the group. These characteristic patterns, which are coconstructed by the individual and others in the group, constitute that person's positional identity

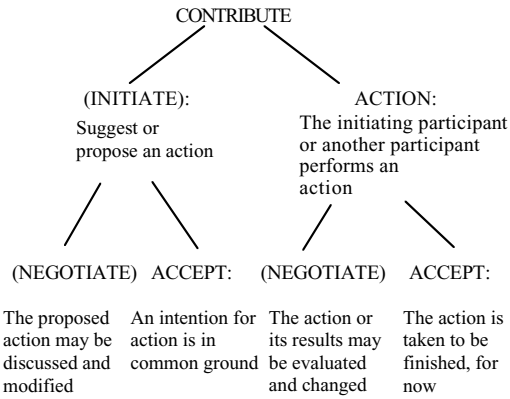

Figure 6.1. A schema of negotiation.

in that activity system. An individual's positioning can be understood both in regard to the other participants in the group – her or his characteristic positioning in participant structures – and in regard to the subject-matter of the group's activities – her or his characteristic positioning in relation to using and generating semiotic structures, for example, with or without conceptual agency. Individuals' identities in a classroom differ, such that some individuals are more likely than others to engage in working on tasks that are assigned, or to work collaboratively with others and try to reach mutual understanding, or to engage in social interaction not related to an assigned task (Gresalfi, 2004). Of course, an individual's participation is not always consistent with her or his general tendencies.

Situative researchers generally do not assume that our models of these conventions, practices, and identities necessarily correspond to cognitive representations inside participant's minds. Of course, people often do construct internal representations of these conventions and practices, and these constructions and interpretations are critical in activity and are an important topic for the learning sciences (e.g., Hall, 1996).

Community Practices

Communities and groups have practices that constrain (but do not determine) the subject-matter contents of their discourse and other activities in their subject-matter domains. These practices include what counts as knowledge in the group's domain, including use and interpretation of its terminology, meanings of its concepts and principles, and applications of its methods. Communities of learners share standards about what characterizes worthwhile problems to engage in, and what constitutes an adequate or excellent solution of such a problem. Many of these standards are implicit: ways of formulating arguments and explanations, and ways of judging the relevance and significance of questions, information, evidence, and conclusions.

In the situative perspective, the institutional contexts of activity systems are important in understanding learning. Attitudes such as having a commitment to succeeding in schoolwork or not (Eckert, 1989, 1990), and having a positive or negative orientation toward activities of learning and knowledge construction, involve issues of affiliation and identity. In schools, students' affiliations in formally organized groups (band, chess club, gangs) as well as informal networks of friends are crucial in the development of their identities, and these groups sometimes shape student's identities in ways that oppose the school's preferred participation structures, as well as in ways that facilitate student engagement in academic pursuits that are valued by the institution. Students' motivation to learn depends on whether the learning activity supports the continual development of their personal identities. When learning environments do not support personal identity, learners will not be deeply engaged, even if they manage to maintain focus long enough to complete a classroom activity (Blumenfeld, Kemplar, & Krajcik, this volume).

Example: A Study of Learning a Classroom Practice

To illustrate how learning scientists can study the learning of practices using the situative perspective, I describe a case study: Hall and Rubin's (1998) analysis of how a representational practice became established in a classroom.[3] They documented

how the practice originated in an individual's work, expanded through that student's small group, and then was broadcast to the class. Their analysis showed how learning to use and understand a representational form can be understood as an achievement of social interaction in activity.

The teacher, Magdalene Lampert, developed innovative practice-oriented teaching methods and examined the processes of her teaching for several years (e.g., 1990, 2001). Lampert often had her students work in groups of four or five students to discuss challenging problems. Each student kept a journal in which he or she recorded problem solutions and explanations. Hall and Rubin (1998) analyzed videotaped records of several segments of class activity involving the mathematics of distance, time, and speed of motion. They analyzed several incidents in the development and use of a kind of representational practice that they called a *journey line*, which represents two quantities – time and distance – by marking units along the line that are labeled with distances above the line, and corresponding times below the line. The sequence began with a student, Ellie, requesting help with a problem. Lampert recruited another student, Karim, to explain to Ellie why multiplication was the way to solve the problem, knowing that Karim had used the journey line in the explanation he had in his journal. Later, Lampert asked Karim to explain the representation to the class, characterizing the contribution as an example of students in a group working together. After Karim's presentation, Lampert had Ellie explain the representation to the class, affirming that it was a resource to be used generally in the class's practice. By attributing authorship of the explanation to Karim, making him the presenter of the explanation both to Ellie and to the class, and having Ellie present her concurring explanation, Lampert established the practice as an outcome of actions in which the students had significant conceptual agency.

Hall and Rubin (1998) distinguished between three levels of activity: private activity (writing in the journal), local activity (small group conversation) and public activity (presentations and discussions with the whole class). They identified several interactions in which the representational practice of the journey line played a key role – it functioned as a resource in the class's practices of problem solving and mutual sense-making. Learning sciences research often examines the role of representational forms as resources for collaborative sense-making and reasoning. It also examines ways that students develop their understanding in their joint activity (see Sawyer, this volume).

Example: A Study of a Learning Environment

To illustrate situative studies of learning environments, I describe a study by Nersessian and her colleagues (Nersessian et al., 2003; Nersessian, 2005), who recently extended this approach to focus more explicitly on learning – how laboratory groups develop over time toward increasing understanding.[4] These authors found it productive to consider activity in the scientific laboratory they studied as an evolving distributed cognitive systems. For example, Nersessian et al. (2003) gave a situative interpretation of several aspects of learning in a bioengineering lab that is trying to develop artificial blood vessels: the evolution of artifacts and methods, the evolution of relationships between individuals, and the evolution of relationships between individuals and artifacts.

Biomedical engineering is a new combination of disciplines in which new knowledge and practices are emerging continually, and the researchers are constantly learning during their problem solving activities. The laboratory team included undergraduates, doctoral students, and postdocs, and all of these participants learned over time and transformed their participation in the activity system. Much of the equipment used in the laboratory was designed and built by the team, and the members of the team often modified the technological artifacts during their practice – such that not only the people but also the tools underwent change over time.

Nersessian et al. (2003) found that to understand how problems were solved in this laboratory, they had to expand the traditional cognitive science notions of "problem space" and "mental representation" to consider these as being distributed across the people and the technology in the laboratory – a defining feature of situative research. The problem space comprised models and artifacts together with a repertoire of activities in which simulative model-based reasoning played a key role (cf. Lehrer & Schauble, this volume). The problem-solving processes of the lab were distributed throughout the cognitive system, which comprised both the researchers and the cognitive artifacts that they use (cf. Hutchins, 1995a).

Nersessian et al. (2003) used a mixed-method approach, combining cognitive analyses of the problems and models used by the biomedical researchers with an ethnographic analysis of the situative activities and tools and how they are used in the ongoing activity of the laboratory. Their close ethnographic analysis allowed them to document temporary and transient arrangements of the activity system – the laboratory routines, the organization of the workspace, the cultural artifacts being used, and the social organization of the team members. Their cognitive analysis allowed them to document how people and their relationships changed over time – as they evaluated and revised problem definitions (often working closely with technological artifacts), as they revised models of phenomena, and as their concepts changed over time.

Because it is impossible to test artificial blood vessels in a live human body, modeling practices were critical to the work. The researchers had to design working models to use for experimentation. Each iteration of a model represented the lab's collective understanding of the properties and behaviors of the human body. For example, the *flow loop* is a device that emulates the shear stresses experienced by cells within the blood vessels. The flow loop originated in the research of the senior scientist, and was passed down through generations of researchers, enabling each to build on the research of others, as it was reengineered in the service of model-based reasoning. The flow loop is constructed so that the test fluid will create the same kinds of mechanical stresses as a real blood vessel. But because the model is a mechanical system, its design is subject to engineering constraints, and these often require simplification and idealization of the target biological systems being modeled. For example, in the body arterial wall motion is a response to the pulsating blood flow, but in the flow loop simulation, known as a *bioreactor*, the fluid doesn't actually flow, although it does model the pulsating changes in pressure experienced by the arterial wall.

In scientific laboratories, collaboration is often mediated by external representations such as these mechanical models, as well as diagrams and sketches. In this lab, devices were external representations of the collective knowledge of the group. Model-based reasoning is a distributed phenomenon, involving both the internal mental models that a researcher holds, as well as the shared external model manifested in devices and other models.

A situative analysis focuses on this distributed nature of cognition in the laboratory, treating it as a process involving multiple people and the technological artifacts that they create and modify together. In the situative view of an activity system, learning is conceived of as transformations over time in the nature of the interactions among people and between people and their constructed artifacts. For example, when newcomers to the lab were first introduced to a device like the bioreactor, they assumed that its design was fixed. As they began to interact with these devices, they quickly learned the many problems: tubes leak, sutures don't keep, reservoirs overflow, pumps malfunction. The newcomers soon realized that everyone else, including the most experienced old-timer, was always struggling to get things to work, always revising and modifying the devices. The newcomer's learning was a process of coming to understand the contingent and changing nature of these devices – the newcomers built relationships with the devices

that Nersessian et al. (2003) called *cognitive partnerships*.

Conclusion

Analyses that use the situative perspective consider learning environments as activity systems in which learners interact with each other and with material, informational, and conceptual resources in their environment. The situative perspective is a synthesis of the two major scientific approaches to understanding human behavior: cognitive science and interactional studies. It combines the strengths of each of these approaches with the goal of better understanding how learning occurs and how to design learning environments.

Situativity is a general scientific perspective and as such does not say what educational practices should be adopted. Even so, it is well suited for analyzing processes of interaction and learning in the types of learning environments recommended by many progressive educators – a move away from a transmission-and-acquisition style of instruction, toward more collaborative, active, and inquiry-oriented classrooms.

By its focus on activity systems, the situative perspective emphasizes that the activities that take place in different learning environments are important, not only because of differences in how effectively they teach content knowledge but also because participation in practice is a central part of what students learn. If an aim in education is for students to learn practices of inquiry and sense-making, then learning environments must provide opportunities for them to participate in such practices. The situative perspective is reflected in a wide range of learning sciences projects, such as mathematics classrooms in which students participate in developing definitions, conjectures, representations, and arguments (e.g., Ball & Bass, 2000; Boaler, 2002; Fawcett, 1938; Lampert, 2001; Moses & Cobb, 2001; Schoenfeld, 1994; Schwartz, Yarushalmy, & Wilson, 1993). In science classrooms, students develop and evaluate hypotheses and arguments in science (Brown & Campione, 1994; Goldman, 1996; Hatano & Inagaki, 1991; Reiner, Pea, & Shulman, 1995) and in social studies (Collins, Hawkins, & Carver, 1991; Scardamalia, Bereiter, & Lamon, 1994).

This kind of practice was advocated by Dewey (e.g., 1910/1978) and is a major focus of learning sciences research and practice. The activities that contribute to these practices encourage students to participate in processes that include conceptual inquiry and the use of skills in solving meaningful problems as part of authentic projects (Krajcik & Blumenfeld, this volume). These learning environments include activities such as formulating and evaluating conjectures, conclusions, and arguments. In participation-oriented practices, class discussions are organized both to foster student learning of content and also to support their learning how to participate in the discourse practices that organize such discussions. Students learn about content and also learn how to participate in collaborative inquiry, and how to use the concepts and methods of a discipline to solve authentic problems. They learn representational systems, not only to express information in a domain but also to apply them in representational practices as they develop and share their understandings of questions, hypotheses, and arguments in the domain. A challenge for the learning sciences is to advance our theoretical understanding of learning to provide more coherent and definite explanations of learning in these environments, as well as more helpful guidance for the design of productive resources and practices. I have tried in this chapter to show that the situative perspective can be a valuable resource in this effort.

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Footnotes

1. Contrasting participation structures with information structures, as I do here, is potentially misleading. Participation structures depend on information, which is produced and conveyed through gestures, timing, intonation, and other aspects of communicative action. Analyses of these aspects of discourse can be understood as analyses of information structures, in the sense that Gibson (1979) and more recent ecological psychologists have characterized their research as studies of information (e.g., Reed, 1996). The structures that I refer to with the term "information structures" are limited to information that participants construct that refers to objects and actions in their activities, and to properties and relations of those.
2. By "semiotic structures" I refer to patterns of information that are nearly (or perhaps completely) coextensive with information structures or symbolic structures in standard cognitive theory. A difference between the theories is that in a situative analysis, semiotic relations are between signs and their referents, including referents that are in the material situation or conceptual domain, rather than in a person's mental representation. These referents of terms in the information structures can be and often are specified, and cognitive processes are assumed to operate on objects in the environment as well as on symbols that represent them and their properties and relations.
3. There are many other studies that also illustrate this perspective, but space limitations prevent my reviewing them here. A few of them are Boaler (2002), Bowers, Cobb, and McClain (1999), Engle and Conant (2002), Rosebery, Warren, and Conant (1992), and Waterman (2004).
4. Again, there are several other examples that illustrate this approach to studying learning environments. Three such examples are Barab et al. (2002), Engeström (2001), and Hutchins (1993).

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