

Chapter for:
Situating Cognition Theory:
Social, Neurological, and Semiotic Perspectives
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COGNITION, CONTEXT, AND LEARNING: A SOCIAL SEMIOTIC PERSPECTIVE

J.L. LEMKE
City University of New York
Brooklyn College School of Education
Brooklyn, New York 11210 USA

Situating Cognition

We blame the early Moderns of Rene Descartes' 17th-century Europe for cleaving Mind from Body and Society from Nature (e.g. Shapin & Schaffer 1985, Latour 1993). From them we inherited a chain -- cognition in the mind, mind "in" a material brain, brain in a mindless body, body in a natural environment separate from society, society made up of persons not bodies, persons defined by cultures, cultures created by minds -- a chain that binds us still and runs us 'round and 'round in ever smaller circles.

We rebel, we transgress. We want the freedom to construct a materiality of mind, an intelligence of the body. We want meaning to arise from material processes and Culture to be once again a part of Nature. We want to re-situate cognition in a larger meaning-making system of which our bodies and brains are only one part. We are willing to pay the price, to abdicate our Lordship over Creation, to become part-ners rather than over-seers. Creation, after all, has been getting pretty unruly anyway.

We are not the first rebels. C.S. Peirce (see Buchler 1955, Houser & Kloesel 1992, and Whitson, this volume) wanted to fuse Logic and Nature into a single system of meaning-making processes: a natural "semiosis", a semiotic Nature. Gregory Bateson (1972) followed the chain of "differences that make a difference" outward from the mind/brain into the motor-body that wielded the cultural tool that engaged the material environment that reacted back on the tool, changing the dynamic

state of nerves, muscles, heartrate, adrenalin, glucose, brain activity, meaning, choice, value, action, activity. Where could you break this circuit? Where did cognition end and action begin? Cognition, information processsing, meaning-making, flowed through the circuit. The system of relevance in which to define and study cognition, now synonymous with meaningful activity, was not arbitrarily bounded by the brain or the body: it was the whole interacting "ecology," including body and brain and tool and environment, through which that circuit flowed.

Jean Lave in a series of classic studies (Lave 1988, Lave & Wenger 1991) observed people in the routine activities of their lives, engaged in what for us is "problem-solving," but which for them is simply a way of participating in immediate, concrete, specific, meaning-rich situations. They are functioning in micro-ecologies, material environments endowed with cultural meanings; acting and being acted on directly or with the mediation of physical-cultural tools and cultural-material systems of words, signs, and other symbolic values. In these activities, "things" contribute to solutions every bit as much as "minds" do; information and meaning is coded into configurations of objects, material constraints, and possible environmental options, as well as in verbal routines and formulas or "mental" operations.

How we play our parts in these micro-ecologies depends not just on what the other parts do to us, and us to them, but on what these doings mean for us. The characteristic meanings of things and happenings vary from person to person, from context to context, even from one run-through of an oft-repeated routine to another, but they do not vary so much, or in such capricious ways, that two-person ecologies cannot function, activities in different contexts become interdependent, or distinct instances of the same activity type be usefully compared. There are communities of practice. There are networks of interdependent practices and activities. There are continuities and trajectories of practice, development, and learning. Or at least we can usefully make sense of such notions.

What does it mean to learn as a participant in such an ecology of people, meanings, and things? Jean Lave has given us the beginnings of a model of learning as participation in a "community of practice" in which we join others in their ecological doings, their situated meaningful activities, as a "legitimate peripheral participant" and come in this way to be able to do as they do. Our activity, our

participation, our "cognition" is always bound up with, co-dependent with, the participation and activity of Others, be they persons, tools, symbols, processes, or things. How we participate, what practices we come to engage in, is a function of the whole community ecology, or at least of those parts of it we join in with.

As we participate, we change. Our identity-in-practice develops, for we are no longer autonomous Persons in this model, but Persons-in-Activity. We are somewhat different as persons from one activity to another, and as participants in one community of practice or another. Work must be done to construct continuities for our Selves across these contexts (cf. Bruner 1990). Learning now becomes an aspect of this developmental process; it is as universal, persistent, and inevitable as change itself.

As with any promising model, in order to develop it further we need to construct significant critical perspectives on it.

Walkerdine (this volume) wants to be sure we can critically analyze the construction of subjects and subjectivities in these ecologies, and not leave Persons still some mysterious melding of bodies and minds. She wants to know how contexts are made, how they are determined, and not leave them as unproblematically given environments. She doubts that the notion of "activity" by itself overcomes the Cartesian separation of the semiotic and the material; how are meanings made in material systems?

Whitson (this volume) and St.Julien (this volume) praise Lave's model for helping us see why abstract mental entities (ideas, concepts) need not automatically transfer from one context to another, because there is now no purely "mental" cognition anymore independent of the specificity of the present context. But they want to know how the same model can also account for the cases where we can usefully abstract across contexts, without subordinating situatedness to abstraction? And St.Julien wants to know what the material brain can tell us about how we link one situation to another, how we can combine the connectionist paradigm with situated cognition in general, as he learned to do in helping students "see" a new pattern.

My own recent work (Lemke 1994, 1995) has led me to pose some of these same questions; some of what I have done may suggest ways to extend and refine the model in order to respond to these

critical concerns. How can systems and networks of activities be simultaneously material ecologies and semiotic makers of meaning? What kinds of learning can take place wholly within a single community of practice and its activities, and what kinds require journeys that must take us also into others? How are human subjects made and differentially valued by their participation in communities of practice, and how do the trajectories of individual lives remake the wider networks that conjoin and disjoin communities? How do biography, history, and culture act in the here-and-now of situated activity? What are the implications for our views of learning and schooling of extending the model in these ways?

The Semiotics of Matter

Tony Whitson (this volume) provides a helpful introduction to the Saussurean and Peircean traditions of formal semiotics. Semiosis is meaning-making; it is taking one thing as a sign for another, construing a thing, event, process, or phenomenon in relation to one or more others. Semiosis is selective contextualization; it is making something meaningful by seeing it as a part of some wholes rather than others, as being an alternative to some options rather than others, as being in some particular relation to some things rather than others. Meaning is possible only where not all possible relations and combinations are equally likely in all possible contexts; deviation from this condition means that there is information, order, regularity, form, meaning, structure, system, semiosis.

Every act of semiosis, every occurrence of semiosis, every semiotic practice in a community is necessarily also a material process in some physical, perhaps also biological, perhaps also social and human system (cf. Walkerdine, this volume, that "all practices are ... both material and discursive"). Meaningful, meaning-making practices are hybrid objects (Latour 1987, 1993; Lemke 1984, 1994, 1995), they are both natural and cultural; they are part of material ecologies and they are part of cultural systems of meaning. They have physical, material, thermodynamic, ecological relationships and interdependencies with one another, and they have meaning-relations of other kinds, including value-relations to one another in the cultural system of a community.

An ecosystem is an example of a complex, self-organizing system (cf. Prigogine & Stengers 1984). Matter, energy, and information in various forms flow through it along complex pathways that link air and water, soil and rock, trees and insects, predators and prey in multiple intersecting networks of interaction and interdependency. A human community is a special kind of ecosystem, if we define it to include not just persons, but all our tools and artifacts, the other species that we depend on and those that depend on us, the air we breathe, the water we drink, the waste we create. In fact, we should define it now as an ecosocial system (Lemke 1994, 1995). What is so special about ecosocial systems among all other possible ecosystems is not that they contain us and our things, but that our behavior within the system, and so the overall dynamics of the system as a whole, depends not just on the principles that govern the flow of matter and energy in all ecosystems, but also on what those flows mean for us. We cultivate some species and exterminate others, mine some ores and ignore others, dam some rivers in some places, produce goods of certain kinds in certain quantities, consume, wage war, and do all the other things we do to, in, and with the rest of the material ecosystem not just on the basis of nutrient chemistry or physical mass, but also because of the all the other cultural meanings and values things have for us.

The dynamics of any ecosystem depends on the networks that link, couple and connect this element with that, make this process interdependent with that. In an ecosocial system, there are additional links based on other principles of cultural meaning. You cannot analyze the behavior of an ecosocial system with just physics, chemistry, and biology; you also need to take into account economics, politics, and other sorts of cultural beliefs and values. If we are made by our participation in networks of micro-ecologies of situated activities, then the conditions of what we can become are determined by the global structure and dynamics of the ecosocial systems which these networks help constitute.

What does it mean to say that ecosystems, and therefore ecosocial systems, are self-organizing? Hurricanes and gas flames are self-organizing. They are defined by systems of processes, by exchanges of matter, energy, and information with their immediate environments, in such a way that from calm or randomly disorganized air-currents, from turbulent gas and oxygen mixtures, emerges a spontaneous pattern, form, order, organization. A circular vortex feeds on surrounding air currents and moisture and

pressure gradients to grow itself; a synergy of convections draws oxygen and flammable gas together in perfect proportion and placement to replicate itself from millisecond to millisecond with hardly a flicker. Living systems are self-organizing in the same sense, though much more complexly. The Earth as a physical-biological totality is also such a system.

These systems are individuals, they have histories, in some cases even histories that matter to their present reactions, and sometimes histories that can matter to new systems of their kind not yet born. Such systems age, and some of them die. Electrons are not self-organizing systems (so far as we know), they do not age, they do not die; they are not individually distinguishable, they have no histories that matter to their behavior. Atoms are the same. Very large molecules or very numerous collections of atoms (even in a gas) begin to have some of these characteristics. Complex systems come in a whole hierarchy of types (Lemke 1995, Salthe 1985), each type with all the properties of those more general than itself, but with new additional properties. The most specified kinds of systems, those with the most properties that matter, the most kinds of differences that make a difference, are ecosocial systems (not individual human organisms).

Ecosocial systems, and most living organisms, are also developmental systems; they have a relevant history, a trajectory of development in which each stage sets up conditions without which the next stage could not occur. Ecosocial systems, and individual human organisms, are also epigenetic systems: the course of their development depends in part on information laid down (or actively available) in their environments from prior (or contemporary) systems of their own kind (our DNA is a kind of interiorized environment of this sort; our families' and neighbors' speech and behavior, the tools and built environments around us, exterior). Such systems, as individuals, develop along an average trajectory typical of their kind, but also deviate from it depending on their unique histories; the average trajectory of the kind evolves.

All of this growth and development is part of the self-organization of the system, or of the larger systems of which it is a part. None of it has a cause. None of it is predictable from a knowledge of the starting point of the system (except by comparison to the past trajectories of other similar systems). There

is no master control program within the system that determines the form of the patterns it achieves. There are only regulating and constraining inputs to the total dynamics of the system. The nucleus does not control the cell, it is just part of the cell. DNA does not control development, it is one part of a developing system. The brain does not control the body, or cognition; it is part of a body-in-environment system that makes order, meaning. All these systems generate order, create information and pattern.

Yes, even the inanimate ones. C.S. Peirce (see Whitson, this volume) tried to say what was madness in his day, and still heresy in ours, that semiosis, meaning-making, is not solely the province of human minds. We do it a bit differently, but all matter is capable of semiosis, of "intelligence" if you wish, provided only that it is properly organized. Even hurricanes, bacteria, ecosystems, living planets. Perhaps even some possible computers; certainly the universe as a whole.

Now we can see learning, too, as an aspect of self-organization, not just of the human organism as a biological system, but of the ecosocial system in which that organism functions as a human Being, a hybrid of both material body and social-cultural persona, a body-subject. And we can look to models of the mosaic (Lemke 1994, 1995) and network (Latour 1987, 1993) organization of ecological and ecosocial systems to understand better how we participate in activities within and across different communities of practice, and how we get constructed as body-subjects, and make an ecosocial difference as body-subjects through this participation.

Participating in Activity Networks

Part of what it means to be a legitimate peripheral participant (LPP) in a community of practice (Lave & Wenger, 1991) is that full membership in the community is the assumed consequence of increasing participation. Both Lave and Walkerdine (this volume) point out that for women and members of other oppressed groups, some communities have ways of denying them full membership no matter what their level of participation. This important fact alone invites more careful consideration of trajectories of participation.

In the simplest case, we might imagine, a small homogeneous community of practice differs from member to member only in the degree of mastery of particular practices. Newcomers can aspire to oldtimer status, the oldtimers welcome their increasing participation, and the newcomers become oldtimers in their turn. If a community of practice (CoP) is defined in relation to its practices, so that any real community consists of many communities of practice, and every community member very likely participates in several of these, then for some CoPs the simplest model will be valid. But many CoPs are not like this. For one thing, many have hierarchically differentiated roles where there is no expected upward mobility for occupants. Teachers do not expect their students to become teachers with increasing participation in the classroom community. Do teachers and students then belong to different communities of practice? Not if the practice is defined in terms of activities in which both roles must be filled.

What if mastery of a practice is not to be had solely by participating in that practice? Then increasing participation in a particular CoP will never be enough by itself to achieve full membership. It may be that one must also participate in some other CoP, engage in some other practices, in order to master, or be counted as having mastered the practices of the first CoP. This, too, often happens in real communities, where participation in a ritual (even if allowed) by non-initiates never in itself reveals to them the keys to its esoteric meanings, which alone could enable them to be full participants. That can be had only by participating in some other activities, some other practices (initiation rites), perhaps even in a different community, certainly in a different CoP. It is not enough to hang around with lawyers or doctors or scientists, to assist them, to learn to speak part of their lingo, even to become very good at some of their visible practices to begin to be counted as one of them. You also have to have been schooled in their mysteries, taken certain (even functionally irrelevant) courses, bear certain credentials, have passed certain rituals. The CoP of schools and the CoP of practitioners are linked, but they are not identically the same CoP.

Because practices are not just performances, not just behaviors, not just material processes or operations, but meaningful actions, actions which have relations of meaning to one another in terms of some cultural system, one must learn not just what and how to perform, but also what the performance

means, in order to function and be accepted as a full member of a CoP. One must know the meaning in order to appropriately deploy the practice, to know when and in what context to perform how. Or one must know just because knowing is a condition of membership. For many practices, participation in the same activity in which the form is learned is sufficient to also learn its meaning, but for some practices in some, perhaps all, communities, this may not be so. In these other cases there are underlying, prerequisite, assumed, linked, or just associated practices that can only be learned in some other CoP, in some other context, some other activity, perhaps by explicit initiatory or schooled instruction.

To understand these more complex cases, we need a model of networks of linked or interdependent activities and CoPs within a complex ecosocial system. The trajectories of individuals' participation in the community as a whole, in the ecosocial system, trace out these networks, from activity to activity, from CoP to CoP, partly constrained by existing networks (opportunities, policing) and partly fashioning in their very biographies new connections and links which others may or may not recapitulate. Individual identities are constructed across the whole trajectory of participations, but not necessarily equally in each activity or CoP.

In the science classroom, teachers do not expect their students to grow up to become either teachers or scientists, and most students do not long for either fate. Only some of them are potentially building, or having built for them, identities as future teachers or future scientists. Many, in fact, even resist the identity of student, though they have little choice except not to participate. But they are building some identities, grounded in the activities of some other CoPs, in the family, the peer group, after-school activity, etc. What are the links that can exist between those activities (and their institutional or ad hoc CoPs) and those of the school and the classroom? What are the possibilities for forging such links? Given the dynamics of the larger ecosocial system in which such bits of networks are embedded, what are the chances these links would last? grow? be traced again by other individuals?

Walkerdine (this volume), discussing mathematics, uses Lacan's semiotic chains of significations (see also Whitson, this volume) to discuss how very specific practices: naming, finger-reckoning, verbal counting, cardinal quantifying, are linked together within a single event that may or

may not be a common cultural activity. This particular sequence of linked practices perhaps recapitulates, as part of the development of some individuals, its own sequence of historical formation. It represents a stable, available fragment of a very small-scale network linking different social practices and activities. Walkerdine offers it as an example of a common tendency in the practices of mathematics: to link and move toward progressively more abstract, less context-specific practices. To leave behind what it was we were counting (people, pebbles) and to make practices in which the salient participant is a pure number, pure cardinality. Insofar as mathematics does this consistently, it also leaves behind the identity-links of many students. It constructs a discourse and repertory of practices to which they literally do not know how to relate; from which, to them, theirs and all human identities are excluded. There are, of course, ways to assume an identity within this network of practices, but they are not taught in most mathematics classes.

Neither mathematics nor the sciences aim to educate "the whole person" as do the humanities. They do not help students construct identities in relation to their practices, they simply display the practices. In this way they actively discourage most students from identifying with them (cf. Lemke 1990). Performing the practices (e.g. by young women in Walkerdine's study) does not count toward membership unless there is evidence that the practices are performed from the proper "motivation", i.e. on the basis of the canonical, esoteric meaning assigned to those practices by (here, a predominantly male) standing membership. Similarly so for working class students relative to the schooled practices of a predominantly middle-class academic culture.

Some students' trajectories will eventually lead them into membership in scientific or mathematical communities of practice. They will have traced a path through the network of practices, activities, and CoPs that will have passed through all the right places to give them the keys to understand and participate fully in the activities of that community. They could not have acquired those keys solely through the activities of that final professional CoP itself; activities in that CoP presume prior learnings in other communities. They build on top of many sedimented layers of such prior learnings. In some cases the links between their visible practices and the material contexts from which alone one could glean their

meanings are so underdetermined that only explicit instruction, elsewhere, in the activities of some very different CoP, can provide them. Not all systems of mutually interdependent practices are lumped together in the activities of a single CoP; some are distributed over more than one, sometimes many CoPs, linking them together into an ecosocial network.

Persons-in-Activity: Theorizing Subjects and Trajectories

If notions of cognition and mind must now be distributed out beyond the boundaries of the human organism, then they can no longer define the human Subject for us in the traditional way. What units of organization and analysis are appropriate in our new model? How can we properly say in what ways we are the same and different as persons in different activities? How does the traditional notion of the human individual get re-mapped onto the now separable notions of biological organism, social subject, personal identity, and person-in-activity?

Lave begins from the notion of person-in-activity, the person as defined by their participation in an activity, by their roles in the social practices that constitute this activity, whether as agent or affected. The person-in-activity is therefore partly specific to that activity and captures the sense in which we are different Selves (cf. Bruner 1990, 1991, 1992) in different company, when we play different life-roles. Lave also uses expressions like "children-becoming-adults" which try to capture the complementary sense of continuity along the trajectories of our lives, from one activity to another and from one age of life to another.

Walkerdine (this volume) uses the work of Foucault (e.g. 1966, 1969, 1980) to make another distinction, "the subject ... is not the same thing as an actual person." The social subject here is the creation of discursive practices in a community (actions as well as representations) which define generic subject-types (the child, the adolescent, the feminine woman, the masculine man, the working-class drunk, the upper-class esthete, etc.) and do the social work of making particular "actual persons" be or seem to fit these types, for others and perhaps even for themselves.

Walkerdine also provides several examples of how people's responses to situations and tasks, their participation in particular activities, is specific to the trajectory of their life history. What did more/no more mean in their home, conceptually and affectively? What has happened in their lives to make seemingly "neutral" math problems more stressful for some people than for others, affecting their calculations? What kinds of subjects has their participation in social activities been trying to make them into? And how does this affect their present participation as persons in an activity like solving a math problem?

== Walkerdine begins here to formulate the important issue of the role of affect in situated, embodied cognition. Contrary to the rather ideologically lopsided tradition of rationalism, which pits affect against cognition, emotion and feeling against reason and logic (and, not accidentally, assigns the one it values more to males and the middle class, and the less valued one more to females and the working class), practitioners' identities load positive affect onto their typical forms of meaning-making practices: reasoning is an affective state or process, and an enjoyable one for the mathematician. All cognition, because it is embodied, is necessarily also affective. We do not think without feeling. When a kind of thinking is a good-feeling, we tend to become good at doing it; and when it feels bad to us, we dither, defer, get distracted, and reject it. Meaning-making is a material process of bodies-in-context; feeling and affect are subjective construals of one aspect of this process. Feeling-tone can be a guide to the quality of our cognition, or it can signal to us a conflict of identity.

The Foucauldian notion of subjectivation, that the social forces we are subjected to in activity make us Subjects of historically particular kinds, complements the more traditional notion of identity, whose formation may be social, but for which the person in question is granted a special right to define what his/her identity is. Identities are also more uniquely individual than subject-types. But both identities and subject-types extend over life trajectories, constructing continuities across participations in distinct events and different activities.

The most basic ground for the continuity of individuals across moments-of-interaction is that of their bodies. We construct a continuity for biological organisms across time and events by a complex set

of semiotic-material practices, despite the fact that the molecules of which we are composed, and most of our cells are constantly being replaced by others. But, as I have argued elsewhere (Lemke 1988, 1995: chap. 5) when analyzing the problem of individuals and subjects, these are very different practices from the ones by which we define the continuity of social persons. Culturally these two sets of practices are linked: we conflate an organism and a social persona to make the hybrid notion of an individual. There are many cases, of course, where this fusion doesn't work so seamlessly, where we can see the joins and analyze them.

In an ecosocial systems model, the primary units of analysis are not things or people, but processes and practices. It is the processes/practices which are interdependent, linked, creating the emergent properties of the self-organizing system. Organisms are defined by the processes that constitute them, critically including the processes that transgress their boundaries, that exchange nutrients and wastes, information and entropy with their immediate environments. The social persona is likewise defined, on the semiotic side, by certain aspects of the meaning and value in a community of the still quite material behaviors and performances of an organism or other (e.g. video or holographic) "embodiment".

Individuals, as organisms, as social subjects, as personal identities, are constructs and products of the activity of the larger self-organizing system, the community and its semiotic ecology; they are not pre-given, natural units of analysis or organization. In each case they are also constructions of continuity along developmental trajectories from interaction/activity to interaction/activity (the moments when they are observed, when they make a difference). These trajectories are themselves defined by the extent to which events earlier along them create the conditions of possibility and shape the possible forms of participation of the trajectory-entity in events further along them (cf. Lemke 1994, 1995; Salthe 1985, 1993; Prigogine & Stengers 1984).

St. Julien (this volume) offers us a partly biological model of continuity of person across activity: the cases, as he says, where some kind of "transfer" does occur from one context to another. Part of what is the same across different contexts is the biological continuity of the human organism, a body-with-a-brain that has acquired certain habits of interacting with its perceptual-motor environment. Once

we have learned to see a pattern of a certain kind, we tend to project this pattern onto a reasonably wide variety of new contexts. This in turn can be interpreted as a continuity of meaningful behavior and so of the social persona, and not just of the biological organism.

In this case, too, as St. Julien notes, there is a social and cultural dimension. The pattern that was learned was a pattern made by others in the community (biologists' ways of seeing morphological differences between prokaryote and eukaryote cells), and it was learned through participation in cultural practices widespread in the community (genres of verbal-visual organization of information), with which the students were already familiar from activities earlier along their personal trajectories. Their learning of this pattern is an aspect of the self-organizing activity of the ecosocial system in which they participate.

How does this learning occur? Clearly, it is more than a matter of a brain entraining itself into some perceptual Gestalt. Perception is always an active process with an efferent, motor component. In Edelman's (e.g. 1992) model of neuronal group selection, in which the brain stimulates some groups of nerve cells by using them, and leaves others to atrophy, the stimulation processes have a motor component, and, in order to get results which simulate cultural categorization, also a value component. The organism not only interacts with the environment, not only self-organizes only insofar as it is coupled into a larger system than itself, but it also requires some criteria of preferential saliency of features to pick out a pattern. For some basic processes these saliences may be built-in by evolution, but for cases like the pattern acquisition in St. Julien's experiment and many others, it is the cultural values of a community of practice which supply this needed element.

The meanings we make when participating in this-activity-now are a function of past participations, not only in similar activities, but also in different ones, and the network of connections that determines which past ones are taken to be more relevant to this present one (cf. the principle of general intertextuality; Lemke 1985, 1988) is an embodiment of our participation in the culture of a community. This notion of embodied dispositions accumulated along a trajectory of interactions in a community is expressed in Bourdieu's concept of a "habitus" (1972, 1990). Like any developmental trajectory notion (see above) it has both a type-specific component, which concerns Bourdieu more, and an individuated

component. The type here is the subject-type of Foucault and Walkerdine. People raised to be women, or working-class, or Catholic (or men, or middle-class, or Protestant) are subjected to forms of participation in activity, and construals of the meaning of their participation, which construct them as subjects of these types. Their trajectories of experience have an average similarity, their dispositions for further participations have an average resemblance, and the cumulative effect is to make their participation in any activity seem more alike.

What about individuation along trajectories? As Walkerdine's and many other examples show, how we participate in a particular activity, while always a function of our trajectory, also depends on relatively unique experiences along this trajectory. The ways in which we connect past events and present ones are always partly unique; our meaning systems have a biological ground, a cultural set of historically specific resources, and a socially shaped set of commonalities with others, but they also have a psychological individuality. That individuality can only be properly identified and analyzed after the other levels of commonality have been factored out. You cannot define how someone's reading of a text, or affective reaction to a math problem, is uniquely individual, until you understand which aspects of their participation are typical of their social subject-positioning, of the use of the resources and common patterns of a particular culture or subculture, or a function of how brains and material environments couple together generally in processes of self-organization.

Individuation is important for social and cultural change. The trajectories of individuals always to some extent create rare or unique new connections among practices, activities, and communities of practice which are not already typical of those that define the prevailing subject-types of a community. People with unusual histories will participate in peculiar ways in activity. Participation in activity is not just a means for reproducing practices and communities of practice. It is also the means for creating new connections, and so new possibilities of emergent patterns of self-organization in the system -- provided that we look at more than just one activity or one CoP at a time. We must look at the networks of interdependencies among practices, activities, and CoPs to understand the dynamics of ecosocial systems.

History, Culture, and Biography in Networked Activities

How do biography, history, and culture act in the here-and-now of situated activity? Walkerdine (this volume) follows Foucault in distinguishing a method "that examines the historical conditions" in which subject-types emerged, from linguistic and semiotic methods which may have great formal power in analyzing activity, but which neglect to situate activity in history and social relations.

The tradition of social semiotics on which I principally draw (e.g. Halliday 1978; Hodge & Kress 1988; Lemke 1984, 1995; Thibault 1991) began from an analysis of how we make meaning with the lexical and grammatical resources of language in particular situated contexts. In this model, however, it is not only the context of situation which is relevant, but also the context of culture (cf. Malinowski 1923, 1935; Firth 1957; Hasan 1985). How we interpret the meaning of a situation, and how we participate in a situated activity, depends on a wider system of cultural formations (discourses, genres, activity-types, institutions, modes of representation) not fully available or wholly contained in the immediate situation itself. In my own work, this notion led to an analysis of how we use intertextuality to make meaning in particular situations (Lemke 1985, 1988, 1990, 1993). We interpret a text, or a situation, in part by connecting it to other texts and situations which our community, or our individual history, has made us see as relevant to the meaning of the present one. Our community, and each of us, creates networks of connections (and disconnections) among texts, situations, activities.

This linking of text to text and situation to situation is not an entirely ad hoc process. There are a small number of systematic principles in our own culture which underlie the kinds of connections we are more or less likely to make. We make these in common with others who share typical trajectories with us, and we may differ in this way from those with other life-experiences. In this way culture, which extends across situations and activities, and which characterizes communities without necessarily being the same for all castes or individuals within a community, finds its way through us into the activity of the moment. Of course we are not the only participants in activity; our tools, our texts, our symbolic productions of many kinds also embody this wider context of culture. For them, too, there are networks of

activities that lead to other sites, other events, which are relevant for here-and-now because what happened there-and-then is embodied in these present non-human participants.

These networks of connections which we make, and which are made in the self-organizing activity of the larger systems to which we belong, extend backwards in time as well outwards into the social-material world. The same principle that governs our developmental trajectories, namely that prior events created the conditions of possibility for, or shape the possible forms of participation in, present events, applies also to networks with historical depth. Not only we, but our tools and technologies also have a history without which they would not exist or would not be as they are. So also do our symbolic resources (e.g. our language, our conventions for writing, drawing, graphing) and our cultural conventions of seeing one thing as relevant to the meaning of another. And so do the actual texts, symphonies, visual designs, etc. in and through which we live as the meaning-making beings we are.

All these notions make sense only insofar as we see networks of connections among events, moments, practices, activities, communities of practice, historical periods, stages of life, texts, etc. These networks are not homogeneous; they do not connect only texts to texts, tools to tools, persons-in-activity to persons-in-activity. They are also fundamentally heterogeneous (Latour 1987, 1993); they make visible the interdependencies, at once material and meaning-based, of texts and tools, tools and people, events and texts, etc.

Ecosocial systems, ecologies of and with meaning-based connections, have a complex topology (Lemke 1993, 1995 and references therein). Viewed in the three-dimensional space they create, they have a fractal topology: subsystems within systems within supersystems, across many scales and orders of magnitude. And they also have a mosaic topology: side by side on the same scale are diverse, variant local systems, of different ages, different compositions, different internal networks of connections. These topologies are mainly a function of local connections, local interactions linking nearby systems.

Ecosocial systems, however, also have, superimposed on these local connectivities and in part coinciding with them, more extended networks of connections which have smaller dimension, or co-dimension. There are layer systems (of co-dimension two) in which points in the same layer, even far

apart, interact more strongly with one another than they do with nearby points in a different layer. And there are networks themselves, of co-dimension one, along which points or events interact strongly even at great distances from one another, but do not necessarily interact equally strongly with points not in the network but which may be at comparable distances or even much closer.

All networks are locally three-dimensional, they all consist of events and interactions in the immediate ecosocial system of the points which belong to the network. But globally they are one-dimensional, linking distant points selectively, and irrespective of the total ecosocial systems on those scales of distance (but within them, of course, and made possible by them). Think of networks of tunnels, networks of power-grids, networks of communication lines, the dedicated communication and supply lines of armies or multinational corporations. Think of your own personal social network of contacts, of people you interact with more often and more intensely even though they are far away, when you may have little interaction with other people who are much closer, who are co-participants in your local ecosocial system (your building, your neighborhood, your city).

Networks of lower co-dimension can intersect in more ways than can subsystems of full dimension (i.e. three dimensional ones). Three-dimensional local systems can only interact with and intersect with their local neighbors at their margins, can only abut them or overlap them. They have two- and three-dimensional boundary-zones, borderlands between them. They tend to exclude one another. But one-dimensional extended networks can freely interpenetrate one another and the local networks of local three-dimensional systems. They can interact and intersect at the center, or anywhere inside, and not just at the boundary or the margin. This is why you can be part working-class and part middle-class, part Christian and part Jewish, part masculine and part feminine, part Hispanic and part African, part child and part adult, part straight and part gay, a farmer, a church-goer, a Mason, and a mother all at once and without occupying more than a metaphorically marginalized borderland.

Yes, some networks do also exclude other networks, but they must do work at more sites to accomplish this feat, and they frequently fail. There is far more interpenetration of networks of different genders, sexual orientations, classes, ages, cultures, ethnicities, etc. in our ecosocial systems than our

prevailing discourses and ideologies might like us to believe (see e.g. Lamphere 1992, Heath 1994).

Individual trajectories that move between these networks also knit them together, also open them up to change due to one another's influences. We need these more topologically complex models and metaphors to understand how history, biography, and culture become present in situated activity.

Learning and Schooling

Yes, we learn in activity, and in a community of practice, but we also learn many things across activities and communities of practice. Yes, learning is an aspect of identity-formation, but we form and incompletely integrate many identities for our Selves, and not every activity, not every practice we learn matters equally to us or equally shapes our identities.

What we have already learned and experienced influences our future learning, in individual and idiosyncratic ways, but also in ways that mark us as more or less typical products of cultures, communities, histories. Our trajectories are each unique and individual, but they are also molded by the social systems around us to conform to prevailing social types by age, gender, class, and caste.

We learn in activities, but more fully in networks of activities which are interdependent on one another, which facilitate and enable one another, which are marked out as being relevant to understanding each other's meanings. These networks are constructed differently by different groups, and to some extent also by different individuals, not only in what we say are relevant connections, but in what we make be relevant connections by how we act and what we do, and sometimes by the very fact of our lives' bridging these networks together.

We always perceive, act, and learn by participating in the self-organization of systems which are larger than our own organism (see the many examples in Smith & Thelen, 1993). The meaning-making, the meaningful activity, whether we call it semiosis or cognition, is taking place in that larger system, and not solely in our organism or its brain. We embody our past, as our environment embodies its (and so our collective) past, and in our interaction not only memory but culture and historical and sociological processes are renewed and continued, diverted and changed.

Schools are communities of practice which do not preach what they practice. They teach about practices of other communities, e.g. about the practices of science and mathematics, but they say very little about the practices of schooling. The practices of science and mathematics which they display have their fully contextualized meanings only when resituated in the activities that gave rise to them historically and in which they enact their present social functions. These same practices, however, cannot be learned solely from participation in these primary contexts because there they are too deeply embedded in other practices, too thoroughly presuppose intertextual connections to practices in other contexts, and depend on meanings underdetermined by their connections to visible and material actions in the primary contexts.

Schools and communities of professional, specialized practice are joined together by networks of interdependency among their activities and by the trajectories of those individuals who pass back and forth between them. Unfortunately, these individuals are rarely students, few of whom and only long after may make this crossing. I have argued elsewhere (Lemke 1994b, 1994c) that we need a substantial "clinical" component in science education (the field I know best), in which we strengthen the network connections between school activities and professional activities and allow students to pass more readily along these networks, integrating them into their personal trajectories on the scale of weeks or months rather than decades or life-stages. If these connections were strengthened, not only would the abstract content of the school curriculum make more sense in relation to its primary contexts of use, but that content would tend to change insofar as it might be actually out-of-step with or useless in these further contexts. For this to happen, not only students, but teachers need to travel along the connections between the networks of school practices and professional practices. And perhaps professional scientists and technologists should make the return journey more often, as well; especially before presuming to prescribe what schools should be doing.

Much of the creative capacity of our society is vested in the capability of individuals to connect networks not usually connected. That capability is greater among the young insofar as they have not yet been as thoroughly subjectified into dispositions that will tend to make them willingly confine themselves

within certain networks of activities. It is greater among the old to the extent that they have acquired the tools available within some networks to do the work of making connections to others (if they have not by then lost all desire to do so.) Why do we place such obstacles in the way of the young to hinder them from crossing the boundaries of the existing networks? Why do we refuse to let them explore all knowledge, as in the model of the library, and instead restrict them to a curriculum shaped entirely within specific subcommunities? Why do we exclude them from most communities of adult professional practice and confine them to schools?

I believe we do these things to minimize the overall rate of social and political change (Lemke 1995: chap. 7), and at the cost of alienating students who do not find congenial identities within the limited parts of these networks that include the practices of schooling. We construe this alienation as failure, and use the "failure" to justify the great disparities of resource provision that characterize our present social and economic order. We justify these restrictions on young adults with a belief in their inherent incapacity, a belief whose consequences, as with any ideology, seem to support the belief. Perhaps, for at least some students, the networks being created by new information technologies will allow them to escape or by-pass these restrictions to a greater degree, unless, in the name of protecting them from themselves, we again oppressively restrict their freedom to do so (Lemke 1994c, 1995, in press).

Even this small potential loophole (the new information technologies and our practices in using them) is itself made possible by practices which belong to particular communities and particular networks, and our culture is fast at work defining some Subjects (male, middle-class, English-speaking, "technophiles") as those who will feel comfortable with these new technologies and subtly excluding others or putting them at a disadvantage. This is work which seeks to extend existing imbalances of power and privilege to a new domain. It is a normal part of the processes of on-going self-organization in our ecosocial system, but so are the processes which directly oppose it and those which can unpredictably shift the balance of power by making new and unexpected connections.

We need to extend the networks of the classroom and the school. To extend them into professional communities of practice. To extend them into the sphere of private life. To extend them into the sphere of direct political activity. To extend them into libraries and information worlds where there are no preferential barriers to crossing from one domain to another at will. To extend them into the productive activities of our ecosocial system: industrial, agricultural, financial, informational. Most of all we need to extend them outside the networks that define only masculine, heterosexual, middle-class, northwest European cultural values and historical traditions as normative and which seek to deny the already pervasive interpenetration of Other networks and practices in our ecosocial systems.

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