

“Vygotsky’s Neglected Legacy”: Cultural-Historical Activity Theory

Wolff-Michael Roth

University of Victoria

Yew-Jin Lee

National Institute of Education, Singapore

The authors describe an evolving theoretical framework that has been called one of the best kept secrets of academia: cultural-historical activity theory, the result of proposals Lev Vygotsky first articulated but that his students and followers substantially developed to constitute much expanded forms in its second and third generations. Besides showing that activity theory transforms how research should proceed regarding language, language learning, and literacy in particular, the authors demonstrate how it is a theory for praxis, thereby offering the potential to overcome some of the most profound problems that have plagued both educational theorizing and practice.

KEYWORDS: cultural-historical activity theory, dialectics, theory-praxis gap, activity systems, contradictions, learning, development.

More than seven decades ago, the Russian psychologist Lev S. Vygotsky (1934/1986) noted that (educational) psychology was in a state of crisis because of the “atomistic and functional modes of analysis . . . [that] treated psychic processes in isolation” (p. 1). Specifically, he pointed out that the separation of intellect and affect

as subjects of study [was] a major weakness of traditional psychology, since it [made] the thought process appear as an autonomous flow of “thoughts thinking themselves,” segregated from the fullness of life, from the personal need and interests, the inclinations and impulses of the thinker. (p. 10)

These analytic challenges remained unresolved for years, leading Vygotsky’s student A. N. Leont’ev (1978) to continue expressing dissatisfaction over the eclectic state of (educational) psychology. As readers will quickly verify, it is difficult to find research recommendations concerned with knowing and learning in and out of schools and across the life span that take into account the kind of holistic integration that Vygotsky had originally championed. Now, as then, we are confronted with a number of conundrums in educational research and practice, which advances in modern psychology have not fully overcome. To better place these issues in context, we present a short vignette below that conveys something of the multiple tensions facing classroom teachers and educators everywhere.

Katherine, a fifth grade teacher in a rural district, is busy planning an introductory lesson on electrical circuits. Because she already has taught her students in previous grades, she feels that the model lesson plan provided in the teachers' guide will be ineffective, if not a big turn-off for these children, who value meaningful, hands-on learning. This feeling is exacerbated because there are a few children in the class who find handling the English language and the language of science concurrently almost too great a burden to bear. "I'll give them lots of time to explore, in small groups, to set up the two circuit layouts and to discover about the concept of current flow at the same time," she ponders by herself. With the push toward increased accountability by her school board, however, Katherine feels compelled to abandon this option and instead rely on direct teaching as the method of choice, given its economy of instructional time and assurances of mastery learning and higher achievement scores. During the week, she sees excited faces slowly dim, although she finishes the learning objectives comfortably within the prescribed time slot. Experiencing some remorse for her pedagogical decision, Katherine consoles herself by saying, "One or two will ultimately make it very big, although most will find their own niches in society and be equally happy. Anyway, I'll make it up by giving them a couple of fun experiments at another time."

In this episode, we see Katherine struggling with contradictions arising between her personal experience and professional sense of what is best for these children and generic statements about what to achieve and how to best attain it. At this time, Katherine does not have the theoretical tools that would allow her to understand that when children choose the motive of activity, they also become emotionally engaged and that learning, which is an expansion of one's action possibilities, is a by-product of the pursuit of motives and goals. She also does not have the capacity that would allow her to understand how language, or rather the utterances students make, is a means to mediate the concrete realization of the goals the children set for themselves during exploration tasks. That is, Katherine does not have a holistic theory of practical activity consistent with her professional life, which would very likely increase her confidence and teaching abilities—at least this is what happened to one of the authors in a curricular unit described later. This theory would in fact help Katherine understand that she is a member of a historically situated educational community, which, after years of more open constructivist approaches to science and mathematics education, has now moved to impose external (political) control through the rigid application of high-stakes examination and accountability procedures.

We therefore observe in this fictitious though commonplace episode with Katherine some of the troublesome questions in education that refuse to go away, including the theory-praxis gap (Roth, Lawless, & Tobin, 2000), the tensions between the epistemological and ontological aspects of human development (Packer & Goicoechea, 2000), the differences between decontextualized and embodied knowledge (Lave, 1993), the difficulty of planning for specific forms of learning (Holzkamp, 1992), and the apparent disjunction between individual learners with other learners and their social environments (Barab & Plucker, 2002; Shultz, 1986). These contradictions, which pervade the everyday lives of teachers such as Katherine, definitely have their parallels among educational researchers too. However, there is a growing movement that does justice to Vygotsky's "fullness of life," which is especially concerned with the primacy of praxis.

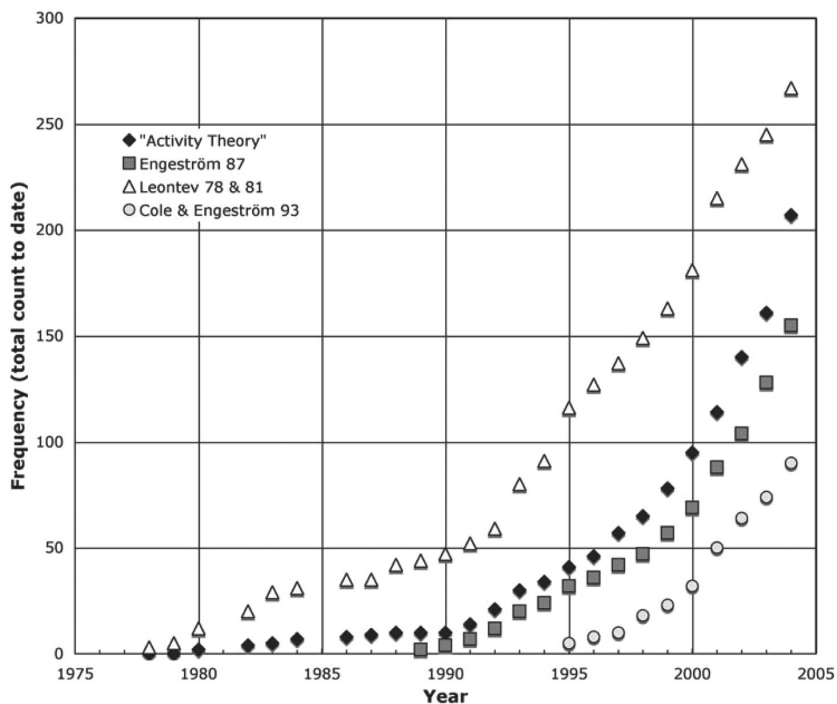


FIGURE 1. Four indicators of the increasing interest shown in cultural-historical activity theory (CHAT) over the past three decades. These citation frequency indicators each reference major CHAT publications (in English) and the search term activity theory in the Institute for Scientific Information's citation database.

Said to be “the best kept secret of academia” (Y. Engeström, 1993, p. 64), (third-generation) cultural-historical activity theory (CHAT) offers the possibility to overcome some of the aforementioned divides besides recovering more humane forms of education. For these important reasons and more, this review showcases CHAT as an integrative road map for educational research and practice. An introduction to CHAT in a special issue of *Mind, Culture, and Activity*, a journal that focuses on interdisciplinary approaches to culture and psychology, provided evidence of the exponentially rising attraction of activity theory, as indicated by various citation-related factors (Roth, 2004). If the latter are accepted as reasonable indicators of interest in a particular theory, then Figure 1 clearly shows the penetration of CHAT into the Anglo-Saxon literature, on the basis of our analysis of the Institute for Scientific Information's Web of Science databases using influential CHAT publications (i.e., Cole & Engeström, 1993; Y. Engeström, 1987; Leont'ev, 1978, 1981) and the search term *activity theory* (see also below). This theory is of immense interest to us because it has shown to be fruitful for both analyzing data recorded in real classrooms and designing change when trouble and contradictions become evident in these cultural settings.

The purpose of this article, therefore, is to explicate activity theory as an intelligible and fruitful alternative to existing psychologies of learning that overcomes some problematic dualisms in education. We further suggest some implications for educational practice and claim that using CHAT leads to changes in the location of representing what is educationally relevant: Its inherently dialectical unit of analysis allows for an embodied mind, itself an aspect of the material world, stretching across social and material environments. This transactive perspective, which CHAT has in common with other approaches within the sociocultural family of learning theories (e.g., Hutchins, 1995; Pea, 1993; Rogoff & Lave, 1984; Wertsch, 1998), theorizes persons continually shaping and being shaped by their social contexts that immediately problematize knowledge as something discrete or acquired by individuals. In fact, CHAT explicitly incorporates the mediation of activities by *society*, which means that it can be used to link concerns normally independently examined by sociologists of education and (social) psychologists. This desirable synthetic approach is possible only because activity theorists are concerned with upholding human activity—the historical results of the division of labor—as the fundamental unit of analysis, which had partially existed in the work of Vygotsky (Cole, 1985; Glassman, 1996). At the risk of oversimplification, Vygotsky privileged sign or semiotic mediation, especially in the form of speech, whereas the activity theorists succeeding him widened the scope to view object-related practical activity as the proper unit of analysis (Kozulin, 1986), as described in the next section, on the origins of CHAT.

A Brief Historical Overview

The contemporary interest in CHAT is remarkable given that its lineage can be traced back to dialectical materialism, classical German philosophy, and the work of Vygotsky, who created what is referred to as first-generation activity theory. It was substantially developed by two of his students, Aleksandr Luria and A. N. Leont'ev, to incorporate societal, cultural, and historical dimensions into an explication of human mental functioning (Eilam, 2003; Stetsenko, 2003), leading to what constituted second-generation activity theory. Whereas Vygotsky formulated practical human labor activity as a general explanatory category of psychology, he did not fully clarify the nature of this category. It was left to Leont'ev to make historically evolving object-practical activity the fundamental unit of analysis and the explanatory principle that determines the genesis, structure, and contents of the human mind. By taking practical labor activity as coextensive with cognition, it is the work of the latter that is recognized as the cornerstone for present forms of activity theory, together with its broader application to classroom learning, linguistics, and speech act theory (Langner, 1984c).

Consistent with its historical focus, we offer a brief history of CHAT in the Western world in this section. Although both Vygotsky and A. N. Leont'ev grounded their work in Marxism, many Anglo-Saxon scholars found it easier to appropriate key aspects from publications of the former than those of the latter. This differential acceptance may be attributed to a variety of reasons: (a) there was a diminished emphasis on this intellectual inheritance—Leont'ev (1978), for instance, devoted two of five chapters to Marxism, whereas there are only two references (index entries) in Vygotsky (1934/1986); (b) the idea of practical “labor activity as an explanatory principle and the idea of determination [of mind] through

activity (even if indirectly) was not represented as logically necessary” (Davydov & Radzikhovskii, 1985, p. 56); and, therefore, (c) the historical aspect of culture and cognition easily could be abstracted and glossed over. It is interesting to note that scholars basing their work in Vygotskian philosophy generally term their approach “sociocultural,” whereas those walking in the footsteps of Leont’ev prefer their research to be known as “cultural-historical.”

CHAT penetrated Anglo-Saxon academia rather late; historians may come to identify in Michael Cole the single most influential person for acquainting Western scholars to this tradition, both through his writings (e.g., Cole, 1988) and through the mediating role of his Laboratory for Comparative Human Cognition (LCHC) at the University of California, San Diego (Cole, 1984). At LCHC, many of those who contributed to the spread of sociocultural and cultural-historical frameworks devoted time, interacted, conducted projects together or in the same contexts, and jointly published, including Yrjö Engeström, Jean Lave, Barbara Rogoff, Sylvia Scribner, and James Wertsch (e.g., Cole & Engeström, 1993; Laboratory for Comparative Human Cognition, 1983). Activity theory further received impetus through publications such as *The Concept of Activity in Soviet Psychology* (Wertsch, 1981), *Learning by Expanding: An Activity-Theoretical Approach to Developmental Research* (Y. Engeström, 1987), and the newsletters associated with LCHC. Over the past decade, it also enjoyed wide dissemination through works from the Center for Activity Theory and Developmental Work Research at the University of Finland, Helsinki (e.g., Y. Engeström, Lompscher, & Rückriem, 2005). An older, albeit less recognized, influence on Western scholarship surfaced in Germany, Denmark, and Austria through Soviet works translated into German. These translations allowed Klaus Holzkamp and other German critical psychologists to elaborate CHAT faithfully to its dialectical roots (Teo, 1998). Intellectual influences from this group in Western learning research can be felt far away through the writings of anthropologist Jean Lave (1993, 1996, 1997) and psychologist Charles Tolman (1994; Tolman & Maiers, 1991), among others.

In the former Soviet Union, CHAT was characterized by its more descriptive focus on personality development and the use of activity as an explanatory principle at the level of human actions rather than an interdisciplinary topic of investigation or intervention more common outside that country (Bedny & Karwowski, 2004; Hakkarainen, 2004; Valsiner, 1988). A strand of action research, practiced at the Center for Activity Theory and Developmental Work Research, made thematic *tool mediation* by subjects interacting with objects in activity within non-school contexts. Subsequently, designers of computer systems and software for collaboration (e.g., Nardi, 1996; Redmiles, 2002), information systems designers and managers (e.g., Hasan, Gould, & Hyland, 1998; Kuutti, 1999), and organizational and workplace theorists (e.g., Blackler, Crump, & McDonald, 2000; Morf & Weber, 2000; Thompson, 2004) found much in CHAT that was congenial to their work. Others adopted this theoretical framework primarily for its overt articulation as a theory *for praxis* and practical action, which assisted researchers and practitioners in remedying contradictions that interfered with everyday learning (Daniels, 2004b; Sawchuk, 2003). Here, *praxis* denotes the moments of real human activity that occur only once (Bakhtin, 1993), which distinguishes it from the notion of practice, which is used to denote a patterned form of action, inherently a theoretical signified. When Katherine teaches, she participates in praxis, in which

there is no time out from the situation, and everything she does has consequences. When Katherine reflects about what she has done, the patterned ways that characterize her actions, she articulates practices, not praxis.

Because CHAT addresses the troubling divides between individual and collective, material and mental, biography and history, and praxis and theory (e.g., Cole, 1988), we believe that it is deserving of wider currency in the educational community. Notwithstanding the good intentions of those who propose balancing monism with multiple voices for advancing the field, basic tenets of CHAT have often been misinterpreted in dualistic ways, hence robbing it of much of its explanatory power (Langner, 1984b). In part, the vigorous dialectical materialist grounding of psychology in Marxism that A. N. Leont'ev pursued may have slowed the reception of CHAT in the West (Langner, 1984a). Yet we emphasize that these powerful analytic tools, existing even in Vygotsky's works, have little to do with totalitarian regimes that have falsely masqueraded under the banner of Marxism, socialism, or communism.

Method and Goals

The chief purpose of this review, then, is to introduce CHAT to wider audiences and to share how it can be beneficial for dealing with a number of unresolved problems both in the psychology of learning across the life span in formal and informal (work) settings and in educational practice. Being an accommodating framework—a metatheory (Scribner, 1990) rather than a set of neat propositions—has, however, produced varying interpretations of what legitimately constitutes CHAT-based research. The initial screening for relevance here began by applying the keyword *activity theory* and the names of leading CHAT scholars (e.g., Michael Cole, Yrjö Engeström, A. N. Leont'ev) to the electronic databases in the Social Science Citation Index, PsycINFO, Academic Search Elite, and Linguistics and Language Behavior Abstracts. Newer Internet search engines such as GoogleScholar also proved invaluable in identifying citation references. This first wave yielded over 600 articles, dissertations, book chapters, and book-length treatments appearing from 1970 onward in English and, to a lesser extent, in German (mastering this language, we have read this CHAT literature in the original). It was also found that the bulk of the literature from the Americas and Europe was published within the past two decades.

The resulting list was narrowed down significantly in the second wave of the review process by eliminating studies that referred to CHAT only in passing or those that were not specifically guided by second- or third-generation activity theory per se. Judgment calls were necessary, because CHAT has strong family resemblances and yet is distinct from *situated cognition*, *distributed cognition*, *legitimate peripheral participation*, *actor-network*, and *practice* theories (see Barab, Evans, & Baek, 2004; Cole, Engeström, & Vasquez, 1997). Similarly, by and large not considered here were the growing corpus of important projects that find much sympathy with CHAT but (a) emphasize less the historical determinations of practical labor and historical conditions of culture, cognition, and learning and (b) adhere more to a discursive, semiotic, or multimodal perspective drawing on Mikhail Bakhtin or Michael K. Halliday (e.g., Franks & Jewitt, 2001; Kress, Jewitt, Ogborn, & Tsatsarelis, 2001; D. R. Russell, 1997; Wells, 1999, 2002). This procedure left us with about 350 texts, not all of which are referenced here to eliminate overlaps. Even then, we do not claim that this review is exhaustive, given the

wide spectrum of interesting themes across disciplines (e.g., educational technology, literacy research, communication studies) that surfaced within the final pool of CHAT publications.

Three major goals are emphasized in this review: (a) introducing and explicating the fundamental dimensions and reviewing the existing CHAT literature within educational and educationally relevant noneducational (workplace, informal, out-of-school) arenas; (b) articulating how CHAT has been used to reformulate educational issues, especially in the areas of language, language learning, and literacy; and (c) sketching new and fruitful avenues for learning theory and educational praxis. This separation was made on heuristic grounds, although significantly, we show at relevant junctures how CHAT can potentially overcome some of the nagging tensions in educational research and practice that were alluded to in the opening section. To embark on the first objective in a nontechnical way, we explicate a vignette about an innovative science course held in western Canada designed and implemented according to CHAT principles. Here, seventh grade students investigated a local creek and the watershed it drained over a 4-month period with the purpose of returning the products of their environmental activity—including knowledge created and representations of creek health—to their own local community.

Learning by Participating in Legitimate Activity

Basically, CHAT was conceived of as a concrete psychology immersed in everyday (work) praxis (Vygotsky, 1989). We now describe a school curriculum that was designed according to the principles of CHAT and then introduce some core concepts of CHAT by explicating the vignette. Consistent with the idea of concrete psychological principles, this unfolding of the episode throughout the review serves as a tangible case in point and touchstone for the theoretical questions under discussion.

A Vignette

One day, the two coteachers of a seventh-grade class brought a newspaper article describing the efforts of an environmental group concerned with the health of the local watershed in which the village lies and its major water-carrying body, Henderson Creek. Besides a plea for improving the sorry state of the polluted creek, the article called for a better understanding of the ecosystem as a whole. The teachers asked the students whether they were interested in doing something about it. Excited by the challenge, the students immediately began to brainstorm what they could do, including cleaning up and documenting the litter that had been discarded there. To help students in framing viable projects, the teachers organized an exploratory field trip, assisted by parents and environmentalists, and then brought the children to different spots along the creek. Mediated by teacher questions and inspired by visiting environmentalists, biologists, water technicians, First Nations elders, and local residents, the students, in groups of three to four individuals, then designed their own projects that concretely realized the general call of the environmentalists to generate scientific knowledge and to rescue the creek.

The students enjoyed relative freedom over the design and implementation of their studies. For example, one group of four girls decided to take photographs at various places along the creek and to record their descriptions and impressions on audiotape. Another group decided to sample the creek at different locations for microorganisms and to correlate their frequencies with water velocity. Yet another



FIGURE 2. *This composite video offprint shows the seventh grade students interacting with small children, students, and adults from all walks of life, teaching them about the creek through their posters and showing them how to use the tools for gathering data. Students' knowing exhibited during this open-house event can be understood only if the unit of analysis captures the situation as a whole.*

group decided to investigate stream profiles and to correlate stream speed with depth, while the last group planned to document and identify all plants that grew in the immediate vicinity.

Every other week, the class dispersed for an entire afternoon, with parents acting as drivers who brought student groups to project sites and assisted in supervision. Some parents also worked alongside the children after having received instruction from the teachers in asking productive rather than yes-no questions. During school-based lessons, the children analyzed their data, engaged in discussions, or worked on a problem that one group had experienced, which with the mediation of the teachers, became a common topic for the entire class. Eventually, the students prepared for an open-house event organized by the environmentalist group at which they presented posters and mounted stations where visitors could use microscopes, dissolved-oxygen meters, or colorimeters (for determining turbidity). Many visitors, young and old, attended the open house (Figure 2), which the environmentalists later attributed in part to the children, who incited their parents and other close relatives to attend. The local newspaper featured a story about the children's efforts, emphasizing their contributions to community-relevant knowledge, while a Web site that featured some of the children's scientific findings was created.

In this unit, even students who often do not "succeed" in school science became core participants in the activity, including girls, aboriginal children, and students marginalized because of a "learning-disabled" classification. One such person was Davie, diagnosed as suffering from attention deficit hyperactive disorder (ADHD); he was regularly taken away from normal class work to receive special attention. Video recordings show that in his mathematics lessons, for example, he behaved in ways that teachers immediately labeled as problematic: He was "on task" for only a fraction of the time allotted and did not produce the requisite graphs that the teacher wanted. In the environmental unit, however, he not only generated usable data and graphs but also became a presenter in other classes, taught the teachers of

other classes about how to conduct scientific inquiry in the creek, accompanied other students as a peer tutor in their biweekly fieldwork, and was an irreplaceable participant in the open house, teaching adults and children alike about doing environmental research. Hence, who was deemed knowledgeable appeared to depend more on their involvement within specific settings rather than being an innate or stable characteristic of individuals.

A First Explication

In this vignette, the students have chosen not only the *object* of their actions (i.e., generating knowledge and saving the creek) but also the *means* by which they are to represent it. In fact, the students enact not just any practices but engage in concretely realizing an existing collectively defined *activity* in their municipality (doing environmentalism), *motivated* by a collective, societal concern for the natural environment. This activity already exists in their community, with its characteristic interests, concerns, and objects or motives. Students learn neither to memorize content matter to prepare for the next academic level nor merely for the purpose of passing tests or obtaining grades. Rather, the students learn science (and other culturally valued content matter) because it expands their action possibilities in and for the production of knowledge and *artifacts* that ultimately benefit their community. During the open-house event, the *products* of students' actions and learning are reintroduced into the community, where they become new social and material resources for furthering the learning of others, including environmentalists, visitors, parents, and children. That is, the products of their actions come to be *exchanged* in conversations and *distributed* in the community, which therefore *consumes* what the children have produced and learned. With the publication of their findings and an acknowledgment of their work in the local newspaper, the students also become known as contributors to the cause that this environmentalist group has espoused in the community. That is, the *identity* of the students has changed from being mere middle school students to being young citizens enacting concern for the environmental health of their community.

Within this class, different groups exercise considerable control over the object of the activity and the means to realize it. That is, they realized the overall object or *motive* of environmentalism in complementary ways, some documenting the current state of watershed health through photographs and verbal descriptions, others creating abstract representations such as the correlation between habitat characteristics (stream speed) and organisms (frequencies) using floating objects, tape measures, stop watches, and D-shaped nets. The different means (tools, instruments) mediate the productive activities in alternate ways, leading, not surprisingly, to dissimilar outcomes. Within their groups, not all students do the same things, but they *divide the work* in interlocking fashion; the benefits of working together provide them with greater room to maneuver and more possibilities for acting and therefore afford individuals expanded opportunities to participate in the activity and, therefore, for overall learning and development. Teachers, parents, elders, and other villagers, who contribute to making this environmental unit possible, all play different roles; without their participation, the outcomes would not exist, at least not in the way others come to see them during the open-house event. That is, these other people mediate the activity and many actions that realize it, expanding the range of possibilities, and therefore contributing to constituting the

activity as a more enriched form than if one teacher is to teach the unit on his or her own. With the necessary vocabularies to understand cognition holistically in CHAT, it makes the learning that is normally invisible amenable to deep reflection and analysis.

This brief example stands in stark contrast to the earlier vignette, in which Katherine directly teaches children about electrical concepts. In this science unit on the environment, the collectivity provides opportunities to children for participating in environmentalism and doing so in ways that are utterly beyond the reach of the solo efforts of individuals. Furthermore, the outcomes of the activity cannot be understood apart from the various mediating elements. That is, environmentalism as a whole and each action that contributes to practically realizing it, and therefore the knowing and learning that is going on, cannot be understood without taking into consideration the activity as a whole. This account immediately contrasts with other theoretical approaches to learning that attribute knowing to individual students' or teachers' intentions or achievements—the epistemology undergirding the textbook Katherine used—rather than to the system as a whole, as Vygotsky envisaged it. Thus, when we look at students such as Davie, our activity theoretical approach helps us realize how in his regular classes, he is in control neither of specifying the object of his activity nor over the productive means. What he generates is qualitatively inferior to the things produced by his peers, although these are used as part of the evidence that has led to the ADHD label. On the other hand, in the environmental unit, others mediate the entire system in such a way that the practical activity in which Davie is involved exceeds those of his normally high achieving classmates. In this context, he also mediates the productions of others and thereby meaningfully contributes to both his and everyone else's learning. As a result, our ethnographic videotapes featuring Davie show little proof of what one normally associates with ADHD. An activity theoretical approach allows us to appreciate the seemingly anomalous observation that the same child exhibits behaviors that are aligned with the ADHD label in one type of class but are thoroughly inconsistent with it in another.

Dialectics

In his analysis of mind and its development through practical labor activity, Vygotsky embraced Marxist concepts (Davydov & Radzikhovskii, 1985). Yet in his lifetime, the philosophical basis for dialectical materialism was still in its infancy, which saw maturity only after his death by philosophers such as Evald Il'enkov (1974/1977, 1960/1982). We believe that the least understood and most violated tenet in Western interpretations of CHAT likely is the dialectical nature of consciousness, which includes cognition, memory, and personality, among others (Elhammoumi, 2002). This situation is unfortunate, because dialectics is “possibly the most appropriate frame of reference for the study of human development, and indeed was actually developed as an explanation for human development” (Glassman, 2000, p. 2). Dialectical approaches to theorizing activities thus offer new opportunities for units of analysis that are analyzed in terms of mutually exclusive category pairs, including individual-collective, body-mind, subject-object, agency-structure, and material-ideal; that is, the opposites are theorized as nonidentical expressions of the same category, which thereby comes to embody an inner contradiction. We accordingly use an analogy of threads, strands, and fibers to share not only dialectics in general but also a number of specific theoretical aspects of CHAT in this review.

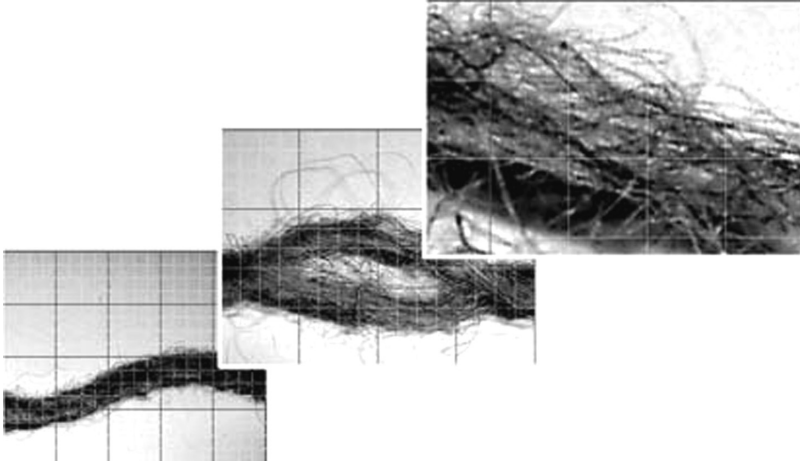


FIGURE 3. *Three microphotographs shown at increasing magnification from left to right showing the relationships between a thread, strands, and fibers.*

Saying that a relation is dialectical is equivalent to saying that any part that one might heuristically isolate within a unit *presupposes all other parts*; a unit can be analyzed in terms of component parts, but none of these parts can be understood or theorized apart from the others that contribute to defining it (Levins & Lewontin, 1985; Valsiner, 1998). Therefore, when one examines a thread, it assumes one form (Figure 3, lower left), though on moving closer, one may note that there are actually two or more interwoven strands (Figure 3, center). Without these strands, there is no thread, which thus presupposes the strands it is composed of. At the same time, the strands are what and where they are only because they are part of a thread; they assume a higher order structure that they contribute to realizing in a concrete way.

With greater magnification, one sees that the strands are actually composed of very short fibers (Figure 3, upper right). The strands again presuppose fibers, for without the fibers, strands would not exist. But similarly, in this configuration, the fibers presuppose the strand, for without it they may be functioning as something very different—as part of recycled paper or collage in an artistic work, for instance. In the particular contexts that a dialectical orientation attempts to explain, therefore, the specific function of individual components cannot be understood decoupled from the function of other parts and the function of the whole. Looking at a fiber, we cannot know what it does unless we look at its place within a larger system and at its relations with everything else. The characteristics of the thread cannot be deduced from the characteristics of the strands or fibers; the latter may be very tender or brittle, but the thread is very strong. Although the strands are very short, the strands and thread can be very long, exceeding the lengths of the former by many orders of magnitude. In the context of the environmental unit, the students are like fibers in a strand (the environmentalist community), itself a constitutive part of the thread (society). This analogy provides us with an initial framework for

understanding Davie's performances: In the environmental unit, he, a fiber, is thoroughly integrated and takes his place in a strand and thread, which in turn provide structures for what he does, which, as we describe, by far exceeds his solo performances in mathematics. Collective exploration also would probably allow Katherine's students to develop deeper understanding that direct teaching targeted at the individual mind.

Dialectical entities are understandably confounding, for in the wake of classical Greek thought, philosophy has evolved dualistic modes of expression, which do not permit contradictory entities. Thus, we conceptualize light in terms of wave or particle rather than saying that it simultaneously (a) is both wave and particle and (b) is not both wave and particle. Dialectical philosophers, on the other hand, realized that a theoretical category could not be a universal unless it also included its opposite (e.g., Hegel, 1807/1977); dialectical categories, however, can aspire to be categorical universals because they assert the mutual presupposition of opposites. To explicitly mark the dialectical nature of such categories, some recent publications have used special notation whereby two mutually exclusive but reciprocal terms are combined together (Roth, Hwang, Lee, & Goulart, 2005; Roth & S. Lee, 2004; Roth, Tobin, Carambo, & Dalland, 2005). These terms are separated by means of the Sheffer stroke \downarrow , which corresponds to the NAND operation in classical Boolean logic that creates statements that are always true when it involves nonidentical terms of the same entity. This approach leads to new categories—for instance, *agencystructure*—that encompass built-in contradictions. Understood in this way, “*individualcollective*” implies that individual and collective presuppose each other and that neither individual nor collective can be used as a theoretical starting point for explaining the other despite the latter dominating the educational literature presently. Thus, Davie turns out to be highly competent in the environmental unit, in which he is a fiber in a communal strand that he contributes to constituting; but as an individual fiber (in math class or the school psychologist's office), he ends up receiving the ADHD label and is administered drugs and other special treatments designed to “fix” his “disability.” Without this breakthrough in dialectical reasoning, it seems unlikely that we would have been able to comprehend how complex, nonliving entities such as classrooms (McDonald, Le, Higgins, & Podmore, 2006), school departments (Ritchie, Mackay, & Rigano, 2006), and workplaces (Y.-J. Lee & Roth, 2007; Miettinen & Virkkunen, 2006) can perform seemingly individualized acts of learning like persons.

Analyzing Activity Systems

Armed with a powerful tool in dialectics at their disposal, activity theorists also use an “activity triangle” for revealing the social and material resources that are salient in activity (Y. Engeström, 1991a, 1999a). Characteristic of second-generation activity theory, Figure 4 is a widely used depiction of the mediated nature of these resources using the aforementioned environmental unit as a case in point. The figure depicting one concrete realization of an *activity system* contains all the theoretical terms that we introduced previously—*subject*, *object*, *means of production*, *division of labor*, *community*, and *rules*—and it contains the higher order processes of production, exchange, distribution, and consumption. Whereas scholars frequently use this representation as an icon to indicate their theoretical allegiance, it is best considered a useful heuristic, though one that is not totally devoid of problems (Roth,

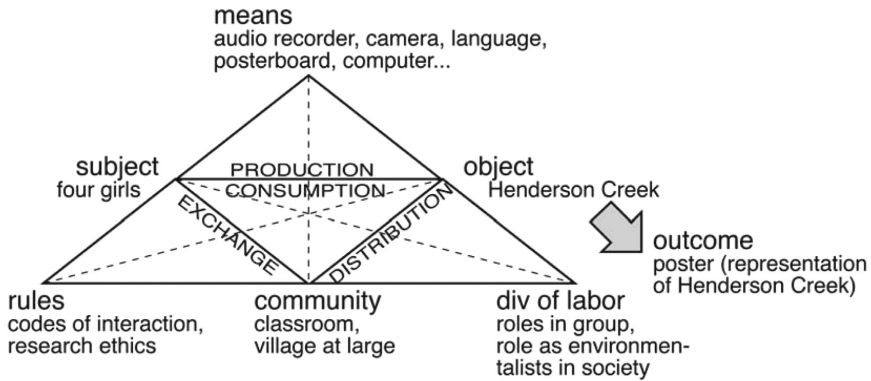


FIGURE 4. A widely used second generation cultural-historical activity theory heuristic known as the “activity triangle” for analyzing an activity system. This activity triangle is exemplified using the environmental unit at Henderson Creek. Note. div = division.

2004). German critical psychologists have also developed a parallel list of structures and actions in the study of praxis called the *praxis portrait* (Markard & Holzkamp, 1989). The latter is a list of items for guiding CHAT research in and on praxis that also explicates the fundamental ways in which research on practical problems ought to be conducted.

To elaborate on some fundamental aspects of CHAT used in the triangle heuristic, the term *activity* is not to be equated with relatively brief events with definite beginning and end points (characteristic of school-based tasks) but an evolving, complex structure of mediated and collective human agency. Thus, farming, commerce, dance, architecture, and, as a more recent form, mass schooling all are historical activities with objects and motives that contribute to maintaining human societies and, therefore, to maintaining individuals. With regard to the object of activity, it exists twice (Hegel, 1807/1977; Leont’ev, 1978): first as a material entity in the world and second as a vision or an image, both in its present state and how people envisage it in the future. Because the image is characteristic of human beings, it is evident that the “subject” cannot be coextensive with the material bodies of the girls in the environmental unit individually or collectively. The girls in the first group using camera and audiotape to represent the creek and their object can therefore not be theorized independently: What the relevant object is in actions and activities observed depends on who the acting subject is, and the nature of the relevant subject depends on the nature of the object (Lave, Murtaugh, & de la Rocha, 1984). Hence, learning is equivalent to the mutual change of object and subject in the process of activity; human beings plan and change the material world and societal life just as these settings mutually transform agents and the nature of their interactions with each other. Learning, which occurs during the expansion of the subject’s action possibilities in the pursuit of meaningful objects in activity (Y. Engeström, 1991b), is thus evident in the vignette from the environmental unit.

Making education relevant by moving from objects of traditional school tasks to objects defined within society more broadly has been used not only in the design of the environmental unit featured here but similarly to promote higher order thinking practices across mathematics (Hershkowitz, 1999), science (Giest & Lompscher, 2003), and other school curricula (Hedegaard, 2001, 2002; Hedegaard & Lompscher, 1999).

In the same way, the four girls in the environmental unit and their productive actions cannot be thought independently of other entities that make their culture. For example, the outcomes of their actions depend on, but are not singularly determined by, the available means. The girls have chosen a camera and a tape recorder rather than a tape measure and a stopwatch, which shapes and is reflected in their product, the poster presentation. In CHAT, one speaks of the mediation of a relation, here subject-object, by another entity: the artifacts that embody the accumulated history of human ingenuity and creativity. In the triangle heuristic, there are other entities, such as the community within and for which some activity takes place, the division of labor that acts both internal to a subject (in the environmental unit, one girl operated the photo camera while others divided up the work of producing text recorded on audiotape) and within the community (e.g., teachers teach and bakers bake, but because of the division of labor in society, both groups of workers have to eat and get their children educated as part of the environmental unit). Finally, rules constitute an important resource for situated actions. All of these theoretical units must be understood as threads that make a strand or fiber, in the sense that the environmental activity as a whole would not materialize without the entities, but these entities appear in this configuration only because the activity is preexisting. That is, these entities and the activity they reference presuppose each other, which seems to be what many scholars partial to CHAT have foremost in mind when they explore cultural behavior holistically in what they call “activity settings” (e.g., Farver, 1999; Gallimore & Goldenberg, 2001). Without such an encompassing frame, we cannot understand why Davie does so well in the environmental unit generally and, for example, during the open house specifically (see also Figure 2).

Resources are available for use in action, but they do not function deterministically, much like a wild-water canoeist’s plans guide his or her actions rather than determine his or her actual descent (Suchman, 1987). Furthermore, actions produce novel resources that become available for subsequent actions by others in the emergence of the social (Saxe, 1999). That is, the *outcomes* of actions become part of the newly transformed system that continues in like manner. We may read Figure 4 in this way: *Consumption* is the opposite of production: Others learn from the children’s productions (Figure 4, center), and all outcomes of productive activity eventually get to be consumed. The relationship of individual subjects with others in their community is one of *exchange*. Objects are asymmetrically accumulated within a society, leading to differential *distribution*: In this village, environmentalists and stream stewards know more about the environmental health of the creek than the students, who in turn know more about it than most residents (Figure 4, lower right).

It is important to note that any material entity is not fixed but can take different functions within an activity system. For example, signs can switch functions and become tools in the process of reading texts that further generate new texts and meanings that are culturally and historically situated (Smagorinsky, 2001). By the

same token, mundane objects such as textbooks can continue their lives in other roles and assume diverse functions within the same or other activity systems (Y. Engeström, 1996). Thus, knowledge about biological (coliform) contamination of the creek (created by an eighth grade student) finds its genesis as an object of activity, moves on to become the outcome of the activity embodied in an exhibit at the environmentalist open house, and subsequently shifts its function to a *tool* when appropriated in political discourse to affect farming practices in the *community*, defines *division of labor* in the community (environmentalists versus farming and industry), and defines *rules* (new community bylaws regulating industrial discharge and cattle grazing practices [minimum grazing distance to creek]). From a CHAT perspective, human cognition thus is considered as situated and distributed across social settings and acting in concert with diverse, changeable artifacts.

Networks of Activity Systems

Third-generation activity theory endorses the fact that all activity systems are part of a network of activity systems that in its totality constitutes human society. Diverse activity systems are the result of a continuous historical process of progressive job diversification and collective division of labor at the societal level (Marx, 1867/1976). Thus, during societal development, some prototypical activity system as depicted in Figure 4 unfolds into two or more systems; the network is formed as activity systems lose their self-containment and exchange entities, including objects, means of productions, people, and various forms of texts. The first activity system is understood as a concrete universal, which particularizes itself into many mutually constitutive activity systems. Thus, the system of schooling produces graduates who enter the workforce; some workplaces, such as paper and scientific instrument companies, produce resources for the system of schooling, here the notebooks, stopwatches, and dissolved-oxygen meters students deployed in Henderson Creek.

As long as individuals contribute to one activity system, they sustain not only its output (production) and its (and their) own reproduction, but also to society as a whole because of the various exchange relations linking the different activity systems that make society (Y. Engeström, 1999c). This situation gives rise to the possibility for contradictions that transcend the individual subject and its relations to other elements in the activity system. In fact, students mediate between school and home as normally separate activity systems containing within- and between-system contradictions that experience resolution once both systems begin sharing ontogenetic histories (Takahashi, 2003). Of course, this mediation presents special challenges for educators who strive to minimize the distance with their students in terms of their life-history trajectories to cultivate meaningful instruction (Tobin, 2004; van Aalsvoort, 2004). Recent work undertaken by the Everyday Science and Technology Group (<http://everydaycognition.org>), based at the University of Washington, violates the common assumptions that school settings are the preferred or primary location for gaining competency in science, digital technologies, and argumentation practices among youth. What is needed is to recognize that the foundations of knowing are surely multisite ecologies integrating the individual, social, and whatever cultural tool kits are salient across the life span. Researchers who adopt third-generation activity theory hence make it a priority to ascertain the role of dialog, multiple perspectives, and issues of power when dealing with interacting activity systems as networks.

Activities, Actions, and Operations

CHAT offers additional theoretical lenses when it distinguishes three dialectically related levels of analysis: object- or motive-oriented activities, goal-oriented actions, and conditioned operations. According to Michael Cole (personal communication, May 1, 2004), these levels are often conflated, which leads to problems in appropriately theorizing the hows and whys of human behavior. These three levels relate to one another much as the thread, strand, and fibers in our analogy, respectively.

The term *activity* is related to work, trade, and professions: Leont'ev (1978, p. 46) likened it to the German term *Tätigkeit* (which has the synonyms *work, job, function, business, trade, and doing*) and distinguishes it from *Aktivität* (which has the synonyms *effort, eagerness, engagement, diligence, and restlessness*). The activity concept therefore differs from the kind of events educators usually denote by *activity*, which are structures that allow children to become engaged, involved, and busy and that one might better refer to as tasks. What Katherine's students in the opening vignette do are tasks; the students in the environmental unit participate in an activity that really and meaningfully contributes to the production and reproduction of society and its relation to the natural environment. Some scholars therefore reject the idea of learning as an activity system (Holzkamp, 1983), whereas others insist that learning can be planned and analyzed as activity system (e.g., Davidov, 1988; Lompscher, 1999). A snapshot of activities described in the CHAT educational literature include *redesigning* instruction (Jonassen & Rohrer-Murphy, 1999; S. Lee & Roth, 2003a), *planning* for teacher learning (Ball, 2000; Edwards & Protheroe, 2004; Grossman, Smagorinsky, & Valencia, 1999; Kärkkäinen, 1999), *providing* for learning or physical disabilities (Bakhurst & Padden, 2001; Daniels & Cole, 2002; Kosonen & Hakkarainen, 2006), and *managing* schools (Gronn, 2000; Spillane, Halverson, & Diamond, 2004); all these concrete activities, as true of activities in general, are characterized by the collective nature of their motives (Leont'ev, 1981). In the realization of collective motives, an activity system contributes to the survival of society and therefore the survival of each individual, in and through whose actions society is realized and exists (Holzkamp, 1991). The subjects of individual activity systems (individuals, groups, organizations) concretely realize collective (generalized) activity by adopting and realizing the general object or motive. Thus, doing environmentalism has a collective motive that exists in various forms in society, which the environmentalists in the community and the students in the seventh grade unit concretely enacted in one form.

An activity is realized through concrete *actions*, which are directed toward goals that are framed by individuals; in CHAT, actions and the goals they accomplish are the dominant features in human consciousness during active engagement with the world. In our example, taking photographs of Henderson Creek near a high school to document uncollected litter is one specific goal. The relationship between action (goal) and activity (motive) is dialectical, for actions constitute activities, but activities motivate particular action sequences. This relationship we denote as sense (McNeill, 1985), for in the context of a different activity, the same action has a different sense, much like the function of a woolen strand would be different if a bird used it to make a nest. The results of actions become part of the resources available in later stages of the activity for subsequent actions. Because the outcome of actions

cannot be anticipated with perfect accuracy, the contexts in which human beings act change constantly, whereas the overall motive (activity) may remain unchanged. The impossibility of perfect anticipation leads to the fact that goals and the actions that realize them have an emergent quality as the subjects of activity consciously choose them under the auspices of the overall object or motive to be achieved (Lave, 1988). Recall that Katherine has student learning as her overriding motive, although there are alternative actions available to her (e.g. student- or teacher-centered pedagogies) to fulfill the former.

Actions (goals) are referents for the sequencing of those unconscious elements that realize them: *operations*. An operation is shaped “not by the goal in itself but by the objective-object conditions of its achievement” (Leont’ev, 1978, p. 65); in other words, operations emerge in response to the relationship of goal and current state of the action and its material context. At Henderson Creek, one girl might have the goal to take a photograph that depicts pollution, but she does not have to consciously consider moving her head to find a suitable shooting angle or bending her finger to press the shutter button. Perceiving things lying around the creek as garbage and pressing the shutter button on the camera are examples of operations. Therefore, the relationship between actions (goals) and operations (conditions) is again dialectical, and they presuppose each other like strand and fiber, respectively, for a sequence of operations constitutes an action, but the action provides the referent for any operation and the sequence as a whole. This relationship is denoted by the term *reference* (Roth, 2006). By its nature, reference is associated with phenomena located in the human body and mind; *sense* is associated with phenomena in collective activity systems. Meaning, as we explain below, is denoted by this interplay between reference and sense and therefore comes to be embodied and cultural-historical simultaneously.

Distinguishing the three levels is “absolutely necessary . . . in the context of the psychological analysis of activity” (Leont’ev, 1978, p. 65), especially when considering *mediation* (Roth, in press). At the level of actions and activities, tools or division of labor are chosen consciously, therefore mediating the subject/object relation. At the level of operations, however, the tools become transparent: They are elements integrated into the human body (Bateson, 1972; Devereux, 1967). The camera a student uses is thus not an entity in itself, but the act of using the camera is of relevance to understanding conscious forms of knowing. When some CHAT researchers isolate tools as a separate analytic entity in the triangle heuristic, they face the threat of misinterpreting their data, because they do not attend to the different functional relations between subject, tool, and object (Suchman, 2000). Avoiding simplistic forms of mediated subject/object relations, some CHAT-based studies showed how tools apparently disappeared into the person concerning mathematical knowing and learning in the workplace (Roth, 2003a, 2005b), whereas others showed how tools undergo continuous transformation during instruction (Schwarz & Hershkowitz, 2001). Also called the repository of culture or “crystallized operations” (Leont’ev, 1978) that reflect and afford certain preferred patterns of culture, tools are made an object of consciousness only when they fail to perform, such as during a breakdown. Not to be taken negatively, these problem situations can in fact provide a valuable reflective stance toward the learning activity, as we explain next (Koschmann, Kuutti, & Hickman, 1998).

Contradictions, Change, and History

As in all dialectical units, activity systems harbor *inner* contradictions, which come with the coexistence of mutually exclusive elements. For example, in a development of a Vygotskian approach to mind, speech and gestures concurrently produced in interaction not only are mutually constitutive elements of the same unit but also are inherently distinct and irreducible to each other (McNeill, 1992). Here, speech and gesture relate like two fibers in a strand or wave and particle in light. They form a speech/gesture unit, each expressing the whole but doing so in very different ways so that they cannot be reduced (translated) to each other. Light expresses itself as a wave (e.g., when bent by a camera lens) or a particle (when activating a camera's light meter); but although both wave and particle are expressions of light, they cannot be reduced to each other. This formation creates a contradiction inside the unit, which then is responsible for the development of communication (McNeill, 2005). Recall also that the same object of activity exists twice, as material and as vision, thus taking very different, mutually contradictory forms.

When inner contradictions are conscious, they become the primary driving forces that bring about change and development within and between activity systems. Generally overlooked is the fact that contradictions have to be historically accumulated inner contradictions, within the things themselves rather than more surface expressions of tensions, problems, conflicts, and breakdowns (Il'enkov, 1974/1977). Subjects can experience contradictions in four types (Barowy & Jouper, 2004; Cole & Engeström, 1993; Roth, 2003d), depending on where they occur in the activity system (Figure 4). At a primary level, they may be internal to a fundamental entity, such as when the children's dissolved-oxygen meters malfunction or when a concept they use to calculate water flow is inappropriate; the inner contradiction of some object, like a cause, may *express* itself in the different symptomatic ways in which individuals actually experience and understand it. Coming closer to the lived realities of learners, performing well during achievement tests is another primary contradiction that sometimes uneasily mediates between learning for learning's sake or for earning (future) rewards. Failing to unpack or resolve this critical issue over the course of one's education may result in strategic choices for learning, including viewing school-based learning as a stepping-stone in the larger pursuit of happiness without much inherent meaning in itself.

At a secondary level, contradictions may exist between two constituent entities, such as when the demand for quality work in complex environmental problems (object) negates the school-based rule of completing curriculum in a fixed amount of time. What Katherine, the fifth grade teacher in the first vignette, experienced concerning the theory-praxis gap exemplifies this particular contradiction. At a third (tertiary) level, they exist between the object (motive) of the dominant and the object of a culturally more advanced form of the activity. An example of a tertiary contradiction is the difference in the object or motive of a regular seventh grade science class in the school (being able to memorize and define certain words related to water and environment) and the one that the students and two teachers in the environmental unit realized (generating knowledge about creek health). Likewise, when a teacher tried to implement problem-based learning in her high school biology class to encourage higher order thinking, impending high-stakes assessment modes and larger societal pressures severely curtailed the effectiveness of learning (Yeo, Tan, & Lee, 2006).

At a fourth and final level, trouble may exist between the central activity and one of its neighboring activities. An example of this situation was the new graduate from a teacher education program (System 1) participating in the Henderson Creek project (System 2), who was unprepared for but nonetheless required to teach seventh grade science, which is an integral part of the elementary school curriculum in British Columbia. By paying attention to these inner contradictions, analysts can therefore gain insights into how larger sociopolitical and economic struggles mediate local practices, subjectivities, and therefore learning among children (Göncü, 1999; Paradise, 2002) and adults (Holland & Lave, 2001; Y.-J. Lee & Roth, 2005).

Whereas inner contradictions reveal themselves only during analysis, they express themselves as trouble in ongoing activity. When such trouble is available to consciousness, it can be addressed by a change of goals (Barab, Barnett, Yamagata-Lynch, Squire, & Keating, 2002) or simply abandoning the introduced technology (D. L. Russell & Schneiderheinze, 2005), for instance. Thus, when the students measuring water speed using a Styrofoam ball found out that the wind was pushing the ball across the water surface, they floated an orange someone had brought, which, because of its weight, was unaffected by the wind. Otherwise, trouble can cause “workarounds,” whereby human beings do things in unintended ways that nevertheless circumvent the trouble (e.g., Bannon & Bødker, 1991). The teachers in the Henderson Creek project also obtained their own teaching resources to make up for a lack brought about by the depletion of the science budget (for the worksheets colleagues in their school had consumed in direct teaching pedagogies). Here, the inner contradiction may be that characteristic of a class society and faulty policies, which expresses itself in the fact that schools serving poor and working-class students receive fewer (financial) resources than those in more affluent neighborhoods.

Contradictions, when they are brought to the level of consciousness, engender homeostatic processes within activity systems, which thereby change and develop over (historical) time. But because complex phenomena are nonlinear, change is unpredictable and nondeterministic, leading to the contingent nature of activity systems, including languages used, notions of selfhood, and communities (Rorty, 1991). Activity systems therefore can be appreciated properly only through structural (synchronic) and cultural-historical (diachronic) analysis (Gutiérrez & Stone, 2000; Scribner, 1985). Even human emotions and motivations can be understood only as integral aspects of human activity systems that are cultural-historical accomplishments at a general level (Tolman, 1994) although concretely realized in situated activity (Goodwin & Goodwin, 2000). Returning to our analogy, unfolding engagement in situated activities, personal biographies, and the histories of groups and societies stand in the same mutually constitutive relationships as fibers, strands, and thread. Research interrelating human development across microgenetic, ontogenetic, cultural-historical, and phylogenetic timescales (Cole & Engeström, 1993; Erickson, 2004; Lemke, 2000) is as yet embryonic, although one important study clarified how schooling (and society) “made” students within an urban community that was caught in the swirl of rapid political and economic change (Packer, 2000).

Collaboration: Enacting Learning and Development

CHAT has much potential for educators, because it is thoroughly about development and learning, encompassing the system as a whole and various subjects and communities that constitute it. Because everyone contributes to productive activity,

in whichever way this may be, they not only contribute to the ultimate reproduction of society but also increase action possibilities for themselves (Holzkamp, 1984b). Two manifestations of *expansive learning* arise from this interplay between individual and society. On one hand, learning is expansive when it contributes to an enlarged room to maneuver for the individual whereby new learning possibilities are formed. On the other hand, learning is also mediated by the division of labor in collaboration, which inherently leads to learning outcomes and forms of societal activity (Donato, 2004; Guberman & Saxe, 2000; Tolman, 1999). Learning occurs whenever a novel practice, artifact, tool, or division of labor at the level of the individual or group within an activity system constitutes a new possibility for others (as resource, a form of action to be emulated) leading to an increase in generalized action possibilities and therefore to collective (organizational, societal, cultural) learning (Putney, Green, Dixon, Durán, & Yeager, 2000; Raeithel, 1996; Roth, 2003b). Individual and collective learning are now linked by “*transgressing the boundaries of individual subjectivity* through immediate cooperation toward the realization of *common interests of collective self-determination against dominant partial interests*—intersubjective relations in a definite sense reflect collective or rather societal subjectivity” (Holzkamp, 1983, p. 373; our translation).

Collective work—of which that involving teacher-student or tutor-tutee interactions is but one kind—allowing new forms of actions, which are appropriated in what is termed the *zone of proximal development* (Vygotsky, 1978). The latter increasingly is used as a descriptor of instances of scaffolded teaching and learning situations from units as small as dyads (parent-child) to larger groupings such as classrooms (Kozulin, Gindis, Ageyev, & Miller, 2003; Shayer, 2003). Notwithstanding that it constitutes a possible misrepresentation of Vygotsky (Gillen, 2000; Leont’ev, 1981, p. 57) and a tough concept to implement (Daniels, 2001; DeVries, 2000), the zone of proximal development sometimes invokes a problematic internalization-externalization dichotomy.

For an individual, there are two forms of learning possible in the zone of proximal development, only one of which is normally made thematic. First, in collaboration, a less experienced person may observe a form of action and, by means of emulation (mimesis), learn to act in a more or less imitative way; in this way, the children at Henderson Creek gain proficiency with the equipment from watching the biologists in the environmentalist group. Second, when two or more individuals collaborate, entirely new actions unfold: By dividing the work, two or more children are enabled to measure the width of a raging creek and thereby learn “to measure the width of a creek,” which was impossible if they were working alone. The possibility of entirely new or more sophisticated actions in collective activity explains why individuals can learn even if they collaborate with peers at the same developmental level rather than with more advanced others (e.g., teachers, parents), such as the learning some have described to occur in computer clubs (e.g., Collins, Brown, & Newman, 1989).

This second dimension is closely related to a reformulated definition of the zone of proximal development as the distance between the actions of an individual and the historically new forms of societal activity created in collaboration (Y. Engeström, 1987). Collective activity not only increases the learning opportunities for students but also leads to learning to teach through implicit ways: the emulation of actions and practice of new forms of actions available in collective activity. It foregrounds the

socially contested nature of learning and has been explicitly used to set up advanced forms of teacher training through *coteaching*, a form of teaching in which two or more individuals teach together simultaneously, enacting full responsibility for all parts of the curriculum (Roth & Tobin, 2002; Roth et al., 2005). Thus, the environmental units, which involved not only the two teachers but also other individuals from the community, gave rise to many learning opportunities on the part of all those participating in teacher roles: regular teachers (e.g., Roth & Tobin, 2002, chap. 1), teaching interns (Roth, Masciotra, & Boyd, 1999), environmentalists (S. Lee & Roth, 2003b), students (Roth & S. Lee, 2004), and parents (S. H. Lee & Roth, 2003c).

Some educators have fruitfully exploited this collectivist interpretation of the zone of proximal development to bridge issues of diversity in classrooms. These approaches have in common a strong commitment to dialog and the production of hybrid spaces that foster mutual understanding (Cole, 1998). Of interest here is the focus on the intersection of teachers' and students' cultural, discursive, and knowledge resources that offer opportunities for shared learning. These unstable and ephemeral spaces for going beyond what counts as knowing promise much for encouraging low-achieving students, such as Davie in his mathematics classes, who have been marginalized by current school practices or even peer groups (Diamondstone, 2002). These pedagogies eschew ascribing stability to cultural ways of knowing and issues of diversity in classrooms. Instead, differences in ability are attributed to learners' participation in specific cultural-historically situated activity systems rather than being blamed on disadvantage and deficits (Gutiérrez & Rogoff, 2003) or narrow conceptions of competence (Gipps, 1999). For example, there has been ongoing research with Bakhtinian forms of discursive practices, or what is called "third spaces" (e.g., Gutiérrez, Baquedano-López, Alvarez & Chiu, 1999; Gutiérrez, Rymes, & Larsen, 1995), while others who work with African American communities have capitalized on the normally undervalued funds of knowledge that these learners embody (e.g., C. D. Lee, 2001; C. D. Lee & Majors, 2003; C. D. Lee, Spencer, & Harpalani, 2003; Majors, 2003). Alternatively, research in technology-intensive learning environments allows students to interact in model activity systems such as Michael Cole's Fifth Dimension (Cole, 1995, 1996; Nicolopoulou & Cole, 1993), Kris Gutiérrez's Las Redes (Gutiérrez, Baquedano-López, & Tejada, 1999), and Sasha Barab's Quest Atlantic program (Barab, Hay, Barnett, & Squire, 2001).

Rethinking Attendant Educational Issues

CHAT has been used to address important educational issues in fresh ways, chief among which is language, which is perhaps the paramount tool, medium, and object in educational practice. We describe in the next section how aspects of language, language learning, and literacy can be reformulated according to CHAT. Of direct relevance to educators, CHAT too has always been a theory grounded in and emerging from praxis so that it aspires to be a theory *for* praxis.

Language, Language Learning, and Literacy

One consequence of using CHAT is an alternative way in which language, language learning, and literacy can be appreciated, understood, and explained. From a cultural-historical approach, language appeared later in human development, when collective activities such as hunting, division of labor (Leont'ev, 1978, used an

account of hunter-beater cooperation), tool production and use (among chimpanzees), exchange relations, and other cultural aspects of human life-forms already existed (Roth, 2003b). Language therefore is a category *subordinate* to activity (Leont'ev, 1971), with the consequence that words accrue to meaning (given by an activity system as a whole) rather than the other way around (Mikhailov, 1980). Thus, with respect to the environmental unit, we cannot theorize students' language and literacy development independent of environmentalism, the activity partially realized in and through the deployment of language and literacy as the means.

Educational researchers concerned with language, language learning, and literacy often ground their work in CHAT and most frequently in reference to *Thought and Language* (Vygotsky, 1934/1986). There is, however, a confusing array of approaches, largely because language and literacy are treated sometimes as tools for the transmission and construction of culturally accepted knowledge (e.g., Pontecorvo & Girardet, 1993; Wells, 1999; Wells & Claxton, 2002), sometimes as action (McNeill, 1985), sometimes as practices (e.g., Hanks, 1996), sometimes as mediating element constituting context (Doehler, 2002; Wake & Williams, 2001), sometimes as means to constitute both topic and terrain of interaction (e.g., Gutiérrez, 1994; Jacoby & Gonzales, 1991), sometimes as part of voice understood as communicative action (R. Engeström, 1995). The issues become even more muddled when the unit of analysis, activity, changes in scale from a collective (societal, historical) dimension (Boag-Munroe, 2004) down to school tasks (Varelas, Pappas, & Rife, 2005) and even parts of tasks, such as questioning and examining during pediatric consultation (e.g., Junefelt & Lindberg, 1995).

Language, language learning, and literacy find a proper place within CHAT when the latter is allied with speech act theory. This integration is made possible because of the central role actions (acts) play in both theories. A speech act has productive, intentional, and outcome components (Austin, 1962); as such, the speech act constitutes a legitimate form of action according to CHAT (Leont'ev, 1971). Similar to other actions, speech acts are constituted by components (operations) that conversationalists do not consciously choose; appropriate words emerge in response to the unfolding utterance by means of which the speaker attempts to achieve communicative goals (Roth, 2005c).

Furthermore, the sense of a speech act is a function of the activity system as a whole: Thus, the utterance "I won't do it!" lacks a sense in itself; rather, its sense properly emerges in its relation to the activity in its entirety. Assuming a student uses it in response to a teacher's request "Get your textbook out," the sense and consequences are altogether different than if it were the response to the admonition "Don't fight during recess." In the first case, the action undermines the teacher's authority, whereas the action affirms this same relation in the second. One observes that the teacher actually does two separate things with the same speech act: *requesting* and *admonishing*; the sense of the student's action, correspondingly, is very different though it looks the same: *refusing* a request and *acceding* to the admonition. Both choose their actions with respect to the activity system as a whole. The choice of a speech act is clearly a function of "the totality of all external influences on an organism extant in the situation, which, together with the motive of activity, completely inform the organism about the choice of that action, which best corresponds to the present motivation" (Leont'ev, 1974, p. 39; our translation).

At any rate, language is used *for* action; the selection and order of words does not require consciousness or reflection. The unfolding utterance (action in pursuit of goals, which may only form in concrete ways in activity) provides the context for the next speech operation (word), which normally is not chosen consciously (Leont'ev, 1971). In this instance, language can be said to serve as primary artifact (Wartofsky, 1979), functioning instead much like a cane in a blind person's hand. Language can also be *about* action, such as when the teacher and student discuss the first exchange and the consequences that might follow. Now, the utterance and the language is an object of attention and therefore a secondary artifact, a way of representing a previous moment of praxis. Language can also assume the form of a tertiary artifact when teachers generate theories *of* practice, which can be more or less independent of praxis (Hoffman-Kipp, Artiles, & López-Torres, 2003). We return to this issue in a subsequent section.

Taken together, these three functions of language mirror the levels of analysis in CHAT. At the level of operation, language (choice of words, grammar) is unconscious. When language is viewed as action, it becomes an explicit tool (e.g., reflecting on action, representing situations), sign, or object. Finally, at the level of activity—theorizing teaching—it also may function as tool, sign, or object. Because in use, language can function as tool, sign, and object—being in each case materially embodied—it can switch its position in the activity system with ease (Figure 4). This close association of language and CHAT has spawned a few CHAT-based models of learning (Gal'perin & Leont'ev, 1974): acting with material objects, acting in spoken language, and acting in consciousness. Engagement with material entities plays an important role that first has to be translated into concurrent articulated speech, which eventually ceases, leaving only inner speech. Nevertheless, even in its utter privacy, inner speech makes use of language, which is not the one of the speaker, making this form of thought an utterly social action (Mikhailov, 1980). Naturalistic observations in science lessons bears witness for these transitions from active engagement with materials, pointing gestures replacing verbal explanations, to the emergence of articulated speech and symbolic hand gestures, to full dependence on scientific language (Roth, 2003c; Roth & Lawless, 2002). Again, one observes language first appearing in its function *for* action prior to being *about* action and situation, which in turn is prior to scientific explanation (theorizing).

Another aspect of significance is the work of Soviet psychologists regarding the internalization of action, especially speech, initially articulated in *Thought and Language* (Vygotsky, 1934/1986) and subsequently taken up in works such as *Language and Cognition* (Luria, 1981). Scholars in language learning who ground their research on these studies unwittingly maintain a dualistic opposition between inside and outside, between the intra- and interpsychological dimensions of learning and human interaction (see Lantolf, 2006). What is overlooked is the notion that language learning as pure acquisition is a “wrong” theory, for it is a dialectical process involving both inside and outside (Jäger & Küchler, 1976). Recent dialectical materialist interpretations insist that all (language) action has both inner and outer elements (Sawyer, 2002; Zinchenko, 2001). Recall that the sense of a (verbal) action exists solely in the action-activity relation, that is, from the social and therefore interpsychological situation, whereas the speech act is realized by operations, which, inherently, emerge on an intrapsychological plane. The sense

of an utterance hence presupposes the activity that encompasses the individual speech act (Keseling, 1979) by means of which the activity is (in part) concretely realized.

This interplay of activity and action, often forgotten, has been shown to influence the processes and products of research on scientists' knowing graphs and biographies. Both the forms of knowing and the biographies that emerged were the outcomes of the interviewer-interviewee interaction in particular and the activity system (social science research) in general (e.g., Roth & Y.-J. Lee, 2004). This study further confirmed that the production of communication begins with a growth point: an idea in the form of a dialectical unit of speech and image (McNeill, 1985). The communicative action, propelled by the inner contradiction in the speech-image unit, unfolds, recognizable in its repeated appearance in the form of a *catchment*, until the idea has been articulated and a (momentary) endpoint has been reached (McNeill, 2000). Here, semantic and syntactic rules, rather than constituting plans to be followed and implemented, provide speakers with stop orders: An utterance is complete once it conforms to the speakers' growing intuition of grammatical completeness and conformity to these rules (McNeill, 2005). Each time language forms are realized in new ways, they become available at a collective level, and parts of culture are created anew (Holland, Lachicotte, Skinner, & Cain, 1998), leading to a continual transformation of culture.

To elaborate further, the structure of the language preserves the system of human practical actions with objects (Mikhailov, 1980). As in pragmatic theories of language (Davidson, 1986), language reproduces the structure of the actual life of society, so that the boundary between mastering a language and knowing one's way around the world has been erased (Rorty, 1989). Some authors therefore suggest that language ought not to be considered an artifact or tool but a form of activity; meaning already exists as the totality of the activity system (Rocha & de Carvalho, 2000). The individual always learns and uses the sense of a word in the process of participating in activity, where he or she encounters its material envelope (sound) as an invariant property. Like other material tools and artifacts, the sense of a word or utterance arises from the relationship between action (goal) and activity (motive). Using a certain sound (word) means pursuing a certain goal. Language as a system reflects social life, but in a metonymic relation: "language taken in relationship to the signified reality, is only a form of its being, just as are those material brain processes of individuals that realize its perception" (Leont'ev, 1978, p. 79). Thus, much like persons learn to use tools, tinkering, trying this or that way, students learn words through using them in particular situations defined by the object, division of labor, and community (Roth, 2005c), discarding some, retaining others. This unproblematic relationship between words and language or rather literacy (*parole*, speech) is like the relation between hammer and hammering. Pedagogical implications of how knowledgeable agents speak and act effortlessly within social worlds extend to second-language-learning research, whereby attention is now focused on the cultural dimensions of language study in which the processes of learning and identity go hand in hand (Lantolf, 2000). Likewise, activity theorists blur the traditional separation of texts, readers, and contexts when they encourage students of literature to go beyond the examination of literary characters' dialog, emotional states, beliefs, or goals. The way to respond to literature is

to holistically engage with texts as a cultural activity in tandem with the cultural worlds or activity systems that the texts signify (Galda & Beach, 2001).

One early study attempted an explicit integration of language into CHAT (R. Engeström, 1995). Accordingly, the social group of the speaker constitutes the community with its specific social language. The current speaker, drawing on words as mediating artifacts, aims at previous utterances (object) to voice (action) a new utterance as an instance of social language (outcome): Language is both a means and product of communication (Leont'ev, 1978), and it may be simultaneously tool and contested terrain (Roth & Barton, 2004). The speech genres are forms of rules at the level of operation that govern the speech act.

Theory for Praxis, Praxis of Theory

One of the most attractive features of CHAT for educators is that it lessens the theory-praxis gap due to the historical primacy of material, work-related activity over language and theory. Indeed, CHAT has been promoted as a developmental theory, for it seeks not only to explain but also, and more important, to influence qualitative changes in human praxis (Y. Engeström, 1999c). Activity theorists believe that human beings are not merely at the mercy of extant institutional contexts but that they are endowed with the power to act (agency), which allows for critique and revision. However, theory has left praxis wanting in two ways: through its inability or unwillingness to provide appropriate means for the analysis of praxis and through its downgrading of praxis to a second-order form of knowing (Holzkamp, 1988).

Actions are always theoretically grounded in the sense that practitioners normally anticipate the results for their actions, which are linked to practical reasons for acting (Ricoeur, 1991). The latter derive from the sense that people make *in* their activity system (praxis), though they often fail to appreciate the structural (societal) relations that energize the activity system with its generalized motive (Dreier, 1980; Holzkamp, 1984a). Uncovering this influence necessitates a thorough interpretive analysis of historical determinants that lie outside the immediate life world of individual social actors (Smith, 1990). This larger canvas of active individuals (and researchers) embedded in organizational, political, and discursive practices constitutes a tangible advantage of second- and third-generation CHAT over its earlier Vygotskian ancestor, which focused on mediated action in relative isolation (Daniels, 2004a; Moll, 2001).

The environmental curriculum was designed on the basis of the teachers' understanding of CHAT and *real societal* activity as mediating cognition and learning. Thus, school tasks normally reproduce schooling, resulting in students getting good at doing schooling; participation in environmentalism, on the other hand, allows students to get good at doing environmentalism and thereby develop knowledge and skills relevant to society. In reviewing the literature, we have found three other basic forms of praxis-oriented research that explicitly claim allegiance to CHAT and its dialectical materialist backbone: the *change laboratory* (e.g., Virkkunen & Ahonen, 2004) and the *boundary-crossing laboratory* (e.g., Y. Engeström, 2000a) both have their origins in and are practiced at the Center for Activity Theory and Developmental Work (Helsinki, Finland), whereas the *coteaching|cogenerative dialoguing* model emerged from and was developed in the teacher education program at the University of Pennsylvania (e.g., Tobin & Roth, 2005). Because "activity theory is at its best in

analyzing poorly understood processes of developmental transformations over time” (Y. Engeström, 2000b, p. 308), all practitioners here are involved with researchers and facilitators in comprehending and theorizing work (instructional) practices for the overt goal of redesigning praxis. The first two programs appear united by the fact that participants largely come from within the activity system of concern, whereas in the third, professionals of very different ilk and geographical and social locations create teams, thus necessitating *boundary crossing*, to redesign the ways in which their various actions interface. By examining what these innovations in best practices have to offer, educators will gain much food for thought in redesigning teaching and learning.

Change Laboratory and Boundary-Crossing Laboratory

Change laboratory denotes a method for developing work practices on the job, in a room or space set aside where practitioners do the analysis and development for practitioners, typically involving a natural team or work unit, but still close to the members (Y. Engeström, Virkkunen, Helle, Pihlaja, & Poikela, 1996). The idea is to arrange space on the shop floor or in the school where there exists a rich set of instruments (e.g., a VCR, digital video, editing software) for analyzing disturbances and troubles and for collectively envisioning new models of work practices. This facilitates both intensive, deep transformations and continuous incremental improvement of practices: learning in a broad sense, or what has been called an expansive visibilization of work (Y. Engeström, 1999b).

In one instance, a change laboratory was convened to deal with the problems articulated by the teachers of a middle school serving a disadvantaged area in Helsinki, Finland (Y. Engeström, Engeström, & Suntio, 2002a). The researchers had identified three main predicaments for the dysfunctional school: (a) teachers’ “weak knowledge” of students’ homes and backgrounds, (b) careers after graduation, (c) and the poverty of the school. The teachers framed the issues in terms of a war against apathy, peaceful time for collaborative planning and preparation, and change in students’ manners. Together, researchers and teachers, unconcerned with the differences in problem framing, traced the historical roots of the attendant problems and then moved to model (using the CHAT triangle [Figure 4] as a heuristic), current activity, and the existing contradictions. Vital in the successful school transformation was teachers’ redefinition of students from “apathetic” to “competent,” which required them also to change their stance from viewing students as controlled to trustworthy learners. This redefinition became the new object of the activity in the change laboratory. The participants then designed a major student project that turned out to change the ways in which students could realize their potential; as a consequence, teachers began to talk in more positive ways about the students. Both kinds of interventions then produced improvement in school climate.

On the basis of their successful change efforts, the teachers of the same school later arranged for a second change laboratory to deal with their instructional practices. The object of their change laboratory work was to create a sustained movement that turned available information and communication technology into a situated and locally grounded means for bringing about pedagogical change (Y. Engeström, Engeström, & Suntio, 2002b). The object or motive of their intervention was an attempt to debunk two related myths: that students “lacked basic skills” and were “unmotivated to produce original work.” By integrating computer technology, which

they had resisted initially, teachers were able to enact a second set of solutions that improved the school even more.

Boundary-crossing laboratories are similar to change laboratories in their joint focus on the identification of contradictions and trouble and in the design of new practices that practitioners find acceptable. When the change laboratory involves practitioners from very different fields, the work in a change laboratory takes on a new dimension. In their work in the Finnish medical system, researchers often found that the care for patients with multiple illnesses involved professionals from different parts of the health care system, which required communication and cooperation across disciplines in primary and specialized care (e.g., Y. Engeström, 2001; Kerusuo, 2001). Working across boundaries and assembling people and, in fact, tying otherwise separate systems of activity together require a new form of collaborative work, *knotworking* (Y. Engeström, Engeström, & Vähäaho, 1999). Because these knots are tied and untied as the case requires, the knots themselves have to become the focus of analysis, and, importantly, knotworking becomes an activity system in its own right.

Coteaching|Cogenerative Dialoguing

In the coteaching|cogenerative dialoguing model, change interventions are brought about as university researchers, supervisors, administrators, evaluators, and methods teachers participate not only in the redesign of curriculum practice but also in the actual teaching. In fact, the practitioners of the model do not allow others to simply observe classrooms but require anybody wanting to know how the praxis works to engage in teaching. This criterion inherently increases the social and material resources available for learning on the part of students and teachers, irrespective of their prior experience. Thus, through coteaching, all stakeholders learn subject matter and subject matter pedagogy (Roth & Tobin, 2001; Roth, Tobin, Zimmermann, Bryant, & Davis, 2002; Tobin & Roth, 2002). It is a way of grounding theories in praxis and making them available for practical purposes (Roth & Tobin, 2004) that leads to development in a way that has also been reported to occur for psychosocial professions more generally (Dreier, 1989). Each time the environmental unit was implemented, two or more individuals cotaught the lessons, taking coresponsibility for all aspects of the lesson: planning, organizing the involvement of nonschool participants (parents, First Nations elders, environmentalists, biologists), and making sense after a lesson of what had happened.

Much of the learning in coteaching appears through implicit ways. During *cogenerative dialoguing*, on the other hand, participants in a classroom event meet after the lesson to share their ways of understanding past experiences, a valuable process of reflection on action. In these meetings, all participants contribute to the emerging understanding and theories of practice, and a checklist is elaborated to monitor these sessions so that individual voices are not silenced. Because individuals not normally part of the school structure are involved from the coteaching encounter, cogenerative dialoguing has a lot in common with knotworking, requiring the identification of common ground, language, and mutual respect for the variety of experiences, competencies, and structural positions that participants bring to the setting. As a by-product of this practice, high school students and teaching interns often copresent at international conferences and coauthor scholarly articles (e.g., Roth, Tobin, Carambo, & Dalland, 2004; Roth, Tobin, Elmesky, et al., 2004). We conceive of coteaching|cogenerative dialoguing as a dialectical unit: Cogenerative dialoguing

presupposes the joint experience in the classroom; changed practices in the classroom presuppose cogenerative dialoguing (Roth et al., 2000). At the same time, it is acknowledged that any knowledge developed *about* praxis, even if it is in terms of the personal and positioned voices of the participants, cannot ever be identical with praxis and practical knowledge, which only comes to be enacted in situation. It is this distinction between knowledge *in* praxis and knowledge *about* praxis that the practitioners of the model advocate in the copresence of all stakeholders in both forms of events.

Reflexivity

Theorizing (praxis) is itself a practical activity and can therefore be analyzed using CHAT, but the tools and motives will differ from the original practice, leading to a reflexively related set of activity systems in which the participants may or may not be the same. In teaching, student learning is the primary motive; teachers use whatever language is appropriate to facilitate student learning. In the change laboratory and cogenerative dialog sessions, their normal activity is the focal object, and the intended outcome is new understanding and designs for change. Here, language is used as a primary and secondary artifact. When researchers describe the secondary activity and changes in the primary activity, they use forms of language appropriate to an academic audience; they also draw on theories that may not have any relevance to the practitioners themselves. Here, then, yet another activity system takes the two previous ones as object (Roth, 2005a). Although the change laboratory is grounded in CHAT, and past projects using the triangle representation were deemed useful, it is beginning to surface that its attendant framework as depicted in the hierarchy of triangles representing sundry forms of activity is not easily grasped by participants (J. Virkkunen, personal communication, October 27, 2004).

New Avenues for Educational Research and Praxis

Besides reframing entrenched problems and ways of thinking about teaching and learning, new educational theories should evoke the imagination for generative research and praxis. The scope of any review article is too limited to present a complete manual of the possibilities ahead from CHAT research, but we sketch some likely avenues in the psychology of learning and educational praxis.

Research in the Psychology of Learning

Activity theory holds much promise for sharpening our thinking and praxis across three interrelated topics in learning research: motive or motivation, emotion, and identity. These concepts are, as Vygotsky (1934/1986) realized, integral to cognition, knowing, and learning, not some independent or peripheral factors that affect cognition. These phenomena and concepts therefore cannot be understood apart from individuals engaging in concrete social activity, which posits addressing them in a dialectical manner.

Motive or Motivation

Fundamental to activity theoretical research is the notion of motive, which, together with the category of emotion, makes superfluous all the “confused concepts and terms that characterize the present condition of the problem of motives” in psychology (Leont’ev, 1978, p. 116). Thus, when students are judged to be

unmotivated, they really are following differing objects or motives from those officially sanctioned from a CHAT perspective. At other times, educators view motivation to be displayed when students do what they (educators) want them to do; that is, the phenomenon becomes an internalization of the external locus of control. At its most fundamental level then, simplistic conceptions of motivation are pervasive whereby learning activity is “subordinated to the principle of maximizing positive and minimizing negative emotions” (Leont’ev, 1978, p. 120).

Motivation in any activity properly involves a degree of control over the object (Lompscher, 1999); the prospects of expanding control and action possibilities has positive emotional valence, leading students to buy into and realize a particular activity (e.g., environmentalism). The students in the environmental unit learned in the course of doing something that contributed to the common good (itself associated with positive emotional valence) and they expanded their action possibilities (i.e., learned) whenever they realized that a new skill or tool would allow them to expand what they could do. Historically, the relation between motivation and control over the object has evolved from needs that were the primary conditions determining what the subjects did. In most educational contexts, however, the freedom to pursue relevant objects—such as the seventh grade students, who choose what they do with respect to the creek and how they implement their plans—is not apparent, nor are the goals and actions of particular tasks independently established. This situation encourages a particular shape to consciousness, cognition, knowing, learning, identity, and all the other aspects that are produced and reproduced throughout the course of participation in learning activity.

Imagine what were to happen if teachers and students enjoyed greater freedom over the choice of objects or motives in their learning. Such an exceptional situation could take the form of deciding in which watershed-related activity system the students would participate, how to realize a particular object or motive (researching or contributing to farming, environmentalism, or industry), selecting appropriate goals, tools, divisions of labor, and so forth. An educator might now wonder, “How does the object or motive mediate the activity realized by students?” “What and how do students learn about water-related issues when they participate in farming versus doing environmentalism?” “How do the respective forms of dividing work mediate knowing, learning, and identity?” If Lave and Wenger’s (1991) contention that mainstream educational systems have favored the exchange value of school grades over their use value is true, allowing students some choice in the objects or motives of their learning might bring educators some way toward rectifying this dilemma. The overlap between individually realized and societal motives is an important consideration for educators because it mediates between cognitive and emotional processes to which we now turn (Holzkamp-Osterkamp, 1977).

Emotion

Emotions are integral to the functioning of the activity system as a whole, for they “reflect relationships between motives (needs) and success, or the possibility of success, of realizing the action of the subject that responds too these motives” (Leont’ev, 1978, p. 120). Yet most educational research disconnects emotional from cognitive issues. Although the pioneers of activity theory always have taken emotion as an integral component, and although there is evidence of the central role emotion plays in mathematical and scientific cognition (e.g., Roth, 2007) and

teacher education (van Huizen, van Oers, & Wubbels, 2005), present users of CHAT do not customarily attend to this aspect. In CHAT, emotion is reinforced at both meaning-determining levels, that is, at the core of the activity/action and action/operation dialectics. On the one hand, there are aspects of emotion that “are relevant to activity and not to actions or operations that realize it” (Leont’ev, 1978, p. 121). Increasing one’s possibilities in the world and control over one’s life conditions—learning in the broad sense—are associated with positive emotional valence. The subject receives successes and failures with respect to the chosen motive positively or negatively, but the possibility of success shapes the way in which the subject engages in activity. On the other hand, current emotional states constitute a context for the selection of meaningful actions and the operations that realize them, but actions also feed back and mediate emotional states. While acting, these emotional states are latent in consciousness but are exhibited nevertheless, for example, in prosody: speech intensity, pitch, pitch contours, speech rates (Pittam & Scherer, 1993). Finally, during cooperative work that is so much part of any teacher’s instructional repertoire, individual and collective emotions are two sides of the same coin, so to speak: Individuals exhibit emotions in their actions, which supply cues and traces for other people who may reproduce them and therefore contribute to a collective emotion (Collins, 2004).

Educational researchers may come to appreciate that emotions are always tied to the motives and goals of learning, which require in situ study: asking individuals in clinical situations, which usually have a different object or motive than the activity of primary interest, elicits peculiar emotions and emotional valences from other activity systems. With respect to the environmental unit, one might ask the following questions: “How does the activity system in general (e.g., farming, environmentalism) and the overlap between individual and collective motives in particular mediate emotions?” “How do emotions mediate the participation in activity (e.g., farming, environmentalism)?” “How do emotions mediate the selection of goals and actions?” “How are the emotions shaped by the concrete actions of realizing the learning activity?” and “How do individual and collective object- or motive-related emotions mediate one another?” For example, does engagement in an activity such as environmentalism lead to a different sense of feeling good, having contributed to the collective well-being, than contributing to the production of food?

Identity

During the pursuit of the object, subjects not only produce outcomes but also produce/reproduce themselves (Wenger, 1998). By extension, the changed modes of participation in social practices—learning in a broad sense—presupposes both what we *become* and how we *act* as knowers. Whichever identities are salient for an individual during a particular context exist in a complex dance with one’s sense of agency and position within the social world. Besides bringing about some change in the world, human agency also provides others and self with resources for making attributions about the kind of person one is. Within school, students exhibit multiple identities, such as Davie, whose actions led to an assessment of ADHD, whereas his observable competence at Henderson Creek led the researchers to another conclusion. Identity is evidently a dialectical feature: It is continuously produced and reproduced in practical activity, which both presupposes and produces

identity (Roth, Tobin, Elmesky, et al., 2004). Instead of being an invariant attribute, the identities of subjects, who we are with respect to others (community), are co-constituted with and by the social and material resources at hand, according to activity theorists (Stetsenko & Arieivitch, 2004). This formation of identity occurs in part through the constant slippage of artifacts between their material and virtual aspects that demarcate social space and positions (Leander, 2002a, 2002b; Penuel & Davey, 1999). Not that changing from one activity system to another and the concomitant negotiations of identity will be smooth, as beginning teachers, for instance, realize the world over when they graduate from college to their first teaching assignments. The key to the growth of a satisfying teacher identity is apparently achieved through an intellectual resolution mindful of social contexts rather than one of mere accommodation or acquiescence to (trying) circumstances on the job (Smagorinsky, Cook, Moore, Jackson, & Fry, 2004).

Much remains to be discovered about learner identities such as gender (Chandler-Olcott & Mahar, 2003) that emerge from participation in online worlds, including gaming and blogging communities. As a "residue," (auto)biographies, in which people recount what they have done in their lives, constitute the persons as particular characters appearing in different life plots (Wortham, 2003). This more stable aspect of identity is dialectically related to the dynamic aspect, though aspects and even entire biographies may be contingently reconstructed in and following specific events and participation in institutional life (Gee, 2001).

Despite being difficult to operationalize, another area of interest is the notion of collective identity such as that of a school or classroom. Personal identity and organizational or group identity are, depending on the theoretical framework taken, connected in some form, though the exact nature of this relationship is still undergoing much debate (Pratt, 2003). Again, CHAT can offer some tentative steps forward because of its dialectical core, which affirms that collective identity is always a structural feature of organizational life. Hence, a child who insists on creative acts of rebellion during instruction time is as much a constitutive member of that classroom and its collective identity as another who is a model student. This unlikely situation arises from the dialectical relation of individual subject and collective, which is asserted simultaneously with every action that concretely realizes the current activity, in this case "being a student" (Roth, Hwang, et al., 2005). When more work is done to uncover the role of emotions in identity, it is hypothesized that one can look forward to better nonreductionist explanations for understanding identity and the cognate notion of identification.

The students at Henderson Creek thus accomplished two things: producing themselves as active participants and learners within the environmental movement while realizing greater collective agency or competency than they could have achieved as individuals. Similarly, the professor who participates in teaching the unit also reproduces himself or herself as an individual who "does community service," and a mother who contributes to driving the children or teaching a group not only contributes to making the environmental unit possible but also reproduces herself and is acknowledged as an "involved parent." Parents' involvement in their children's schooling, in this light, should now be reconceptualized not just as a laundry list of things to do but rather an essential ingredient of the complex ecological process that leads to children's identity formation in and out of school (Barton, Drake, Perez, St. Louis, & George, 2004).

In the context of the environmental unit focusing at Henderson Creek, one might ponder, “How does participating in environmentalism mediate the formation of identity?” “Are particular types of identity developed in preference over other?” Because students move between overlapping activity systems, we may ask, “How do students tie these different identities—perhaps in a new activity system where the ‘knotworking’ connecting the two preceding activity systems is done?” Seventh grade students already have an experiential history and an identity stabilized in their early forms of autobiography. We might contemplate, “How do existing identities mediate the participation in activity and, therefore, the production and reproduction of identity in ongoing activity?”

Educational Praxis

Adopting CHAT as a guiding framework allows for a questioning of the structural determinations of current educational practices. As argued in “Theory for Praxis, Praxis of Theory” above, when stakeholders themselves have opportunities to participate in determining their teaching and learning settings, it permits greater control over aspects of their life conditions and the expansion of action possibilities in personally relevant ways. In a nutshell, it would stimulate a greater congruence between individual and collective motives, resulting more often than not in win-win situations. At the same time, we expect significant resistance to this suggestion as normally localized decision-making powers diffuse downward to collectives. Where these educational experiments have occurred, as in some French secondary schools (e.g., Lycée autogérée de Paris, <http://www.l-a-p.org/>), higher rates of success were experienced, especially among those deemed failures in the regular school system.

It is also common knowledge that out-of-school activity systems are relatively stable, changing slowly across historical time. Newcomers to such systems find themselves in meaningful wholes, with established relations, practices, tools, division of labor, and rules (Roth & Y.-J. Lee, 2006). This stability might lead educators, in some circumstances, to reexamine the practice of streaming students by age and instead adopt multiage groupings typical, for example, of one-room schools. Again, the French experience is illustrative, for it was found there that there was an organizational memory, preserved in the activity structure with characteristic artifacts and practices. Because each new school year began with only a few students graduating, newcomers settled in and learned more quickly by becoming members of preexisting activity structures, which constitute a social world that outlasted any one individual (Roth, 2002). As in plucking a few fibers from a thread and replacing them with a few new ones, the changes in the overall structure through the contribution an individual makes are small and accumulate over longer periods of time; at the same time, the individual threads find a structure in place that constitutes a constraint on their place in the collective.

Consistent with the aforementioned control principles, students in these innovative institutions choose what they do, when they do it, whom they do it with, and so forth; at least at one elementary school, they even choose when to come to school (Collot, 2002), and in the high schools, they decide whether to come to the school at all on any one day. This arrangement eliminates the frequent complaint by teachers that they have to spend much time implementing the kinds of rules and behaviors that they deem optimal for learning. The outcomes on French national

exams in fact show that elementary students from such schools, though never subjected to direct instruction, perform slightly above the national average.

To briefly summarize why activity theory is highly suitable for and in praxis, we revisit Katherine, the fifth grade teacher, who has now enrolled in graduate courses in education. Exposed to CHAT as part of her course work, she discusses that very teaching episode involving the electrical circuits with her instructor, Ben:

Katherine: Well, thinking about that, it now feels like one of those theory-praxis gaps that you were sharing with us yesterday, you know?

Ben: It could be, but why do you think it was so?

Katherine: I think I now have a framework for understanding the contradictions that have arisen between my professional instincts, including those about theory—that model lesson plan—and my praxis (hands-on lessons), human development (the needs of *these* children at *this* time), and the difference between decontextualized knowledge (of words) versus the embodied and situated knowledge (direct teaching versus exploration). It also allows me to understand the difference between teaching (praxis), when I am oriented to the children subject to the constraints of the unfolding lesson versus my own descriptions of how I act in this or that real or hypothetical situation.

Ben: So how do you think this might change what you are doing as a teacher?

Katherine: I really learned a lot from the environmental lesson exemplar and the way it is theorized that to learn, children have to be part of a larger context, being part of real activities that exist beyond the school rather than simply doing tasks, even the hands-on I used to employ. I think this orientation to real activity comes with an overall motive that students can realize in different ways and, in so doing, expand their own possibilities for living in an inherently complex world.

Coda

In this review, we showcase what has been called one of the best kept secrets of academia: CHAT. Thoroughly immersed in dialectics, this framework can potentially overcome a range of troublesome dualisms in education: individual versus collective, body versus mind, subject versus object, and theory versus praxis. By making activity the minimal unit of analysis, activity theorists take a holistic approach without reducing any pole of a dualism to its corresponding opposite. If in fact the polar categories are adopted into a new framing of problematic issues, then they are viewed as expressions of the same unit, neither one of which can be reduced to the other. This integration occurs at a higher level: the activity as a whole. This avenue therefore promises to lead to an integration of research that heretofore has often been kept separate, such as the sociological and psychological prerequisites of educational achievement. A researcher using CHAT therefore does not separate the poverty or culture of urban students' home lives from conditions of schooling, consideration of the curriculum, problems of learning, or learning to teach under difficult settings. Most important, CHAT cannot be viewed as a master theory or quick fix, for true to its origins, it is subject to inner contradictions, which compel researchers to update, transform, and renew constantly it so that it becomes a reflection of its object.

Note

Several research grants from the Social Sciences Humanities Council of Canada and the Natural Sciences and Engineering Council of Canada allowed us to complete this review and conduct the research used in the examples. We are grateful to current and past members of CHAT@UVic, an interdisciplinary research group focusing on cultural-historical studies of individual and collective knowing across the life span. In particular, M. H. G. Hoffmann provided incisive comments, and SungWon Hwang engaged us in extended discussions, both of which pushed us to explain CHAT in ways more accessible to outsiders and newcomers. We are grateful to Michael Cole and Peter Smagorinsky for the helpful comments they provided on an earlier version of this article. Correspondence concerning this article should be addressed to Wolff-Michael Roth, University of Victoria, Applied Cognitive Science, MacLaurin Building A548, Victoria, BC V8W 3N4, Canada; e-mail: mroth@uvic.ca.

References

- Austin, J. (1962). *How to do things with words*. Cambridge, MA: Harvard University Press.
- Bakhtin, M. M. (1993). *Toward a philosophy of the act*. Austin: University of Texas Press.
- Bakhurst, D., & Padden, C. (2001). The Meshcheryakov experiment: Soviet work on the education of blind-deaf children. *Learning and Instruction, 1*, 201–215.
- Ball, A. F. (2000). Preparing teachers for diversity: Lessons learned from the US and South Africa. *Teaching and Teacher Education, 16*, 491–509.
- Bannon, L. J., & Bødker, S. (1991). Beyond the interface: Encountering artifacts in use. In J. M. Carroll (Ed.), *Designing interaction: Psychology at the human-computer interface* (pp. 227–253). Cambridge, UK: Cambridge University Press.
- Barab, S. A., Barnett, M., Yamagata-Lynch, L., Squire, K., & Keating, T. (2002). Using activity theory to understand the systemic tensions characterizing a technology-rich introductory astronomy course. *Mind, Culture, and Activity, 9*, 76–107.
- Barab, S. A., Evans, M. A., & Baek, E.-O. (2004). Activity theory as a lens for characterizing the participatory unit. In D. H. Jonassen (Ed.), *Handbook of research on educational communities and technology* (pp. 199–214). Mahwah, NJ: Lawrence Erlbaum Associates.
- Barab, S., Hay, K. E., Barnett, M., & Squire, K. (2001). Constructing virtual worlds: Tracing the historical development of learner practices. *Cognition & Instruction, 19*, 47–94.
- Barab, S. A., & Plucker, J. A. (2002). Smart people or smart contexts? Cognition, ability, and talent development in an age of situated approaches to knowing and learning. *Educational Psychologist, 37*, 165–182.
- Barowy, W., & Jouper, C. (2004). The complex of school change: Personal and systemic co-development. *Mind, Culture, and Activity, 11*, 9–24.
- Barton, A. C., Drake, C., Perez, J. G., St. Louis, K., & George, M. (2004). Ecologies of parental engagement in urban education. *Educational Researcher, 33*, 3–12.
- Bateson, G. (1972). *Steps to an ecology of mind*. New York: Ballantine.
- Bedny, G. Z., & Karwowski, W. (2004). Activity theory as a basis for the study of work. *Ergonomics, 47*, 134–153.
- Blackler, F., Crump, N., & McDonald, S. (2000). Organizing processes in complex activity networks. *Organization, 7*, 277–300.

- Boag-Munroe, G. (2004). Wrestling with words and meanings: Finding a tool for analyzing language in activity theory. *Educational Review*, 56, 165–182.
- Chandler-Olcott, K., & Mahar, D. (2003). Tech-savviness meets multiliteracies: Exploring adolescent girls' technology-mediated literacy practices. *Reading Research Quarterly*, 38, 356–385.
- Cole, M. (1984). *LCHC: A twelve-year program of research and training in cultural psychology*. Retrieved May 20, 2005, from <http://communication.ucsd.edu/LCHC/Histarch/lchc.history.html>
- Cole, M. (1985). The zone of proximal development: Where culture and cognition create each other. In J. V. Wertsch (Ed.), *Culture, communication, and cognition: Vygotskian perspectives* (pp. 146–161). Cambridge, UK: Cambridge University Press.
- Cole, M. (1988). Cross-cultural research in the sociohistorical tradition. *Human Development*, 31, 137–157.
- Cole, M. (1995). Socio-cultural-historical psychology: Some general remarks and a proposal for a new kind of cultural-genetic methodology. In J. V. Wertsch, P. del Río, & A. Alvarez (Eds.), *Sociocultural studies of mind* (pp. 187–214). New York: Cambridge University Press.
- Cole, M. (1996). *Cultural psychology: A once and future discipline*. Cambridge, MA: Harvard University Press.
- Cole, M. (1998). Can cultural psychology help us to think about diversity? *Mind, Culture, and Activity*, 5, 291–304.
- Cole, M., & Engeström, Y. (1993). A cultural historical approach to distributed cognition. In G. Salomon (Ed.), *Distributed cognitions: Psychological and educational considerations* (pp. 1–46). Cambridge, UK: Cambridge University Press.
- Cole, M., Engeström, Y., & Vasquez, O. (Eds.). (1997). *Mind, culture, and activity: Seminal papers from the Laboratory of Human Cognition*. New York: Cambridge University Press.
- Collins, A., Brown, J. S., & Newman, S. (1989). Cognitive apprenticeship: Teaching the crafts of reading, writing, and mathematics. In L. Resnick (Ed.), *Knowing, learning and instruction: Essays in honor of Robert Glaser* (pp. 453–494). Hillsdale, NJ: Lawrence Erlbaum Associates.
- Collins, R. (2004). *Interaction ritual chains*. Princeton, NJ: Princeton University Press.
- Collot, B. (2002). *Une école du 3ième type ou "La pédagogie de la mouche"* [A school of the third type, or "The pedagogy of the fly"]. Paris: L'Harmattan.
- Daniels, H. (2001). *Vygotsky and pedagogy*. New York: Routledge.
- Daniels, H. (2004a). Activity theory, discourse and Bernstein. *Educational Review*, 56, 121–132.
- Daniels, H. (2004b). Cultural historical activity theory and professional learning. *International Journal of Disability, Development and Education*, 51, 185–200.
- Daniels, H., & Cole, T. (2002). The development of provision for young people with emotional and behavioural difficulties: An activity theory analysis. *Oxford Review of Education*, 28, 311–329.
- Davidov, V. V. (1988). Learning activity: The main problems needing further research. *Multidisciplinary Newsletter for Activity Theory*, 1, 29–36.
- Davydov, V. V., & Radzikhovskii, L. A. (1985). Vygotsky's theory and the activity-oriented approach in psychology. In J. V. Wertsch (Ed.), *Culture, communication, and literacy: Vygotskian perspectives* (pp. 35–65). New York: Cambridge University Press.
- Davidson, D. (1986). A nice derangement of epitaphs. In E. Lepore (Ed.), *Truth and interpretation* (pp. 433–446). Oxford, UK: Blackwell.

- Devereux, G. (1967). *From anxiety to method in the behavioral sciences*. The Hague, the Netherlands: Mouton.
- DeVries, R. (2000). Vygotsky, Piaget, and education: A reciprocal assimilation of theories and educational practices. *New Ideas in Psychology*, 18, 187–213.
- Diamondstone, J. (2002). Keeping resistance in view in an activity theory analysis. *Mind, Culture, and Activity*, 9, 2–21.
- Doehler, S. P. (2002). Mediation revisited: The interactive organization of mediation in learning environments. *Mind, Culture, and Activity*, 9, 22–42.
- Donato, R. (2004). Aspects of collaboration in pedagogical discourse. *Annual Review of Applied Linguistics*, 24, 284–302.
- Dreier, O. (1980). *Familiäres Sein und familiäres Bewußtsein: Therapeutische Analyse einer Arbeiter Familie* [Familiar being and familiar consciousness: Therapeutic analysis of a worker family]. Frankfurt-am-Main, Germany: Campus.
- Dreier, O. (1989). Fortbildung im Bereich psychosozialer Berufe als Einheit von Forschung und Praxis [Development in psychosocial professions as unity of research and praxis]. *Forum Kritische Psychologie*, 24, 48–84.
- Edwards, A., & Protheroe, L. (2004). Teaching by proxy: Understanding how mentors are positioned in partnerships. *Oxford Review of Education*, 30, 183–197.
- Eilam, G. (2003). The philosophical foundations of Aleksandr R. Luria's neuropsychology. *Science in Context*, 16, 551–577.
- Elhammoumi, M. (2002). To create psychology's own capital. *Journal for the Theory of Social Behaviour*, 32, 89–104.
- Engeström, R. (1995). Voice as communicative action. *Mind, Culture, and Activity*, 2, 192–215.
- Engeström, Y. (1987). *Learning by expanding: An activity-theoretical approach to developmental research*. Helsinki, Finland: Orienta-Konsultit.
- Engeström, Y. (1991a). Activity theory and individual and social transformation. *Multidisciplinary Newsletter for Activity Theory*, 7/8, 6–17.
- Engeström, Y. (1991b). Non scolae sed vitae discimus: Toward overcoming the encapsulation of school learning. *Learning and Instruction*, 1, 243–259.
- Engeström, Y. (1993). Developmental studies of work as a testbench of activity theory: The case of primary care medical practice. In S. Chaiklin & J. Lave (Eds.), *Understanding practice: Perspectives on activity and context* (pp. 64–103). Cambridge, UK: Cambridge University Press.
- Engeström, Y. (1996). Interobjectivity, ideality, and dialectics. *Mind, Culture, and Activity*, 3, 259–265.
- Engeström, Y. (1999a). Activity theory and individual and social transformation. In Y. Engeström, R. Miettinen, & R.-L. Punamäki (Eds.), *Perspectives on activity theory* (pp. 19–38). Cambridge, UK: Cambridge University Press.
- Engeström, Y. (1999b). Expansive visibilization of work: An activity-theoretical perspective. *Computer Supported Cooperative Work*, 8, 63–93.
- Engeström, Y. (1999c). Innovative learning in work teams: Analyzing cycles of knowledge creation in practice. In Y. Engeström, R. Miettinen, & R.-L. Punamäki (Eds.), *Perspectives on activity theory* (pp. 377–404). Cambridge, UK: Cambridge University Press.
- Engeström, Y. (2000a). Activity theory as a framework for analyzing and redesigning work. *Ergonomics*, 43, 960–974.
- Engeström, Y. (2000b). Comment on Blackler et al. Activity theory and the social construction of knowledge: A story of four umpires. *Organization*, 7, 301–310.

- Engeström, Y. (2001). Making expansive decisions: An activity-theoretical study of practitioners building collaborative medical care for children. In C. M. Allwood & M. Selart (Eds.), *Decision making: Social and creative dimensions* (pp. 281–301). Dordrecht, the Netherlands: Kluwer Academic.
- Engeström, Y., Engeström, R., & Suntuio, A. (2002a). Can a school community learn to master its own future? An activity-theoretical study of expansive learning among middle school teachers. In G. Wells & G. Claxton (Eds.), *Learning for life in the 21st century: Sociocultural perspectives on the future of education* (pp. 211–224). Oxford, UK: Blackwell.
- Engeström, Y., Engeström, R., & Suntuio, A. (2002b). From paralyzing myths to expansive action: Building computer-supported knowledge work into curriculum from below. In G. Stahl (Ed.), *Computer support for collaborative learning: Foundations for a CSDL community* (pp. 318–324). Mahwah, NJ: Lawrence Erlbaum.
- Engeström, Y., Engeström, R., & Vähäaho, T. (1999). When the center does not hold: The importance of knotworking. In S. Chaiklin, M. Hedegaard, & U. J. Jensen (Eds.), *Activity theory and social practice* (pp. 345–374). Aarhus, Denmark: Aarhus University Press.
- Engeström, Y., Lompscher, J., & Rückriem, G. (2005). *Putting activity theory to work: Contributions from developmental work research*. Berlin, Germany: Lehmanns Media.
- Engeström, Y., Virkkunen, J., Helle, M., Pihlaja, J. & Poikela, R. (1996). Change laboratory as a tool for transforming work. *Lifelong Learning in Europe*, 1(2), 10–17.
- Erickson, F. (2004). *Talk and social theory: Ecologies of speaking and listening in everyday life*. Cambridge, UK: Polity.
- Farver, J. A. M. (1999). Activity settings analysis: A model for examining the role of culture in development. In A. Göncü (Ed.), *Children's engagement in the world: Sociocultural perspectives* (pp. 99–127). Cambridge, MA: Cambridge University Press.
- Franks, A., & Jewitt, C. (2001). The meaning of action in learning and teaching. *British Educational Research Journal*, 27, 201–218.
- Galda, L., & Beach, R. (2001). Response to literature as cultural activity. *Reading Research Quarterly*, 36, 64–73.
- Gallimore, R., & Goldenberg, C. (2001). Analyzing cultural models and settings to connect minority achievement and school improvement research. *Educational Psychologist*, 36, 45–56.
- Gal'perin, P. J., & Leont'ev, A. N. (1974). *Probleme der Lerntheorie* [Problems of learning theory]. Berlin, Germany: Volk und Wissen.
- Gee, J. P. (2001). Identity as an analytic lens for research in education. *Review of Research in Education*, 25, 99–125.
- Giest, H., & Lompscher, J. (2003). Formation of learning activity and theoretical thinking in science thinking. In A. Kozulin, B. Gindis, V. S. Ageyev, & S. M. Miller (Eds.), *Vygotsky's educational theory in cultural context* (pp. 267–288). New York: Cambridge University Press.
- Gillen, J. (2000). Versions of Vygotsky. *British Journal of Educational Studies*, 48, 183–198.
- Gipps, C. (1999). Socio-cultural aspects of assessment. *Review of Research in Education*, 24, 355–392.
- Glassman, M. (1996). Understanding Vygotsky's motive and goal: An exploration of the work of A. N. Leontiev. *Human Development*, 39, 309–327.
- Glassman, M. (2000). Negation through history: Dialectics and human development. *New Ideas in Psychology*, 18, 1–22.

- Göncü, A. (Ed.). (1999). *Children's engagement in the world: Sociocultural perspectives*. Cambridge, MA: Cambridge University Press.
- Goodwin, M. H., & Goodwin, C. (2000). Emotion within situated activity. In N. Budwig, I. C. Uzgris, & J. Wertsch (Eds.), *Communication: An arena of development* (pp. 33–54). Stamford, CT: Ablex.
- Gronn, P. (2000). Distributed properties: A new architecture for leadership. *Educational Management and Administration*, 28, 317–338.
- Grossman, P. L., Smagorinsky, P., & Valencia, S. (1999). Appropriating tools for teaching English: A theoretical framework for research on learning to teach. *American Journal of Education*, 108, 1–29.
- Guberman, S. R., & Saxe, G. B. (2000). Mathematical problems and goals in children's play of an educational game. *Mind, Culture, and Activity*, 7, 201–216.
- Gutiérrez, K., Rymes, B., & Larsen, J. (1995). Script, counterscript, and underlife in the classroom: James Brown versus Brown v. Board of Education. *Harvard Educational Review*, 65, 445–471.
- Gutiérrez, K. D. (1994). How talk, context, and script shape contexts for learning: A cross-case comparison of journal sharing. *Linguistics and Education*, 5, 335–365.
- Gutiérrez, K. D., Baquedano-López, P., Alvarez, H. H., & Chiu, M. M. (1999). Building a culture of collaboration through hybrid language practices. *Theory Into Practice*, 38, 87–93.
- Gutiérrez, K. D., & Baquedano-López, P., & Tejada, C. (1999). Rethinking diversity: Hybridity and hybrid language practices in the third space. *Mind, Culture, and Activity*, 6, 286–303.
- Gutiérrez, K. D., & Rogoff, B. (2003). Cultural ways of learning: Individual traits or repertoires of practice? *Educational Researcher*, 32, 19–25.
- Gutiérrez, K. D., & Stone, L. D. (2000). Synchronic and diachronic dimensions of social practice: An emerging methodology for cultural-historical perspectives on literacy learning. In C. Lee & P. Smagorinsky (Eds.), *Vygotskian perspectives on literacy research: Constructing meaning through collaborative inquiry* (pp. 150–164). New York: Cambridge University Press.
- Hakkarainen, P. (2004). Editor's introduction: Challenges of activity theory. *Journal of Russian and East European Psychology*, 42, 3–11.
- Hanks, W. F. (1996). *Language and communicative practice*. Boulder, CO: Westview.
- Hasan, H., Gould, E., & Hyland, P. (Eds.). (1998). *Information systems and activity theory: Tools in context*. Wollongong, Australia: University of Wollongong Press.
- Hedegaard, M. (Ed.). (2001). *Learning in classrooms: A cultural-historical approach*. Aarhus, Denmark: Aarhus University Press.
- Hedegaard, M. (2002). *Learning and child development: A cultural-historical approach*. Aarhus, Denmark: Aarhus University Press.
- Hedegaard, M., & Lompscher, J. (Eds.). (1999). *Learning activity and development*. Aarhus, Denmark: Aarhus University Press.
- Hegel, G. W. F. (1977). *The phenomenology of spirit* (A. V. Miller, Trans.). Oxford, UK: Oxford University Press. (Original work published 1807)
- Hershkowitz, R. (1999). Reflective processes in a mathematics classroom with a rich learning environment. *Cognition & Instruction*, 17, 65–91.
- Hoffman-Kipp, P., Artiles, A. J., & López-Torres, L. (2003). Beyond reflection: Teacher learning as praxis. *Theory Into Practice*, 42, 248–254.
- Holland, D., Lachicotte, W., Skinner, D., & Cain, C. (1998). *Identity and agency in cultural worlds*. Cambridge, MA: Harvard University Press.

- Holland, D., & Lave, J. (2001). *History in person: Enduring struggles, contentious practice, intimate identities*. Santa Fe, NM: School of American Research Press.
- Holzkamp, K. (1983). *Grundlegung der Psychologie* [Foundations of psychology]. Frankfurt-am-Main, Germany: Campus.
- Holzkamp, K. (1984a). Die Menschen sitzen nicht im Kapitalismus wie in einem Käfig [People do not sit in capitalism as if in a cage]. *Psychologie Heute*, pp. 29–37.
- Holzkamp, K. (1984b). Zum Verhältnis zwischen gesamtgesellschaftlichem Prozeß und individuellem Lebensprozeß [On the relation between the collective process of society and individual life process]. *Konsequent*, 6, 29–40.
- Holzkamp, K. (1988). Praxis: Funktionskritik eines Begriffs [Praxis: Functional critique of a notion]. In J. Dehler & K. Wetzel (Eds.), *Zum Verhältnis von Theorie und Praxis in der Psychologie* [On the relation of theory and praxis in psychology] (pp. 15–18). Marburg, Germany: Verlag Arbeiterbewegung und Gesellschaftswissenschaft.
- Holzkamp, K. (1991). Societal and individual life processes. In C. W. Tolman & W. Maiers (Eds.), *Critical psychology: Contributions to an historical science of the subject* (pp. 50–64). Cambridge, UK: Cambridge University Press.
- Holzkamp, K. (1992). Die Fiktion administrativer Planbarkeit schulischer Lernprozesse [On the fiction of the possibility to administratively plan learning processes at school]. In K.-H. Braun & K. Wetzel (Eds.), *Lernwidersprüche und pädagogisches Handeln* (pp. 91–113). Marburg, Germany: Verlag Arbeit und Gesellschaft.
- Holzkamp-Osterkamp, U. (1977). Die Übereinstimmung/Diskrepanz zwischen individuellen und gesellschaftlichen Zielen als Bestimmungsmoment der Vermittlung zwischen kognitiven und emotionalen Prozessen [On the congruence/discrepancy between individual and collective goals as determining moment of the mediation between cognitive and emotional processes]. In K. Holzkamp & K.-H. Braun (Eds.), *Bericht über den I. Kongress Kritische Psychologie in Marburg* (pp. 72–88). Cologne, Germany: Pahl-Rugenstein.
- Hutchins, E. (1995). *Cognition in the wild*. Cambridge, MA: MIT Press.
- Il'enkov, E. (1977). *Dialectical logic: Essays in its history and theory* (H. Campbell Creighton, Trans.). Moscow, Soviet Union: Progress. (Original work published in 1974)
- Il'enkov, E. (1982). *Dialectics of the abstract and the concrete in Marx's Capital* (S. Kuzyakov, Trans.). Moscow, Soviet Union: Progress. (Original work published in 1960)
- Jacoby, S., & Gonzales, P. (1991). The constitution of expert-novice in scientific discourse. *Issues in Applied Linguistics*, 2, 149–181.
- Jäger, S., & Küchler, R. (1976). Zur Bedeutung der Sprache für das Lernen: Materialien zur Kritik etablierter Lernbegriffe [On the meaning of language for learning: Materials for the critique of established notions of learning]. *Linguistische Berichte*, 42, 62–94.
- Jonassen, D. H., & Rohrer-Murphy, L. (1999). Activity theory as a framework for designing constructivist learning environments. *Educational Technology Research and Development*, 47, 61–79.
- Junefelt, K., & Lindberg, E. (1995). Activity in theory and practice in pediatric consultations. *Gothenburg Papers in Theoretical Linguistics*, 73, 53–73.
- Kärkkäinen, M. (1999). *Teams as breakers of traditional work practices: A longitudinal study of planning and implementing curriculum units in elementary school teacher teams* (Research Bulletin 100). Helsinki, Finland: University of Helsinki, Department of Education.

- Kerusuo, H. (2001). "Boundary encounters" as a place for learning and development at work. *Outlines*, 3, 53–65.
- Keseling, G. (1979). Textwissen und Gedächtniswissen als Kategorien in einer Theorie sprachlichen Handelns [Textual knowledge and remembered knowledge as categories in a theory of speech acts]. *Osnabrücker Beiträge zur Sprachtheorie*, 10, 23–36.
- Koschmann, T., Kuutti, K., & Hickman, L. (1998). The concept of breakdown in Heidegger, Leont'ev, and Dewey and its implications for education. *Mind, Culture, and Activity*, 5, 25–41.
- Kosonen, K., & Hakkarainen, K. (2006). Systematic formation of reading comprehension in visually impaired children. In S. A. Barab, K. E. Hay, & D. T. Hickey (Eds.), *7th International Conference of the Learning Sciences, 27 June–1 July* (pp. 952–953). Mahwah, NJ: Lawrence Erlbaum.
- Kozulin, A. (1986). The concept of activity in Soviet psychology: Vygotsky, his disciples and critics. *American Psychologist*, 41, 264–274.
- Kozulin, A., Gindis, B., Ageyev, V. S., & Miller, S. M. (Eds.). (2003). *Vygotsky's educational theory in cultural context*. New York: Cambridge University Press.
- Kress, G., Jewitt, C., Ogborn, J., & Tsatsarelis, C. (2001). *Multimodal teaching and learning: The rhetorics of the science classroom*. London: Continuum.
- Kuutti, K. (1999). Activity theory, transformation of work, and information systems design. In Y. Engeström, R. Miettinen, & R.-L. Punamäki (Eds.), *Perspectives on activity theory* (pp. 360–376). Cambridge, UK: Cambridge University Press.
- Laboratory for Comparative Human Cognition. (1983). Culture and cognitive development. In P. H. Mussen (Series Ed.) & W. Kessen (Vol. Ed.), *Handbook of child psychology, Vol. 1: History, theory, and methods* (4th ed., pp. 295–356). New York: John Wiley.
- Langner, M. (1984a). Rezeption der Tätigkeitstheorie und der Sprachtätigkeitstheorie in der Bundesrepublik Deutschland, Teil I [Reception of activity theory and speech act theory in the Federal Republic of Germany, part I]. *Deutsche Sprache*, 3, 239–275.
- Langner, M. (1984b). Rezeption der Tätigkeitstheorie und der Sprachtätigkeitstheorie in der Bundesrepublik Deutschland, Teil II [Reception of activity theory and speech act theory in the Federal Republic of Germany, part II]. *Deutsche Sprache*, 4, 326–358.
- Langner, M. (1984c). Tätigkeitstheorie—Sprechfähigkeitstheorie [Activity theory—Speech act theory]. *Deutsche Sprache*, 2, 110–140.
- Lantolf, J. P. (Ed.). (2000). *Sociocultural theory and second language learning*. Oxford, UK: Oxford University Press.
- Lantolf, J. P. (2006). Sociocultural theory and L2: State of the art. *Studies in Second Language Acquisition*, 28, 67–109.
- Lave, J. (1988). *Cognition in practice: Mind, mathematics, and culture in everyday life*. New York: Cambridge University Press.
- Lave, J. (1993). The practice of learning. In S. Chaiklin & J. Lave (Eds.), *Understanding practice: Perspectives on activity and context* (pp. 3–32). Cambridge, UK: Cambridge University Press.
- Lave, J. (1996). Teaching, as learning, in practice. *Mind, Culture, and Activity*, 3, 149–164.
- Lave, J. (1997). On learning. *Forum Kritische Psychologie*, 38, 120–135.

- Lave, J., Murtaugh, M., & de la Rocha, O. (1984). The dialectic of arithmetic in grocery shopping. In B. Rogoff & J. Lave (Eds.), *Everyday cognition: Its development in social context* (pp. 67–94). Cambridge, MA: Harvard University Press.
- Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. New York: Cambridge University Press.
- Leander, K. (2002a). Locating Latanya: The situated production of identity artifacts in classroom interaction. *Research in the Teaching of English*, 37, 198–250.
- Leander, K. (2002b). Polycontextual construction zones: Mapping the expansion of schooled space and identity. *Mind, Culture, and Activity*, 9, 211–237.
- Lee, C. D. (2001). Is October Brown Chinese? A cultural modeling activity system for underachieving students. *American Educational Research Journal*, 38, 97–141.
- Lee, C. D., & Majors, Y. (2003). “Heading up the street”: Localised opportunities for shared constructions of knowledge. *Pedagogy, Culture and Society*, 11, 49–67.
- Lee, C. D., Spencer, M. B., & Harpalani, V. (2003). “Every shut eye ain’t asleep”: Studying how people live culturally. *Educational Researcher*, 32, 6–13.
- Lee, S., & Roth, W.-M. (2003a). Of traversals and hybrid spaces: Science in the community. *Mind, Culture, and Activity*, 10, 120–142.
- Lee, S., & Roth, W.-M. (2003b). Re-mapping the landscape: Science educators within a community action network. *Perspectives in Education*, 21(2), 15–30.
- Lee, S. H., & Roth, W.-M. (2003c). Science and the “good citizen”: Community based scientific literacy. *Science, Technology, & Human Values*, 28, 403–424.
- Lee, Y.-J., & Roth, W.-M. (2005). The (unlikely) trajectory of learning in a salmon hatchery. *Journal of Workplace Learning*, 17, 243–254.
- Lee, Y.-J., & Roth, W.-M. (2007). The individual/collective dialectic in the learning organization. *The Learning Organization*, 14, 92–107.
- Lemke, J. L. (2000). Across the scales of time: Artifacts, activities, and meanings in ecosocial systems. *Mind, Culture, and Activity*, 7, 273–290.
- Leont’ev, A. A. (1971). *Sprache, Sprechen, Sprechfähigkeit* [Language, speech, speech act] (C. Heeschen, Trans.). Stuttgart, Germany: Kohlhammer.
- Leont’ev, A. A. (1974). *Psycholinguistik und Sprachunterricht* [Psycholinguistics and language education] (G. Schulz & G. Seyfahrt, Trans.). Stuttgart, Germany: Kohlhammer.
- Leont’ev, A. N. (1978). *Activity, consciousness and personality*. Englewood Cliffs, NJ: Prentice Hall.
- Leont’ev, A. N. (1981). *Problems of the development of the mind*. Moscow, Soviet Union: Progress.
- Levins, R., & Lewontin, R. (1985). *The dialectical biologist*. Cambridge, MA: Harvard University Press.
- Lompscher, J. (1999). Motivation and activity. *European Journal of Psychology of Education*, 14, 11–22.
- Luria, A. R. (1981). *Language and cognition*. New York: John Wiley.
- Majors, Y. (2003). Shoptalk: Teaching and learning in an African American hair salon. *Mind, Culture, and Activity*, 10, 289–310.
- Markard, M., & Holzkamp, K. (1989). Praxisportrait. Ein Leitfaden für die Analyse psychologischer Berufstätigkeit [Praxis portrait: A guide for the analysis of the professional work of psychologists]. *Forum Kritische Psychologie*, 23, 5–49.
- Marx, K. (1976). *Capital volume I*. London: Penguin. (Original work published 1867)
- McDonald, G., Le, H., Higgins, J., & Podmore, V. (2006). Artifacts, tools and classrooms. *Mind, Culture, and Activity*, 12, 113–127.

- McNeill, D. (1985). Language viewed as action. In J. V. Wertsch (Ed.), *Culture, communication, and cognition: Vygotskian perspectives* (pp. 258–270). Cambridge, UK: Cambridge University Press.
- McNeill, D. (1992). *Hand and mind: What gestures reveal about thought*. Chicago: University of Chicago.
- McNeill, D. (2000). Catchments and context: Non-modular factors in speech and gesture. In D. McNeill (Ed.), *Language and gesture* (pp. 312–328). Cambridge, UK: Cambridge University Press.
- McNeill, D. (2005). *Gesture and thought*. Chicago: University of Chicago Press.
- Miettinen, R., & Virkkunen, J. (2006). Learning in and for work and the joint construction of mediational artifacts: An activity theoretical view. In E. Antonacopoulou, P. Jarvis, V. Anderson, B. Elkjaer, & S. Hoeyrup (Eds.), *Learning, working and living: Mapping the terrain of working life learning* (pp. 154–169). New York: Palgrave.
- Mikhailov, F. (1980). *The riddle of self*. Moscow, Soviet Union: Progress.
- Moll, L. C. (2001). Through the mediation of others: Vygotskian research on teaching. In V. Richardson (Ed.), *Handbook of research on teaching* (pp. 111–129). Washington, DC: American Educational Research Association.
- Morf, M. E., & Weber, W. G. (2000). I/O psychology and the bridging potential of A. N. Leont'ev's activity theory. *Canadian Psychology*, 41, 81–93.
- Nardi, B. (Ed.). (1996). *Context and consciousness: Activity theory and human computer interaction*. Cambridge, MA: MIT Press.
- Nicolopoulou, A., & Cole, M. (1993). Generation and transmission of shared knowledge in the culture of collaborative learning: The Fifth Dimension, its playworld, and its institutional contexts. In E. A. Forman, N. Minick, & C. A. Stone (Eds.), *Contexts for learning: Sociocultural dynamics in children's development* (pp. 283–314). New York: Oxford University Press.
- Packer, M. (2000). *Changing classes: School reform and the new economy*. New York: Cambridge University Press.
- Packer, M. J., & Goicoechea, J. (2000). Sociocultural and constructivist theories of learning: Ontology, not just epistemology. *Educational Psychologist*, 35, 227–241.
- Paradise, R. (2002). Finding ways to study culture in context. *Human Development*, 45, 229–236.
- Pea, R. (1993). Practices of distributed intelligence and designs for education. In G. Salomon (Ed.), *Distributed cognitions* (pp. 47–87). New York: Cambridge University Press.
- Penuel, W. R., & Davey, T. L. (1999). “I don't like to live nowhere but here”: The shelter as mediator of U.S. homeless youth's identity formation. *Mind, Culture, and Activity*, 6, 222–236.
- Pittam, J., & Scherer, K. R. (1993). Vocal expression and communication of emotion. In M. Lewis & J. Haviland (Eds.), *The handbook of emotions* (pp. 185–197). New York: Guilford.
- Pontecorvo, H., & Girardet, H. (1993). Arguing and reasoning in understanding historical topics. *Cognition and Instruction*, 11, 365–395.
- Pratt, M. (2003). Disentangling collective identities. In J. T. Polzer (Ed.), *Identity issues in groups* (pp. 161–188). Boston: JAI.
- Putney, L. G., Green, J., Dixon, C., Durán, R., & Yeager, B. (2000). Exploring collective-individual development in a bilingual classroom. In C. Lee & P. Smagorinsky (Eds.), *Vygotskian perspectives on literacy research: Constructing meaning through collaborative inquiry* (pp. 86–126). New York: Cambridge University Press.

- Raeithel, A. (1996). On the ethnography of cooperative work. In Y. Engeström & D. Middleton (Eds.), *Cognition and communication at work* (pp. 319–340). New York: Cambridge University Press.
- Redmiles, D. F. (Ed.). (2002). Introduction to the special issue on activity theory and the practice of design [Special issue]. *Computer Supported Cooperative Work*, 11(1–2).
- Ricœur, P. (1991). *From text to action: Essays in hermeneutics, II*. Evanston, IL: Northwestern University Press.
- Ritchie, S. M., Mackay, G. & Rigano, D. L. (2006). Individual and collective leadership in school science departments. *Research in Science Education*, 36, 141–161.
- Rocha, C. T. da Costa, & de Carvalho, M. G. (2000). A linguagem e a atividade [Language as activity]. *Cadernos de Estudos Linguísticos*, 39, 111–129.
- Rogoff, B., & Lave, J. (Eds.). (1984). *Everyday cognition: Its development in social context*. Cambridge, MA: Harvard University Press.
- Rorty, R. (1989). *Contingency, irony, and solidarity*. Cambridge, UK: Cambridge University Press.
- Rorty, R. (1991). *Objectivity, relativism, and truth: Philosophical papers (Vol. 1)*. Cambridge, UK: Cambridge University Press.
- Roth, W.-M. (2002). Learning in Moussac. In L. M. Richter & R. Engelhart (Eds.), *Life of science: Whitebook on educational initiatives in natural sciences and technology* (pp. 45–55). Copenhagen: Learning Lab Denmark.
- Roth, W.-M. (2003a). Competent workplace mathematics: How signs become transparent in use. *International Journal of Computers for Mathematical Learning*, 8(3), 161–189.
- Roth, W.-M. (2003b). From environmental determination to cultural-historical mediation: Toward biological plausible social theories. *Cybernetics & Human Knowing*, 10(2), 8–28.
- Roth, W.-M. (2003c). From epistemic (ergotic) actions to scientific discourse: Do gestures obtain a bridging function? *Pragmatics & Cognition*, 11, 139–168.
- Roth, W.-M. (2003d). *Toward an anthropology of graphing: Semiotic and activity-theoretic perspectives*. Dordrecht, the Netherlands: Kluwer Academic.
- Roth, W.-M. (2004). Activity theory in education: An introduction. *Mind, Culture, and Activity*, 11, 1–8.
- Roth, W.-M. (2005a). *Doing qualitative research: Praxis of methods*. Rotterdam, the Netherlands: Sense.
- Roth, W.-M. (2005b). Mathematical inscriptions and the reflexive elaboration of understanding: An ethnography of graphing and numeracy in a fish hatchery. *Mathematical Thinking and Learning*, 7, 75–109.
- Roth, W.-M. (2005c). *Talking science: Language and learning in science classrooms*. Lanham, MD: Rowman & Littlefield.
- Roth, W.-M. (2006). Activity theory. In N. J. Salkind (Ed.), *Encyclopedia of human development* (Vol. 1, pp. 16–23). Thousand Oaks, CA: Sage.
- Roth, W.-M. (2007). Mathematical modeling “in the wild”: A case of hot cognition. In R. Lesh, E. Hamilton, & J. J. Kaput (Eds.), *Foundations for the future of mathematics education* (pp. 77–97). Mahwah, NJ: Lawrence Erlbaum.
- Roth, W.-M. (in press). On mediation: Toward a cultural-historical understanding of the concept. *Theory & Psychology*.
- Roth, W.-M., & Barton, A. C. (2004). *Rethinking scientific literacy*. New York: Routledge.
- Roth, W.-M., Hwang, S.-W., Lee, Y. J., & Goulart, M. I. M. (2005). *Participation, learning, and identity: Dialectical perspectives*. Berlin, Germany: Lehmanns Media.

- Roth, W.-M., & Lawless, D. (2002). Signs, deixis, and the emergence of scientific explanations. *Semiotica*, *138*, 95–130.
- Roth, W.-M., Lawless, D., & Tobin, K. (2000). {Coteaching | cogenerative dialoguing} as praxis of dialectic method. *Forum Qualitative Sozialforschung/Forum Qualitative Social Research*, *1*(3). Available at <http://www.qualitative-research.net/fqs-texte/3-00/3-00rothetal-e.htm>
- Roth, W.-M., & Lee, S. (2004). Science education as/for participation in the community. *Science Education*, *88*, 263–291.
- Roth, W.-M., & Lee, Y.-J. (2004). Interpreting unfamiliar graphs: A generative, activity-theoretic model. *Educational Studies in Mathematics*, *57*, 265–290.
- Roth, W.-M., & Lee, Y.-J. (2006). Contradictions in theorizing and implementing communities in education. *Educational Research Review*, *1*, 27–40.
- Roth, W.-M., Masciotra, D., & Boyd, N. (1999). Becoming-in-the-classroom: A case study of teacher development through coteaching. *Teaching and Teacher Education*, *17*, 771–784.
- Roth, W.-M., & Tobin, K. (2001). The implications of coteaching/cogenerative dialogue for teacher evaluation: Learning from multiple perspectives of everyday practice. *Journal of Personnel Evaluation in Education*, *15*, 7–29.
- Roth, W.-M., & Tobin, K. G. (2002). *At the elbow of another: Learning to teach by coteaching*. New York: Peter Lang.
- Roth, W.-M., & Tobin, K. (2004). Coteaching: From praxis to theory. *Teachers and Teaching: Theory and Practice*, *10*, 161–179.
- Roth, W.-M., Tobin, K., Carambo, C., & Dalland, C. (2004). Coteaching: Creating resources for learning and learning to teach chemistry in urban high schools. *Journal of Research in Science Teaching*, *41*, 882–904.
- Roth, W.-M., Tobin, K., Carambo, C., & Dalland, C. (2005). Coordination in coteaching: Producing alignment in real time. *Science Education*, *89*, 675–702.
- Roth, W.-M., Tobin, K., Elmesky, R., Carambo, C., McKnight, Y., & Beers, J. (2004). Re/making identities in the praxis of urban schooling: A cultural historical perspective. *Mind, Culture, and Activity*, *11*, 48–69.
- Roth, W.-M., Tobin, K., Zimmermann, A., Bryant, N., & Davis, C. (2002). Lessons on/from the dihybrid cross: An activity theoretical study of learning in coteaching. *Journal of Research in Science Teaching*, *39*, 253–282.
- Russell, D. L., & Schneiderheinze, A. (2005). Understanding innovation in education using activity theory. *Educational Technology & Society*, *8*(1), 38–53.
- Russell, D. R. (1997). Writing and genre in higher education and workplaces. *Mind, Culture, and Activity*, *4*, 224–237.
- Sawchuk, P. (2003). *Adult learning and technology in working-class life*. New York: Cambridge University Press.
- Sawyer, R. K. (2002). Unresolved tensions in sociocultural theory: Analogies with contemporary sociological debates. *Culture & Psychology*, *8*, 283–305.
- Saxe, G. B. (1999). Cognition, development, and cultural practices. In E. Turiel (Ed.), *Development and cultural change: Reciprocal processes* (pp. 19–35). San Francisco: Jossey-Bass.
- Schwarz, B. B., & Hershkowitz, R. (2001). Production and transformation of computer artifacts toward construction of meaning in mathematics. *Mind, Culture, and Activity*, *8*, 250–267.
- Scribner, S. (1985). Vygotsky's uses of history. In J. V. Wertsch (Ed.), *Culture, communication, and cognition: Vygotskian perspectives* (pp. 119–145). New York: Cambridge University Press.

- Scribner, S. (1990). A sociocultural approach to the study of mind. In G. Greenberg & E. Tobach (Eds.), *Theories of the evolution of knowing* (pp. 107–120). Hillsdale, NJ: Lawrence Erlbaum.
- Shayer, M. (2003). Not just Piaget; not just Vygotsky, and certainly not Vygotsky as alternative to Piaget. *Learning and Instruction, 13*, 465–485.
- Shultz, J. (1986). The individual and the group: An examination of American folk ideology. *Anthropology & Education Quarterly, 17*, 239–252.
- Smagorinsky, P. (2001). If meaning is constructed, what is it made from? Toward a cultural theory of reading. *Review of Educational Research, 71*, 133–169.
- Smagorinsky, P., Cook, L. S., Moore, C., Jackson, A. Y., & Fry, P. G. (2004). Tensions in learning to teach: Accommodation and the development of a teaching identity. *Journal of Teacher Education, 55*, 8–24.
- Smith, D. E. (1990). *Conceptual practices of power: A feminist sociology of knowledge*. Toronto, Canada: University of Toronto Press.
- Spillane, J. P., Halverson, R., & Diamond, J. B. (2004). Toward a theory of leadership practice: A distributed perspective. *Journal of Curriculum Studies, 36*, 3–34.
- Stetsenko, A. (2003). Alexander Luria and the cultural-historical activity theory: Pieces for the history of an outstanding collaborative project in psychology. *Mind, Culture, and Activity, 10*, 93–97.
- Stetsenko, A., & Arievidtch, I. (2003). The self in cultural-historical activity theory: Reclaiming the unity of social and individual dimensions of human development. *Theory & Psychology, 14*, 475–503.
- Suchman, L. (1987). *Plans and situated actions: The problem of human-machine communication*. New York: Cambridge University Press.
- Suchman, L. (2000). Embodied practices of engineering work. *Mind, Culture, and Activity, 7*, 4–18.
- Takahashi, N. (2003). Learning of disabled children in Japan: Simultaneous participation in different activity systems. *Mind, Culture, and Activity, 10*, 311–331.
- Teo, T. (1998). Klaus Holzkamp and the rise and decline of German critical psychology. *History of Psychology, 1*, 235–255.
- Thompson, M. P. A. (2004). Some proposals for strengthening organizational activity theory. *Organization, 11*, 579–602.
- Tobin, K. (2004). Building enacted science curricula on the capital of learners. *Science Education, 89*, 577–594.
- Tobin, K., & Roth, W.-M. (2002). Evaluation of science teaching performance through coteaching and cogenerative dialoguing. In J. Altschuld & D. Kumar (Eds.), *Evaluation in science education in the 21st century* (pp. 187–217). Dordrecht, the Netherlands: Kluwer Academic.
- Tobin, K., & Roth, W.-M. (2005). Coteaching/cogenerative dialoguing in an urban science teacher preparation program. In W.-M. Roth & K. Tobin (Eds.), *Teaching together, learning together* (pp. 59–77). New York: Peter Lang.
- Tolman, C. W. (1994). *Psychology, society, and subjectivity: An introduction to German critical psychology*. New York: Routledge.
- Tolman, C. W. (1999). Society versus context in individual development: Does theory make a difference? In Y. Engeström, R. Miettinen, & R.-L. Punamäki (Eds.), *Perspectives on activity theory* (pp. 70–86). Cambridge, UK: Cambridge University Press.
- Tolman, C. W., & Maiers, W. (Eds.). (1991). *Critical psychology: Contributions to an historical science of the subject*. Cambridge, UK: Cambridge University Press.

- Valsiner, J. (1988). *Developmental psychology in the Soviet Union*. Bloomington: Indiana University Press.
- Valsiner, J. (1998). *The guided mind: A sociogenetic approach to personality*. Cambridge, MA: Harvard University Press.
- van Aalsvoort, J. (2004). Activity theory as a tool to address the problem of chemistry's lack of relevance in secondary school chemical education. *International Journal of Science Education*, 26, 1635–1651.
- van Huizen, P., van Oers, B., & Wubbels, T. (2005). A Vygotskian perspective on teacher education. *Journal of Curriculum Studies*, 37, 267–290.
- Varelas, M., & Pappas, C. C., & Rife, A. (2005). Dialogic inquiry in an urban second-grade classroom: How intertextuality shapes and is shaped by social interactions and scientific understandings. In R. Yerrick & W.-M. Roth (Eds.), *Establishing scientific classroom discourse communities: Multiple voices of teaching and learning in research* (pp. 139–168). Mahwah, NJ: Lawrence Erlbaum.
- Virkkunen, J., & Ahonen, H. (2004). Transforming learning and knowledge creation on the shop floor. *International Journal of Human Resources Management*, 4, 57–72.
- Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Cambridge, MA: Harvard University Press.
- Vygotsky, L. S. (1986). *Thought and language* (A. Kozulin, Ed., Trans.). Cambridge, MA: MIT Press. (Original work published 1934)
- Vygotsky, L. S. (1989). Concrete human psychology. *Soviet Psychology*, 27(2), 53–77.
- Wake, G., & Williams, J. (2001). *Using college mathematics in understanding workplace practices: Summative report of research project funded by the Leverhulme Trust*. Retrieved May 27, 2005, from http://www.education.man.ac.uk/Ita/publications/leverhulme_report.pdf
- Wartofsky, M. (1979). *Models: Representations and scientific understanding*. Dordrecht, the Netherlands: Reidel.
- Wells, G. (1999). *Dialogic inquiry: Towards a sociocultural practice and theory of education*. New York: Cambridge University Press.
- Wells, G. (2002). The role of dialogue in activity theory. *Mind, Culture, and Activity*, 9, 43–66.
- Wells, G., & Claxton, G. (Eds.). (2002). *Learning for life in the 21st century: Sociocultural perspectives of the future of education*. Oxford, UK: Blackwell.
- Wenger, E. (1998). *Communities of practice*. New York: Cambridge University Press.
- Wertsch, J. V. (Trans. & Ed.). (1981). *The concept of activity in Soviet psychology*. New York: M. E. Sharpe.
- Wertsch, J. V. (1998). *Mind as action*. New York: Oxford University Press.
- Worham, S. (2003). Representation and enactment in autobiographical narrative. In N. Stephenson, H. L. Radtke, R. Jorna, & H. J. Stam (Eds.), *Theoretical psychology: Critical contributions* (pp. 258–266). Concord, Canada: Captus.
- Yeo, J., Tan, S. C., & Lee, Y.-J. (2006). A learning journey in problem-based learning. In S. A. Barab, K. E. Hay, & D. T. Hickey (Eds.), *7th International Conference of the Learning Sciences, 27 June–1 July* (pp. 859–865). Mahwah, NJ: Lawrence Erlbaum.
- Zinchenko, V. P. (2001). External and internal: Another comment on the issue. In S. Chaiklin (Ed.), *The theory and practice of cultural-historical psychology* (pp. 133–147). Aarhus, Denmark: Aarhus University Press.

Authors

WOLFF-MICHAEL ROTH is Lansdowne Professor of Applied Cognitive Science at the University of Victoria, MacLaurin Building A548, Victoria, BC V8W 3N4, Canada; e-mail *mroth@uvic.ca*. His interdisciplinary research interests concern knowing and learning in science and mathematics across the life span. He publishes in numerous disciplines and is editor or coeditor of three journals: *Mind, Culture, and Activity*; *Cultural Studies of Science Education* (with K. Tobin), and *FQS: Forum Qualitative Social Research* (with K. Mruck, F. Breuer, and J. Reichertz). Among his recent publications are *Doing Teacher-Research: A Handbook for Perplexed Practitioners* (SensePublishers, 2007) and *Talking Science: Language and Learning in Science Classrooms* (Rowman & Littlefield, 2005).

YEW-JIN LEE is assistant professor in the Natural Science and Science Education Section of the National Institute of Education, Singapore. He continues to bring to science and biology education concepts from qualitative research (e.g., discourse and conversation analysis, ethnomethodology, ethnography), sociology, philosophy, and organizational learning. In 2006, he was awarded, together with Wolff-Michael Roth, the Outstanding Paper Award at the Emerald Literati Network Awards for Excellence 2006 for *The (Unlikely) Trajectory of Learning in a Salmon Hatchery*. His publications include *Participation, Learning, and Identity: Dialectical Perspectives* (with W.-M. Roth, S. W. Hwang, and M. I. M. Goulart; Lehmanns Media, 2005).