From Theory of Mind to a Theory of Distributed Shared Sense-Making

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Abstract. The current study proposes conceptualizing human intellectual activity in terms of mutually constitutive interactions among a distributed network of sense-making systems, rather than as individual cognition/learning situated in sociocultural context or as individual participation/apprenticeship in collective social practice. The model of distributed shared sense-making incorporates mutually constitutive interactions among sense-making systems, among mental models of sense-making systems, and between sense-making systems and their mental models. The model provides an integrated theoretical framework to support empirical examination of interactions among humans, and among humans and their cultural tools—in particular, their technological tools. The study uses the proposed theoretical framework to interpret teacher-student developing interactions in a technology-rich middle-school science classroom over the course of a year of scaffolded introduction to inquiry-based science instruction.

Theoretical Framework

Recent debate in the educational literature has focused on two foundational questions of human cognition/learning: Where is the mind (Cobb, 1994a, b), and how should learning be characterized (Anderson, Reder, & Simon, 1996, 1997; Greeno, 1997). The discussion has focused on teasing apart the subtle distinctions between dichotomous perspectives—social constructivism versus socioculturalism (Cobb, 1994a,b; Driver, Asoko, Leach, Mortimer, & Scott, 1994), cognitive versus situative learning (Anderson, Reder & Simon, 1996; Greeno, 1997), acquisition versus participation metaphors for learning (Sfard, 1998), and interaction versus intersubjectivity (Kieren, 2000; Lerman, 1996, 2000; Steffe & Thompson, 2000)—in order to engage in a meaningful discussion of human intellectual activity/ development.

A number of researchers have suggested that neither half of these various dichotomies provides an adequate picture of human intellectual activity/development (Cobb, 1994a,b; Driver et al., 1994; Greeno, 1997; Kieren, 2000). Greeno (1997) proposed that what is needed is a synthesis of the separate lines of cognitive and situative research into one coherent theory of social interaction and cognitive processes.

Human Systems of Distributed Shared Sense-making

The current study follows the direction proposed by Greeno (and Vygotsky (1978)) and attempts to contribute to efforts synthesizing a coherent theory of social interaction and cognitive processes. Toward that end, we conceptualize human intellectual activity/development in terms of shared sense-making rather than as individual cognition/learning situated in sociocultural context or as individual participation/apprenticeship in collective social practice. We develop a model of distributed shared sense-making through integration of the following key ideas: (a) elaboration of Vygotsky's (1978) zone of proximal development (ZPD); (b) elaboration of a construct termed the interaction space (or I-space), an extension of the *n*-dimensional space describing development of psychosocial entities originally proposed by Harré (1984); (c) elaboration of Tomasello's ideas of perspectival shift, joint attentional/referential fields, and shared intentional agent (Tomasello, 1999; Tomasello, Carpenter, Call, Behne & Moll, 2005); (d) elaboration of a broad definition of theory of mind (Astington & Olson, 1995; Hatano, 2002, 2005; Lagattuta & Wellman, 2001); and (e) cohesive tools (Halliday & Hasan, 1976).

We propose that Vygotsky's construct of the zone of proximal development can be fruitfully extended to designate a human system of shared sense-making, and human cognition can thus be fruitfully conceptualized as distributed across a network of mutually constitutive sense-making systems and mental representations of those systems. We propose conceptualizing an interaction space or I-space (as extended from Harré (1984)) to characterize sense-making interactions among sense-making systems and mental models. Interactions can be characterized in terms of the three major dimensions that describe the

I-space—realization, definition/ideas, and convergence/control. Movement within the I-space—that is, changing interactions—can be characterized in terms of *perspectival shifts*, shifts across dimensions (realization⇔definition/ideas⇔convergence/control) or shifts in perspective from one sense-making system to another along the same dimension. The interaction space can also be characterized in terms of the components that comprise the space—the network of sense-making systems, mental models of those systems, and the processes that function to develop coherence among the systems and mental models.

Coherence Processes: Inquiry and Reflection

We conceive sense-making systems to be mutually constitutive with mental models of those systems and to include processes for developing coherence among sense-making systems and mental models. In particular, we conceive of inquiry and reflection as two mutually constitutive coherence processes, through which humans systematically "open" to consider multiple possible interconnections among actions/ideas and then "close" to a single "best fit" option based on culturally developed criteria of consistency, repeatability, fruitfulness, and/or robustness.

Tomasello (1999) proposed that what may be unique about human cognition is not our ability to innovate, but rather our ability to ratchet; that is, our ability to distribute innovations among other humans in order to form a new basis for further innovation/ratcheting. Tomasello and colleagues (2005) further proposed that an important aspect of human cognition may be our ability to act as shared intentional agents—constructing dynamic interactive models of our own and others' minds to enable such ratcheting/shared sense-making. Conceiving of inquiry and reflection as coherence processes within a network of distributed shared sense-making suggests a potentially powerful role for such processes in developing complex networks of minds—multiplying human mental processing capacity by enabling integration of experiences and perspectives from multiple minds—a process that may be unique to human mental processing.

Methods

To demonstrate the utility of the proposed theoretical framework to describe important aspects of teacher-student shared intellectual work, we used the above framework and methods of conversation analysis (Psathas, 1995) to characterize developing teacher-student interactions in a technology-enriched middle school science classroom over the course of a year-long scaffolded introduction to inquiry-based science instruction (see Ladewski (2006) for a more complete description of the study methods).

An interpretive case study comprised of "telling" mini-cases (Knobel, 1996) was developed to capture both the subtle nuances of teacher-student interaction as they unfolded over the course of a lesson and also as they changed over extended time. Primary data sources used in developing the case study included videotaped and transcribed recordings of nine key lessons—four 45-minute lessons from each of two project-based units that spanned a year of instruction, as well as a culminating end-of-year student-designed investigation. Other data sources—including teacher semi-structured interviews, teacher-written case reports, and videotapes of teacher professional development worksessions—provided additional data to corroborate the story told by the mini cases.

We characterized sense-making interactions in terms of the following constructs of shared sense-making: (a) *joint attentional field*—on what object was joint attention focused and by whom; (b) *referential field*—what ideas/links were added to the referential field and by whom; (c) *perspectival shifts*—what shifts in perspective were initiated and by whom, and what corroborating or conflicting ideas/experiences were added to the referential field as a result of the shift; (d) *inquiry and reflection*—what processes were carried out to develop coherence among experiences and ideas within/among sense-making systems, and who initiated/participated in those processes; and (e) *cohesive tools*—what cohesive elements were added to link elements within the referential field and by whom.

Conclusions/Implications

Empirical findings indicate that perspectival shifts became increasingly frequent in number and increasingly diverse in terms of type during teacher-student interactions across the year of scaffolded introduction to inquiry-based science instruction. Initially the most common perspectival shifts were collective⇔individual realization, as the teacher modeled and her students then enacted prescribed experimental procedures in the classroom. Over time, teacher and students began to orchestrate additional perspectival shifts, including realization⇔definition (description), action⇔definition (explanation), and

closed⇔open control (nascent inquiry/reflection); students also began to initiate perspectival shifts. Thus, experiences with inquiry-based instruction seemed to provide templates of sense-making that began to change the shape of sense-making itself. However, few cohesive tools linking or synthesizing ideas and/or experiences over extended time were contributed by either teacher or students.

The theory development adds to an emerging cross-disciplinary area of research exploring the integration of the psychological and the social. A model of distributed shared sense-making provides a potentially fruitful theoretical framework for characterizing human sense-making systems and developing interactions among such systems—and thus for examining the role of technological tools (and perhaps also the unique role of humans) in such sense-making systems.

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