Chapter 20
A Transactional Perspective on the Workshop: Looking Again and Wondering

William J. Clancey

Introduction

My target chapter begins by stating the charge I was given by Tim Koschmann, to "relate the 'transactional perspective' to a practice-based science of teaching and learning," which I understood as referring to the work of John Dewey and situated cognition (Clancey, 1997). As Säljö eloquently explains (pp. 281–282), my chapter has two faces, with different scientific intentions: the first to inform cognitive science (particularly theories of memory, conceptualization, and consciousness), the second to inform instructional practice. In this response to the commentaries I will revisit these two objectives and discuss others' remarks that have stirred me and might be useful for future work to consider.

I was so buoyed by the commentaries' constructive and helpful tone, I proceeded to read all of the other chapters. I find them wonderfully articulate, with delightful and inspiring nuances about theorizing, theories, teaching, and learning. Several of the articles caught me short, particularly Confrey's commentary on my chapter, which I will focus on here, and Macbeth's commentary on Greeno's analysis, which I will simply recommend for careful attention.

In interpreting my chapter it is helpful to recall the intellectual demons that haunted me in the 1990s. Like Greeno, I have a background in cognitivism, which is perhaps always "the last war" that I am continually fighting (like Vera and Simon's [1993] anti-behaviorist response to situated cognition). This battle is partly always in my own mind, as an unending fascination over theories I once believed about human memory, knowledge, and reasoning. The battle is also an argument with friends and colleagues in my original artificial intelligence community of practice—people who are not just fighting the last war, but are still in the trenches, believing they might win (e.g., Nilsson, 2009). After two decades I no longer enjoy pursuing this missionary discourse. I now believe that paradigm shifts occur by forming new

W.J. Clancey (✉)
Intelligent Systems Division, Florida Institute for Human & Machine Cognition and NASA Ames Research Center, Moffett Field, CA, USA
e-mail: william.j.clancey@nasa.gov

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scientific communities, not by transforming belief systems of academics, even when they are our friends. Cognitive theories of learning have largely failed to account for discourse across entrenched points of view, where denial is the easiest way to deal with discrepant information (Clancey, 2005).

I remain fascinated by the transactional perspective because it seems fundamental for addressing common personal questions about meaning, reality, and purpose. In particular, the commentaries have caused me to wonder what we accomplish in classes that teach math (e.g., geometry theorem proving) as a *tool* independent of a practical inquiry, and on a broader the scale, the relevance of a practice-based science for teachers and learners.

I begin with the issue of cognitive science, then consider Confrey's commentary, and finally revisit what a "practice-based science for teaching and learning" means.

Informing Cognitive Science: Neuropsychology and Humor

As Säljö notes (which I restate here in my terms), as a cognitive scientist I believe a transactional view might enable us to see and articulate the multithreaded nature of change occurring in the classroom, including aspects of disciplinary curricula, personality, economic utility, and so on."Transactional" is understood here as being about change, the dynamics of development, expressing and reflecting on interests, concepts, and emotions within a dance of mutual influence. Thus I interpret a transactional perspective as a broad orientation for analyzing systems; in particular, how to think about causality (see Macbeth's remarks about situated action and Clancey [2008]). I asked "how inquiry might have occurred differently in the classroom we are studying." A transactional analysis provides insight by revealing what is particular about these happenings. "How it could have been different" shows influences, choices, and intentions in the unfolding dynamics.

Throughout, I viewed myself as interpreting Dewey's theory, not "Clancey's transactional perspective" (pace Chapter 17, Chapter 19). In this respect, the analysis is philosophical: seizing on some phrases and distinctions, making them my own, and then using them to point to, articulate, and explain what interests me.

In elaborating the notion of "inquiry," I seized Dewey's biological metaphors and grounding to ask what contact I could make with neuropsychological aspects of cognition—as I then understood it (presented broadly in Clancey [1997] and as a neuropsychological theory of conceptualization in [1999]). I illustrated Dewey's notion of "transactional inquiry" by putting on those eyeglasses and examining the videos for events in which perception and humor were salient. Thus, I was delving into two ends of the "neural-psychological-social" spectrum not related well by cognitivism: the non-verbal aspects of conceptualization (visible in how the class talked about marks on the graph paper) and the social aspects of conceptualization (visible in both small and large group bantering).

With respect to humor, I wrote, "This perspective makes salient functional aspects of behavior that were generally ignored by 1980s cognitive science studies of problem solving and instruction, in particular, the role of emotion in conceptual

change" (p. 276). I stress again that my research interest is to make dreaming, humor, consciousness, autism, and so on an integral part of cognitive science. I have argued (Clancey, 1999) that this means making contact between accepted cognitivist theories (e.g., hierarchical models of language processing) and neuropsychology—by which I mean explaining how well-established psychological processes of remembering, speaking, and reasoning occur in the brain. Rather than viewing neural processes as matters of "implementation," I have argued that the architecture of cognition, including especially how categories in different modalities (touch, hearing, vision) are formed, organized, and coordinated over time must be understood if we are to explain the full range of human mental experience and behavioral capability. The cornerstone claim is that theories of conceptualization are woefully insufficient, particularly in accounting for varieties of consciousness. In particular, the dominant "cognitivist" theories of the 1960s–1980s, based on the notion of semantic (concept) networks, are gross simplifications based on a fundamentally wrong metaphor of human memory as storage—that "knowledge" is something static that can be put away and taken out like tools from a shed. Elman (2005) presents the kind of process theory of memory that I have advocated.

In short, I saw the workshop, the tapes, and my charge in the target article as an opportunity to expose human behavior that cognitive science needed to incorporate, here specifically, in a science of teaching and learning.

Säljö is correct that my analysis of the classroom humor is not "grounded in neuropsychological concepts or assumptions" (p. 285). My intent goes the other way: Speaking to cognitive scientists and AI researchers, I am saying, "Look, humor is not epiphenomenal, it is a naturally occurring, universal part of human experience, and our nascent theories of situated action imply that humorous behavior reveals aspects of the neural structure and processes of conceptualization." So by my perhaps idiosyncratic reckoning, to talk of humor is to talk of neuropsychology. Or put another way, humor has not been admitted as being part of "cognition" proper, and a science of teaching and learning practices offers an opportunity to elevate its importance.

Again picking up on Säljö's comments, my hope is for "the promises of modern biology" to relate theories of memory and learning to how the brain actually works and to reveal how our brains are as different as our bodies,[1] as opposed to being like identical INTEL® processors. I want cognitive science to explain why some of us can draw and play music by ear, and others excel at math puzzles or gymnastics, etc. For example, I couldn't play the piano even half well until I learned folk dancing—rhythmic action that coordinates feeling, seeing, and moving. What aspects of attention and sequencing are at work here? Understanding the neural aspects of rhythm and musicality is part of the study of multiple "intelligences" (Gardner, 1985). A more inclusive cognitive science—partly created by theorizing learning practices—will provide a better basis for using theories of cognition to inform pedagogy. I have assigned this exploratory exposition to the discipline of "neuropsychology," with the strong heuristic that it is the full range of cognition—including dance, dreaming, drawing, and dysfunctions—that will reveal how ordinary reading, writing, and arithmetic are possible for human beings. What

indeed are the "basic skills" of cognition? How do minds develop to account for proclivities and talents? What might we teach to bring human experience together in more holistic, fruitful ways?

In summary, my analysis of humor in the classroom video has multiple aspects: 1) calling out humor as being an aspect of classroom practice, 2) characterizing humor as involving physical processes of conceptualization in the brain we have barely begun to unravel, 3) using the analysis to argue that cognitive science should not be ignoring humor, but should accept its dual functional nature in the development of a conceptual system (in the brain) and a social system (in human relations).

This part of my target chapter illustrates how a practice-based science of teaching learning need not say anything directly about instructional design—that's the province of a *science-based practice* of teaching and learning. As Cobb (pp. 291–293) allows, one measure of scientific progress is insight, an enriching of observation, seeing ordering and meaningfulness in behaviors that might otherwise be glossed over as irrelevant or aberrant. In this respect, I am content with my foray into the discussion of humor.

My discussion of graphing comes from another direction, using theories of learning for guiding instructional design.

Informing Instructional Practice: What Is the Point of the Graphing?

Confrey's commentary provides for me the heretofore secret key to the classroom videos—the lesson plan from a mathematics education ("disciplinary") perspective. She says, in what feels deeply ironic to me, "In an educative situation, the goals and intentions of the teacher, or the lesson, can provide a worthwhile starting place" (p. 335). On reading this remark, I was befuddled: What was the workshop about if we did not start with the teacher's perspective or know Lehrer and Schauble's experimental plan? How could I have analyzed the videos without knowing that the "key curricular goal (was) the understanding of variability, not the issue of graphs" (p. 333)? Further, in my grasping for context, I thought that when the teacher referred to growth rate ("fast plant")—he meant plants that were growing faster! I didn't know that these are Wisconsin Fast Plants®. Did the students and teacher share an understanding of "spread" as well; and I, not knowing this background, saw these repeated mentions as ungrounded and forced?

In their introduction to the classroom (Chapter 2), Lehrer and Schauble (L&S) describe their research program as investigating "modeling approaches to science" (p. 21). They view their presentation in this book as essential background "before readers dive into the chapters" (p. 20). Why wasn't this provided as background reading before the target chapter authors viewed the classroom videos? Hall's commentary shows that he was conversant in L&S's research program; had I failed to do my homework? I checked my notes and files, and found this note to Koschmann from August 15, 2003:

> I need a thorough understanding of Rich Lehrer's work. Can he send us a paper that presents his study, interests, and findings over the past two years? I don't think we should work in a vacuum. Given that an informed observer has worked on this for so long, let us reflect on his perspectives rather than try to work out of context from scratch.

Lehrer is copied again on September 9 with a request to post the papers, but we didn't receive a list of L&S's publications until an email on December 12, with the papers arriving December 19, a month after the November 2003 workshop. A year later, Koschmann reports in an email that he has "discovered a piece . . . describing the classroom study that we discussed in the workshop," namely (Lehrer and Schauble, 2004).

I completed my target paper first draft in October 2003. Fully occupied by the amount of data and my task, I assumed that the world of the classroom was what was visible on the tapes. Then in responding to comments on my target paper, with the primary focus on shortening it, I never read L&S's papers until now. Confrey's commentary was the first attempt to directly communicate to me the educational research design of the class sequence.

Based on the videos I saw and limited background, I complained that the students and teacher "are myopically talking about the graphs as objects in their own right, removed from a plant-growing activity." But unknown to me, in other classes the "students discussed changes in the distributions of measures and interpreted what the 'shapes of the data tell us' about changes in the plants" (Lehrer and Schauble, 2004, p. 7). Further, the students grew the plants to answer, "questions about the effects of light and fertilizer on growth" (p. 334). So the overall activity was not just about growing plants to generate height data for the sake of teaching statistics concepts.

In the classes for which we have videos, Confrey explains that "the primary goal is to teach mathematics, or in this case, statistics" (p. 354). Hall says the purpose is "inventing statistical displays" (p. 360). He cites Lehrer and Schauble (2004) that the students are led to "invent their own representational conventions and then to evaluate the resulting displays against their evolving criteria for communicability and mathematical precision" (p. 669). Confrey (p. 386) says something similar in emphasizing the activity as a time to learn what the tools are (e.g., generating histograms), rather than applying them.

Wertsch explains how the lesson conveys cultural conventions for creating statistics graphs. The pedagogical theory is that these mathematical ideas should be "put in place" before they are "needed to support the modeling approaches to science" (Chapter 2, p. 21). Thus, the initial graphing activity had a scientific motivation, but it is not mentioned in these classes. The topic was not (only) "variability" in a pure statistical sense, but "natural variability," specifically variability in mathematical descriptions of causal processes in a population. Thinking in terms of a population (versus individual entities) is an important concept in the 28-day lesson plan. The graphing activity aims to teach about detecting or visualizing natural variability, when they are viewed in the later classes as scientific models. Not knowing the designed curriculum sequence, I was disconcerted by the absence of a

guiding purpose for organizing the data—a context for evaluating the adequacy of a particular visualization of "spread" or "typical" in providing *information*.

Did the other workshop participants know the overarching curriculum? In the twenty target and commentary chapters of this book only L&S themselves refer explicitly to "natural variability." However, Sherin stresses that the instruction is about the "natural world" (p. 195), and Collins notes, "By plotting variability of plant growth in a bar graph, they could see how a normal function arises naturally" (p. 107). Many authors do mention "variability," which Hall highlights as important knowledge of the classroom history: "So in looking back, we find prior cycles of collecting and displaying data with variability." But again, aside from the reference to scientific modeling by L&S, Sherin, and Collins, everyone views "variability" in a set of numbers having a "distribution" and "central tendency" as being what Derry, for example, calls "statistical ideas," in contrast with "science ideas such as force and friction" (p. 228).

In sum, 14 chapters out of 20 do not relate the observed graphing activity to L&S's scientific modeling lesson plan (excluding Koschmann's introduction and the other responses to commentaries, which are not available as I write). Several observers make observations similar to mine; for example, Greeno says, "In the case of spread, there was no reference to the plants. . .and the discussion seemed entirely focused on the variability of numbers" (p. 60).[2] So two groups—the students and the workshop participants—were dealing with the graphs as displays of statistics concepts, as tools for talking about numbers, without addressing their value for "communicability and precision" in a scientific model. Does this matter?

Would the classroom sessions we observed have proceeded with more alacrity, engagement, or scientific depth if the scientific context motivating what and why you need to "see better" had been restated throughout? Would the term "spread" be more meaningful if coupled with mention of populations and natural variations? Examining again the teacher's framing of the graphing activity on the first day [Excerpt 1, 0:00:07–0:05:34], we see references to "how spread out" and "the range" and no mention of "population" or "natural variability." By design, the scientific modeling context was omitted from these initial steps toward thinking about distribution (see Chapter 2).

In contrast, one could continuously refer back to what the graph, as a model, is telling us, how it in-forms the situation, structuring and orienting our grasp and action within some project: Show how a problematic situation might be resolved with statistical concepts. For example, start by graphing a population of plants grown under different lighting conditions, where variability might be correlated to the amount of light. Then ask what variability might be normal in plants grown under the same conditions, thus motivating the graphing in the classes we observed. The distinction between accuracy and precision could then be tangible (Alder, 2007).

Besides feeling sorry for the students, as a workshop participant I regret that I did not know L&S's intentions or the background of the class. We might have had a different kind of workshop, one that started with L&S's project, framing the classroom activitywith respect to their goals and the curriculum. Following a typical

approach in video interaction analysis (Jordan and Henderson, 1995), we might have viewed the videos with Confrey, Lehrer, Schauble, and Rolfing during the workshop, hearing their interpretations and inquiring about their intentions and experiences. An evaluative workshop, oriented around the design of the class, would have put our intellectual tools to work—not just to use the videos to illustrate theoretical points, but to apply these theories for guiding instructional design.

But speaking apparently to the contrary view, Cobb remarks (p. 300) that it was important for our project to have an inquiring, not an evaluative perspective. We came in cold (most of us) and knowing the overall genre of the setting, were asked to study multiple sessions and small group activities, and to bring to bear our ways of looking, talking, organizing materials into a scientific presentation. In that exercise, Greeno, Wertsch, and myself selected materials that allowed us to develop the themes that interest us (Fred Erickson summarizes these selections in Chapter 20). The commentators then refined our presentations along multiple disciplinary dimensions (e.g., Garrison's (Chapter 16) very fine amplifications and elaborations about Dewey; Cobb's (Chapter 15) mention of symbolic interactionism; Säljö's discussion of cultural institutions).

Recently Koschmann asked me, "Does knowing the mathematical intent of the class and the series of prior classes change your analysis?" No, but now the point about using graphs to provide information shifts from being a kind of tutorial ("here is what a modeling analysis looks like") to an expression of how strange it seems that three hours or more of classroom time would be about graphs without explicitly relating them to the broader inquiry about populations or plant growth. Pedagogically, the activity was aimed at first teaching tools for such an inquiry, but what is the meaning of a tool outside the context in which it appears? Statistics, like logic and geometry theorem proving, can be a kind of language game; an inquiry might just be about numbers and the shapes of distributions.

Why not begin with the practical questions? By a transactional perspective the subject matters of plant growing experiments, biology population theory, and statistics are mutually influencing—in scientific practice, in social-historical development, and in individual understanding. An either/or, linear notion of first learning the tool and then learning the application is antithetical to a transactional perspective, in which the understanding of "what the tools are" (theory) is conceptually coupled[3] to what you can do with them (practice).

The traditional curriculum ordering of mathematics, science, and engineering views these disciplines as cumulative, assembled in the mind like subatomic particles, elements, and molecules of thought. Dewey's approach was to begin with "community life" and in particular occupational activity, just as a "model farm" that would motivate the conventional school topics (Dewey, 1896; Westbrook, 1993). The graphing activity fits Dewey's philosophy in inventive form, but not purposeful project content—learning statistics has been separated out from the problem it will resolve, which will only be presented later when the students are "ready" to tackle it. If this context (e.g., farming) were the ongoing topic, the more general scientific modeling ideas and experiment analysis would then be pervasive in the discourse, and could guide and better motivate the graphing activity than

mathematical qualities of the numbers alone. Imagine for example framing this entire discussion within the current debate about global warming, where natural variability plays a key role. The plant growing experiments might then be introduced as a way to help the students evaluate political and economic issues facing their community.

What Is a "Practice-Based Science of Teaching and Learning"?

In the final section of my target chapter I explored the task of developing a science of instructional design. Confrey also frames her commentary in terms of the usefulness of the transactional perspective for mathematics instruction. But the title of the workshop proposal, "Coupling Theories of Learning and Research on Practice," and Koschmann's introductory chapter, "Theorizing Practice," do not necessarily promise practical results for instructional design. Our social-psychological theories (situated action, dialogic theory, and transactional inquiry) might help us model classroom practices, describing and/or explaining what occurs, without also being used as tools for formulating classroom activities.

Erickson indicates that our charge has been to "critically evaluate the theories in terms of what they made (and failed to make) visible in the videos" (p. 395). Similarly, Koschmann's original proposal said that the purpose was to determine what different theoretical perspectives could elucidate about "actual classroom practices" or more specifically, what produced learning outcomes. Going beyond this, relating learning outcomes to pedagogy and thus providing constructive assistance to L&S's research project, would have required a different analysis, for example, considering the separation and ordering of the statistics and scientific modeling discussions by examining a variety of classes in the 28 day sequence.

Reflecting on the course of our writing, we see how our own analysis has a transactional quality that both interprets the past and prompts new interpretations. I wrote, "Actions are *commentaries* that promote reconceptualizing . . . what has transpired (i.e., what are the events of the past) and what the past means going forward" (p. 276). And so the transactional perspective is a way of understanding these investigations, including our examination of the materials (both the videos and our chapters), and the workshop overall.

For individual researchers and the community, developing an understanding is a back and forth, reflective process (Schön, 1987): I interpret my own chapter and reflect on what it accomplishes, trying to understand better and articulate my "original intent"—and struggling to prove to myself that my ignorance of L&S's research program doesn't invalidate my remarks. The variability in the population of chapters provides further evidence for evaluating the classroom videos—and the Allerton meeting in 2003. We look again at the transcripts; reflections on our analysis prompt reorganizing the data (and even our chapters become data). I look again at the workshop schedule, wondering, what did Lehrer and Schauble say after my presentation on Sunday morning, November 23, 2003? Our writing sparks new conversations: Garrison and I exchanged a handful of lengthy emails (in which I sought to better

understand Dewey's "acausality"); Confrey and I spoke on the phone for over an hour, as I learned for the first time a teacher's perspective on this whole enterprise. Then I "went back" to watch the video of Confrey's workshop presentation, comparing her remarks to her subsequent paper; and seeing myself in the first row wonder why my understanding today seems so different. Perhaps we are ready for another meeting.

Notes

1. "Brains differ from person to person, just like hair colour, height, the pattern of the facial bones and the proteins in the blood" (Norman Geschwind quoted in Miller [1984, p. 129]).
2. Greeno, Lehrer, & Schauble (2004) provide an interesting re-contextualization in discussing the variability of the population of *representations* and the students' selection among them.
3. As a clarification for Säljö's concern, I use "coupling" (Clancey, 1997, 1999) to refer to a causal process of co-determination within a neural or social system, not a relation across systems of analysis, such as between biology and sociology.

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