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Timothy Koschmann
Southern Illinois University Carbondale

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Timothy Koschmann
Department of Medical Education
Southern Illinois University
School of Medicine
P.O. Box 19230
Springfield, IL 62704-9230
e-mail: tkoschmann@acm.org

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> [F]or one may explain (or predict) behavior by observing what are the 'obvious' things to do to attain the goal (even though they may be insufficient), and therefore what are the things that the problem solver, being a bear of little brain, will do.
>
> Newell & Simon (1972, p. 79)

> The attempt to clarify the concept of situated learning led to critical concerns about the theory and to further revisions that resulted in the move to our present view that learning is an integral and inseparable aspect of social practice.
>
> Lave & Wenger (1991, p. 31)

> These steps were all definitely in the line of the transactional approach: the seeing together, when research requires it, of what before had been seen in separations and held severally apart. They provide what is necessary at times and places to break down the old rigidities: what is necessary when the time has come for new systems.
>
> Dewey & Bentley (1991/1949, pp. 106–107)

This volume marks the anniversary of an earlier Carnegie Symposium on the topic of cognition and instruction that took place twenty-five years ago. David Klahr (1976), in the preface to an edited collection of papers from that symposium, quoted Forehand (1974) who observed, "In what seems remarkably few years, information processing psychology has come to dominate the experimental study of complex human behavior" (p. 159). Forehand went on to predict that the potential of information-processing theory "for illuminating recalcitrant problems in education seems evident" (p. 159). Klahr observed that the chapters comprising the volume from the first cognition and instruction symposium served as evidence that this potential had already begun to be realized.

Looking at the papers presented at the more recent symposium, it is clear that our community no longer possesses such a unified theoretical foundation. The cognition and

instruction research community has grown since the first symposium and with this growth has come plurality with respect to our foundational theories of learning and problem solving. The emergence of new theories has been attended with extensive (and sometimes rancorous) debate (cf., Norman, 1993; Anderson, Reder, & Simon, 1996, 1997; Greeno, 1997; Cobb & Bowers, 1999). Information processing theory itself has been subjected to critical reappraisal from both within (Scardamalia, Bereiter, & Lamon, 1996; Greeno, 1998) and outside (Bredo, 1994, 1997; Dreyfus & Dreyfus, 1986; Lave, 1988) this community.

As Sfard (1998) has pointed out, advocates of different sides in this debate have appealed to different metaphors of what constitutes learning and, as a consequence, have developed incommensurable vocabularies, making productive dialog difficult. Though the debate about how to appropriately frame research into human learning and problem solving is multifaceted, it is useful for the purposes of this discussion to characterize the controversy, as Sfard did, as a conflict between two specific metaphors—an acquisition metaphor by which learning is treated as "gaining possession over some commodity" (p. 6) and a participation metaphor by which learning is "conceived of as a process of becoming a member of a certain community" (p. 6). This division can be seen in microcosm in the chapters of this book—a few standing defiantly on one side of the divide or the other, others being more ambivalent with respect to the metaphor underlying the work.

To ultimately overcome this division will require finding a new metaphor for learning. I will argue that some useful clues for how this might be accomplished can be found in the writings of the American philosopher, John Dewey. Dewey was a tireless crusader against all forms of dualism. He endeavored in his writing to demonstrate that many of the intractable problems of western philosophy were an outcome of the way in which the questions were initially framed. Dewey's methods may prove useful, therefore, in overcoming the acquisition/participation dualism currently dividing the educational research community. In fact, it is my hope that he can provide us with a new vocabulary for discussing human problem solving that will enable us to bridge this division. Before turning to Dewey's writings, however,

I will begin by summarizing the basic tenets of two currently prominent theories of learning, one that entails a metaphor of learning as acquisition and another that employs a metaphor of learning as participation.

Learning as Acquisition

Sfard (1998) observed that the view of learning as achieving "ownership over some kind of self-sustained entity" (p. 5) is so deeply engrained in our thought and language that it is difficult to consider it any other way. Information processing theory, mentioned earlier by virtue of its historical importance to research in cognition and instruction, is one example of a theory constructed on this metaphor. Information processing theory is by no means the first or the only theory of learning to embrace the metaphor of learning as acquisition—it is just one in a long tradition that stretches back to the work of Thorndike and other early learning theorists (Koschmann, 2000).

Newell and Simon (1972) summarized the underlying principles of information processing theory in the form of four interlocking claims:

1. A few, and only a few, gross characteristics of the human IPS [Information Processing System] are invariant over task and problem solver.
2. These characteristics are sufficient to determine that a task environment is represented (in the IPS) as a problem space, and that problem solving takes place in a problem space.
3. The structure of the task environment determines the possible structures of the problem space (i.e., the class of admissible problem spaces).
4. The structure of the problem space determines the possible programs that can be used for problem solving. (p. 788–789)

Three concepts fundamental to these postulates are the IPS as a problem solving "processor," the problem space within which the problem solver operates, and the methods by which the problem solver produces a solution.

In information processing theory, the computer serves as both a metaphor and a medium for modeling human problem solving capabilities. As Newell and Simon (1972) put it: the "programmed computer and human problem solver are both species belonging to the genus IPS" differing only in "memory organization, elementary processes, and program organization" (p. 870). They describe an IPS as, "a serial system consisting of an active processor, input (sensory) and output (motor) systems, an internal LTM and STM and an EM" (p. 808). In the human problem solver, LTM (long-term memory) is described as being of indefinite capacity and organized associatively. STM (short-term memory), on the other hand, has extremely limited capacity (on the order of five to seven symbols) but is immediately accessible to the processor. Representation in the LTM and STM of the human problem solver are assumed to be "homogenous", that is "sensory patterns in all sensory modalities, processes, and data patterns are symbolized and handled identically" (p. 808). EM (external memory) is defined as "the immediately available visual field" (p. 809).

As stipulated in the second postulate, problem solving is said to occur by searching a problem space. A problem space can be defined formally as:

1. A set of elements, U, each representing a "state of knowledge".
2. A set of operations, Q, each of which allow transformations from one knowledge state to another.

A problem on a space so defined is specified by an initial state, u_0, and a set of one or more possible goal states. A problem space is a representation of a particular task environment, but any given task environment can be represented in a variety of ways, though the authors conceded that problem solving can be effective "only if significant information about the objective environment is encoded in the problem space" (p. 790). Information processing theory, therefore, seeks to understand problem solving performance through detailed study of the problem itself and the processes by which the problem might be solved, that is through a careful cognitive task analysis.

Finally, Newell and Simon introduced the notion of methods which are "organizations for behavior that bear a rational relation to solving a problem", in which "rational" is taken to mean, "if the premises of the method are granted, then it is possible for the method to produce a solution" (p. 835). Methods are implemented as a program. The program envisioned by Newell and Simon by which the IPS performs the search for the goal state(s) is implemented as a production system comprised of a set of stimulus-response couplings known as productions. Appropriate productions are triggered by the appearance of a particular symbol or symbols in the STM augmented by the foveal EM.

Newell and Simon acknowledged that any useful account of human problem solving must include a description of the process or processes by which the capacity for problem solving develops ontogenetically, or stated in their own terms, "the processes by which the contents of the LTM of the human adult are acquired" (p. 866, italics added). Newell and Simon were silent on what these processes might be, but extensive work has been carried out in cognitive psychology to provide an information processing account of development (cf. Klahr & Wallace, 1976; Case, 1985; Siegler, 1989).

That information processing theory has not been abandoned as an inspiration for current research in cognition and instruction is demonstrated most clearly in the Anderson and Gluck chapter (this volume). They begin by noting the substantial difference in scale between the types of tasks studied by cognitive psychologists (e.g., memorizing a list of nonsense syllables, recognizing a symbol) and the more complex types of activities studied by educational researchers (e.g., proving a theorem, writing a computer program, solving an algebra word problem) and propose cognitive architectures as an conceptual framework for decomposing the more complex activities into components that can be studied in the laboratory. They define cognitive architectures as computational models of complex problem solving and describe one such model based on Anderson's ACT theory. ACT theory is an elaboration of information processing theory that conceptualizes cognition as "a sequence of . . . production rule firings" (p. XXX). The findings they describe include eye-tracking data for students engaged in a solving

problems posed by a computer-based algebra tutor. In Newell and Simon's terms, the students can be construed as IPSs employing portions of the computer screen as a "foveal EM" in their problem solving. Studies employing "high-density sensing" data, such as this, could provide a basis for making conjectures about the problem solving methods used by the students, the problem solving spaces they might construct, and the specific productions used in solving the problem.

The acquisition metaphor appears in different guises in other chapters, as well. The chapter by Klahr, Chen, and Toth (this volume), describes work done in both the laboratory and the classroom to facilitate children's acquisition of a strategy for designing experiments. Sharon Carver's description (this volume) of doing task analyses of the instructional activities of an experimental preschool, though less bound to classic information processing theory than the Anderson and Gluck chapter, still embraces a view of learning as acquisition. Lesgold and Nahemov (this volume) begin their chapter with the proposition: "Learning by doing is a central way in which people acquire substantial expertise" (p. XXX, italics added). Their model of the knowledge underlying expert performance, while more complex than the one proposed by Newell and Simon (1972), appeals, nonetheless, to the traditional metaphor.

Chapters by Case (this volume), Minstrell (this volume), Sandoval and Reiser (this volume), and Lehrer and Schauble (this volume) all emphasize the importance of learners' active engagement in the learning process, stressing themes consistent with constructivist theories of learning (cf., Steffe & Gale, 1995). Constructivist theories represent a departure from more traditional theories of learning that treat the learner as a passive object written upon (the tabula rasa of British empiricism) by experience. When construction becomes an alternative means to acquisition, however, the underlying metaphor is, nevertheless, preserved.

Learning as Change in Participation

Lave began Cognition in Practice (1988) with the declaration:

> There is reason to suspect that what we call cognition is in fact a complex social phenomenon. The point is not so much that arrangements of knowledge in the head correspond in a complicated way to the social world outside the head, but that they are socially organized in such a fashion as to be indivisible. (p. 1)

This radical re-construal of cognition as a fundamentally social process necessitated a corresponding rethinking of what it means to learn and a number of authors (e.g, Bruffee, 1993; Gee, 1992; Nunes, Schliemann, & Carraher, 1993; Lave & Wenger, 1991; Smith, 1988) have made moves in this direction. Ellis and Gregoire[1] discussed some of the implications of re-conceptualizing learning in this way.

Lave and Wenger's social practice theory is one of the most influential and better-elaborated formulations based on a view of learning as modal changes in participation in a socially-organized activity. There are three key concepts associated with this theory: communities of practice, legitimate peripheral participation, and participants' developing identities. They (1991) define a community of practice as "a set of relations among persons, activity, and world, over time and in relation with other tangential and overlapping communities of practice" (p. 98). They stress that this definition does not necessarily imply "co-presence, a well-defined, identifiable group, or socially visible boundaries," but does require "participation in an activity system about which participants share understandings concerning what they are doing and what that means in their lives and for their communities" (p. 98). Though they concede that their definition leaves community of practice as a "largely as an intuitive notion" (p. 42), they strengthen the intuition by providing many practical examples (e.g., midwife and tailor apprentices, participants in an AAA 'twelve-step' programs) from the world around us.

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[1] Shari Ellis and Michele Gregoire, University of Florida, made a presentation entitled, "Sociocultural and cognitive aspects of teaching and learning in mathematics and science classrooms" at the June 1999 Carnegie Symposium. It does not appear in this volume.

Lave and Wenger describe legitimate peripheral participation as opportunities extended to newcomers to a community of practice to learn, that is "of both absorbing and being absorbed in - the 'culture of practice'" (p. 95). Herein lies their solution to the problem of how to describe learning in strictly social terms; they stipulate, "learning occurs through centripetal participation in the learning curriculum of the community" (p. 100). This is a crucial point, with respect to a participation view of learning—learning is not simply construed as joining or entering a community of practice (that is as a one-time event), but rather represents continuous changes in the nature of participation over time. Greeno (Greeno & MMAP, 1998) highlights this point in defining a participant's identity as, "regularities of an individual's activities, in a trajectory that spans participation at different times in a community and participation in different communities" (p. 6), a definition he credits to Wenger (1999).

The Palincsar and Magnusson (this volume) chapter exemplifies some aspects of this view of learning as changing participation. They describe a series of studies involving what they term "second-hand investigations" (p. XXX) in the context of guided inquiry instruction. In these studies, they employed a particular set of teaching materials; a text designed to resemble a scientist's notebook. Palincsar and Magnusson make explicit their view of the classroom as a "community of inquiry" (p. XXX). Inquiry in such a classroom is a form of social practice in which students, in the process of becoming active participants in a community of practice, take up a new set of discursive practices, (we hope) eventually mastering the more precise language and argumentation methods of bench scientists involved in scientific investigations. Legitimate peripheral participation is reflected in the distinction made in the chapter between first-hand and second-hand investigations which might be construed as different modes of participation within a community of inquiry. The pre- and post-test data reported in the chapter are actually more consistent with a view of learning as acquisition, but I interpret this more as a bridge-building move on the part of the authors that does not fundamentally detract from a more generally expressed treatment of learning as a participatory trajectory.

Minstrell's chapter also addresses learning as a change in participation. Though his description of student learning vacillates between a focus on outcome measures (acquisition) and a concern with the learner's changing ability to articulate their physics understanding (participation), his description of his own professional trajectory as a teacher and researcher is more consistently in keeping with a view of learning as a restructuring of relationships within particular communities of practice.

Other chapters also contain hints and suggestions of a participatory view. The Klahr et al. chapter and the chapter by Sandoval and Reiser, for example, describe efforts to construct and sustain scientific communities of practice within classrooms. Similarly, the chapter by Lehrer and Schauble describes students' changing identities as model builders, a practice clearly relevant to becoming a science practitioner. Kalchman, Moss, and Case (chap. 1) also addressed learner identity issues in their discussion of children's acquisition of numeracy. In each case, learning is presented as occurring within a particular social and material setting.

Dewey on Information Processing and Social Practice

Dewey's Notion of Inquiry

I would contend that Dewey could be read selectively to provide support for either information processing theory or social practice theory. This is because, as I will argue, Dewey espoused a broader view of learning and human problem solving that subsumes both of these theories. To see this, let us turn first to Dewey's account of reflective inquiry.

In How We Think, a text written for schoolteachers, Dewey (1989/1933) described what he termed “the five phases of reflective thought”:

> . . . as states of thinking, are (1) suggestions, in which the mind leaps forward to a possible solution; (2) an intellectualization of the difficulty or perplexity that has been felt (directly experienced) in a problem to be solved, a question for which the answer must be sought; (3) the use of one suggestion after another as a leading idea, or hypothesis, to initiate and guide

> observation and other operations in collection of factual material; (4) the mental elaboration of the idea or supposition as an idea or supposition (reasoning, in the sense in which reasoning is a part, not the whole, of inference); and (5) testing the hypothesis by overt or imaginative action. (p. 200)

Though sometimes understood by readers as a linear process, Dewey made clear that these are "phases" not steps. The order in which the phases occur (and reoccur) is indeterminate and the overall process is more recursive than sequential.

Dewey's description, written for a lay audience and stated in everyday terms, highlights a number of issues that concerned Dewey throughout his career. In How We Think, he argued that learning is a process of developing new adaptive "habits," habits that enable us to conduct our lives more easily and more comfortably. Reflective thought is only one of several available means by which new habits can be developed, but it is also a habit itself, one that can, therefore, be developed and fostered through educational activities (Dewey, 1985/1916). This, in fact, was the central function of schools for Dewey—to help students develop robust habits for reflective thinking.

Dewey (1988/1929) developed these ideas further when he wrote: "Thinking is objectively discoverable as that mode of serial responsive behavior to a problematic situation in which transition to the relatively settled and clear is effected" (p. 181). Dewey later introduced a more general term, inquiry, to describe the process of human problem solving, which he (1991/1938) defined as "the controlled or directed transformation of an indeterminate situation into one that is so determinate in its constituent distinctions and relations as to convert the elements of the original situation into a unified whole" (p. 108).

It should be noted that Dewey's definition of inquiry, at least by a casual reading, is not inconsistent with the descriptions of problem solving offered by Newell and Simon (1972). This can be seen most strikingly in his discussion of symbolic reasoning. Dewey (1988/1929) wrote:

> Organic biological activities end in overt actions, whose consequences are irretrievable. When an activity and its consequences can be rehearsed by representation in symbolic terms, there is no such final commitment. If the representation of the final consequence is of

> unwelcome quality, overt activity may be foregone, or the way of acting be replanned in such a way as to avoid the undesired outcome (p. 63).

There are some important differences, however, between Dewey's account of inquiry and the approach to studying problem solving advocated within information processing theory.

Newell and Simon (1972) wrote, "Restricting the discussion to symbolic entities and processes does not severely limit our analysis or problem solving, except at physiological boundaries (e.g., the physiological aspects of sensory and motor skills, especially those requiring real-time action and coordination)" (p. 72), a position that Dewey would contest. He (1988/1929) emphasized that knowledge could not be separated from its contexts of use and wrote: "Knowing is, for philosophical theory, a case of specially directed activity instead of something isolated from practice" (p. 163). Dewey later (1991/1938) stipulated "the position here taken is that inquiry effects existential transformation and reconstruction of the material with which it deals" (p. 161). He acknowledged the possibility and importance of what might be termed the cognitive phases of inquiry, but also stressed that inquiry entails additional phases of observation, testing, and implementation, what Hickman (1998, p. 184) refers to as the "excursus" and "recursus" of inquiry, and can only be understood as a cohesive unit.

Situating Meaning in Conjoint Activity

Dewey (1991/1938) further elaborated his views on the nature of symbol grounding when he wrote:

> [T]he meaning which a conventional symbol has is not itself conventional. For the meaning is established by agreements of different persons in existential activities having reference to existential consequences. . . For agreement and disagreement are determined by the consequences of conjoint activity. (p. 53)

He went on to observe, "Meanings hang together not in virtue of their examined relationships, but because they are current in the same set of group habits and expectations" (p. 55-56) and, as a consequence, "[a] word means one thing in relation to a religious institution, still another thing in

a business, a third thing in law, and so on" (p. 56). Dewey concluded, "Genuine community of language or symbols can be achieved only through efforts that bring about community of activities under existing conditions" (p. 56).

These ideas resonate with certain themes developed in conjunction with social practice theory. Greeno et al. (1998), for instance, argued "Conventions of interpreting meanings of symbols, icons, and indexes are a crucial part of social practices, and attunements to those constraints and affordances of interpretation are a crucial part of individuals' participation in those practices" (p. 10). Wenger (1999) developed this further by observing that the ability to participate in meaning negotiation itself controls the possibility for learning within a community of practice. He contended:

> A split between production and adoption of meaning . . . compromises learning because it presents it as a choice between experience and competence: you must choose between your own experience as a resource for the production of meaning and your membership in a community where your competence is determined by your adoption of other's proposals for meaning. In other words, learning depends on our ability to contribute to the collective productions of meaning because it is by this process that experience and competence pull each other. (p. 203)

By the tenets of social practice theory, learning is conceptualized as a trajectory of changing participation within a community. Producing and adopting new meanings and interpretations is one aspect of practice. It would be consistent with such a theory to study meaning negotiation within a community of practice as a basis for understanding how learning is accomplished.

The point was made earlier that one could not (at least by Dewey's lights) understand inquiry by focusing exclusively on the cognitive aspects of the process. A similar point can be made with respect to studying learning exclusively as a process of social interaction. Dewey would argue that it is not sufficient to understand inquiry purely as an interactional

achievement[2]—a full understanding must include both "the opus operatum and the modus operandi" (Bourdieu, 1990, p. 52) of inquiry.

Transaction: A Third Metaphor for Learning

Toward the very end of his career Dewey jointly published a volume with Arthur Bentley, entitled Knowing and the Known. It was written, among other purposes, to provide a more disciplined terminology for doing behavioral inquiry. In this work Dewey used the notion of inquiry not only as a description of how human problem solving is accomplished, but also reflexively as the means by which all valid understandings are to be developed, including our understanding of inquiry itself.

Dewey and Bentley (1991/1949) elaborated that inquiry can be conducted at three levels or stages of development, namely:

> Self-action: where things are viewed as acting under their own powers.
>
> Inter-action: where thing is balanced against thing in casual interconnection.
>
> Trans-action: where systems of description and naming are employed to deal with aspects and phases of action, without final attribution to "elements" or other presumptively detachable or independent "entities," "essences," or "realities," and without isolation of presumptively detachable "relations" from such detachable "elements." (pp. 101-102)

Self-actional inquiry results in types of pre-scientific explanations employed by primitive cultures as accounts of natural phenomena, though Dewey and Bentley cited examples of self-actional accounts in contemporary writings. Much influenced by contemporary developments in the physical sciences, they viewed classical Newtonian mechanics as exemplifying inter-actional

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[2] I use the term interactional here in the sense in which it is employed in ordinary parlance and not in the special sense in which Dewey (as we will see in the next section) used it in his later works. To make the distinction clear, I will use the hyphenated form (i.e., inter-action) when using the term in the technical sense proposed by Dewey.

inquiry, while they considered the just emerging theories of quantum mechanics to represent a shift toward a trans-actional perspective.

Dewey and Bentley stipulated that transactional inquiry must proceed without pre-established conceptualizations and specifications, that interacting components cannot be studied in isolation except in and for the purposes of forming preliminary and partial descriptions, and that phenomena under study must be researched in full extension, both in space and time. They wrote, "Transaction is the procedure which observes men talking and writing, with their word-behaviors and other representational activities connected with their thing-perceivings and manipulations, and which permits a full treatment, descriptive and functional, of the whole process, inclusive of all its 'contents,' whether called 'inners' or 'outers,' in whatever way the advancing techniques of inquiry require" (p. 114).

With respect to the need to subject human behavior to a more transactional form of analysis, Dewey and Bentley wrote:

> In ordinary everyday behavior, in what sense can we examine a talking unless we bring a hearing along with it into account? Or a writing without a reading? Or a buying without a selling? Or a supply without a demand? How can we have a principal without an agent or an agent without a principal? We can, of course, detach any portion of a transaction that we wish, and secure provisional descriptions and partial reports. But all this must be subject to the wider observation of the full process. (p. 127)

Dewey had introduced the idea of transactionalism in earlier writing. For example, in Experience and Education (1988/1938) he wrote, "An experience is always what it is because of a transaction taking place between an individual and what, at the time, constitutes his environment" (p. 25, emphasis added). In Knowing and the Known (1991/1949), Dewey and Bentley attempted to make this notion more concrete through appeal to the example of a simple sales transaction:

> Th[e] transaction determines one participant to be a buyer and the other a seller. No one exists as buyer and seller save in and because of a transaction in which each is engaged. Nor is that all; specific things become goods or commodities because they are engaged in the

> transaction. There is no commercial transaction without things which only are goods, utilities, commodities, in and because of a transaction. Moreover, because of the exchange, or transfer, both parties (the idiomatic name for participants) undergo change; and the goods undergo at the very least a change of locus by which they gain and lose certain connective relations or "capacities" previously possessed. (p. 242)

This description might be seen as an alternative metaphor for the learning process; one that illustrates that learning is a process that not only transforms the learner, but also the environment within which the learning occurs. Observations, facts, and suggestions become knowledge by virtue of the unfolding transaction between the learner and the learner's environment. The acquisition metaphor, which focuses exclusively on the changes presumed to be taking place within the learner, is like describing a sales transaction as a simple entry on a balance sheet. By the same token, a participatory account of such a transaction would only reveal the socio-interactional aspects of the event. A Deweyan transactional analysis, on the other hand, would subsume both forms of description into a single account.

Toward a Form of Transactional Inquiry into Inquiry

Invoking Dewey is a familiar move in educational writing and I am not the first to suggest that his ideas might be helpful in resolving the divisions within our research community (cf., Clancey, 1993; Greeno & Moore, 1993; Greeno & MMAP Group, 1997), but the conclusions reached here differ slightly from those earlier treatments of Dewey's work. Clancey (1993) cites Dewey in constructing a critique of the symbolic perspective and as support for a more situated view. Greeno (Greeno & MAP, 1997, 1998) cites Dewey in similar ways, but offers a more sympathetic treatment of the cognitive perspective and allows that cognitive forms of analysis could be subsumed under an appropriately conceptualized situated view. Bredo (1994) comes closest to the position being argued here; namely that there is a need for a more pluralistic approach that honors and incorporates both perspectives. That Dewey would endorse such a move can be inferred from his comment in the preface to Knowing and the Known:

> In advancing fields of research, inquirers proceed by doing all they can to make clear to themselves and to others the points of view and the hypotheses by means of which their work is carried on. When those who disagree with one another in their conclusions join in a common demand for such clarification, their difficulties turn out to increase command of the subject. (p. 3)

Boisvert (1998) recounted how the metaphor of philosopher as mapmaker is a recurrent one in Dewey's writing. In the cursory survey presented here, I have attempted to show how certain contributions from Dewey's work might be used as a basis for charting a new direction in research on cognition and instruction. Like a roadmap, Dewey's ideas provide guidance but unfortunately lack detail with respect to how such a research agenda might actually be carried out. Instead, Dewey proposed standards for what would constitute a methodologically adequate account of learning and problem solving, leaving the implementation to others. Information processing theory and social practice theory both address important aspects of Deweyan inquiry though neither alone meets his standards for a transactional account. Developing a more

comprehensive framework, therefore, remains an open challenge for the next generation of researchers as we enter our second quarter-century of research in cognition and instruction.

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