Articles

The Theory of Inquiry: Dewey's Legacy to Education

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THE CRISIS OF CONFIDENCE IN PROFESSIONAL KNOWLEDGE AND EDUCATION

Over the past twenty years, as we have become increasingly aware of a crisis of confidence in the professions, we have experienced a growing skepticism about the beneficence and practical utility of professional knowledge and, with this, a growing unwillingness to grant the professions the autonomy, license, and control they have traditionally enjoyed. At the heart of the crisis of confidence in the professions is a widening gap between thought and action, theory and practice, the academy and the everyday world.[1]

The sources of this gap are rooted not in science or the professions themselves but in a particular *view* of them embodied in the technical rationality inherited from nineteenth-century positivism, according to which instrumental, practical knowledge becomes professional when it is based on the results of scientific research. The research universities—Thorsten Veblen's "schools of higher learning"[2]—are seen as having a mission to produce systematic, preferably scientific knowledge; and the professional schools, Veblen's "lower schools," are seen as having a mission to *apply* such knowledge to the problems of everyday practice. In return for the favor of locating their schools in the prestigious research universities, the professions have accepted what I call the "Veblenian bargain": from the "higher schools," their systematic knowledge; from the "lower," their practical problems. This bargain has had institutional consequences of great importance. It has engendered a normative professional curriculum, based largely on the model of medical education, that begins with the classroom teaching of relevant basic and applied science and ends with a practicum devoted in principle to applying classroom knowledge to the problems of everyday practice. It has also reinforced a radical separation of the world of the academy from the world of practice, according to which the academy holds a monopoly on research, which is considered to be out of place in practice.

Curriculum Inquiry 22:2 (1992)

From these historical processes two dilemmas have resulted.

First of all, there is a dilemma of rigor or relevance, which comes to bear especially on those who consider themselves researchers. A topographical image helps to convey the feeling of this dilemma. One can imagine a cliff overlooking a swamp. Researchers may choose to say on the high, hard ground where they can conduct research of a kind the academy considers rigorous, though on problems whose importance they have come increasingly to doubt. Or they may go down to the swamp where they can devote themselves to the social problems they consider truly important, but in ways that are not rigorous in any way they know how to describe. They must choose whether to be rigorous on the high ground or relevant in the swamp.

Over the past twenty or thirty years, the social and personal costs of this dilemma have become increasingly apparent. In the same period, technical rationality, which is at the root of the dilemma, has come under vigorous attack on the part of such philosophers of science as Thomas Kuhn, Imre Lakatos, Jürgen Habermas, and Paul Feyerabend.[3] In these circles, hardly anyone wants any longer to be considered a positivist. Nevertheless, in everyday institutional life, technical rationality is resurgent. One has only to observe the deliberations of hiring, promotion, and tenure committees in the research universities, deliberations on which the future of the academy largely depends. One has only to observe the behavior of students who anxiously vote with their feet to acquire "hard skills" like statistical analysis and computer programming. Indeed, the contemporary academy is the scene of an epistemological battle, albeit a battlefield of snails (one has to look very closely and patiently in order to see it). As a result of this and related trends, the schools of the professions—not only the ones Nathan Glazer calls "minor," such as education, city planning, and social work, but the ones he calls "major," such as medicine, law, and business[4]—are in a state of ferment.

A second dilemma, very much related to the first, bears especially on practitioners in the field. This might be called the dilemma of abandonment or alienation. There has been, on the one hand, an erosion of practitioners' faith in the ability of academic research to deliver knowledge usable for solving social problems—indeed, a growing suspicion that academic research may actually *exacerbate* social problems.[5] In this sense, practitioners may feel, in relation to the academy, a sense of having been seduced and abandoned. On the other hand, when practitioners accept and try to use the academy's esoteric knowledge, they are apt to discover that its appropriation alienates them from their own understandings, engendering a loss of their sense of competence and control.

Nowhere are these dilemmas more apparent than in the field of education. Here, where professors in the schools and teachers in the schools tend to accept the research university's claim to a monopoly on the generation of new practice knowledge, packages of knowledge, in the form of curricular materials and pedagogical advice, are handed down to practicing teachers as though from the higher school to the lower. And these packages of knowledge tend to conform to the bureaucratically based

epistemology of the schools—a molecular approach to knowledge, progressively arranged from "basic" to "advanced" skills.[6]

According to this view, teaching tends to be seen as a process of delivering information and testing students for its reception and retention. Students tend to be disconnected from the commonplace understandings and competences built into their ordinary commerce with the world. Teachers, likewise, tend to be disconnected from what they already know. They may teach math, for example, in ways that have little to do with how they *do* math; and their descriptions of their own teaching may bear little resemblance to the knowledge they actually reveal when they teach well. Teachers are cut off, then, both from the possibility of reflecting and building on their own know-how and from the confusions that could serve them as springboards to new ways of seeing things.

Teachers, I hasten to add, often rival members of the academy in the tenacity with which they cling to beliefs like these. They often collude in seeing the truth as lying wholly outside themselves, regarding as "higher" the knowledge that appears more general, abstract, and theoretical. In the field of education, it seems to me, it is often difficult or impossible to get down to brass tacks; it is as though concrete examples carried a palpable stigma.

DEWEY'S THEORY OF INQUIRY

Ironically, the greatest American philosopher of education, John Dewey, devoted his life to the project of overcoming the dualisms that afflict the field of education along with the rest of the modern world—the dualisms of thought and action, research and practice, science and common sense, the academy and everyday life. The centerpiece of Dewey's revolt against these dualisms, as against epistemological individualism and the quest for certainty, was his theory of inquiry.

Inquiry, for Dewey, combines mental reasoning and action in the world. His theory of inquiry repudiates both the "autonomy of thought" that had been advocated by the mentalists and the image of the "ladder of knowledge," dear to the ancient Greek philosophers, that elevates abstract theory over practical skills and wisdom in everyday affairs. This ladder of knowledge, which has been so powerful an influence on modern Western thought up to and including Thorsten Veblen's invidious distinction between the higher and lower learning, was in Dewey's belief a vestige of the social class structure built into the Greek society of Plato's time.

It was in *Logic*, published in 1938 and subtitled "The Theory of Inquiry," that Dewey gave fullest articulation to his revolt against epistemological dualism.[7] Here, he went so far as to question the very existence of thought. He wrote:

> Personally, I doubt whether there exists anything that may be called *thought* as a strictly psychical existence . . . [but] even if there be such a thing, it does not determine the meaning of "thought" for logic. Either the word "thought" has no business at all in logic or else it is a synonym of "inquiry" and its meaning is determined by what we find out about inquiry.[8]

Dewey believed that logic is an empirical discipline because it is properly the theory of reflective thought (a term he used, confusingly in this context, as a synonym for "inquiry"). He believed that the meaning of logic could be discovered only by turning inquiry back on itself, that is, by inquiry into inquiry.[9]

Inquiry, as Dewey conceived it, is transactional, open-ended, and inherently social. He thought that inquiry proceeds, as Peirce[10] had said earlier, from doubt to the resolution of doubt. But as Dewey would have it, "*We* are doubtful because the *situation* is inherently doubtful.[11] Inquiry begins, Dewey believed, with an indeterminate (i.e., confusing, obscure, or conflictual) situation and goes on to make that situation determinate. The inquirer does not stand outside the problematic situation like a spectator; he is *in* it and *in transaction with* it.

Both doubt and its resolution are transactional properties of a continuing and inherently open-ended relationship between the inquirer and the situation. Inquiry "does not merely remove doubt by recurrence to a prior adaptive integration" but "institutes new environing conditions that occasion new problems," with the result that "there is no such thing as a final settlement."[12]

Dewey believed that scientific inquiry grows out of and returns to common sense. "The scientific theory of colors and light is extremely abstract and technical," he wrote, "but it is *about* the colors and light involved in everyday affairs.[13] Science and common sense are distinguished from each other, not by their epistemologies, but by their particular purposes and subject matters: the *pattern* of inquiry is the same in both.

In science and common sense alike, Dewey thought, inquiry is inherently social. Like Peirce before him, he saw individual inquirers as members of *communities of inquiry*,[14] bound by community responsibilities of a contractual nature. He wrote that an inquirer enters into a "*contract* such that . . . [he] is committed to stand by the results of similar inquiries. . . ."[15]

With its emphasis on the situational, the transactional, the open-ended, and the social, Dewey's theory of inquiry is an appealing antidote to the dualisms that plague the field of education. Nevertheless, we should beware of accepting it precisely as he left it to us. A child of his time as well as a prophet who looked beyond his time, Dewey wished to heal the split in the commonsense world between parts affected and unaffected by "scientific method." He reveals, at least in *Logic*, a faith in the progress that can be achieved by applying to human, social, and political problems the methods that he thought had worked so well in fields like metallurgy, agronomy, and medicine. As a consequence, he does not attempt the difficult task of explaining how the methods of the natural sciences are like and unlike the methods of commonsense inquiry, nor does he satisfactorily differentiate the kinds of rigor appropriate to each of them.

Moreover, Dewey treats human inquiry as continuous with the biological transaction between organism and environment, hoping in this way to establish an objective basis for describing both what is problematic about problematic situations and what is determinate about their resolution. As a consequence of his biological strategy for warding off the specter of relativism, Dewey never fully confronts the *ontological* differences in our

ways of seeing situations and construing them as problematic or not (differences whose importance I shall discuss later in this article). He is not *constructivist*, along the lines laid out by thinkers like Jean Piaget and, more recently, Nelson Goodman.[16] He is well aware, it is true, that our constructed problems determine what facts we select for attention, and that our ways of constructing problems from problematic situations are subject to variation from culture to culture, person to person, time to time, and context to context. He appears, however, to hold a robust belief that "observed facts" being just what they are, judgments about problems can be tested against them.[17]

When I was a graduate student at Harvard in the 1950s, my friend, Chester, urged me to read Dewey. But when I tried to do so, I found him muddy and unintelligible. Later on—I am not sure how—I saw that Dewey's was a *generative* muddiness: he was trying to say new things that were bound to seem muddy to anyone trained as I had been in the logical empiricism fashionable at the time. *Logic*, which I took as the basis for my doctoral thesis, was the book that changed my mind about Dewey. Some thirty years later, in the midst of writing *The Reflective Practitioner*, I realized that I was reworking that thesis, now on the basis of empirical studies of professional practice that would have been out of order in the Harvard philosophy department of the mid-1950s. I was attempting, in effect, to make my own version of Dewey's theory of inquiry, taking "reflective practice" as my version of Dewey's "reflective thought."

Here I shall revisit and further develop the idea of reflective practice, in the spirit of Deweyean inquiry that seeks to integrate thought and action, theory and practice, the academy and the everyday world, but also in the spirit of a constructivist approach to the variety of ways in which we construct the reality of problematic situations. I shall describe *designing*, understood as reflective conversation with the materials of a situation, as the core of practice, and I shall consider *teaching* in the light of lessons from designing. And finally, in the spirit of Dewey's recognition of practitioners as inquirers, I want to explore how we might think of research—especially educational research—as *inquiry-enhancing*.

Along the way, I shall try to clear up certain confusions—some of which I may have helped to create—that have made it too easy to read my proposals as support for business as usual in the academy.

REFLECTIVE PRACTICE AND THE REFLECTIVE TURN

When we attend to what we know already, appreciating the artistry and wisdom implicit in competent practice, believing that by reflection on that practice we can make some of our tacit knowledge explicit, we take a "reflective turn"[18] that leads us to see students and teachers (at their best) as participants in a kind of reflective practice, a communicative and self-reflective practice of reciprocal inquiry.

In this section, I shall proceed step-by-step to describe increasingly complex components of reflective practice: knowing-in-action, reflection-in-action, and reflective conversation with the situation. I shall then consider designing and teaching as modes of reflective conversation with the situation.

Knowing in Action

By *knowing-in-action* I mean the knowing built into and revealed by our performance of everyday routines of action. This is not inquiry, in Dewey's sense of the term, because the situation of action is not problematic; the smooth flow of action is not interrupted by surprise. We display knowing-in-action in the exercise of physical skills like walking, crawling, bicycle riding, and juggling; but we also reveal it in such ordinary activities as getting around the neighborhood, working familiar problems in math, and managing our everyday interactions with other people. Knowing-in-action is sometimes labeled "intuition," "instinct," or even "motor skills." Whatever we call it, we are bound to recognize it as a form of intelligence, for in such cases we continually control and modify our behavior in response to changing conditions, as when, in driving an automobile, we continually make small adjustments to follow the directions and contours of the road. Knowing-in-action draws on *prestructures*, about which I shall presently have more to say, that guide our seeing, thinking, and doing in familiar situations.

Knowing-in-action is located not only in the actions but also in the objects in relation to which we act. It is through our commerce with familiar objects that we gain access to what we know. As Sylvia Scribner observed in her landmark study, experienced milkmen fill orders for milk products not so much by counting up the items in an order as by recognizing the patterns made by full and empty cells in the box.[19] The box functions for them, in Seymour Papert's phrase, as a "thing to think with."[20]

Knowing-in-action often takes the form that Jeanne Bamberger and I have called a "felt path": as we type on a keyboard or play a musical instrument, for example, our performance follows a pattern of next-next-next.[21] We move through the performance, from one position to the next, as though we were walking along a path, finding our way from landmark to landmark. At each position along the way, we know what to do next. Yet we may be unable to skip a step, or work our way backwards, or visualize the path as a whole in its intersection with other paths. In order to gain access to such felt-path knowledge, I must put myself, actually or virtually, into the situations where the routine can be executed. Take me out of the situation and what do I know?

Much of our knowing-in-action is tacit, in Michael Polanyi's sense.[22] Often we find that we cannot say what we already know how to do, or we give descriptions of it that turn out to be inaccurate—as with a juggler who says he "tosses" the ball when he actually "passes" it. Yet we can learn to observe, reflect on, and describe our knowing-in-action, and we can test such descriptions—for example, by writing out instructions for performance and observing what happens when other people try to follow them.

Reflection-in-Action

What we already know how to do includes a remarkable ability to take note of surprise and respond to it—to be puzzled, uncertain, or doubtful, if

only momentarily, and to respond smoothly through on-the-spot experiments.

The word *reflection* in the phrase "reflection-in-action" suggests—misleadingly, from my point of view—that reflection-in-action involves what Hannah Arendt calls a "stop-and-think,"[23] a pause during which we think back on what we have done, reasoning about it verbally. But the reflection I have in mind here takes place in the midst of action, in what I call the action-present, and it need not employ the medium of words. Think of a basketball player's instant maneuvering in response to an opponent's surprising move, or a jazz pianist's on-line improvisation on the melody she has just heard the trumpet play. Such performers think of what they are doing while doing it, without the use of words. On the other hand, some reflection-in-action *is* verbal, like the improvisations that make up a good conversation, falling somewhere between the boredom of repetitive routine and the insanity of utter unpredictability.

Whether in its verbal or nonverbal mode, reflection-in-action is centrally important to the artistry of competent practitioners, such as athletes, musical performers, teachers who try to make on-the-spot sense of their students' unexpected questions, and physicians who, in Erik Erikson's phrase, treat each patient "as a universe of one."[24]

Reflection-in-action has received surprisingly little research attention. But this is explained by its very nature. It is an ephemeral episode of inquiry that arises momentarily in the midst of a flow of action and then disappears, giving way to some new event, leaving in its wake, perhaps, a more stable view of the situation. We tend to "wipe it out" as soon as it is over, like the error one makes and quickly forgets on the way to discovering the solution to a puzzle.

Conversation with the Situation

The term *conversation with the situation* refers to a type of reflection-in-action understood from Dewey's transactional perspective. Here, an inquirer, in transaction with the materials of a situation, encounters a surprise in the form of "back-talk" that momentarily interrupts action, evoking uncertainty. The inquirer goes on to transform the situation in a way that resolves uncertainty, at least for the moment. Edmund Carpenter, for example, has described an Inuit sculptor scraping away at a reindeer antler with his knife, examining the bone now from one angle, now from another, until he cries out, "Ah, seal!"[25] The inquirer is *in* the situation, influenced by his appreciation of it at the same time that he shapes it by his thinking and doing—in Dewey's words, "instituting new environing conditions that occasion new problems."

The term *conversation* is, in this usage, metaphorical. It does not refer to a literal conversation *about* the situation but to an inquirer's conversation-like transaction with the materials at hand. Such a conversation need not be accompanied by explicit self-awareness, though it may be, or may come to be when it is subjected to retrospective reflection.

Reflection on Knowing- and Reflection-in-Action

This is Hannah Arendt's stop-and-think. Here, thought is turned back on itself, either on the knowing-in-action revealed by a pattern of behavior or on the reflection-in-action that reshapes understanding in the midst of action.

The basketball player, when he watches on Monday morning a videotape of the game he played on Saturday night, may observe and reflect on his clumsy response to the defenseman's surprising move. The jazz musician may listen to a recording of a set he has played, pausing to consider what he did with the tune at a particular moment, how that "worked" or failed, imagining what else he might have done. And the teacher, perhaps on the way home from school, may replay in the privacy of her own mind both the strange question her student asked in class that morning and her own immediate response to it, sensing that she had not fully grasped the meaning of the question, considering what she might have said or done in order to discover its meaning.

Reflection on knowing- and reflecting-in-action is a process of getting in touch with the understandings we form spontaneously in the midst of action. It is central to the work of criticism, coaching, learning, and teaching. A good dance teacher, for example, may ask herself, as she tries to describe a new move to her student, "What do I really do at this point?" In order to answer such a question, she must observe herself in the doing, and in order to communicate what she discovers, she must describe it; there is an art of description distinct from the art that may be involved in the action described.

Reflective Conversation with the Situation

This is Deweyan inquiry, mediated by conscious reflection on the situation and, at the same time, on one's way of thinking and acting on it. As conversation with the situation is a version of reflection-in-action, so reflective conversation with the situation is a version of reflection on reflection-in-action—a version undertaken in the situation of action itself.

Reflective conversation with the situation may occur in the mode of discovery, or in the mode of design, or in hybrid forms that combine the two.

In the mode of discovery, one inquires mainly in order to make sense of some puzzling phenomenon. Inquiry's end-in-view is a workable understanding. But one must first attend to phenomena in such a way as to allow an experience of surprise to occur; one must have, as Barbara McClintock put it, "the time to look, the patience to 'hear what the material has to say to you', the openness to 'let it come to you'. . . ."[26]

Reflective conversation with the materials of a situation can also occur mainly in the mode of *designing*—a term I use here in a very broad sense to include both what architects, industrial designers, engineers, and other members of the "design professions" do, but also what all of us do insofar as we make things out of the materials of a situation under conditions of complexity and uncertainty.

I dwell on designing for two reasons. First of all, designing, in the narrower sense proper to the design professions, offers a vivid way of understanding what Dewey meant by *transactional* inquiry—inquiry shaping and then shaped by a problematic situation, "institut[ing] new environing conditions that occasion new problems." Second, designing in its broader sense constitutes the core of practice in all professions, occupations, and everyday living. As Herbert Simon has taught us, practitioners are of necessity designers;[27] the production of artifacts—a manager's policy, a lawyer's brief, a physician's diagnosis—is essential to their business. Hence, an epistemology of practice must be an epistemology of *designing*.

A close look at a small, homely example of designing, in the narrower sense, will give us a parable of design practice, and will enable us to explore what it would mean to treat practice in general as a reflective conversation with the materials of a situation.

A HOMELY EXAMPLE OF DESIGNING

Imagine a workshop/classroom at MIT. As part of a course on designing and learning, taught by Jeanne Bamberger and myself, four MIT undergraduates—Rex, U-Chin, Mimi, and Bob—were asked to work with construction systems. They were given the task of "building something they like," using each of the three systems in turn: LEGO, Tinkertoys, and a new system called "Modula," recently invented with an eye to its use in engineering design courses. The three sets of materials were located at different places in the room, and each of the students moved from one station to another, spending half or three-quarters of an hour at each.

In one sense, the four students had access to the "same" materials. On the other hand, because each student saw the materials in a special way and choosed to focus on different elements, features, and relationships, he or she worked with a *unique* technical universe. In each case, the student's strategies of selective attention, ways of seeing things, and likings or dislikings determined the choice of modules and connectors out of which larger aggregates were made.

For example, although there were tubes in the Modula set, Mimi and Bob did not use them at all and U-Chin used them as though they were rigid beams. Only Rex took advantage of their flexibility (see figure 1).

U-Chin found the blue cubes and the club-shaped connectors, fitting a connector into a hole on each surface of the cube. That arrangement struck him as "neat," and he proceeded to replicate it, treating it as the basis of his building system. Rex also found the cube, but he made bricks out of Modula elements and attached a brick to each surface of the cube. Bob made his own version of brick-based modules and strung them together on rods (see figure 2).

The choice of modules was associated at times with different interpretations of the task. For example, whereas Bob and Rex made Modula bricks, connecting them together to assemble their structures, Mimi used

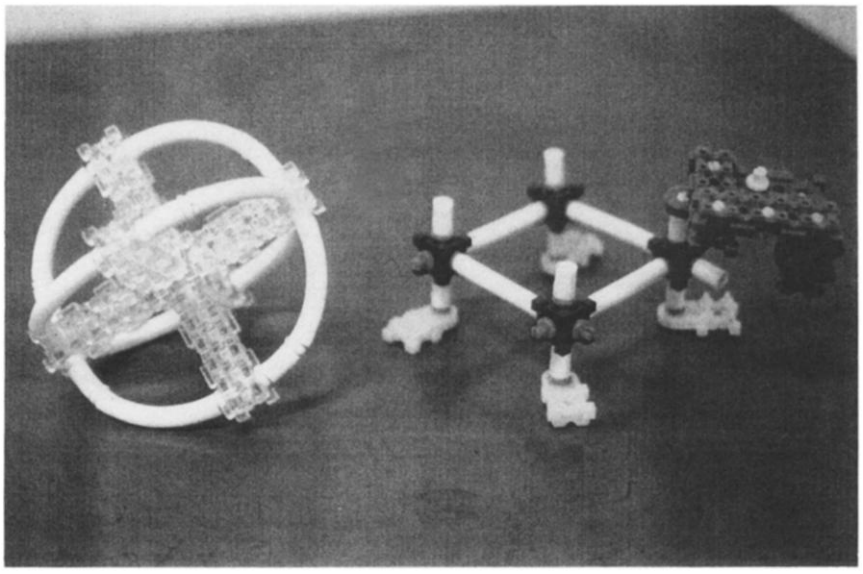

FIGURE 1

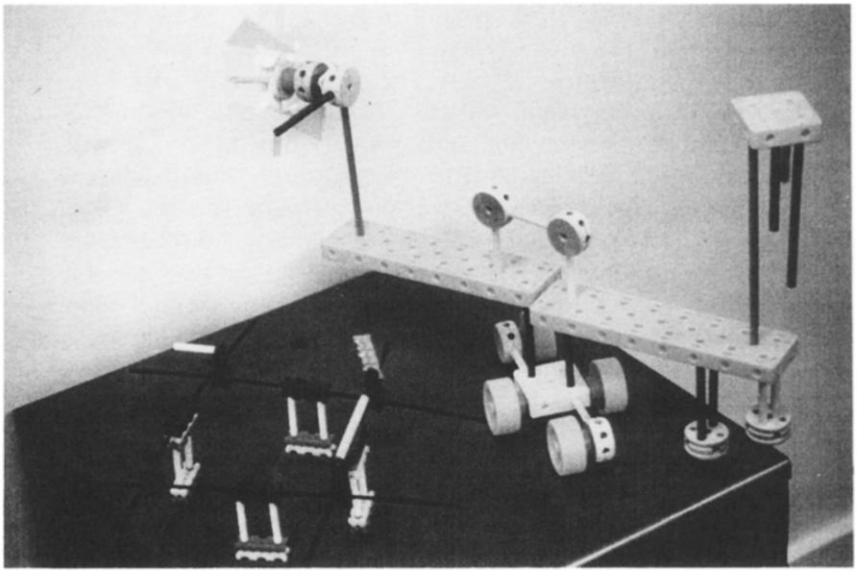

FIGURE 2

the Modula pieces more or less as they came because, as she said, she "thought we were supposed to." She built her structure piece by piece in situ (see figure 3).

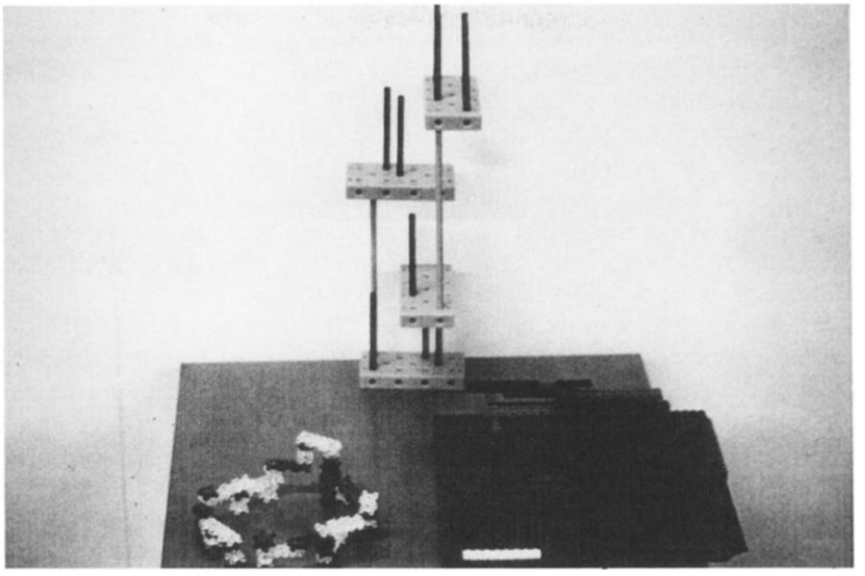

FIGURE 3

The students' interpretations of the task were shaped, in part, by their views of the materials, tools, and possible fabrication processes; and their views were linked, in turn, to their likings and dislikings. For example, a hammer included in the Modula set could be used to join male and female pieces into bricks. Bob and Rex used it in this way, but Mimi and U-Chin chose not to. Mimi said that using the hammer would be like "cheating," U-Chin did not like the idea of making permanent connections, and both of them said they didn't like the noise.

What the students chose to make, and how they chose to make it, were influenced by *prestructures* they brought to the building process: familiar models and prototypes that shaped their views of materials, their interpretations of the task, and their images of a completed product. Mimi said, for example, that she was "trying to make the Modula pieces into LEGOs." She had made her LEGO structure first; indeed, she put her Modula structure on a LEGO base. She also said that she was playing in all three cases with "architecture" (she was the only student majoring in that discipline). She pointed out that her LEGO and Modula structures contained versions of a "monumental arch."

Based on familiar prestructures, ways of seeing things, strategies of selection, and interpretations of the task, each designer carried out, in closely coupled interaction, a *double* design process. Each one made, from the given technical universe, a construction system of his own, a personal *design world*; and within this world, each one built a particular structure.

Individual likings and dislikings—"appreciations," as Dewey would say—were essential to the double design process. As the students played with

the materials, they made appreciative judgments, finding things "interesting," "neat," "noisy," or "disagreeable," for example. In this way, they selected a few elements, features, and relationships from the daunting array of possibilities.

Appreciations varied from designer to designer in a way that was, in one sense of the term, arbitrary. Bob and Rex liked using the hammer, for example, and Mimi and U-Chin did not. It seems inappropriate (and ungrateful) to say that either pair was right or wrong. In another sense, however, the students' appreciations were not arbitrary. For one thing, appreciations tended to be keyed to particular discoveries. For example, Mimi found that connecting individual Modula pieces with clublike connectors made "twisty" joints that she "allowed herself to use" because "that would be neat." Moreover, the students' appreciations were consistent across construction systems, and each such pattern of appreciations was associated with a readily identifiable style of building. We found that, without knowing ahead of time who had made what, we had no trouble identifying the three structures attributable to each builder.

Once the designer had formed appreciations of the materials, and embodied them in construction modules, the character of the building process changed. Rex, for example, had chosen to make bricks and had assembled them in a three-dimensional cross around a single cube. He found, then, that he wanted to interconnect the ends of the cross. Now he had a *problem*, and he began to work in a problem-solving mode, searching for suitable connectors. Finding no rigid pieces of the right size, he got the idea of using the tubes. Because he saw them as flexible, he could readily use them in this way; or perhaps he came to see them as flexible as he searched for a way to solve this problem. In any case, he soon discovered that the tubes were not of the right length to serve as connectors. But he invented a way out: he linked short and long tubes to make connectors of the right size.

Something like this also happened to Mimi. Once she set about making a LEGO-like Modula structure, she wanted to get male pieces to sit evenly at the same level so that she could lay female beams on top of them. She searched for small pieces to use as "shims" and found a way of using the cubes for this purpose.

The students' problem solving began with an interruption in the flow of activity: they were unable to keep on building to get what they intended or liked. The appreciations they had formed in the course of playing with the materials had furnished them with a new set of functional requirements, which they could *not* satisfy arbitrarily. Regardless of Rex's likes or dislikes, for example, a given piece of tubing would, or would not, serve to connect the ends of his cross.

Once Rex and Mimi had accepted functional requirements, and thereby set problems for themselves, they could go on to solve the problems and could tell when they had done so. Their "stopping rule" seemed to be that designing came to closure when the problems they had set were solved. Moreover, their solutions could be judged adequate or inadequate with *objectivity*, in an important sense of that term (independence of

"think-so"); and *rigor*, or the lack of it, could be attributed to their processes of search and experimentation. Paradoxically, it was their subjective appreciations that enabled them to make sense of what would otherwise be a mess and to construct design worlds in which the problems they had framed could be said, objectively, to be solved.

All of the above negates a widely accepted theory, held by Simon, among others, according to which designing consists in heuristic search within an *initially given* "search space."[28] According to this view, designing is an information-processing task that begins with objective "inputs." In contrast, the parable of designing sketched above highlights that designer's active role in constructing, prior to what are usually considered design inputs, a personal design world. It emphasizes the construction of coherence through play and appreciative judgment. But it also reinstates, *within* personally constructed design worlds, a view of problem solving and experimentation that is objective and potentially rigorous.

Once we see the strength of a constructivist understanding of design practice, however, we are left with a critically important question: How is it possible to communicate across different design worlds? For example, as the students in the class described above inspected each other's work and talked together about what they had done, one could detect an incipient movement toward a sharing of appreciations and toward a formation of a collective design world. In short, one could detect the beginnings of a *community of inquiry* of a type that is sometimes found fully developed in architects' offices. How does such a thing come into being?

This question throws an interesting light on learning and teaching.

Designing and Learning

Designing and discovering are closely coupled forms of inquiry. Because learning is essential *to* designing, there is a great potential for learning *through* designing. The design process opens up possibilities for surprise that can trigger new ways of seeing things, and it demands visible commitments to choices that can be interrogated to reveal underlying values, assumptions, and models of phenomena.

For example, Mimi, Rex, U-Chin, and Bob might, as they reflected on their work, become aware of how their choices of modules and connectors influenced the kinds of structures they produced. They might—and, to some extent, did—become aware of their diverse design worlds, styles of building, and images of a desirable product. Perhaps most important, they might learn to see more deeply into what some design instructors call "the problem of this problem"—the nature of the set of conflicting requirements whose interplay, within a given design world, sets the terms for a design solution. Initial designing may serve in this way as a source of learning preparatory to later designing: having learned, through early probes and experiments, something about the nature of the problem, the designer may go on to make final design commitments of a very different kind than he or she had tried up to that point. Indeed, an entire design project may sometimes function as preparation for the execution of future

projects. When a designer reflects on the strategies and assumptions that underlie her choices, daring to disrupt them, she may learn critically important things about *herself.* Mimi, for example, might learn, by reflecting on her work, how she had confined herself unawares to a particularly narrow and untested conception of the task at hand. U-Chin, considering his uses of materials in relation to Rex's, might become aware of possibilities for expanding his vision of the technical universe.

These are ways in which designing includes, or stimulates, learning. It is also fruitful, however, to think of learning—in the mode of puzzle or problem solving—as a kind of designing. Let us consider, in this regard, Max Wertheimer's well-known analysis of the problem of finding the area of a parallelogram.

Wertheimer points out[29] that how one *sees* the parallelogram opens up, or constrains, the paths to a possible solution. He found that some people to whom he gave the problem arrived at a vision of figure 4 that contained the two triangles, *AED* and *BFC.* If you see these triangles in the figure, and see, further, that the first can be moved over to fill the "hole" of the second, then you can see the parallelogram as a version of a rectangle whose area you can find by multiplying base times height. Moreover, you cannot understand the problem-solving instruction—"Drop an altitude from point *A* and multiply it by the base, *DC*"—in such a way as to apply it to parallelograms in a variety of different orientations, *unless* you see the figure in this way.

Some people saw the figure in this way and some did not, and some people who did not see it in this way at first came later on to do so. One might say that, in some sense, the triangles are "there" in the parallelogram to be seen. From the point of view of the phenomenology of problem solving, however, the triangles are there and interchangeably there, only when one has constructed a problem-solving world (analogous to the design worlds described above) in which they exist.

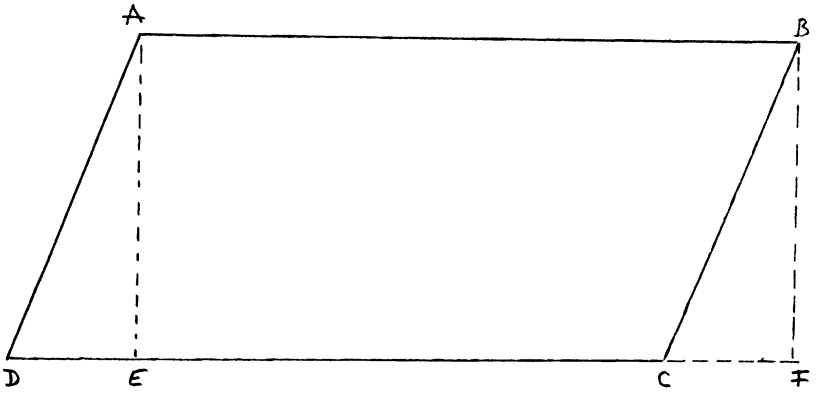

FIGURE 4

Working such a problem involves, again, a double design task. It is essential that the inquirer restructure the situation—including the figure and the "problem" and the relations of figure and problem to familiar prototypes—in such a way as to open up new problem-solving paths. Then, he or she can follow one path through to solution.

The construction of a problem-solving world is an achievement in itself. The perceived figure of the parallelogram, with its interchangeable triangles, is something the problem solver arrives at through work on the problem; to read it back onto the figure initially given constitutes a species of cognitive historical revisionism that wipes out a crucial component of the problem-solving work.

Teaching as a Reflective Conversation with the Situation

From the perspective of designing as learning and learning as designing, the teaching/learning process could be seen, at its best, as a collaborative, communicative process of design and discovery. We would see it, then, in David Hawkins's words,[30] as a "dialogue of I, thou and it," a dialogue within which teachers and students would be designers in several respects. In relation to "it"—the material at hand—they would seek to design a way of framing the situation that opens up paths to solution. In relation to each other, "I" and "Thou," they would face a problem of communicating across divergent design or problem-solving worlds; their task here would be to create and sustain a community of design inquiry. This is the meaning I would like to reserve for the term "reflective teaching."

A student in such a classroom might try to make sense of an unfamiliar problem or puzzle, asking, for example, "How can I discover what this teacher means by what she says and does? How can I discover the way of seeing things that underlies her messages to me? And how—especially when I am stuck—can I discover how *I* am seeing these materials, this situation? How do I become aware of alternate ways of seeing them that yield other possible paths to a solution?" A teacher, struggling to help her students make new sense of the material, would try to see things from the position of "that kid over there." She would ask herself, for example, "How must that kid be seeing things in such a way as to lead him to say and do these things? What possibilities, and what limits, inhere in his way of seeing?" The teacher would try then, as Jeanne Bamberger and Eleanor Duckworth have put it,[31] to "give the kid reason." She might then go on to help the kid discover other ways of seeing things, other paths to solution, especially the privileged views and paths embedded in "school knowledge." She might coach him to build up *multiple representations* of phenomena and cultivate the ability to move back and forth among them. In order to do this, she would need to interrogate her own understandings and hang onto her own present or past confusions and the steps by which she may have arrived at a new and fruitful way of seeing things.

What Jeanne Bamberger and I did, in the MIT class described above, included some—but not all—of the elements of such an approach to teaching. Our aim was to set up a situation in which the students could

discover some important things about their own ways of designing and to open up the range of possibilities accessible to them; we were not interested at this point in exposing them to "expert knowledge" about designing. We paid careful attention to their products and their ways of building, and we encouraged them to do likewise. We asked them to think about and describe what they had done. We focused on similarities and differences in their ways of working, from project to project on the part of the same student, and from one student to another. We encouraged them to reflect on the appreciations and assumptions that underlay their different structures, and we urged them to explore how—confronted with the "same" task and the "same" materials—they could have produced such different products.

In reflective teaching, as I mean it here, teacher and student engage in a reflective conversation with the situation, which takes the form of communicative design inquiry. They inquire into the materials, the situation, the problem at hand. From the materials and from one another they sometimes get back-talk that makes them rethink their understandings of what is going on. They reflect on their own and one another's ways of seeing these things, and strive—at best, through reciprocal reflection-in-action—to communicate about them. Whatever lessons they may learn about the problem at hand—parallelograms or construction systems, for example—they also learn something about inquiry into inquiry.

SOME IMPLICATIONS FOR EDUCATIONAL RESEARCH

When teachers become on-the-spot researchers, in the sense I have just described, what roles should university-based educational researchers play? I suggest that, in the first place, they should join in collaborative studies aimed at helping teachers reflect on their own teaching and learning, seeking to stimulate teachers' inquiry into their own work, or to join and enhance inquiry already under way. In the second place, they should develop frameworks, materials, and experimental environments in support of such reflection. In all such cases, they would look at teaching practice as a context for *generating*, not only for *applying*, usable knowledge.

Let me illustrate briefly. Although my proposals are far removed from mainstream educational research, a small but significant number of researchers have been moving steadily in these directions for some time (indeed, they have helped to shape my own thinking about these matters).

Earlier in this paper, I have referred to research carried out by Jeanne Bamberger, Eleanor Duckworth, and David Hawkins. Together, in the early 1980s, Bamberger and Duckworth carried out the Teacher Project, in which they worked with a small group of elementary school teachers in Cambridge, Massachusetts.[32] They were inspired, at least in part, by the much earlier work of David Hawkins, who had been, in his own words, "a scientific amateur and philosopher of science [who tried to help] in the recasting of subject matter for young learners" and suspected that he "indeed might learn a good deal about himself in the process."[33] Bamberger and Duckworth wanted to engage the teachers in apparently

simple tasks—studying the behavior of a ball rolling down an inclined plane, building a tune with the use of Montessori bells, describing and theorizing about what Duckworth called "the habits of the moon"—in order to help the teachers get in touch with their own ways of thinking about these phenomena and their own ways of learning the subject matter they were helping students to learn. These researchers believed that teachers needed to be helped to think about how they themselves learned if they were to teach in such a way as to "give kids reason." It is of the essence of their research that it illustrates reflective teaching at the same time that it illustrates research in support of such teaching.

In more recent years, both Bamberger and Duckworth have gone on to pursue lines of investigation opened up by the Teacher Project. Duckworth's *The Having of Wonderful Ideas*[34] documents her persistent commitment to the notion that, by joining teachers in the exploration of puzzling phenomena and minimizing recourse to expert knowledge, she could help teachers uncover and live through their own fruitful confusions and thereby "discover that they have a brain."

Bamberger's recent work has centered on "The Design Lab" at the Graham-Parks School in Cambridge. This project Bamberger has described in the following terms:

> The Lab was created in an effort to address a poorly understood but well-recognized phenomenon: Children who are most successful, even virtuosos, at using their hands to build and fix complicated things in the everyday world around them (bicycles, plumbing, car motors, musical instruments . . .) are often the same children who are having the most difficulties learning in school. These children are frequently identified as having trouble in working with common symbolic expressions—numbers, graphs, music notation, written language—the "privileged languages" that form the core of schooling. With the emphasis in schooling on symbolic knowledge, it is not surprising that attention focuses on what these children *cannot* do, and it is also not surprising that the school world sees them not as virtuosos but as "failing to perform."
>
> Starting from a different assumption, namely that "hand knowledge" and "symbolic knowledge" constitute equally powerful but different and not equally appreciated ways of organizing worldly phenomena, I asked first: How can we gain insight into the kinds of knowledge and especially the *ways of learning* that children bring with them from the world outside the school? And second, if we could better understand the kind of knowledge children bring to what they do so well, could we also help them use this knowledge not as a *deterrent* but rather as a *source* for achieving success in the kind of learning and understanding that is expected of them in the classroom?[35]

Both Bamberger and Duckworth have concentrated, in their collaborations with teachers, on the substantive understandings of subject matter held by both teachers and students and on processes by which both may be helped to see things in new ways. Other researchers have concentrated on helping teachers to uncover and reflect, not on particular materials or phenomena, but on pervasive difficulties or dilemmas in classroom teaching or in relations with parents or administrators. How, for example, is it possible to maintain classroom discipline without becoming a jailor? How can a teacher gain parents' effective cooperation in encouraging children to read? Such researchers explore how teachers cope with issues like these, on

the basis of what underlying understandings and strategies exist, and with what consequences. In one such case, two researchers—Tom Russell and Hugh Munby—have conducted long-term studies of the development of novice teachers, following the teachers' evolving approaches to the dilemmas of the classroom.[36]

Educational researchers may collaborate with teachers in studies that hitch onto puzzling or troubling issues in the life of an entire educational institution. Norman Newberg, for example, has carried out a long-running intervention that took as its starting point the problem of dropouts in the Philadelphia school system.[37] Newberg's work was a version of the kind of action research pioneered many years ago by Kurt Lewin,[38] where the researcher joins practitioners—for example, teachers, students, parents, and administrators—in an experimental approach to issues, like the dropout rate, with which they are centrally concerned. In Newberg's project, the inquirers began with a vague sense of worry or trouble, conducted explorations that helped them to formulate a manageable problem, and proceeded to design, implement, and evaluate a series of intervention experiments. In this process, they came to question assumptions that had been built into their own practice (assumptions, for example, about who and what was mostly to blame for dropouts) and came to invent some midlevel theories they could use to make sense of their confusing, frustrating, and stressful world.

In such a project, collaborative inquiry aims at a kind of organizational learning: the participants join in trying to reunderstand and solve a critically important problem and, if they succeed, leave a residue of usable organizational knowledge. One could imagine a highly general version of an action research project of this kind: it would address the question of creating and sustaining a school environment conducive to reflective teaching.

If educational researchers were to move in directions like the ones sketched above, they would need—indeed, they would be likely to invent—a variety of tools, frameworks, and experimental environments supportive of their inquiries. They would need, for example, to learn to tell good stories about their interventions, case studies of their practice that could serve as prototypes for others' replication and transformation. (The case studies included in *The Reflective Turn* aim at providing examples of such stories.)

They would need to develop learning environments conducive to the sort of teaching and learning that consists in reflective conversation with the situation—environments designed to help learners discover how they already see things and to confront them with surprises that trigger the search for new ways of seeing things. Some of these environments would contain materials for hands-on use, like the building systems described earlier in this article; some of them might employ the computer in what Seymour Papert calls its "microworld" embodiment.[39] Some of them, like Bamberger's Design Lab, would combine the two kinds of environments.

Educational researchers would also need access to studies that provide languages and frameworks for describing the prestructures built into

students' and teachers' knowing- and reflection-in-action, and for describing and analyzing the processes by which prestructures are, on occasion, transformed. Studies of the kind I have in mind, epistemological in their orientation and close to the phenomena of inquiry, are exemplified by some of the writings of Dewey, Piaget, and the neo-Piagetians,[40] Vygotsky,[41] Wertheimer, Wittgenstein[42] (who was a reflective and inventive teacher before he achieved fame as a philosopher), and Hawkins. For educational researchers who seek to move in the directions I have been describing, the point of reading the works of authors like these is not only to assimilate their languages and frameworks but, as Duckworth once observed about one of them, "to become Piaget."

I believe that John Dewey, if he were alive today, would approve the sketch of educational research I have just proposed. But, of course, Dewey remains alive for us insofar as we are inspired to rethink and renew the meanings of the ideas he planted so long ago in the subsoil of our minds.

NOTES

1. This article is based on the John Dewey lecture I presented at the April 1990 meeting of the American Educational Research Association.

The material in this introductory section comes from Donald A. Schön, *The Reflective Practitioner* (New York: Basic Books, 1983), and Donald A. Schön, *Educating the Reflective Practitioner* (New York: Jossey-Bass, 1987).

2. Thorsten Veblen, *The Higher Learning in America* (1918; reprint New York: Hill and Wang, 1962).

3. See, for example, Kuhn's *The Structure of Scientific Revolutions* (Chicago: University of Chicago Press, 1962); I. Lakatos and A. Musgrave, eds., *Criticism and the Growth of Knowledge* (Cambridge, England: Cambridge University Press, 1970); Jürgen Habermas, *Knowledge and Human Interests* (Boston: Beacon Press, 1971); and Paul Feyerabend, "Explanation, Reduction and Empiricism," in H. Feigl and G. Maxwell, eds., *Scientific Explanation, Space and Time*, Minnesota Studies in the Philosophy of Science, vol. 3 (Minnesota: University of Minnesota Press, 1962), 60–61.

4. Nathan Glazer, "The Schools of the Minor Professions," *Minerva*, 1974: 346.

5. In addition to my two books, previously mentioned, see Joseph Gusfield, "'Buddy, Can You Paradigm?' The Crisis of Theory in the Welfare State." *Pacific Sociological Review*, 1979, 22(1): 3–22.

6. This point has been argued, with eloquence, by Jeanne Bamberger and Eleanor Duckworth. See, for example, Duckworth's *The Having of Wonderful Ideas* (New York: Teachers College Press, 1989) and Bamberger's *The Mind Behind the Musical Ear* (Cambridge, MA: Harvard University Press, 1991).

7. John Dewey, *Logic: The Theory of Inquiry* (New York: Holt, Rinehart and Winston, 1938).

8. Dewey, *Logic*, 21.

9. Ibid.

10. Charles Sanders Peirce, "The Fixation of Belief," in C. Hartshorne and P. Weiss, eds., *Collected Papers* (Cambridge, MA: Harvard University Press, 1931–1935).

11. Dewey, *Logic*, 106.

12. Ibid, 8.

13. Ibid, 71.

14. See Peirce, "Lectures on Pragmatism," in *Collected Papers*, V.

15. Ibid, 18.

16. See Jean Piaget, *The Language and Thought of the Child* (New York: Meridian Books, 1955), and Nelson Goodman, *Ways of Worldmaking* (Indianapolis: Hackett, 1978).

17. This (perhaps questionable) attribution can be supported by reference to Dewey's treatment, at several points in *Logic*, of "observed facts" as having an identity independent of the inquirer's way of seeing them. Noting, for example, that "a problem must be felt before it can be stated" (70), he goes on to say that there is then "something that can regulate the selection and the weighing of observed facts and their conceptual ordering." And, writing about the example of a fire alarm in a crowded hall, he describes what is determinate about problematic situations, the "observed facts" that suggest "ideas" (109).

18. See Donald A. Schön, ed., *The Reflective Turn: Case Studies of Reflection in and on Educational Practice* (New York: Teachers College Press, 1991).

19. Sylvia Scribner, "Studying Working Intelligence," in B. Rogoff and J. Lave, eds., *Everyday Cognition: Its Development in Social Context* (Cambridge, MA: Harvard University Press, 1984).

20. See Seymour Papert, *Mindstorms* (New York: Basic Books, 1980).

21. See Jeanne Bamberger and Donald Schön, "The Figural/Formal Transaction," Division for Study and Research in Education working paper, Massachusetts Institute of Technology, 1976.

22. Michael Polanyi, *The Tacit Dimension* (New York: Doubleday, 1967).

23. Hannah Arendt, *Thinking*, vol. 1 of *The Life of the Mind* (New York: Harcourt, Brace, Jovanovich, 1971).

24. Erik Erikson, "The Nature of Clinical Evidence in Psychoanalysis," in D. Lerner, ed., *Evidence and Inference* (New York: Free Press, 1959).

25. Edmund Carpenter, *Eskimo* (identical to *Explorations*, no. 9; Toronto: University of Toronto Press, 1960), 66–67.

26. Quoted in Evelyn Fox Keller, *A Feeling for the Organism* (New York: W. H. Freeman and Company, 1983), 198.

27. See Herbert Simon, *The Sciences of the Artificial* (Cambridge, MA: MIT Press, 1976). Simon was the first to identify designing as central to professional practice, and the first to call for a science of design as a fundamental basis for practice knowledge. However, his view of design is very far from the one I advocate in this article.

28. See, for example, Simon, *Sciences of the Artificial*, 68–69.

29. Max Wertheimer, *Productive Thinking* (Chicago: University of Chicago Press, 1945).

30. David Hawkins, *The Informed Vision* (New York: Agathon Press, 1974).

31. Jeanne Bamberger and Eleanor Duckworth, "The Teacher Project; Final Report to the National Institutes of Education" (Massachusetts Institute of Technology, 1979, mimeo).

32. Bamberger and Duckworth, "The Teacher Project."

33. Hawkins, *The Informed Vision*, vii. Hawkins speaks, in his preface to *The Informed Vision*, of the years he spent with the Elementary Science Study at the Educational Development Center in Newton, Massachusetts.

34. Eleanor Duckworth, *The Having of Wonderful Ideas* (New York: Teachers College Press, 1989).

35. Jeanne Bamberger, "Exploring Children's and Teachers' Understandings," in Donald A. Schön, ed., *The Reflective Turn* (New York: Teachers College Press, 1991).

36. See Tom Russell and Hugh Munby, "Reframing: The Role of Experience in Developing Teachers' Professional Knowledge," in Donald A. Schön, ed., *The Reflective Turn* (New York: Teachers College Press, 1991).

37. Norman Newberg, "Bridging the Gap: An Organizational Inquiry into an Urban School System," in Donald A. Schön, ed., *The Reflective Turn* (New York: Teachers College Press, 1991).

38. See, for example, Kurt Lewin, "Cassirer's Philosophy of Science and Social Science," in Paul A. Schlipp, ed., *The Philosophy of Ernst Cassirer* (New York: Tudor, 1949).

39. Seymour Papert, *Mindstorms.* Jeanne Bamberger's "Music Logo" is an excellent example of a computer-based microworld, in Papert's sense, as is John Slater's program "Growltiger," a computer-based simulation environment in which one can draw structures, "load" them, and observe their deflections.

40. For example, Hermione Sinclair and Annette Karmiloff-Smith, "If You Want to Get Ahead, Get a Theory," *Cognition,* 3(3): 195–212.

41. Lev S. Vygotsky, *Thought and Language* (Cambridge, MA: MIT Press, 1962).

42. Ludwig Wittgenstein, *Philosophical Investigation,* trans. G. E. M. Anscombe (New York: Macmillan, 1953).