

---

# On Two Metaphors for Learning and the Dangers of Choosing Just One

ANNA SFARD

*This article is a sequel to the conversation on learning initiated by the editors of Educational Researcher in volume 25, number 4. The author's first aim is to elicit the metaphors for learning that guide our work as learners, teachers, and researchers. Two such metaphors are identified: the acquisition metaphor and the participation metaphor. Subsequently, their entailments are discussed and evaluated. Although some of the implications are deemed desirable and others are regarded as harmful, the article neither speaks against a particular metaphor nor tries to make a case for the other. Rather, these interpretations and applications of the metaphors undergo critical evaluation. In the end, the question of theoretical unification of the research on learning is addressed, wherein the purpose is to show how too great a devotion to one particular metaphor can lead to theoretical distortions and to undesirable practices.*

*Educational Researcher, Vol. 27, No. 2, pp. 4-13*

---

O! this learning, what a thing it is.  
—W. Shakespeare, *The Taming of the Shrew*

Theories of learning, like all scientific theories, come and go. Some innovations reach deeper than others. Occasionally, theoretical changes amount to a conceptual upheaval. This is what seems to be happening right now in the research on learning. Numerous books and articles in professional journals come up with radically new approaches, and whether one likes the innovative ideas or not, one cannot just brush them aside. The field is in a state of perturbation, with prospects of a new equilibrium not yet in sight. The recent discussion on transfer in *Educational Researcher* (Anderson, Reder, & Simon, 1996; Donmoyer, 1996; Greeno, 1997; Hiebert et al., 1996) brings the controversial nature of current theories of learning into full relief. Strenuous attempts of many authors to come to terms with the change by forging theoretical bridges between competing outlooks (Billett, 1996; Cobb, 1995; Smith, 1995; Vosniadou, 1996) complete this picture. This article will bring a closer look at this controversy, as well as at the issue of theorizing in general. The discussion will be organized around the question of whether the struggle for a conceptual unification of research on learning is a worthwhile endeavor. The first step, however, will be to sketch a bird's-eye view of the competing trends in our present conceptualizations of learning.<sup>1</sup>

To be able to embrace the whole issue at a glance, one has to reach the most fundamental, primary levels of our thinking and bring to the open the tacit assumptions and beliefs

that guide us. This means digging out the metaphors that underlie both our spontaneous everyday conceptions and scientific theorizing. Indeed, metaphors are the most primitive, most elusive, and yet amazingly informative objects of analysis. Their special power stems from the fact that they often cross the borders between the spontaneous and the scientific, between the intuitive and the formal. Conveyed through language from one domain to another, they enable conceptual osmosis between everyday and scientific discourses, letting our primary intuition shape scientific ideas and the formal conceptions feed back into the intuition. Thus, by concentrating on the basic metaphors rather than on particular theories of learning, I hope to get into a position to elicit some of the fundamental assumptions underlying both our theorizing on learning and our practice as students and as teachers. First, however, let me add a few words on the relative status of language, metaphors, and scientific theories.

It was Michael Reddy who, in the seminal paper titled "The Conduit Metaphor," alerted us to the ubiquity of metaphors and to their constitutive role (Reddy, 1978). Using as an example the notion of communication, he showed how the language we use to talk about a given concept may take us in a systematic way to another, seemingly unrelated conceptual domain. (In his example, the figurative projection was from the domain of communication to that of transport.) Since then, the systematic conceptual mappings came to be known as conceptual metaphors and became objects of a vigorous inquiry (Johnson, 1987; Lakoff, 1987, 1993; Lakoff & Johnson, 1980; Sacks, 1978). What traditionally has been regarded as a mere tool for better understanding and for more effective memorizing was now recognized as the primary source of all of our concepts.

The idea that new knowledge germinates in old knowledge has been promoted by all of the theoreticians of intellectual development, from Piaget to Vygotsky to contemporary cognitive scientists. The notion of metaphor as a conceptual transplant clearly complements this view by providing a means for explaining the processes that turn old into new. One may say, therefore, that metaphorical pro-

---

ANNA SFARD teaches mathematics education as a member of the Faculty of Education, University of Haifa, Mount Carmel, Haifa 31905, Israel ([annasd@construct.haifa.ac.il](mailto:annasd@construct.haifa.ac.il)). In her research, she uses the discursive approach to investigate mathematical thinking.

jection is a mechanism through which the given culture perpetuates and reproduces itself in a steadily growing system of concepts.

According to Scheffler (1991), "[t]he line, even in science, between serious theory and metaphor is a thin one—if it can be drawn at all. . . . [T]here is no obvious point at which we may say, 'Here the metaphors stop and the theories begin'" (p. 45). The indispensability of metaphors in science may render them practically transparent, and, as a result, scientists often maintain that figurative representations are not more than explanatory tools. Philosophers of science, however, agreed quite a long time ago that metaphors play a constitutive role, and, in fact, no kind of research would be possible without them (Hesse, 1966; Ortony, 1993). The difficulty with telling the metaphorical from the scientific is aggravated by the fact that scientific vocabulary is usually borrowed from other domains (take as an example such terms as *cognitive strain*, *closed set*, *constructing meaning*, *messenger DNA*) and that the figurative expressions are the only ones in which the theories can be formulated. On the other hand, the fact that concealing the metaphorical origins of ideas in mathematical formalism is a mandatory part of the scientific game can make the figurative roots of scientific theories fairly difficult to restore.<sup>2</sup>

Because metaphors bring with them certain well-defined expectations as to the possible features of target concepts, the choice of a metaphor is a highly consequential decision. Different metaphors may lead to different ways of thinking and to different activities. We may say, therefore, that we live by the metaphors we use. It is also noteworthy that metaphors are a double-edged sword: On one hand, as a basic mechanism behind any conceptualization, they are what makes our abstract (and scientific) thinking possible; on the other hand, they keep human imagination within the confines of our former experience and conceptions. In the process of metaphorical projection, old foundational assumptions and deeply rooted beliefs, being tacit rather than explicit, prove particularly inert. As such, they tend to travel from one domain to another practically unnoticed. Such an uncontrolled migration of metaphorical entailments is not always to the benefit of new theories. It may bar fresh insights, undermine the usefulness of the resulting conceptual system, and—above all—perpetuate beliefs and values that have never been submitted to a critical inspection.

Eliciting the metaphors that guide us in our work as learners, teachers, and researchers is the first aim of the remainder of this article. Given my professional background, I am inclined to use examples taken from mathematics education; this, however, should not diminish the generality of the argument. After identifying two leading metaphors that inform our thinking about learning, I will examine their entailments. While doing so, I will be arguing that implications of a metaphor are a result of contextual determinants not less than of the metaphor itself. Thus, the same figurative idea may engender several greatly varying conceptual frameworks. The principal aim of the analysis that follows is to identify the ways in which one can put the different metaphors for learning to their best uses while barring undesirable entailments. In the end, I will try to show how too great a devotion to one particular metaphor and rejection of all the others can lead to theoretical distortions and to undesirable practical consequences.

## Acquisition Metaphor Versus Participation Metaphor

The upshots of the former section can be put as follows: All our concepts and beliefs have their roots in a limited number of fundamental ideas that cross disciplinary boundaries and are carried from one domain to another by the language we use. One glance at the current discourse on learning should be enough to realize that nowadays educational research is caught between two metaphors that, in this article, will be called the *acquisition metaphor* and the *participation metaphor*. Both of these metaphors are simultaneously present in most recent texts, but while the *acquisition metaphor* is likely to be more prominent in older writings, more recent studies are often dominated by the *participation metaphor*.

### Acquisition Metaphor

Since the dawn of civilization, human learning is conceived of as an acquisition of something. Indeed, the *Collins English Dictionary* defines learning as "the act of gaining knowledge." Since the time of Piaget and Vygotski, the growth of knowledge in the process of learning has been analyzed in terms of concept development. Concepts are to be understood as basic units of knowledge that can be accumulated, gradually refined, and combined to form ever richer cognitive structures. The picture is not much different when we talk about the learner as a person who constructs meaning. This approach, which today seems natural and self-evident, brings to mind the activity of accumulating material goods. The language of "knowledge acquisition" and "concept development" makes us think about the human mind as a container to be filled with certain materials and about the learner as becoming an owner of these materials.

Once we realize the fact that it is the metaphor of acquisition that underlies our thinking about learning mathematics, we become immediately aware of its presence in almost every common utterance on learning. Let us look at a number of titles of publications that appeared over the last two decades: "The Development of Scientific Knowledge in Elementary School Children," "Acquisition of Mathematical Concepts and Processes," "[C]oncept-Mapping in Science," "Children's Construction of Number," "Stage Theory of the Development of Alternative Conceptions," "Promoting Conceptual Change in Science," "On Having and Using Geometric Knowledge," "Conceptual Difficulties . . . in the Acquisition of the Concept of Function." The idea that learning means acquisition and accumulation of some goods is evident in all of these titles. They may point to a gradual reception or to an acquisition by development or by construction, but all of them seem to imply gaining ownership over some kind of self-sustained entity.

There are many types of entities that may be acquired in the process of learning. One finds a great variety of relevant terms among the key words of the frameworks generated by the *acquisition metaphor*: knowledge, concept, conception, idea, notion, misconception, meaning, sense, schema, fact, representation, material, contents. There are as many terms that denote the action of making such entities one's own: reception, acquisition, construction, internalization, appropriation, transmission, attainment, development, accumulation, grasp. The teacher may help the student to attain his or her goal by delivering, conveying, facilitating, mediating, et cetera. Once acquired, the knowledge, like any other

commodity, may now be applied, transferred (to a different context), and shared with others.

This impressively rich terminological assortment was necessary to mark dissimilarities—sometimes easy to see and sometimes quite subtle—between different schools of thought. Over the last decades, numerous suggestions have been made as to the nature of the mechanism through which mathematical concepts may be turned into the learner's private property; however, in spite of the many differences on the issue of "how," there has been no controversy about the essence: The idea of learning as gaining possession over some commodity has persisted in a wide spectrum of frameworks, from moderate to radical constructivism and then to interactionism and sociocultural theories. Researchers have offered a range of greatly differing mechanisms of concept development. First, they simply talked about passive reception of knowledge, then about its being actively constructed by the learner; later, they analyzed the ways in which concepts are transferred from a social to an individual plane and internalized by the student; eventually, they envisioned learning as a never-ending, self-regulating process of emergence in a continuing interaction with peers, teachers, and texts. As long as they investigated learning by focusing on the "development of concepts" and on "acquisition of knowledge," however, they implicitly agreed that this process can be conceptualized in terms of the *acquisition metaphor*.

#### *Participation Metaphor*

The *acquisition metaphor* is so strongly entrenched in our minds that we would probably never become aware of its existence if another, alternative metaphor did not start to develop. When we search through recent publications, the emergence of a new metaphor becomes immediately apparent. Among the harbingers of the change are such titles as "Reflection, Communication, and Learning Mathematics," "Democratic Competence and Reflective Knowing," "Development Through Participation in Sociocultural Activities," "Learning in the Community," "Reflective Discourse and Collective Reflection," "Mathematics As Being in the World," "Dialogue and Adult Learning," "Cooperative Learning of Mathematics," and "Fostering Communities of Inquiry." The new researcher talks about learning as a legitimate peripheral participation (Lave & Wenger, 1991) or as an apprenticeship in thinking (Rogoff, 1990).

A far-reaching change is signaled by the fact that although all of these titles and expressions refer to learning, none of them mentions either "concept" or "knowledge." The terms that imply the existence of some permanent entities have been replaced with the noun "knowing," which indicates action. This seemingly minor linguistic modification marks a remarkable foundational shift (cf. Cobb, 1995; Smith, 1995). The talk about states has been replaced with attention to activities. In the image of learning that emerges from this linguistic turn, the permanence of *having* gives way to the constant flux of *doing*. While the concept of acquisition implies that there is a clear end point to the process of learning, the new terminology leaves no room for halting signals. Moreover, the ongoing learning activities are never considered separately from the context within which they take place. The context, in its turn, is rich and multifarious, and its importance is pronounced by talk about situatedness, contextuality, cultural embeddedness,

and social mediation. The set of new key words that, along with the noun "practice," prominently features the terms "discourse" and "communication" suggests that the learner should be viewed as a person interested in participation in certain kinds of activities rather than in accumulating private possessions.

To put it differently, learning a subject is now conceived of as a process of becoming a member of a certain community. This entails, above all, the ability to communicate in the language of this community and act according to its particular norms. The norms themselves are to be negotiated in the process of consolidating the community. While the learners are newcomers and potential reformers of the practice, the teachers are the preservers of its continuity. From a lone entrepreneur, the learner turns into an integral part of a team. For obvious reasons, this new view of learning can be called the *participation metaphor*.<sup>3</sup> From now on, to avoid tiresome repetition, I will sometimes use the abbreviations "AM" and "PM" for *acquisition* and *participation metaphor*, respectively.

To clarify the idea of learning-as-participation, a number of explanatory remarks would be in place. First, the question may be asked, "What is metaphorical about the issue of participation?" After all, learning implies participation in instructional activities, and thus its participational nature should perhaps be treated as literal, not as figurative. To answer this, let us take a closer look at the concept of participation as such. A quest after its roots will lead us, once again, to the world of physical objects. "Participation" is almost synonymous with "taking part" and "being a part," and both of these expressions signalize that learning should be viewed as a process of becoming a part of a greater whole. It is now relatively easy to spot those beliefs about learning that may be brought by PM as its immediate entailments. Just as different organs combine to form a living body, so do learners contribute to the existence and functioning of a community of practitioners. While the AM stresses the individual mind and what goes "into it," the PM shifts the focus to the evolving bonds between the individual and others. While AM emphasizes the inward movement of the object known as knowledge, PM gives prominence to the aspect of mutuality characteristic of the part-whole relation. Indeed, PM makes salient the dialectic nature of the learning interaction: The whole and the parts affect and inform each other. On one hand, the very existence of the whole is fully dependent on the parts. On the other hand, whereas the AM stresses the way in which possession determines the identity of the possessor, the PM implies that the identity of an individual, like an identity of a living organ, is a function of his or her being (or becoming) a part of a greater entity. Thus, talk about the "stand-alone learner" and "decontextualized learning" becomes as pointless as the attempts to define lungs or muscles without a reference to the living body within which they both exist and function.

Second, one may oppose the above classification of theories of learning by saying that most conceptual frameworks cannot be regarded as either purely "acquisitional" or purely "participational." The act of acquisition is often tantamount to the act of becoming a participant, and if so, one can find it difficult to consider AM and PM separately, let alone as mutually exclusive.<sup>4</sup> No claim on exclusivity of the metaphors has been made in this article, however. Later, I

will argue for the inherent impossibility of freeing the discourse on learning from either of the two metaphors. Theories can be classified as acquisition-oriented or participation-oriented only if they disclose a clear preference for one metaphorical ingredient over the other.

Finally, the dichotomy between acquisition and participation should not be mistaken for the well-known distinction between individualist and social perspectives on learning. The examples here have shown that the former division crosses the demarcation lines established by the latter. According to the distinction proposed in this article, theories that speak about reception of knowledge and those that view learning as internalization of socially established concepts belong to the same category (AM), whereas on the individual/social axis, they must be placed at opposite poles. Whereas the social dimension is salient in the PM, it is not necessarily absent from the theories dominated by the AM. It is important to understand that the two distinctions were made according to different criteria: While the acquisition/participation division is ontological in nature and draws on two radically different answers to the fundamental question, "What is this thing called learning?," the individual/social dichotomy does not imply a controversy as to the definition of learning, but rather rests on differing visions of the mechanism of learning. A schematic comparison between the two is presented in Table 1.

#### What Can Go Wrong With AM, and How PM Can Help

It is time to ask for the reasons underlying the metaphorical shift. If we have been living with the AM for millennia, it is not all that obvious why a change should now be necessary. Well, we might have been living with AM, but have we been happy with it? The latest developments make it rather clear that the answer should probably be "no." It does not take much effort to identify at least two areas in which the AM reveals a particular weakness. First, our thinking about learning has always been plagued by foundational quandaries that would not yield to the finest of philosophical minds. Second, the conception of knowledge as property, when not controlled, leads to too literal a translation of beliefs on material properties into beliefs on learning; some of the resulting norms and value judgments are likely to have adverse effects on both the theory and practice of learning and teaching. It may well be that the reason behind the conceptual unrest we are witnessing these days is the hope that the new metaphor will remedy both of these afflictions.

#### Foundational Dilemmas

Probably the best-known foundational dilemma obviously inherent to the AM was first signaled by Plato in his dialogue *Meno* and came to be known later as "the learning paradox" (Bereiter, 1985; Cobb, Yackel, & Wood, 1992). Although brought up in many different disguises throughout history, the quandary is always the same: How can we want to acquire a knowledge of something that is not yet known to us? Indeed, if this something does not yet belong to the repertoire of the things we know, then, being unaware of its existence, we cannot possibly inquire about it. Or, to put it differently, if we can only become cognizant of something by recognizing it on the basis of the knowledge we already possess, then nothing that does not yet belong to the assortment of the things we know can ever become one of them. Conclusion: Learning new things is inherently impossible.

Philosophers and psychologists have been grappling with the learning paradox for ages, but until recently, no real attempt to transgress the boundaries of the AM was made. The metaphor just did not look like a metaphor at all. How could it be otherwise if the AM has always been engraved in language, from which there is no escape?

Thinking about the epistemological and ontological foundations of our conception of learning intensified a few decades ago, when the doctrine of radical constructivism entangled the psychologists in a new dilemma. Without questioning the thrust of the AM, the constructivists offered a new conception of the mechanism that turns knowledge into one's private possession. It is the central constructivist idea of learners as the builders of their own conceptual structures that, at a closer look, turns problematic. Whatever version of constructivism is concerned—the moderate, the radical, or the social—the same dilemma must eventually pop up: How do we account for the fact that learners are able to build for themselves concepts that seem fully congruent with those of others? Or, to put it differently, how do people bridge individual and public possessions?

One of the reasons some people may be attracted to the PM is that it seems to help us out of these foundational quandaries. It is an escape rather than a direct solution: Instead of solving the problem, the new metaphor simply dissolves vexing questions by its very refusal to objectify knowledge. Here, "objectifying" means treating something as a well-defined entity that can be considered independently of human beings. It should be stressed that the doubt about the soundness of the tendency to objectify knowledge

Table 1  
*The Metaphorical Mappings*

Acquisition metaphor		Participation metaphor
Individual enrichment	Goal of learning	Community building
Acquisition of something	Learning	Becoming a participant
Recipient (consumer), (re-)constructor	Student	Peripheral participant, apprentice
Provider, facilitator, mediator	Teacher	Expert participant, preserver of practice/discourse
Property, possession, commodity (individual, public)	Knowledge, concept	Aspect of practice/discourse/activity
Having, possessing	Knowing	Belonging, participating, communicating

is not new and that the idea of disobjectification has been considered by many thinkers—notably Plato, Hegel, and neo-Kantians (Kozulin, 1990, pp. 22–23; Woodfield, 1993). The PM does the disobjectification job by providing an alternative to talk about learning as making an acquisition. Within its boundaries, there is simply no room for the clear-cut distinction between internal and external (concepts, knowledge), which is part and parcel of objectification. By getting rid of the problematic entities and dubious dichotomies and clearing the language of essentialist aftertaste, PMs circumvent the philosophical pitfalls of AMs in an elegant manner.

This account would not be complete without a caveat: It may well be that the PM has in store new foundational dilemmas not yet suspected by its ardent followers. The PM's present appeal stems from the fact that it brings immediate relief from the old headache. There is no guarantee, however, that it is not going to disclose its own maladies one day. The danger of finding ourselves entangled in difficulties as we go on fathoming the intricacies of the participation mechanism is only too real. After all, the physical metaphor of "turning into a part of a greater whole" has its own pitfalls and may eventually lead us to an epistemological dead end just like any other metaphor that crosses ontological boundaries.

#### *The Question of Norms and Values*

Whereas the impossibility of "something out of nothing" seems endemic to the property of being an object, so that dismissing the learning paradox would mean rejection of the metaphor itself, there are MA-engendered views and opinions that are optional rather than necessary and only come to the fore if one chooses to endorse them. Metaphorical entailments that have to do with norms and values are usually of the latter kind.

If knowledge is conceived of as a commodity,<sup>5</sup> it is only natural that attitudes toward learning reflect the way the given society thinks about material wealth. When figuratively equated, knowledge and material possessions are likely to play similar roles in establishing people's identities and in defining their social positions. In the class-ridden capitalist society, for example, knowledge understood as property is likely to turn into an additional attribute of position and power. Like material goods, knowledge has the permanent quality that makes the privileged position of its owner equally permanent.

As a result, learning-according-to-AM may draw people apart rather than bring them together. As in a society driven by a pursuit of material goods, so in the AM-based approach to learning, learners and scientists are likely to put forward competition and solitary achievement. The American sociologist of science R. K. Morton notes that a scientist who just arrived at what may count as an important result "will be under pressure to make his *contribution to knowledge* known to other scientists and . . . they, in turn, will be under pressure to acknowledge *his rights to his intellectual property*" (Morton, 1973, p. 294, emphases added). In a footnote to this description, Morton seems to be apologizing for the vocabulary he uses, stating that "[b]orrowing, trespassing, poaching, credit, stealing, a concept which 'belongs' to us—these are only a few of the many terms in the lexicon of property adopted by scientists as matter of course" (p. 295). If this is the language in which this com-

munity speaks of intellectual achievement, no wonder that incidents of scientific fraud become more and more frequent in the increasingly crowded academia. While these are certainly extreme cases, there are symptoms much milder than obvious misconduct that can count as consequences of the acquisitionist approach. A not-altogether-infrequent occurrence of self-centered, asocial attitude toward knowing, creating, and learning is certainly a case in point. If people are valued and segregated according to what they have, the metaphor of intellectual property is more likely to feed rivalry than collaboration.

It is noteworthy that within the acquisition paradigm, not only knowledge, but also the means for gaining it, counts as a highly priced possession that, if of a superior quality, can make the possessors themselves superior to others. Such terms as "gift" or "potential," often used to denote a special propensity for learning and creating, suggest that this characteristic is given, not acquired. It is a person's "quality mark." Students' achievements may depend on environmental factors, but the teachers feel they can tell students' real (permanent) potential from their actual performance. The gifts and potentials, like other private possessions, are believed to be measurable and may therefore be used for sorting people into categories. In this climate, the need to prove one's "potential" sometimes overgrows his or her desire to be useful. This is what evidently happened to the Cambridge mathematician G. H. Hardy (1940/1967) who, after confessing that his interest in mathematics was motivated by the wish to show his outstanding abilities (mathematics "gives unrivaled openings for the display of sheer professional skill," p. 80), defiantly admitted to being perfectly happy in the academy without ever doing anything "useful" (the quotes are Hardy's own).

While these distortions are definitely not a necessary outcome of the AM, the metaphor is apparently what made them possible. Attitudes like those presented in the last paragraph are most likely to appear in societies that value—or even just tolerate—uncompromising pursuit of material wealth. As long as a metaphor enjoys full hegemony, its normative implications are usually taken for granted; introduction of a new metaphor is often enough to bring the issue of norms to the fore and turn it into an object of explicit reflection. This is exactly what is likely to happen when the PM enters the scene as a possible alternative to the AM. The new metaphor replaces the talk about private possessions with discourse about shared activities. This linguistic shift epitomizes the democratic nature of the turn toward the PM. The democratization of the language may lead, eventually, to a far-reaching change in awareness and in beliefs about learning.

The promise of the PM seems, indeed, quite substantial. The vocabulary of participation brings the message of togetherness, solidarity, and collaboration. The PM language does not allow for talk about permanence of either human possessions or human traits. The new metaphor promotes an interest in people in action rather than in people "as such." Being "in action" means being in a constant flux. The awareness of the change that never stops means refraining from a permanent labeling. Actions can be clever or unsuccessful, but these adjectives do not apply to the actors. For the learner, all options are always open, even if he or she carries a history of failure. Thus, quite unlike the AM, the PM seems to bring a message of an everlasting hope: Today you act one way; tomorrow you may act differently.

To sum up, the *participation metaphor* has a potential to lead to a new, more democratic practice of learning and teaching. Because, however, social, normative, and ethical morals of metaphors are not inscribed in the metaphors themselves but rather are a matter of interpretation, the intentions and skills of those who harness the metaphor to work are of central significance.<sup>6</sup> In the final account, what shape the practice will take is up to interpreters rather than to legislators. Thus, only time will tell whether the promise of a more democratic process of learning, brought by PM, is going to materialize. When it comes to social issues, PM-based theories are not any less susceptible to abuses and undesirable interpretations than other conceptual frameworks. We can only protect ourselves from falling into such traps by constantly monitoring our basic beliefs. It may well be that the most important merit of the PM is that it serves as an eye-opening device with respect to the *acquisition metaphor*. This relation, by the way, is symmetric: The social implications of the PM, listed above—far from being the only possible—are brought into full relief against the contrasting background of common beliefs induced by the AM and could be much harder to see without it. The mutual dependence of interpretations of the metaphors is something to be remembered when we arrive at the conclusions of the present discussion in the last section of this article.

#### Why Do We Need AM After All?

After pointing out the weaknesses of the AM and the relative advantages of the PM, I will now argue that giving up the AM is neither desirable nor possible. When it comes to research, some important things that can be done with the old metaphor cannot be achieved with the new one. Besides, the PM, when left alone, may be as dangerous a thing as the AM proved to be in a similar situation.

#### *Research Issues: The Question of Transfer*

The refusal to reify knowledge seems to go hand in hand with wondering about the notion of transfer. There are two ways in which the opponents of objectifying and abstracting argue against this notion. Some of them claim that, based on empirical evidence, transfer is a rare event, and the most extreme among them would simply deny its existence. Others reject the very idea of transfer, saying that it is "seriously misconceived" (Lave, 1988, p. 39). Many opponents of the PM argue against the former type of claim (Anderson et al., 1996), but, in fact, only the latter line of reasoning is truly consistent with the PM-based frameworks. As Greeno (1997, p. 5) aptly notices in his contribution to the present discussion, those who overlook this point may, as a result, "talk and write past each other because they address different questions."

A persistent follower of the PM must realize, sooner or later, that from a purely analytical point of view, the metaphorical message of the notion of transfer does not fit into PM-generated conceptual frameworks. Learning transfer means carrying knowledge across contextual boundaries; therefore, when one refuses to view knowledge as a stand-alone entity and rejects the idea of context as a clearly delineated "area," there is simply nothing to be carried over, and there are no definite boundaries to be crossed. It is only natural that when it comes to the centrally important controversy over transfer, many PM adherents, not yet pre-

pared to face the ultimate consequences of the new vision of learning, go only halfway: They bring empirical evidence to refute the claims about the possibility of transfer rather than admit that the notion, at least as it is traditionally understood, is intractable within their framework. By doing so, they unwittingly succumb to the rules of AM-based discourse. Naturally, the discussion between the participationist and acquisitionist is bound to be futile because the former cannot convince the latter of the nonexistence of transfer, just as a physiologist would not be able to convince a psychiatrist about the nonexistence of mental illness: It takes a common language to make one's position acceptable—or even just comprehensible—to another person.

If we agree that there is no room for the traditionally conceived notion of transfer in the PM-based discourse, the long-standing controversy would disappear just as the learning paradox disappeared before. But the benefits of this new disappearance are not so obvious as those of the former one. For one thing, I doubt the very possibility of clearing the discourse on learning from any traces of the AM. Whereas growing numbers of thinkers are ready to agree that the dependence of learning on context is much too great to allow for talk about universal cross-situational invariants, nobody—not even the most zealous followers of the PM-based line of thought—would deny that something does keep repeating itself as we move from situation to situation and from context to context. Our ability to prepare ourselves today to deal with new situations we are going to encounter tomorrow is the very essence of learning. Competence means being able to repeat what can be repeated while changing what needs to be changed. How is all of this accounted for if we are not allowed to talk about carrying anything with us from one situation to another??

Aware of the impossibility of circumventing these questions, some writers are trying to reconcile the idea of transfer with the PM. One such attempt has been presented by Greeno (1997) in his contribution to the present discussion. Greeno's central idea is to provide the old notion with a new interpretation.<sup>8</sup> Defining learning as "improved participation in interactive systems," he proceeds to account "for transfer in terms of transformations of constraints, affordances, and attunements" (p. 12). This description, oriented toward interactions between learners and situations, may indeed be regarded as compatible with the PM framework. In spite of this, one may still wonder whether the proposal has a chance to bring the heated controversy between the two camps to a stop. Even if the new approach is welcome in acquisitionist circles, it may be unacceptable in the eyes of the most devoted adherents of the PM. The latter may claim that the switch to the new framework cannot be regarded as complete until the professional discourse is thoroughly purged of expressions that bring to mind the old metaphor. Indeed, if this is what they said in response to the attempts to preserve the terms "knowledge" and "concept" (see, e.g., Bauersfeld, 1995; Smith, 1995), this is also what they are likely to say about any attempt to save the notion of transfer. Because the notion is fraught with acquisitionist connotations, some people may simply be unable to say "transfer" and "situatedness" in one breath.

Whether fully effective or not, Greeno's attempt shows that even if one agrees with the contention that any human action is a result of a dialectic between the situation and the actor rather than of any predesigned, abstract plan of that

action, one may still believe that there is no satisfactory account of learning that does not take into account the actor's previous experience. Thus, if a model of learning is to be convincing, it is probably bound to build on the notion of an acquired, situationally invariant property of the learner, which goes together with him or her from one situation to another.

To sum up, it seems that even if one does not like its objectifying quality, one finds it extremely difficult to avoid the acquisitionist language altogether. Whenever we try to comprehend a change, the perceptual, bodily roots of all our thinking compel us to look for structure-imposing invariants and to talk in terms of objects and abstracted properties. We seem to know no other route to understanding. No wonder, therefore, that those who oppose objectification and try to exorcise abstraction and generalization from the discourse on learning find themselves entangled in conflicting statements. They may be making heroic efforts to free themselves from the idea of learning as acquisition, but the metaphor—engraved in the language—would invariably bounce back. Some of the proponents of the PM framework are aware of the contradictions implicit in the call for disobjectification and wonder about it explicitly: "How can we purport to be working out a theoretical conception of learning without, in fact, engaging in the project of abstraction rejected above?" ask Lave and Wenger (1991, p. 38, emphasis in the original). There is no simple way out of this entrapment. As I argue in the concluding section, even if one cannot solve the dilemma, one can—and probably should—learn to live with it.

Let me finish this section by saying that even if we could create an AM-free discourse, we probably shouldn't. Within the participationist framework, some powerful means for conceptualization of learning are lost, and certain promising paths toward understanding its mechanism are barred. This very article, if it resonates with the readers' thinking, may serve as evidence. This discussion on learning is founded in the theory of conceptual metaphor, according to which any new conceptualization—thus, any learning—is only possible thanks to our ability to transfer existing conceptual schemes into new contexts. The metaphor itself was defined as a "conceptual transplant."<sup>9</sup> The foregoing sections abound in concrete examples of such transplants. All of this testifies to my sustained faith in the power of the AM.

#### *Pedagogical Issues: The Worry About Subject Matter*

Whereas the above considerations deal with inevitable implications of the *participation metaphor*, I am now going to focus on metaphorical entailments that are a matter of interpretation and choice rather than of logical necessity.

More often than not, it is not all that obvious how the request to disobjectify knowledge and "put it back into context" should be interpreted. Within the science and mathematics education communities, the claims about inherent contextuality of knowledge are often construed as contentions that scientific and mathematical concepts can be meaningfully learned only within a "real-life" context (see, e.g., Heckman & Weissglass, 1994). As it now becomes clear, however, real-life situations that would be likely to become for mathematics or science students what a craftsman's workshop is for the apprentice are extremely difficult to find. Another translation of PM-engendered theoretical ideas into the language of instructional practice

is offered by those who suggest that the student should become a member of a "community of practice" (Lave & Wenger, 1991), within which he or she would have a chance to act as a (beginning) practitioner. According to Ball (1991, p. 35), "the goal [of teaching mathematics] is to help students . . . become active participants in mathematics as a system of human thought," whereas Schoenfeld (1996) promotes the idea of turning mathematics class into a "community of inquiry." At a closer look, this approach also turns quite problematic, as it is far from clear how we should construe the term "community of practice" and whom we should view as "expert practitioners" and the shapers of a given "practice."

Whichever of the two interpretations is chosen, what used to be called "subject matter" may change so dramatically that some people would begin wondering whether the things we would then be teaching could still be called science or mathematics (see, e.g., Hiebert et al., 1996; Sierpinkska, 1995; Thomas, 1996). Naturally, the question of naming is not the main reason for concerns expressed by those who hold the PM responsible for current changes in mathematics education. The main problem, it seems, is that of a gradual disappearance of a well-defined subject matter. Without a clearly delineated content,<sup>10</sup> the whole process of learning and teaching is in danger of becoming amorphous and losing direction. No wonder, then, that current talk about "challenges for Reform" (see, e.g., Smith III, 1996)—perhaps even as a backlash to reform—indicate a growing disillusionment with what is going on in many classrooms a few years into the "participation era."

#### **Conclusion: One Metaphor Is Not Enough**

The message of the above critical examination of the two basic metaphors for learning is rather confusing: It now seems that we can live neither with nor without either of them. In this concluding section, I wish to make it clear why it is essential that we try to live with both. Later, I make suggestions about the ways in which this seemingly impossible demand might be fulfilled after all.

#### *Why Do We Need More Than One Metaphor?*

The relative advantages of each of the two metaphors make it difficult to give up either of them: Each has something to offer that the other cannot provide. Moreover, relinquishing either the AM or the PM may have grave consequences, whereas metaphorical pluralism embraces a promise of a better research and a more satisfactory practice. The basic tension between seemingly conflicting metaphors is our protection against theoretical excesses, and is a source of power.

As was emphasized before, the metaphors we use should not be held responsible for unsatisfactory practices, but rather their interpretations. When a theory is translated into an instructional prescription, exclusivity becomes the worst enemy of success. Educational practices have an overpowering propensity for extreme, one-for-all practical recipes. A trendy mixture of constructivist, social-interactionist, and situationist approaches—which has much to do with the *participation metaphor*—is often translated into a total banishment of "teaching by telling," an imperative to make "cooperative learning" mandatory to all, and a complete delegitimation of instruction that is not "problem-based" or not situated in a real-life context. But this means

putting too much of a good thing into one pot. Because no two students have the same needs and no two teachers arrive at their best performance in the same way, theoretical exclusivity and didactic single-mindedness can be trusted to make even the best of educational ideas fail.

What is true about educational practice also holds for theories of learning. It seems that the most powerful research is the one that stands on more than one metaphorical leg (cf. Sford, 1997). An adequate combination of the *acquisition* and *participation metaphors* would bring to the fore the advantages of each of them, while keeping their respective drawbacks at bay. Conversely, giving full exclusivity to one conceptual framework would be hazardous. Dictatorship of a single metaphor, like a dictatorship of a single ideology, may lead to theories that serve the interests of certain groups to the disadvantage of others. A metaphor that has been given hegemony serves as an exclusive basis for deciding what should count as "normal" and what is "anomalous," what should be viewed as "below average" rather than "above," and what should be regarded as "healthy" and what as "pathological." The exclusivity is often equated with certainty, whereas the very presence of a competing metaphor may be enough to disclose the arbitrary nature of some of the generally accepted classifications. This disclosure, therefore, has an immediate emancipatory effect. When two metaphors compete for attention and incessantly screen each other for possible weaknesses, there is a much better chance for producing a critical theory<sup>11</sup> of learning (Geuss, 1981; Habermas, 1972). Such a theory would inquire after the true interests of all of the parties involved in the learning process and thus engage the research community in an endeavor likely to have a liberating and consolidating effect on those who learn and those who teach.

#### *Living With Contradictions*

After making the case for the plurality of metaphors, I have to show that this proposal is workable. Indeed, considering the fact that the two metaphors seem to be mutually exclusive, one may wonder how the suggested metaphorical crossbreeding could be possible at all. In fact, however, the problem is not new, and it is not restricted to the research on learning. We can turn to contemporary science for many more examples of similar dilemmas, as well as for at least two ways in which the difficulty can be overcome.

First, we can look on the PM- and AM-generated conceptual frameworks as offering differing perspectives rather than competing opinions. Having several theoretical outlooks at the same thing is a normal practice in science, where, for instance, chemistry and physics offer two different—but not incompatible—accounts of matter, while physiology and psychology bring mutually complementing outlooks at human beings. In the spirit of this approach, acquisitionists and participationists might admit that the difference between them is not a matter of differing opinions but rather of participating in different, mutually complementing discourses.

Somebody may argue, however, that the tension between the AM and the PM is too fundamental to be treated with such tolerance. After all, people may say, the AM and the PM make incompatible ontological claims about the nature of learning. To this, Kuhn, Rorty, and many other contemporary philosophers would respond that the metaphors are

incommensurable rather than incompatible,<sup>12</sup> and because "[i]ncommensurability entails irreducibility [of vocabularies], but not incompatibility" (Rorty, 1979, p. 388), this means a possibility of their peaceful coexistence. Science and mathematics are a rich source of examples showing that such an option is not purely theoretical. Thus, for instance, today's mathematicians are able to live with Euclidean and non-Euclidean geometries without privileging any of them, whereas contemporary physicists admit a mixture of ostensibly contradictory approaches to subatomic phenomena, sanctioning this decision with Bohr's famous principle of complementarity.

Remembering the metaphorical underpinnings of the claims on the nature of learning, we might find it quite easy to adopt Bohr's principle in our own research. This would mean that, ontological discrepancy notwithstanding, we could view learning as an acquisition or as participation, ac-

---

### **[M]etaphorical projection is a mechanism through which a given culture perpetuates and reproduces itself in a steadily growing system of concepts.**

---

ording to our choice. How this choice is made depends on several factors. First, there are a few necessary conditions a metaphor must fulfill to rank as a candidate. If it is to have any chance at all, the resulting theories must be found convincing and coherent. The seemingly straightforward idea of "convincing" is, in fact, rather complex, and it includes a belief in the usefulness of the theories and an expectation that they will lead to what Rorty (1991) calls an intersubjective agreement. In addition to its role as a potent sense-making tool, a theory has to be an effective producer of new insights about learning.

If the necessary conditions for the acceptance of a metaphor seem relatively easy to pinpoint, the sufficient conditions are rather elusive. Clearly, some metaphors may be more attractive than others because of their accessibility, flexibility, imaginativeness, or aesthetic value. In the final account, however, the choice made by individual researchers would probably depend mainly on what they want to achieve. If, for example, one's purpose is to build a computer program that would simulate human behavior, then the *acquisition metaphor* is likely to be chosen as one that brings forward the issue of representations—something that has to be constructed and quite literally put into a computer. If, on the other hand, one is concerned with educational issues—such as the mechanisms that enable successful learning or make its failure persistent, then the participational approach may be more helpful as one that defies the traditional distinction between cognition and affect, brings social factors to the fore, and thus deals with an incomparably wider range of possibly relevant aspects.<sup>13</sup>

Finally, let me add that being aware of the essentially figurative nature of our sense-making activities, we may sometimes go so far as to merge seemingly conflicting



metaphors within one theoretical framework. The merger becomes possible when acquisitionist utterances stop being read as ontological stipulations (as is usually the case within the AM framework) and are interpreted instead as bringing an "as if" message. In this case, their figurative nature is never forgotten and their use is justified pragmatically, with arguments of effectiveness and productivity.

One point cannot be overstated: With all of the flexibility of the proposed multimetaphorical metaframework, plurality of metaphors does not imply that "anything goes;" neither does it result in a complete methodological freedom or in a reduced need for empirical evidence. To count as trustworthy, the resulting theories must still be experimentally testable and congruent with data. The only thing that changes is the relative status of data and theory. While traditionally, data were regarded as previous to, and independent of, theory, now it is assumed that they are already tinted by theory when we first set our eyes on them. As shown by the heated discussion on transfer, the very existence of "facts" may sometimes be a matter of a theoretical lens used by an observer. The relationship between theory and data is dialectic in that they have a tendency for generating each other. It is notable that the persuasive power of data may be confined to the paradigm within which they came into being. Because there is no such thing as "naked facts," the power of empirical findings may sometimes be lost in a transition from one framework to another. For that reason, empirical evidence is unlikely to serve as an effective weapon in paradigm wars.

The basic message of this article can now be put in a few sentences. As researchers, we seem to be doomed to living in a reality constructed from a variety of metaphors. We have to accept the fact that the metaphors we use while theorizing may be good enough to fit small areas, but none of them suffice to cover the entire field. In other words, we must learn to satisfy ourselves with only local sense-making. A realistic thinker knows he or she has to give up the hope that the little patches of coherence will eventually combine into a consistent global theory. It seems that the sooner we accept the thought that our work is bound to produce a patchwork of metaphors rather than a unified, homogeneous theory of learning, the better for us and for those whose lives are likely to be affected by our work.

## Notes

This article is an extended version of an invited lecture given at the Eighth International Congress of Mathematics Education in Seville, Spain, in July 1996. I wish to thank Paul Cobb, Robert Thomas, and Devorah Kalekin-Fishman for their patient reading and commenting on different drafts of the article. Special acknowledgments go to anonymous reviewers and to the editor, Dr. Robert Donmoyer, for their helpful questions and suggestions.

<sup>1</sup> This article may be read as an interim report on my own face-to-face confrontation with the new approaches to learning and with my conflicting feelings about them. Initially, my mathematical-scientific background made me suspicious—indeed, resentful—of such ideas as abstaining from abstraction and "putting learning back into context" to a total banishment of a "distilled" content that can be carried across situational boundaries (Lave & Wenger, 1991). At the same time, however, I found myself strangely attracted to the new vision of learning that grew out of the innovative approach.

<sup>2</sup> Bruner (1986) makes this claim in a particularly clear—and beautifully metaphorical!—way. After stating that metaphors are "crutches

to help us get up the abstract mountain," he notes that once we make it to the top, we are eager to get rid of them "in favor of a formal, logically consistent theory that (with luck) can be stated in mathematical or near-mathematical terms" (p. 48).

<sup>3</sup> It should be noted that the decision to view learning as an integration with a community in action gave rise to quite a number of conceptual frameworks. The theory of situated learning (Brown, Collins, & Duguid, 1989; Lave, 1988; Lave & Wenger, 1991), the discursive paradigm (Edwards & Potter, 1992; Foucault, 1972; Harre & Gillet, 1995), and the theory of distributed cognition (Salomon, 1993) are probably the best developed among them. All of these are theories of a new kind, differing from the old doctrines not only in their vision of learning but also, and perhaps most importantly, in their epistemological foundations and in the underlying assumption about the mission of research on learning.

<sup>4</sup> Harbingers of revolution tend to believe that the old and the new are mutually exclusive. It is only natural that profound change like the one we are witnessing these days is marked by a dose of single-mindedness and zealotry. Often, one feels obliged to declare his or her exclusive devotion to the new metaphor if the other metaphor—the one by which we have been living for centuries—is ever to be made explicit and susceptible to critical scrutiny. As I declared at the outset, however, it is the aim of this article to show the dangers of such total, single-minded devotion to one metaphor.

<sup>5</sup> One should not forget that the "knowledge as commodity" metaphor, as any other, can only go so far; for example, while passing a commodity to others deprives its original owner of his or her possession, giving knowledge does not mean the giver loses it.

<sup>6</sup> All of this is obviously true, for example, about the NCTM's new *Standards* for teaching and learning mathematics (National Council of Teachers of Mathematics, 1989, 1991), which seem to favor the PM but cannot bring the desired change by their mere existence.

<sup>7</sup> The range of possible situations in which we may be able to profit from the given learning sequence differs from person to person; it is interesting that we tend only to talk about transfer when the range is particularly wide. Let us not forget, however, that if so, the difference between the phenomena we recognize as simple cases of successful learning and those we regard as instances of successful transfer is qualitative rather than quantitative, and the line between the two is undefined and probably indefinable.

<sup>8</sup> At times of major paradigm shift, endowing old notions with new definitions is a usual practice. In this way, the continuity of the scientific endeavor may be preserved in spite of the apparently unbridgeable breaches. For example, in the transition from the AM to PM framework, Lave and Wenger (1991) proposed to redefine the old terms "learning" and "knowing" as "relations between people in activity in, with, and arising from the socially and culturally structured world" (p. 51). Much earlier, Foucault (1972) redescribed "concept" in discursive terms.

<sup>9</sup> The "transplant" is not a simple procedure, and the way a particular conceptual scheme is deemed appropriate for the conceptualization of a given phenomenon is an intricate question to which no satisfactory answer has been found as yet (Johnson-Laird, 1989; Sford, 1997). A metaphor is built in a complex interaction between the source and the target, and the recognition of similarity between the two, initially regarded as a point of departure for the metaphorical projection, is now considered as something that is only constructed in the course of this projection. All of these intricacies notwithstanding, it is clear that the theory of the conceptual metaphor belongs to the AM framework.

<sup>10</sup> Please note that this notion only makes sense in an AM framework!

<sup>11</sup> What came to be known as critical theories can be defined as conceptual frameworks that deal with human beings in a social context and "aim at emancipation and enlightenment, at making agents aware of hidden coercion, thereby freeing them from that coercion and putting them in a position to determine where their true interests lie" (Geuss, 1981, p. 55). While "theories in natural science are 'objectifying,' critical theories are 'reflective'" (p. 2).

<sup>12</sup> "By 'commensurable,'" says Rorty (1979), "I mean able to be brought under a set of rules which will tell us how rational agreement can be reached on what would settle the issue on every point where statements seem to conflict" (p. 316). In other words, incommensurability means that there is no super-theory that would provide tools for proving one framework right while refuting the other. This is certainly the case with the controversy over our two metaphors for learning: There is no possibility of solving this type of conflict with a scientific argument, as it is traditionally understood.

<sup>13</sup> Let me remark that when it comes to a choice of a paradigm, a researcher's personal preferences and the question of his or her professional identity, although purportedly irrelevant, may, in fact, be of considerable importance.

## References

- Anderson, J. R., Reder, L. M., & Simon, H. A. (1996). Situated learning and education. *Educational Researcher*, 25(4), 5-11.
- Ball, D. (1991). Research on teaching mathematics: Making subject-matter knowledge part of the equation. In J. Brophy (Ed.), *Advances in research on teaching: Vol. 2. Teacher's subject-matter knowledge* (pp. 1-48). Greenwich, CT: JAI Press.
- Bauersfeld, H. (1995). "Language games" in the mathematics classroom: Their function and their effects. In P. Cobb & H. Bauersfeld (Eds.), *Emergence of mathematical meaning: Interaction in classroom cultures* (pp. 271-291). Hillsdale, NJ: Lawrence Erlbaum Associates.
- Bereiter, C. (1985). Towards the solution of the learning paradox. *Review of Educational Research*, 55, 201-226.
- Billett, S. (1996). Situated learning: Bridging sociocultural and cognitive theorising. *Learning and Instruction*, 6(3), 263-280.
- Brown, J. S., Collins, A., & Duguid, P. (1989). Situated cognition and the culture of learning. *Educational Researcher*, 18(1), 32-42.
- Bruner, J. (1986). *Actual minds, possible worlds*. Cambridge, MA: Harvard University Press.
- Cobb, P. (1995). Continuing the conversation: A response to Smith. *Educational Researcher*, 24(7), 25-27.
- Cobb, P., Yackel, E., & Wood, T. (1992). A constructivist alternative to the representational view of mind in mathematics education. *Journal for Research in Mathematics Education*, 23(1), 2-33.
- Donmoyer, R. (1996). This issue: A focus on learning. *Educational Researcher*, 25(4), 4.
- Edwards, D., & Potter, J. (1992). *Discursive psychology*. Newbury Park, CA: Sage.
- Foucault, M. (1972). *The archaeology of knowledge*. New York: Harper Colophon.
- Geuss, R. (1981). *The idea of critical theory: Habermas and the Frankfurt school*. Cambridge, UK: Cambridge University Press.
- Greeno, J. G. (1997). On claims that answer the wrong question. *Educational Researcher*, 26(1), 5-17.
- Habermas, J. (1972). *Knowledge and human interests*. Boston: Beacon Press.
- Hardy, G. H. (1967). *A mathematician's apology*. Cambridge, MA: Cambridge University Press. (Original work published 1940)
- Harre, R., & Gillet, G. (1995). *The discursive mind*. Thousand Oaks, CA: Sage.
- Heckman, P., & Weissglass, J. (1994). Contextualized mathematics instruction: Moving beyond recent proposals. *For the Learning of Mathematics*, 14(1), 29-33.
- Hesse, M. (1966). *Models and analogies in science*. Notre Dame, IN: Notre Dame University Press.
- Hiebert, J., Carpenter, T. P., Fennema, E., Fuson, K., Human, P., Murray, H., Olivier, A., & Wearne, D. (1996). Problem solving as a basis for reform in curriculum and instruction: The case of mathematics. *Educational Researcher*, 25(4), 12-21.
- Johnson, M. (1987). *The body in the mind: The bodily basis of meaning, imagination, and reason*. Chicago: The University of Chicago Press.
- Johnson-Laird, P. N. (1989). Analogy and the exercise of creativity. In S. Vosniadou & A. Ortony (Eds.), *Similarity and analogical reasoning* (pp. 313-365). Cambridge, UK: Cambridge University Press.
- Kozulin, A. (1990). *Vygotsky's psychology: A biography of ideas*. New York: Harvester Wheatsheaf.
- Lakoff, G. (1987). *Women, fire and dangerous things: What categories reveal about the mind*. Chicago: The University of Chicago Press.
- Lakoff, G. (1993). The contemporary theory of metaphor. In A. Ortony (Ed.), *Metaphor and thought* (2nd ed., pp. 202-250). Cambridge, UK: Cambridge University Press.
- Lakoff, G., & Johnson, M. (1980). *The metaphors we live by*. Chicago: The University of Chicago Press.
- Lave, J. (1988). *Cognition in practice*. Cambridge, UK: Cambridge University Press.
- Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. Cambridge, UK: Cambridge University Press.
- Morton, R. K. (1973). *The sociology of science*. Chicago: The University of Chicago.
- National Council of Teachers of Mathematics. (1989). *Curriculum and evaluation standards for school mathematics*. Reston, VA: Author.
- National Council of Teachers of Mathematics. (1991). *Professional standards for teaching mathematics*. Reston, VA: Author.
- Ortony, A. (Ed.). (1993). *Metaphor and thought* (2nd ed.). Cambridge, UK: Cambridge University Press.
- Reddy, M. (1978). The conduit metaphor: A case of frame conflict in our language about language. In A. Ortony (Ed.), *Metaphor and thought* (2nd ed., pp. 164-201). Cambridge, UK: Cambridge University Press.
- Rogoff, B. (1990). *Apprenticeship in thinking: Cognitive development in social context*. Oxford, UK: Oxford University Press.
- Rorty, R. (1979). *Philosophy and the mirror of nature*. Princeton, NJ: Princeton University Press.
- Rorty, R. (1991). *Objectivity, relativism, and truth*. Cambridge, UK: Cambridge University Press.
- Sacks, S. (Ed.). (1978). *On metaphor*. Chicago: The University of Chicago Press.
- Salomon, G. (Ed.). (1993). *Distributed cognitions: Psychological and educational considerations*. Cambridge, UK: Cambridge University Press.
- Scheffler, I. (1991). *In praise of cognitive emotions*. New York: Routledge.
- Schoenfeld, A. (1996). In fostering communities of inquiry, must it matter that the teacher knows the "answer"? *For the Learning of Mathematics*, 16(3), 11-16.
- Sfard, A. (1994). Reification as the birth of metaphor. *For the Learning of Mathematics*, 14(1), 44-55.
- Sfard, A. (1997). Commentary: On metaphorical reasons of conceptual growth. In L. English (Ed.), *Mathematical reasoning: Analogies, metaphors, and images* (pp. 339-372). Mahwah, NJ: Erlbaum.
- Sierpinska, A. (1995). Mathematics "in context," "pure" or "with applications"? *For the Learning of Mathematics*, 15(1), 2-15.
- Smith, E. (1995). Where is the mind? "Knowing" and "knowledge" in Cobb's constructivist and sociocultural perspectives. *Educational Researcher*, 24(7), 23-24.
- Smith, J. P., III. (1996). Efficacy and teaching mathematics by telling: A challenge for reform. *Journal for Research in Mathematics Education*, 27(4), 387-402.
- Thomas, R. (1996). Proto-mathematics and/or real mathematics. *For the Learning of Mathematics*, 16(2), 11-18.
- Vosniadou, S. (1996). Towards a revised cognitive psychology for new advances in learning and instruction. *Learning and Instruction*, 6(2), 95-110.
- Woodfield, A. (1993). Do your concepts develop? In C. Hookway & D. Peterson (Eds.), *Philosophy and cognitive science* (pp. 41-67). Cambridge, UK: Cambridge University Press.

Manuscript received August 29, 1996

Revision received January 22, 1997

Accepted October 7, 1997

## AERA Annual Meeting Program Available Online

The AERA home office and the ERIC Clearinghouse on Assessment and Evaluation are pleased to announce that the 1998 Annual Meeting Program is available online as a searchable database. You can search by words that appear in the session descriptions, including author's name, author's affiliation, session title, paper title, session number, and time. Go to the AERA Web page (<http://aera.net>).