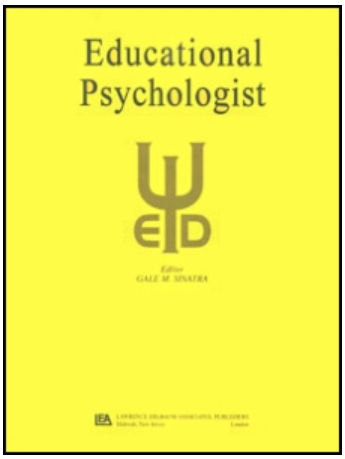

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What Is Learning Anyway? A Topographical Perspective Considered

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What Is Learning Anyway? A Topographical Perspective Considered

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The overarching purpose of this treatise was to develop a means by which to describe and evaluate existing perspectives on learning and to guide future explorations in this domain. Specifically, using the metaphor of a river system, we advance a framework into which theoretical perspectives and empirical investigations of learning can be positioned. We began by articulating nine principles of learning shared by diverse theoretical orientations. The primary focus of our analysis was a framework with four dimensions of learning (i.e., the *what*, *where*, *who*, and *when*) in continual interaction constituting the products and processes of learning. Based on these common principles and the interactive dimensions, we offered a definition of learning. Finally, we used three cases drawn from real-life experiences, and representing different configurations of the *what*, *where*, *who*, and *when* dimensions, to illuminate the comprehensiveness and utility of the topographical perspective on learning forwarded.

In the book, *California Rivers and Streams*, Jeffrey Mount (1995) described the nature of rivers, chronicled the processes contributing to their birth and development, and analyzed the dynamic and reciprocal relation between the ever-moving and transforming river and its surrounding environs. For example, extrusions of igneous rock or uplift in the land cause the river to go in a particular direction or limit its movement. In other cases, the river overflows its banks carrying sediment and debris, scouring the landscape and creating canyons and meander pools. Mount's description of the interplay between the river and the landscape in river systems seems to echo many aspects of the ever-changing interactions among learner characteristics, what is to be learned, the context and situations in which learning occurs, and the always present countenance of time. Just as one cannot begin to understand the true nature of a river system without understanding the continual interactions of all its elements at a time and over time, one cannot begin to understand the true nature of human learning without embracing its interactional complexity.

More specifically, it is not enough to proffer a working definition of *learning* or even to provide a detailed accounting of any one of its constituent parts (e.g., learner characteristics). Rather, what is required, and what we seek to accomplish here, is a mapping of what we see as criterial dimensions of learning and a description of the complex interactions among the dimensions that form the basis of a learning system. Not only does the metaphor of a river system bring to light the concept of complex interactions as it relates to learning, but it also allows us to envision the dynamic nature of learning, which like the river system is in continual flux. Thus, as we engaged in this undertaking, we did so with the overarching intention to lay out criteria against which the viability and comprehensiveness of theoretical perspectives and empirical

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investigations of learning could be judged (Cobb, 2008). In our use of the term *theoretical perspective,* we are acknowledging that broad orientations to learning are instantiated by particular models and theories offering mechanisms of learning. Our focus is most often on how the broad categories, or *perspectives*, fare in the criterial evaluation to which we put them.

The accomplishment of our overarching intention was predicated on the completion of four specific and interrelated tasks. Therefore, we first articulate principles of learning, acceptable to those holding multiple theoretical perspectives, and basic to a viable conceptualization of learning. Second, we position four dimensions of learning within an interactive framework that can serve as a basis for judging the comprehensiveness and potential viability of current and future theoretical perspectives and empirical investigations. Third, having considered these common principles and interactive dimensions, we forward a working definition of learning. Last, we present three exemplars to illustrate the way in which the interactive dimensions of learning dynamically unfold in everyday instances of human learning.

It is important to consider the value of this endeavor before we initiate these tasks. One apparent value is to bring the notion of learning into the realm of explicit discourse so that we may contemplate the construct more deeply. Although it would be convenient if the nature of learning were well established thereby requiring no detailed explication, we contend that there is no such clear consensus and that a thoughtful, critical look at the very nature of learning is beneficial, both for those just entering the field and for those more deeply invested in the domain. In this article, we want to highlight how conceptualizations of learning, whether expressed or not, shape everyday decisions that have import in our lives.

In addition, it is easy to read the research literature as implying that each professed view on learning is fully adequate and thus requires no further justification. Such views, we suggest, have underestimated the complexity of learning and led to a disregard for competing notions and to a fracturing of the community along theoretical fault lines. Such parochialism and fracturing can contribute to a balkanization of the field, an unproductive breakdown in willingness to entertain alternative frameworks beyond the level of caricature. This lack of theoretical comity within education and psychology as to the nature of learning has been noted (Alexander, 1997; Eisner, 1997; Mayer, 2001; Reynolds, Sinatra, & Jetton, 1996; Schallert & Martin, 2003). Indeed, contrasting and contentious views of learning dot the educational landscape and hinder progress in this domain for researchers and practitioners alike. Nonetheless, because learning remains core to educational and psychological (e.g., cognitive, motivational, and emotional) endeavors despite its problematic and elusive nature, we consider it worthwhile to search for a way to frame the problem differently.

Our proposal is that the seemingly irreconcilable differences among theoretical perspectives arise largely from their specific position in the learning landscape and the vista on learning that each position affords. This is not to say that all such perspectives are equally defensible. Rather, we attempt to demonstrate that their differences may arise from defending quite different locales within the learning landscape. Such views as espoused by cognitive contextualists (Anderson, 1977; Bransford, 1979; Piaget, 1926; Spiro, Vispoel, Schmitz, Samarapungavan, & Boerger, 1987), socioculturalists (Anderson et al., 2001; Schoultz, Säljö, & Wyndhamn, 2001; Vygotsky, 1978; Wertsch & Kanner, 1992), cognitive-evolutionist researchers (Donald, 1991; Geary, 2005; Pinker, 2002; Plotkin, 1998), and situativists (Cobb, 1994; Cole & Engström, 1993; Greeno & van de Sande, 2007), among others, give us an invaluable but limited view of learning's landscape. Specifically, our approach is to propose a topographical framework for the learning system that allows us to pinpoint more accurately contemporary theories and models on the basis of their attention to essential dimensions of learning. Once positioned within this multidimensional space, we can then undertake a more thoughtful analysis of the theories and models not only in terms of their conceptualization of learning but also their ability to capture particular facets of the learning system in valid and reliable ways.

FINDING COMMON GROUND

When the three of us began our analysis, we were aware that through a long history of involvement in this domain, almost a century cumulatively, we had developed affinities for theoretical perspectives that perceive learning from diverse, and sometimes even seemingly incommensurate, vantage points. Despite good intentions to set aside personal agendas and theoretical perspectives and to achieve a shared understanding, we found that differences in our conceptualizations of learning quickly asserted themselves and became barriers to progress, even threatening to scuttle the enterprise. For that reason, we determined that any hope for success required that we first seek common ground, a basis from which subsequent delineations could emerge. In essence, we sought *consilience*, a term introduced by Whewell (1840) and used by Wilson (1998) to describe unity of knowledge across varied disciplines. We appropriated the term to refer to our efforts to find commonality across varied perspectives on learning in the same field. Throughout, we focused expressly on human learning, acknowledging that aspects of the common ground we were seeking might well apply to other living organisms.

A surprising by-product of this initial theoretical compact was that the common ground we sought took the form of principles and, more important, principles foundational to the nature of human learning. We appreciate that the simplicity of the language we use and the brevity of the points expressed may unintentionally mask the significance of the principles we forward. It is conceivable that those long engaged in the study of learning may be tempted to dismiss

this collection of principles as givens, or as commonsense or well-established axioms of learning. However, we would counter that temptation on several grounds. First, for all our years and investment in this domain, we are not aware of any explication of the nature of learning that captures all the points articulated herein. Further, what may seem commonsense to experts in learning and learning theory cannot be treated as such by those who are either new to the domain or whose expertise does not fall directly under the banner of learning. Finally, to those who would see our principles as self-evident, we point to the late Nate Gage's (1991) seminal essay titled "The Obviousness of Social and Educational Research Results," in which such impressions were frequently shown to be untrustworthy.

With this caveat in place, we now turn to the resulting nine principles:

- *Principle 1 Learning is change*
- *Principle 2 Learning is inevitable, essential, and ubiquitous*
- *Principle 3 Learning can be resisted*
- *Principle 4 Learning may be disadvantageous*
- *Principle 5 Learning can be tacit and incidental as well as conscious and intentional*
- *Principle 6 Learning is framed by our humanness*
- *Principle 7 Learning refers to both a process and a product*
- *Principle 8 Learning is different at different points in time*
- *Principle 9 Learning is interactional*

Principle 1: Learning Is Change

A fundamental characteristic of what it means for humans to learn is that *change happens*. This notion of change applies whether the focus is on simpler learning of physical movements (e.g., skipping on one foot) or more complex learning of abstract principles (e.g., understanding the allegorical nature of the American classic *Moby-Dick*). For instance, change may be seen as the development of social practices in individuals or groups, or change may be regarded as altered conceptions that arise from person–environment interactions. Alternatively, change might be understood as arising from the evolved, innate processing capacities of the human brain/mind and the adaptive nature inherent in human beings or as being driven by stages of physiological maturation. Indeed, there are no current conceptions of learning that do not include the notion of change, either explicitly or implicitly. Embedded in this conception of change are three corollaries. First, the change that happens can range from the dramatic to the almost imperceptible. Second, change can occur over infinite scales of time; it can occur in an instant or transpire over expanses of time. Third, change is invariably systemic. In effect, just as a river sculpts aspects of the landscape, even as aspects of the landscape shape the river, change that happens in the learner, be it dramatic or imperceptible, or immediate or gradual, exerts a reciprocal effect on the learner's surroundings.

Principle 2: Learning Is Inevitable, Essential, and Ubiquitous

Being alive means being a learner. Being alive for humans brings with it the inevitability of learning, as well as its necessity. In effect, one cannot prevent learning from occurring (inevitable), nor can one hope to survive unless learning happens (essential). Moreover, learning is not relegated to any singular physical or cultural environment, but unfolds wherever humans move in the world (ubiquitous). Indeed, learning is a biological imperative for human beings; so much so that most of learning happens automatically and is not under the conscious control of the learner (Bargh & Chartrand, 1999; Norman, 1968; Reber, 1989). In his commentary on human memory, Flavell (1971) asserted that children do not need to be taught how to remember; memory happens. So it is with learning. Humans are evolved learners, and through maturation and experience, certain aspects of learning become seemingly effortless and below the level of consciousness, whereas other aspects become more complex, differentiated, and demand conscious effort (Bransford, Brown, & Cocking, 1999). Although educational researchers and practitioners regularly invest attention on forms of higher order learning, it is important to remember that learning also encompasses these less apparent, yet critical, forms of learning (Reynolds, 2000).

Of course, learning is not unique to humans. Although the learning of nonhuman animals has received much attention from researchers, particularly in the first half of the 20th century, it is not difficult to gain consensus on the point that humans are fascinating examples of learning systems (especially to other humans). What makes humans fascinating as learners is that they enter the world in such a helpless state but possess innate abilities that avail them of the opportunity to acquire understandings and procedures over a relatively short period. Such innate capacities coupled with environmental and contextual affordances permit humans to navigate even arduous social and physical terrains. Further, human learning continues over the lifespan.

Learning is ubiquitous, applying in all sorts of situations and in all sorts of environments. Even though we are prone to conceive of learning as nested in schools and associate it with formal educational systems and procedures, learning will not be so delimited. The processes of learning are in operation whenever and wherever humans are situated.

Principle 3: Learning Can Be Resisted

As inevitable, essential, and ubiquitous as learning is, a curious corollary is that there are instances when humans resist learning (and the change it implies), even finding it painful. Resistance does not make us immune to learning. In fact,

there are many times when we learn in spite of ourselves. Why might that be? Why are we sometimes so reluctant to engage in the effort required to learn a new way of thinking or acting even when the goal is desirable? It could well be that the effort required is judged as too great, or the rewards too small (Kahneman, 1973; Wigfield & Eccles, 2000), or the likelihood of success deemed too risky for learning to be pursued. Or it is possible that the attainment of the desired goal might create dissonance within the individual or particular social system that cannot be tolerated. Thus, it often happens that opportunities for changing deeply held or habitual ways of interacting with the world are sometimes, at least initially, circumvented, resisted, or denied. Conceived in this manner, this principle of learning embraces much of the theoretical and empirical work within the literatures on conceptual change (e.g., Vosniadou, 2003) and epistemic beliefs (e.g., Murphy & Mason, 2006).

Principle 4: Learning May Be Disadvantageous

It seems clear that learning results in changes that are not always advantageous to self or others. Yet, because the construct of learning has such positive connotations, it may be important to make this principle explicit. We cannot limit learning only to what is valued, accepted, or acceptable. The construct of learning applies as readily to the student who has learned to disrupt a teacher's lecture as to the student who has learned to be respectful and well behaved, to learning a concept incorrectly as to learning it correctly, to the person who has learned to be helpless when confronted with a new or challenging task as to the person who responds strategically and efficaciously, or to the learning of unacceptable attitudes and behaviors as to the learning of valued attitudes and behaviors (e.g., the ways of a gang as seen from the perspective of the broader society or a gang member, respectively).

Here we must clarify that the notion of advantageous or disadvantageous that we posit has two valid interpretations. On one hand, there is the learning that happens when someone has learned something that he or she wishes had never been learned (e.g., smoking or how pâté de foie gras is made). On the other hand, there is the learning that is utile and satisfying to the person (and perhaps a group of like-minded individuals), but disadvantageous and undesirable to some broader social group (e.g., excessive online gaming). Although the more positive and advantageous outcomes of learning are what may be sought, the learning system does not discriminate.

Principle 5: Learning Can Be Tacit and Incidental as Well as Conscious and Intentional

Much (perhaps most) learning happens outside the realm of conscious control or intentionality (Epstein, 2001; Polanyi, 1966); hence, much of learning is tacit and incidental. Often learners cannot give an explicit rendering of when learning occurred, how learning happened, or how they were changed. Even in the classroom where academic development is the business at hand, much of learning lives in the water table below the surface. What proportion of learning is tacit remains open to debate; Bargh and Chartrand (1999) suggested that as much as 90% of all learning is implicit. Whatever the proportion is, we would agree that, just as in the physical world, there is much below the surface of learning's landscape.

For example, a student learning the concept of solving for an unknown in an algebraic equation is learning mathematical ideas, and we would say this is the student's intentional task. However, at the same time, the student is learning the language of algebra with its peculiar vocabulary, symbolic representations, and syntactic constructions, as well as the social practices that this algebra classroom prefers, such as how solutions should look on paper or how homework pages should be stapled. Turning to out-of-school examples, we want to point to the largely unconscious and incidental nature of first language acquisition and of motor development, where in both domains the interaction of environment and innate human wiring results in particularly suitable outcomes (Chomsky, 1957; Clark, 1994; Wells, 1987). Moreover, even when acquisition was initially effortful and conscious, subsequent use of that learning can be unconscious and automatic. Language is again a great example as when individuals automatically deploy what they know about words and the syntax of their language even as their conscious focus is on how to express what they want to say.

Principle 6: Learning Is Framed by Our Humanness

Our humanness plays a critical role in how we learn and what we learn. Here we are primarily referring to the contribution of the particular neurobiological architecture humans have developed. To paraphrase *Star Trek*'s Mr. Spock, we are "carbon-based" life-forms whose neurological structures shape the nature of how the world is experienced and whose senses are conduits for interacting with the world and with others who populate that world. Those senses are particular in structure for our species and limited in range. Their evolved structure and the environment that has surrounded them across time restrict our senses and cognitive processes. Consequently, the colors we see, the tones we hear, the smells we can detect, and the nature of our reasoning are all constrained by our evolved biology.

It is not just that our neurological and biological bases frame the processes and products of learning. Even within the range of human possibilities, there is variability with which we must contend. Just as some of us are taller or faster than others, some of us have greater visual acuity, or memory capacity, or facility with language than others. Indeed, there can be significant differences among individuals with regard to any cognitive or noncognitive factor. In essence, these physiological differences set upper or lower

boundaries within which learning may be constrained in the human system. Thus, just as our evolved biology—that which makes us human—must be embraced in any model or theory of learning, so too must the differences that manifest at the level of the individual be recognized.

Principle 7: Learning Refers to Both a Process and a Product

Descriptions of learning frequently toggle between portraying learning as a process, as a set of operations progressing through time, and depicting it as an end-product of that process, much like a chemical substance is produced when elements are combined. When we think of learning as a process, we are focusing on the time course of operations resulting in relatively durable changes. When we consider learning as product, we are referring to the relatively durable change that results when learning has occurred, as when new ideas or procedures have been internalized or memories accumulated as a result of experiences in the physical world or in the world of the mind.

Where learning as process refers to the change as it is taking place, learning as product refers to the outcome of that process. Formal measures of learning are almost always about learning as product—the consequences of learning. Although it is perhaps unfortunate that the same word refers to a progressive action and a gerundial noun and may lead to misinterpretations that pivot exactly on this difference, it is our contention that any comprehensive rendering of learning must regard this construct as both process and product. Indeed, research in which the focus is only on learning as a product may oversimplify our conception of the learning process. The same applies to research in which process is all that is considered.

Principle 8: Learning Is Different at Different Points in Time

Because learning is a process, change transpires in time and over time, and leads one to focus on the dynamic flux of factors affecting the beginning, middle, and late stages of learning. The learning process itself is affected by where the learner is in a progression to increasing expertise and acquisition of knowledge in a domain. This developmental view of learning is tied in part to the neurological and biological changes that come with age (Bjorklund & Pellegrini, 2002). We learn differently at different ages, and the process of learning changes, reflecting the accumulation of experiences that give rise to more complex understandings and more intricate relationships among individuals or the relations between person and environment (Bereiter, 2002; Wentzel, 1999). As mature individuals, we cannot draw aside the veil of life experiences to see the world as we did in our childhood. We may seek to "remember" what we thought or felt, but those memories are never replications or duplications.

This phenomenon occurs in part because of the recursive and iterative nature of learning; processes result in products that in turn influence subsequent processes. An oftencited example can be found in the Matthew effect (Stanovich, 1986), which, simply stated, refers to when a learning product (e.g., graphophonemic knowledge that underlies rapid and accurate word recognition) interacts with the process of learning (e.g., comprehending), what Stanovich called a *reciprocal causation* effect. Those with decoding facility read more and hence acquire more background knowledge, which in turn leads to better understanding of future information and more reading, and so on.

Principle 9: Learning Is Interactional

When we assert that learning is interactional, we are highlighting that learning engages an intermutual sequence of operations that are shaped by human culture and biology, among a host of such influences, and by how humans act and react to a dynamically changing world. All serious discussions of learning would agree that the world "out there" matters to how learning takes place, although there might be debate in how to construe that world (Bereiter, 1994; Stanovich, 2000). Moreover, any postbehaviorist learning perspective includes in its description of the interactive nature of learning, the iterative coinfluences between current and past constructions or representations. In this interactional mix, continual change occurs not only to learners, but to the context in which learning is embedded as well. Learners are influenced by, and at the same time push back, take from, change, control, and create the environment in which learning is situated.

FRAMING THE NATURE OF LEARNING

Embedded in the nine principles of learning are characteristics that stand as salient attributes of this complex but elusive construct. The careful definition of core constructs is certainly a necessary step in any effort to formulate theory, build models, or conduct investigations; yet more is required. In theory and research, conceptualization and operationalization must go hand and hand. Thus, although the principles of learning help us answer the question "What is learning," they cannot help us answer the question of whether an existing perspective of learning is fully specified or of whether a particular attempt to engineer learning represents a viable operationalization of the construct. What is also required are criteria that will allow us to judge the manner in which core constructs are theorized, modeled, or empirically investigated. Toward that end, we offer the dimensions of learning as components in an interactive framework.

Specifically, we assert that any comprehensive theoretical perspective of learning should be constituted of at least four dimensions that are continuously interwoven and interactive, represented by the *what*, *where*, *who*, and *when* of learning.

As we seek to demonstrate, although there may well be other features to the learning system that merit consideration in a specific instantiation of learning, these four dimensions should be viewed as primary (i.e., necessary). Although we describe each dimension separately, the interactional perspective represented by Principle 9 holds that learning involves the continual interplay of multiple dimensions at any point or under any circumstance. Indeed, we describe our rendering of this emergent framework for learning as *topographical* precisely because we think the interplay among these four dimensions results in a shape to learning that is fluid and dynamic, but that also gives rise to discernible and predictable patterns that are multiply determined.

We acknowledge that current contrasting views of learning attend to one or more of these dimensions, however tacitly. Yet it is also our contention that no existing perspective of which we are aware has explicitly addressed all four of these dimensions in any systemic manner. Rather, what we have determined is that current theoretical orientations center on certain dimensions, such as the *who* and *what* or the *who* and *where* dimensions, without due consideration for other equally important facets. Certainly, extant theoretical perspectives on learning have not dealt with the time dimension, the *when*, in the innovative way that we do. We support this contention by demonstrating how seemingly oppositional views can be subsumed within our broader four-dimensional framework largely because they are seeking to explain learning from different vantage points within this multidimensional space.

Moreover, because much of the emphases within existing theoretical perspectives resides at the juncture of person–environment (i.e., the *who–where* connection), we have chosen to begin discussion with the *what* of learning and conclude with the *when* of learning, dimensions of seemingly less import in extant accounts. In our presentation of the interactive framework, we consider how distinctions among orientations that might be seen as incommensurate outside the purview of our topographical framework can more accurately be depicted as differential positions within the vector space created by the *what*, *where*, *who*, and *when* dimensions.

Dimension 1: The *What* of Learning

A comprehensive rendering of learning must give due consideration to the objects or foci of that dynamic system (Giussani, 1995). There is always a *what* that is being learned or that is in the process of change. Further, there is ample evidence that the objects of learning are distinguishable and classifiable, and that those differences are significant in how the process of learning unfolds. For our purposes, we propose that the *whats* of learning can be well represented as different levels ranging from acquired habits and conditioned responses, to spontaneous concepts and action sequences learned in everyday informal interactions with the world, to scientific concepts and practices that are often the result of formal education, as illustrated in Figure 1.

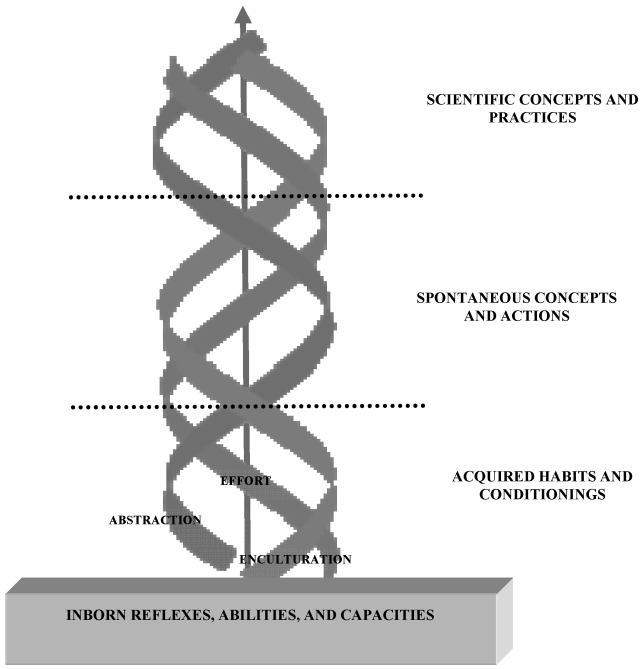

FIGURE 1 A representation of interactive complexification as pertaining to the what of learning.

These levels are formed from the interplay of various factors implicated in the learning process. Those factors, which can systemically vary in degree (e.g., intensity, frequency, or magnitude), include but are not limited to the degree to which enculturation into a particular social practice is required, or the degree to which conscious effort is needed, or the degree of abstraction or complexity involved. What distinguishes the levels of learning to which we refer is the extent to which their attainment depends on a particular interplay of these salient factors. Because we feared that using an existing term from the field might carry with it inappropriate connotations, we coined the term *interactive complexification* to refer to the confluence of factors that give rise to the increasing intricacy of any given aspect of the products or processes (i.e., the *whats*) of learning.

We appreciate that there may be other systems of classifying the *what* of learning that rely on other features or mechanisms than our own interactive complexification; witness Spiro's (with Feltovich, Jacobson, & Coulson, 1992) insightful identification of important differences between well-structured and ill-structured domains. We do not view these alternatives as problematic, provided that they are justified and defensible. Rather, our critical point here is that theoretical perspectives must take account of the differing objects of learning in some manner and not treat learning as a unitary process or outcome. For instance, it is not our goal to support or refute behaviorism as a theory of learning but rather to argue that certain premises underlying a behavior

theory perspective are easier to understand and apply if one stays within the realm of acquired habits. When behaviorism meanders away from this familiar terrain, it is far less sustainable, as the history of psychology has so clearly demonstrated (Robins, Gosling, & Craik, 1999). Of course, the same argument can be directed toward any other theory of learning. Our contention is that certain conflicts between stances on learning rest on their disregard of this very concern.

Given this understanding and prior to describing attributes and characteristics of the first level, acquired habits and conditionings, we want to acknowledge that all learning has as its foundation a biological and neurological basis (as represented by the base of the helix in Figure 1). Inborn reflexes, abilities, and capacities are initiating points for future physical, cognitive, and psychosocial development. Whereas such inborn reflexes, abilities, and capacities are not themselves learned, they represent the primordial matter from which learning emerges over time and space and, in fact, remain influential across the levels. This continuing influence is depicted as the axis of the helix in Figure 1.

Consider, for example, what might qualify as inborn reflexes, abilities, and capacities for the domain of reading—a domain with which we are intimately familiar. For one, we might regard certain perceptual and visual processes, such as the ability to discriminate light and dark areas or to discern objects in the visual field (Gibson, 1966), as among the hard-wired abilities that support children's later literacy development. The ability to see light and dark or shapes comes with the human system and is, clearly, not reading in itself. Still, developing reading is reliant on these human capacities. Similarly, the human capacity to find commonalities across experiences, to form categories out of what is perceived, and to make cause and effect judgments supports and interacts with learning at all levels of interactive complexification.

The first level of the "what" dimension comprises acquired habits and conditionings representing simpler learned responses to the world that are often more concrete, are less socialized, and may require conscious awareness for a shorter period than other levels. Returning to our literacy example, within a matter of months, most infants gain the ability to hear and pronounce a range of phonemes representative of the language around them, even as they learn to hold a book, grasp the corner of a page, and turn to the next. These acquired habits and conditionings will continue to support reading even as it progresses across levels.

At the next level of the *what* model are the spontaneous concepts that humans acquire from the extraordinary number of different learning opportunities they encounter, informally or incidentally, over the course of a lifetime—from dressing one's self to engaging in appropriate conversation, from cooking a meal to learning how to parent. Such spontaneous concepts, with their associated actions and emotions, can acquire the status of scientific concepts and practices, the next level, as when one realizes a love for and interest in cooking and takes up the preparation of becoming a chef or a food science expert. The role of spontaneous concepts and actions is very evident in early literacy development, as when children begin to acquire print concepts and reading conventions through interactions with those that populate their environment or as a consequence of focused effort.

When it comes to the third level of the *what* dimension, our choice of the term *scientific concept* follows usage introduced by Vygotsky (1934/1986) not to represent concepts about science as a discipline (or not only about science) but to refer to "languaged" ideas that have become abstracted or generalized from human interactions and aligned with formal disciplines or communities of practice. Thus, scientific concepts are often associated with intentional learning or formal knowledge (Gardner, 1991), in contrast to spontaneous concepts that are, in effect, less formalized understandings often acquired from everyday experiences (Vygotsky, 1934/1986) and often associated with unintended or incidental learning (Reber, 1989; Shiffrin & Schneider, 1984). Thus, as one examines the interactive complexification of the "what" dimension, there is an increased need for the support and guidance of others to assist in one's learning (Anderson et al., 2001; Cobb, Wood, & Yackel, 1991). We represent this aspect by the enculturation strand of the helix in Figure 1.

In addition, as the learning progresses across levels, there is the real possibility that a successful outcome will necessitate greater effort exerted across time and place (the effort strand). Because reading development continues across the lifespan, there are many scientific concepts and practices that come as individuals engage in increasingly demanding, specialized, and potentially more abstract print-related activities. For instance, scientific concepts and practices come into play as individuals encounter technical or domain-specific texts or are introduced to new genres or new ways of analyzing a variety of traditional and nontraditional texts.

Overall, Figure 1 represents our attempt to portray how certain factors implicated in learning operate at varying degrees and how their changing nature individually and in concert (what we call *interactive complexification*) with other significant factors constitute distinguishable levels of learning's objects or foci. As we suggested, we contend that these levels and the interplay of factors they represent encompass the foci of a range of learning perspectives that might otherwise appear at odds. For instance, the *whats* that garner much attention from behavior theorists would fit well within the acquired habits and conditionings level of our depiction, whereas the interests of sociocultural theorists may more often nest themselves at the level of scientific concepts and practices. What developmental theorists might emphasize in their research, by comparison, is not the *whats* that fall at any one level of our representation, but rather the process by which individuals progress within and across those levels. Cognitive-evolutionary theorists, like developmental theorists, might be drawn to movement across levels, especially as it pertains to the ever-present influence of humans' inborn reflexes, abilities, and capacities on the nature

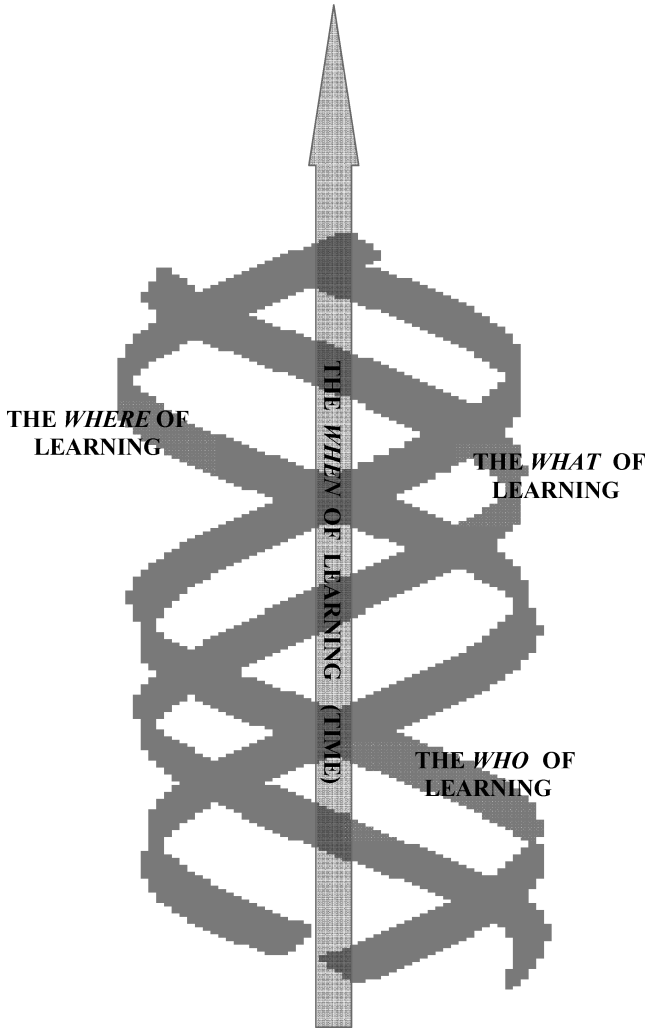

FIGURE 2 A model of the interactive nature of the what, where, and who dimensions of learning at time and across time (i.e., the when dimension).

of learning. Further, just as these individual strands continually interact with each other to give the *what* dimension its character, so too does the *what* dimension interact with the *where*, *who*, and *when* dimensions to give learning its character, as we will see shortly (see Figure 2).

Dimension 2: The *Where* of Learning

Learning does not happen in a vacuum. The *where* of learning refers to the ecological context in which learning occurs. By ecological context, we are referring to such primary aspects as the physical environment and the social and cultural milieu that are intertwined and interdependent in their influence on learning. An interesting characteristic of this ecology is that there is an intermingling of the more concrete with the more abstract, and of the more physical with the more social, influencing the learning process at every turn. As in a river system, there are physical elements and tangibles in the learning ecology that shape the flow of learning. As well, there are social and cultural influences that emerge from the cultural practices and social dynamics in which the learning is taking place, especially as learning progresses toward the level of scientific concepts and practices.

Consider, for example, a 1-year-old who has discovered the wonders of banging a spoon on a highchair tray. At this point, banging requires a coordination of movement that may have begun accidentally but quickly developed into a rhythmic movement with its attendant cacophony of sounds. The physical context impinging on learning may involve the processing of the distance between hand and tray and of how the spoon fits in the child's hand for maximum effect. At this point, the social/cultural context may include how adults in the family interpret, react to, and label the child's banging and the particular kind of highchair and spoon that have come to be used in that home. As the child grows older, the context surrounding drumming may develop to include what it means to learn to play the drums musically, with all its related cultural practices. Reading musical notation, knowing when to quiet a drumhead, and responding to a conductor's subtle direction become contextual features to which the budding percussionist must appropriately respond, even as our learner reacts conceptually, motivationally, and emotionally to the degree to which this new skill is appreciated by the local culture. Moreover, as learning proceeds, what the learner takes the context to be changes. This ever-changing interpretation of what exactly is salient and relevant about the contextual ecology influences the process and products of learning.

One of many domains in which contextual influences have been studied is reading. Context has come to mean many things within this domain. It sometimes pertains to the texts themselves, including their organization, structure, and features (Chambliss & Calfee, 1998; Meyer & Poon, 2001; Schallert, 1976). Context can also refer to the physical place in which the reading occurs, such as in the home (Purcell-Gates, 2007), in the classroom (e.g., reading class or other content domains; Jetton & Alexander, 2004), or in out-of-school environments (e.g., libraries, museums, or everyday locales; Moje & O'Brien, 2001). Or it can relate to the mode or medium of delivery, (e.g., online or hypermedia environments; Leu et al., 2007). Also, the *where* of reading can focus on the human resources that are present and that may serve to facilitate or inhibit the learning process or its outcomes (Allington, 2001; Almasi, 1995).

Finally, as with the other learning dimensions, the *where* of learning interacts with the *what, who,* and *when* (see Figure 2). To explore just one of these interactions, we want to highlight how a learner's relation with context changes over time. When one is learning something new, the particular physical environment and social/cultural setting are critical to how the learning proceeds. In fact, these details of context are so critical that often one's initial steps in learning will

incorporate them as essential components of the learning, leading to learning that seems tied to the situation. Theorists of a certain persuasion might claim that all learning is like this, situated in particular contexts of practice (Greeno & van de Sande, 2007). However, exactly because contexts are themselves always changing, the learner must continue to adjust, adapt, and broaden the application of what was learned and to respond appropriately to contextual cues in the here and now that are close enough but slightly different from the context that was in place when learning "began."

Dimension 3: The *Who* of Learning

With the *who* dimension, we are pointing to how learning is influenced by characteristics of the learner along biological, cognitive, experiential (including individual and cultural experience), and affective (motivation/emotion) lines. Further, we acknowledge that the particulars of all that a learner brings to a situation critically influence the process and product of learning. Indeed, over time humans have evolved a number of innate learning capacities that have helped them become more efficient and effective learners, thus enabling them to survive and prosper in their ecological niche. For example, humans appear to have a capacity to distinguish between a temporal string of nonrelated stimuli and a similarly appearing string that displays a series of cause and effect relations (Bjorklund & Pellegrini, 2002; Kant, 1787/1963).

As we begin to explicate this dimension, we are aware that a frequent interpretation of learner characteristics aligns itself with measuring individual differences in achievement or performance on high-stakes exams. Because our focus is on learning, we want to make explicit the distinction between learning and achievement, concepts that we think have been conflated in the educational and psychological literatures (Alexander & Riconscente, 2005). Because achievement test scores measure performance and not learning per se, they include measures of factors not representative of learning either as process or product.

The kinds of learner characteristics that we consider important are several. First, there are the biophysical characteristics. We acknowledge that simply by virtue of evolved biology and how humans are wired, who the learner is plays a critical role in the learning process. The embodied consciousness that represents the human learner cannot help but shape the learning process (Lakoff & Johnson, 1999). Also, there are cognitive variations for nearly every human characteristic. For example, although it is highly unlikely to find a person with more than three times the normal working memory capacity, there is always variation in working memory across humans, as well as in the capacities of the brain to process information efficiently. These differences can be detected in both the processes and products of learning. Take reading as a case in point. There has been great interest in fluency within recent reading research. Readers' fluency is associated in part with the graphophonemic abilities they bring to the text, combined with their working memory capacity and their skill at producing the desired sounds and expressions apace.

Another source of influence on learning is represented by learners' motives, intentions, and general psychological traits. What are learners in a particular learning situation consciously or unconsciously seeking to accomplish? How do their psychological propensities foster or frustrate those intentions? Much attention has been paid to motivational and emotional differences among learners. As this literature reminds us, individuals not only manifest different goals for learning, but also ascribe different values to learning, have varied expectations for success (Linnenbrink & Pintrich, 2003; Pintrich & Schrauben, 1992; Wigfield & Eccles, 2000), and experience different emotions during the process (Damasio, 2005; Pekrun, Goetz, Titz, & Perry, 2002). Different psychological traits (e.g., persistence or extroversion) influence the learning of individuals even when they find themselves more or less in the same physical context confronting the same cognitive task (Matthews, Zeidner, & Roberts, 2006).

The motives, intentions, emotional states, and interests of readers have garnered increasing attention in the last decade (Guthrie & Cox, 2001; Wigfield & Guthrie, 1997). This growing presence has illustrated that those who perform well at a given reading task or who manifest a positive learning trajectory in the domain have more than the neurophysiological basics. They also have a reported interest in reading generally or in the particular domain or topic of the text (Wade, 2001). They are more likely to report an orientation toward learning about the domain/topic than toward simply doing adequately on the task (Hidi & Harackiewicz, 2000). They are also more apt to hold beliefs about themselves as readers and about reading that will sustain them and promote their cognitive and affective engagement (Dai & Wanga, 2007).

Another example of learner characteristics that come into play in descriptions of learning is individuals' previous learning, the relevant knowledge they have acquired that they bring to bear in a particular learning situation (Anderson, Reynolds, Schallert, & Goetz, 1977). We point to the extremely prolific research on how prior knowledge influences learning. The particular interface between what one knows and what one is learning intimately influences what is understood from the interaction and what one takes away from it.

In an interesting study that combined two of these ways of differentiating learners, Walker (1987) compared army enlisted personnel who were either high or low in aptitude to learn (based on scores on a standardized ability measure) and high or low in knowledge of baseball (based on responses to factual questions about the game) on how well they remembered an oral play-by-play of a half inning of a fictitious baseball game. Results indicated that participants with high baseball knowledge did better than those with low baseball knowledge whether they came from the high- or low-ability

groups. In fact, within the high-knowledge groups, low-ability recruits recalled as much of the play-by-play account as high-ability learners, and the low-ability/high-knowledge group outperformed the high-ability/low-knowledge group.

Walker's study is interesting in the context of our consideration of the importance of learner characteristics because it juxtaposed two different ways of thinking of how learners can differ from one another. There are many other studies, some to which we have been intimately connected, that have demonstrated the clear impact that prior knowledge can have on learning something new (Alexander & Murphy, 1998; Anderson et al., 1977; Goetz, Schallert, Reynolds, & Radin, 1983; Reynolds, Taylor, Steffensen, Shirey, & Anderson, 1982). In a review of the theoretical and empirical literature on knowledge, Alexander, Schallert, and Hare (1991) offered a synthesis of the myriad of constructs associated with prior knowledge and showed how these interacted with each other.

We close our discussion of this dimension with a point we have made in our descriptions of the *what* and *where* dimensions. As we depict in Figure 2, the *who* dimension interacts with all other dimensions so that particular characteristics of the learner are emphasized or deemphasized through interaction with what is being learned, in what context, and at different points in time. In effect, because people as learners differ greatly, different facets of the *who* are instantiated or become more salient as the particulars of the *what* and *when* of learning unfold in time and space.

Dimension 4: The *When* of Learning

Others have recognized, in their way, the *what*, *who*, and *where* dimensions of human learning (Jenkins, 1974). However, the fourth dimension in our topography has received less consideration especially in interaction with the aforementioned learning dimensions. Yet just as learning does not occur in a vacuum, there is always a temporal nature to learning. As humans, our movements in the world are inevitably constrained both by time and space. With each imperceptible moment, the frame for learning has shifted, not merely because the place itself has changed (e.g., light refractions or creature movements), but because the learner himself or herself has changed, however inconspicuously, from Time 1 to Time 2. Thus, a learning moment can never be duplicated, only approximated. It is precisely because of the invasiveness of time throughout this topography that we conceive of it as a force that must be addressed.

We find that different renderings have in their purview, though rarely explicitly, many iterations and variations on the dimension of time, each representing different gradations in the span of time considered or the distributions of events or the number of relevant experiences within a given interval of time. Consider the time frames of evolutionary theories vis-à-vis sociocultural, cognitive-contextual, developmental, and situated perspectives on learning. For evolutionary theorists, the course of time that is of importance can be millennia or eras, as their primary concern is the mental adaptation and the consequent development of the human species as a result of mutation and natural selection. Thus, one might study aspects of learning that are biologically primary (numeracy) or secondary (reading) or the role of evolved adaptation in human development (Ellis & Bjorklund, 2005; Geary, 2005; Pinker, 2002; Reynolds & Sinatra, 2005).

From sociocultural perspectives, time is framed by the history of a particular group, which could encompass months, years, or even centuries. Thus, one might study the cookie-selling practices of Girl Scouts (Rogoff, 1990), the ways in which graduate students come to adopt the proper stances, idiom, and understandings of a discipline (Fox, 1994), or the meaning and import of literacy to individuals born at different points in the 20th century (Brandt, 2001). The time perspective of developmental psychologists, by comparison, is the human life span and the predictable neurobiological, motor, cognitive, socioemotional changes that come with maturation and experience. The characteristics of young children as learners may be compared to those of older children, adolescents, or adults. By comparison, theoretical perspectives concerned with learning in situ appear more concentrated on the immediate temporal unfolding and on how words, actions, or cultural artifacts are plied by individuals or groups around shared problems or tasks. Time plays another role in certain orientations when learning is attributed to the frequency with which individuals encounter certain conditions or are embedded in particular experiences. Here, it is not time itself that matters but the flow of experiences or the availability of human and nonhuman resources that come with the flow of time.

The intersection of these time orientations with the *what*, *who*, and *where* dimensions of learning can be well illustrated in the study of expertise development within complex domains (Alexander, 2003; Spiro et al., 1992). For one, the ability of individuals to move out of a state of acclimation or naiveté in any field is predicated in part on their level of neurological and biological development; that is, the mind and body must be at some sufficient level of maturation or experience to benefit from any potentially educative event. Also, there are characteristics of the learner (the who) that become relevant in such development in that individuals may be more or less predisposed to the neurobiological, physical, cognitive, social, and motivational demands associated with any particular domain. That is why individuals can be positioned at significantly different points in expertise development for each and every complex domain. The same person may well be acclimated in physics, competent in statistics, but expert in linguistics.

Moreover, the human and nonhuman resources that individuals will require will shift as they gain facility in the domain and as central principles of the domain become part of their knowledge core. Of course, it is also assumed that the journey toward expertise means that the objects of learning

become increasingly more complex and that the processes and products of learning mirror that growing complexity. Also, it is well documented that the attainment of expertise in any complex domain requires an extended period, many thousands of relevant exposures, and the tapping into the knowledge of others (either with or without their explicit support and guidance) who have likewise attained expertise in that domain (Ericsson & Smith, 1991).

LEARNING DEFINED

Now with the principles and dimensions of learning in place, we are ready to propose a definition of learning that operates in concert with those principles and dimensions.

> Learning is a multidimensional process that results in a relatively enduring change in a person or persons, and consequently how that person or persons will perceive the world and reciprocally respond to its affordances physically, psychologically, and socially. The process of learning has as its foundation the systemic, dynamic, and interactive relation between the nature of the learner and the object of the learning as ecologically situated in a given time and place as well as over time.

Within formal logic, it is considered essential not just to establish what a thing is, but also to note what it is not (i.e., antinomy). Similarly, we think that our definition of learning would be inadequate if we were unable to specify some aspects of what learning is not. The principles that we previously proffered serve us in this endeavor because certain characteristics of "not learning" are implicitly or explicitly stated within those principles. First, all innate capacities, those genetically and biologically programmed inborn aspects of our humanness, influence learning but are in and of themselves outside the parameters of learning as we have conceptualized it. Second, and related to the issue of innateness, the biological/neurological maturation of the human organism in and of itself does not constitute learning. Third, the simple recall of that which was previously learned does not constitute learning per se; only when recall results in some new configuration or change does it reach the level of learning. Finally, although as sensory beings, humans are in continual physical contact with the world around them, only when those experiences leave some relatively enduring footprint do they fall within the realm of learning as we have defined it.

TOUCHSTONE CASES

It is easy when dealing with fundamental constructs that describe human functioning to remain at an abstract level that does not allow for a valid test of notions against the complexities that a real learning situation would bring with it. Learning is often so associated with formal instructional settings that it is easy to forget how ubiquitous it is. Testing our developing notions about learning against different kinds of real-world situations challenges us to see whether our views are broad, comprehensive, and justifiable. The three examples we chose involve different kinds of learners, each learning something at different levels and in different places and times. For each case, we attempt to establish why it represents learning and how it sits at the nexus of the primary dimensions within our topographical framework.

Case 1: Biting Into a Cherry

When Diane's son, Robbie, was barely 2 years old, he had acquired some degree of experience with eating an array of "adult" foods. One might even say that he was skilled at bringing a spoon up to his mouth and swallowing yogurt or cereal he had scooped onto it from a bowl. Yet it often happened that he would face some new substance and would have to learn about it, not only whether it was edible but also such characteristics as how it looked, how one should hold it to eat it, what to do with it in the mouth, and how it tasted. On a particular day, Robbie grabbed a cherry as his mother looked on, popped it into his mouth, and bit down. What made this otherwise insignificant step in Robbie's knowledge acquisition of "cherry-as-foodstuff" memorable was the look of sharp surprise he displayed as his teeth met the pit of the cherry straight on. It was clear that he had not "predicted" a cherry pit and that he did not, in some essential way, know how to eat a cherry. Where an adult carefully, albeit often automatically, negotiates the teeth around the center of the cherry and squeezes down making sure that the juice of the fruit stays inside the lips, Robbie had bit hard into the center of the cherry and had made bright red juice spurt out down the front of his T-shirt. Even by his second cherry, he was more cautious in biting, more careful about the mess of the juice, and more eager to reproduce the taste of the fruit. He had learned how to eat cherries, or more accurately, how not to eat them, adjusting his teeth and lips so as to avoid painful effects.

According to our learning framework, Robbie was developing a simple set of acquired actions (habits) and responding to the effect of the punishing stimulation coming from the pain of biting into a hard substance and of spoiling his favorite T-shirt with red cherry juice. What he had to learn in this situation—how to chew and how to position his mouth with this new food—could not easily be acquired by imitation as most of what needed to be discovered was hidden from view. Yet his own physical sensations could "teach" him what to do in this case.

Because Robbie was learning in a particular context, represented by the physical environment (e.g., the objects on the picnic table on the family patio, the presence of his mom and dad, the smells and tastes of the food, or the pain of having

bit into it wrong) and the social/cultural context (e.g., that his family loved cherries, that they saw them as a treat, or that they ate them directly out of a bowl) influenced whether he would want to have a cherry again, let alone know how to eat it. His learning was shaped by who he was as a learner of cherry eating, his motives and likes, his ability to figure out how to position body parts so as to avoid pain and gain tasty sensations, his current level of maturation and knowledge development about this small domain, his favored status in his indulgent parents' eyes, and a host of other characteristics that made him learn as he did on that particular occasion. Finally, because of his age and the number of times he had previously eaten a cherry, a trajectory to his learning could be envisioned even then. Now at the age of 30, Robbie can eat cherries with the best of them.

The acquired habit and conditioned response this child had learned would be immediately understood by a learning theorist coming from a behaviorist perspective, although the details of context, personal motives, and interpretations of the experience would likely be seen as unnecessary and distracting. Such a view might even downplay the importance of the maturational level of the learner even as it placed emphasis on the feedback loop created by the pain sensations (and in less restrictive versions of the theory, the frustration of having spoiled a favorite shirt) on the acquisition of the proper behavioral production routines. By contrast, a sociocultural view might emphasize the meaning of a family picnic as a context to a child being introduced to a new food while overlooking, perhaps, the working out of the proper lip, teeth, and tongue movements required in eating a cherry properly. A cognitive-constructivist, on the other hand, might employ this case to illustrate the manner in which Robbie's lack of experience and his still emerging schema for fruit-eating led to the undesired event and how this particular experience would likely add salient information to his mental model for cherry consumption.

Case 2: Crossing the Via dei Fori Imperiali in Rome

In the second case, we describe what happened when Ralph, on a first visit to Rome, had the occasion to cross one of the major streets in Rome. Taking off on foot from his hotel, he had already spent several hours navigating the ruins of the old Forum when he decided to visit the Piazza Campo de Fiori designed by Michelangelo. Nothing particularly remarkable happened as he crossed several smaller streets on his way but then he came to an extremely large street, Via dei Fori Imperiali, six lanes wide with vehicles crowding every lane and moving at a daunting rate of speed.

Although critical elements of Ralph's well-learned, American street-crossing schema did not seem to apply, they did guide his attention in the search for a solution, a process that in this rendering may seem much more protracted and analytical than it actually was. First, he looked for a streetlight that would stop the traffic, immediately ascertaining that there were none in sight. Next, he looked for a corner from which to cross, only to discover that, although some corners did indeed have pedestrian crossing markings, the people driving the cars seemed to pay no attention to them, never stopping or even reducing speed. Hesitating as to what to do next, he noticed that the native Romans were crossing the street, albeit quickly and with great agility, by simply wading into the traffic, crossing one lane at a time whenever even the smallest traffic gap occurred, standing on the lane marker when their progress stalled, and moving ahead when another opening came. The only people stuck on the curb seemed to be tourists. He watched for another minute, launched into the traffic crossing as the natives had crossed, and soon found himself on the other side of the street.

Some of the same well-learned motor and sensory-perceptual skills acquired as part of his American street-crossing schema had served him well. However, Ralph had learned a host of new things about crossing a street from his experience in Rome, changes in how he should propel himself, staccato-style, across the street, attitudes about stepping into traffic, signs that it was acceptable to force himself into traffic in this way, and appreciation of the drivers' intentions to maneuver around pedestrians. In this new context, the *how* of crossing the street certainly had been changed. The speed with which he had learned the new procedure was remarkable, reflecting some of his abilities as an athlete and his sangfroid in a new situation. By the time his wife, Bonnie, joined him from the States a few days later, he had become extremely adept at crossing the street and was surprised at her reluctance when he tried to take her hand and help her cross the street, Roman style. She reacted by pulling her hand out of his with a look of alarm and resolutely remained stuck to the curb watching him show off his newly acquired skill. With all the differences between them relative to this particular learning occasion, it is perhaps not surprising that Bonnie resisted somewhat longer in adopting the "Roman" street-crossing routine, but soon came to see this response as necessary and not as life-threatening as she initially thought.

To us, this case is a useful illustration of learning for multiple reasons. We see that the *what* of the learning has many of the features of spontaneous concepts and actions discussed earlier. Being nested in the current physical and cultural context of Rome and heeding the movements and behaviors of those around him proved sufficient for Ralph—an experienced traveler—to master the art of Roman street crossing. No formal instruction in this process was sought, and none was required. In terms of the *where* dimension, it is quite evident that these pedestrian conventions were not broadly generalizable but rather more closely tied to a given local context. Ralph and Bonnie knew immediately that to try crossing a street in Los Angeles, New York, or London in the Roman way would lead to the disaster anticipated by Bonnie on her first attempt in Rome. Still, there is every reason to assume that Ralph and Bonnie will not soon forget

the routine they had acquired, and this durability is further evidence that learning had, indeed, taken place.

Different aspects of this case would likely be appealing to those holding to diverse perspectives on learning. For instance, situated cognitivists would find intriguing Ralph's reading of the immediate context and of the affordances it provided and would focus on how and why Ralph responded as he did at that given moment. Conversely, a socioculturalist might be drawn to the street crossing routine that a "foreigner" might need to adopt in order to function within this environment, focusing on the coregulations occurring between walkers and drivers navigating the Via dei Fori Imperiali at the same time. A cognitive-constructivist might be interested in the knowledge that Ralph and Bonnie acquired from this experience, and how each of their existing conceptions of street crossing interacted with the new experience and was changed, either moderately or radically, as a result of this memorable occasion. A cognitive-evolutionist, by comparison, might be fascinated with the way in which Ralph, as representative of his species, had the capability to deal with the myriad of stimuli bombarding him in this modern urban setting, to discern a sophisticated pattern within that myriad of stimuli, and to respond adroitly to the causal implications suggested by the emerging pattern in a manner that ensured his survival and achieved his goals.

Case 3: Learning to Write an Academic Paper in a New Discipline

In our third case, we focus on a critical task that students face when admitted to graduate school, learning how to write in ways deemed acceptable to the field. Patricia's office at the University of Maryland is normally full of activity, with students and colleagues dropping by frequently to ask questions and share observations and insights. The atmosphere is generally upbeat and highly interactive. However, this apparent informality belies the serious nature of the learning taking place. Like many doctoral students elsewhere, Patricia's students must learn to write for publication in their field and, for those involved more closely in assisting her in her editorial duties, they must develop the skills and insights about academic writing that come from being involved in the complex role of editorial assistant.

What Patricia's students are required to master include the syntactic and stylistic conventions and regulations of publishing in their field (i.e., APA style). Learning to write for these doctoral students takes the form of frequent interactions around issues of publication, writing, and the selection of appropriate publication outlets in an interactive cycle of generating ideas, interpreting research findings, drafting manuscripts, jointly critiquing and editing papers, and producing publication-ready manuscripts. This cycle reoccurs frequently as Patricia's students learn the skills and concepts necessary to help her in her editorial enterprises. Learning in this situation is the product of active participation in the editorial process. Students learn the imperative of meeting all editorial and production deadlines, the value of conceptual precision and writing clarity in their own and others' manuscripts, and the importance of using appropriate methodological treatments of data. Even 1st-year students learn as they apprentice in the process, and they gain the finer nuances of these general practices as they advance in their studies and participate in discussion, critique, and production cycles.

We included this case because the learning involved is different from that described in the first two cases, cases that dealt with learning at the levels of acquired habits and conditionings and of spontaneous concepts and actions. In the cherry pit and crossing the street cases, the learning occurred rather quickly, was more concrete than abstract, and required conscious effort for only a short to moderate duration. The learning described in this case fits best into our third learning level, scientific concepts and practices. Hence, it illustrates learning that occurs over a long period requires considerable effort and involves a relatively high level of abstraction. Also, whereas learning in the first two cases could be viewed as primarily individual and experiential, this level of learning is best accomplished with the involvement of more knowledgeable others who can mentor the beginner across what may at times be very large gaps in knowledge.

What Patricia's students experience in the Disciplined Reading and Disciplined Learning Research Laboratory, the ways that emerging scholars learn to write for their disciplinary community, has in fact been described frequently in the composition literature. For example, in a classic piece, Berkenkotter, Huckin, and Ackerman (1988) described the history of a doctoral student as he experienced the sometimes painful transformation of losing the style of his English literature undergraduate major and acquiring appropriate ways of conceiving of evidence and presenting it adequately for a social science academic journal. As the student reported, there was a period during that 1st year of his academic studies when he felt that he was losing himself even as he was learning what to attend to and how to write about it that made up his new discipline.

Similarly, reporting on years of intensive observation and disciplined analysis, Fox (1994) delineated the difficulties that international students experienced as they learned not only to adopt the style appropriate to their discipline but also the ways that feedback about writing was provided in this country, self-assured, direct, even abrupt. Prior (1995) documented the processes in which a new graduate student engaged as she learned to write a conference proposal with her major advisor, at first simply taking every suggestion as a sign that her advisor knew so much more than she did about what to say and how to say it in the proposal. Slowly as she continued to work with her advisor, she acquired the knowledge of current issues in the field, the language appropriate to their expression, and the confidence to resist at least some of the advisor's suggestions as she came to know

and care more about what was being said and how it was being said.

We consider this progression in graduate students to be learning because students' abilities to write are significantly transformed over the span of a few years. Learning seems clearly evident when graduate students move from turning in their first course paper to the point of writing a first-authored or sole-authored publication. When they graduate, they eventually find they can use the knowledge they have acquired in graduate school to guide their own students in the process of academic writing even as they continue to learn their craft. What it is that a graduate student is learning about writing includes some aspects that may be relatively simple to master (e.g., style of citation format) as well as more subtle and difficult conventions for deciding how to frame an argument, whom to cite when doing so, which stance to indicate vis-à-vis a particular finding, and when to deem any particular section of a paper as "done." In essence, Patricia's students have to learn how to deploy the scientific concepts and practices of their field in their own writing. These practices reflect historically situated and continually evolving conventions and standards for scholarly writings.

It is hard to imagine what facets of our third case a behaviorist would find informative or appealing, except perhaps to focus on the relation between the feedback students receive and the accolades given (e.g., coauthorship) as critical reinforcement that would sustain their efforts over the years. To a cognitive-contextualist, a student's journey toward expertise as a writer would prove especially compelling, particularly in terms of the transformations in knowledge, problem solving, and motivations that would unfold over the developmental course. A socioculturalist would be interested in describing how students had appropriated the cultural practices of the field (i.e., became enculturated), even as they changed not only the local culture of the program but also, eventually, the wider culture as they achieved greater status within their field. Perhaps for the social-constructivist, the scaffolding invited by students and provided by Patricia and more advanced students during the graduate school experience would be the point of analysis in this learning case. To the cognitive-evolutionist, areas of interest would include students' ability to adapt productively to this new situation, to set viable goals, and engage in activities to achieve them, to use background knowledge and innate capacities to understand and instantiate what they are learning. Of course, the outcomes of this learning and their success in their new field would enhance their ability to procure the necessities of survival, within a suitable academic institution.

CONCLUDING THOUGHTS

Our overarching intention in this analysis was to consider deeply the notion of learning and, in so doing, to advance a fresh perspective on this foundational construct as well as to offer a criterial framework against which theoretical perspectives and empirical investigations on learning can be assessed. Throughout the discussion, we adopted the metaphor of a river system as a clear reminder that learning, like the river, operates as part of a dynamic system that is continuously and reciprocally transformed through the interactions of its constituent parts. Thus, understanding the essence of human learning demands a consideration of its primary dimensions not as independent contributors to the products and processes of learning but as inseparable aspects of an intricate and fluid system. We represented our understanding of the human learning in a topographical framework, a quadrangulation based on the convergence of the *what*, *where*, *who*, and *when* dimensions of learning. Along with these interactive dimensions, our topographical mapping has as its legend nine principles of learning that are arguably core to all manner of perspectives, even those that consider distinct levels of learning (the *whats*) for diverse individuals (the *who*) learning at markedly different places (the *where*) and times (the *when*).

A value of our framework is that it disturbs existing views of learning, which remains a fundamental construct within educational theory and practice. The multidimensional framework we have advanced offers a different approach to considering the views and assumptions of existing, even competing, perspectives on learning. It does so by allowing us to position more precisely the purviews of these varied perspectives and thus appreciate better what they do and do not address about the nature of learning. Moreover, our criterial framework allows us to understand that arguments among different theoretical perspectives may often reflect their theoretical geopositioning and, thus, their inability to see learning from the vantage point of rival "camps." Thus, one perspective may be particularly helpful at describing the acquisition of scientific concepts in children new to the cultural setting of school by means of the rich interplay with more knowledgeable, sometimes more powerful, others in the setting (sociocultural views). By contrast, another perspective may prove more informative about the manner in which individuals acquire habits and conditionings through their interaction with the given environment and the stimuli it affords (behavior theory).

As stated, our intention was not simply to illustrate how varied and contrasting views of learning can coexist within the multidimensional map we constructed. Rather, we see the resulting framework as serving an evaluative function as well. What the criterial framework reminds us is that existing perspectives differentially attend to the *what*, *where*, *who*, and *when* dimensions of learning. Further, to be regarded as comprehensive, we hold that some consideration of each of these dimensions is warranted. Should the *what* dimension be overlooked or the *when* dimension disregarded, then we would consider that perspective to be underspecified and, potentially, nonviable. What the criterial framework also serves to remind us it that no "grand theory" of learning exists and

that any effort to formulate such a grand theory must not only incorporate each and every dimension, but must also encompass all levels or variations of those dimensions. To explain only acquired habits at the expense of scientific concepts, or to disregard the role of innate capacities in learners' subsequent development is, in effect, to relegate a perspective to only a particular corner of learning's vast and complex landscape. We appreciate that there are even more fine-grained analyses required if one seeks to judge the viability of learning theories and models that are subsumed in the broader theoretical families we have targeted here. Nonetheless, we contend that our theoretical framework represents a critical first step.

A final contribution of our framework is that it includes attention to dimensions that have often been underemphasized in other conceptions of learning. For example, the particular strands that make up our own approach to the *what* dimension, the increasing complexification along continua of enculturation, effort, and abstraction, represent, we think, a potentially generative way to differentiate the objects of learning. Also, the *when* dimension, we assert, has not been previously elaborated to the level we advance here. What follows from having represented learning to this level of specificity is that heretofore overlooked quadrants of the learning landscape may now be fruitfully incorporated in future considerations. Our claim is that were we to mark where in our framework current and past explorations have proliferated, we would at the same time identify the "dark lands," the uncharted territory at the nexus of the four dimensions that merit attention by the research community.

There were many reasons why the three of us first embarked on this challenging and uncertain expedition to map learning's landscape. As we noted at the outset, the construct of learning has been comfortable territory for each of us for decades. Yet we thought that there was much about learning that we had come to take for granted or that we simply had overlooked, sidestepped, or even avoided in the course of our work. By embarking with those who viewed the terrain differently, we hoped that we could be prompted to see what we had individually overlooked or be urged to visit empirical and theoretical places that were too daunting to visit alone. On the whole, we think that the resulting topographical map has much to offer, as the prior discussion suggests. Yet, for all the exertion, we recognize that the resulting charting is but a starting point, as first mappings must be. What becomes of our charting is dependent on factors that are well outside our control, such as whether others, especially those who perceive the landscape differently, find our conception of the principles and dimensions useful in their journeys into the terrain of learning, or whether others will feel the wanderlust we experienced and similarly embark on such a mapping expedition, or whether the tools and equipment required to probe wider and deeper into the learning landscape are currently available or will be forged in the near future.

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