Neurophenomenological Praxis: Its Applications to Learning and Pedagogy

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Between the exploration and what it will teach me, between my movements and what I will touch, there must exist some relationship….

(Merleau-Ponty, 1968, p.133)

Teaching must be able to get caught up in the play of learning.

(Davis, Sumara, & Luce-Kapler, 2005, p. 148)

The purpose of this chapter is to first explore potential hybrid theories and methodologies that will help to explicate specific and immediate moments of learning, such as *situated* learning as well as *embodied* and *enactive* learning and, second, to advocate for the use of a pedagogical portfolio assessment and praxis that is appropriate for adult learners and that values these ways of learning.[1] Accordingly, in continuation of my previous work (McInerney, 2010), I will synthesize specific ways of learning (situated, embodied, enactive) with a neurophenomenologically inspired pedagogy and praxis for the purpose of liberating these ways of learning from educational subjugation (Fendler, 1998; Foucault, 1980; hooks, 1994; Kincheloe, 2008).[2]

To briefly define some of the terms mentioned above:

1. *Situated learning*. Sawyer and Greeno (2009) relate, “from a situated perspective, learning is the gradual appropriation, through guided participation, of the ability to participate in culturally defined, socially situated activities and practices” (p. 354; see also Greeno, 1998; Lave & Wenger, 1991; Walkerdine, 1997). For Lave and Wenger (1991), “learning is not merely situated in practice – as if

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it were some independently reifiable process that just happened to be located somewhere; learning is an integral part of a generative social practice in the lived-in world" (p. 35).

2. *Embodied cognition and learning*. Embodied cognition is prereflective perceiving, thinking, and learning that emerges from the lived body in action (Gallagher, 2005). As Merleau-Ponty (1962/1989) states: "My body has its world, or understands its world, without having to make use of my 'symbolic' or 'objectifying' function" (pp. 140–141). When thoughts, choices, and attitudes are considered at one with the proprioceptive, sensorimotor, and perceptual body, this helps us understand a diversity of ways in which humans learn (see McInerney, 2010).
3. *Enactive cognition and learning*. Enactive cognition and learning suggests that perceiving, thinking, and learning are actively inseparable from our meaningful engagement with the environment (Bateson, 1972/2000; Fenwick, 2000; Varela, Thompson, & Rosch, 1991). Francisco Varela (1999) tells us that enaction includes "coupling of the cognitive agent, a permanent coping that is fundamentally mediated by sensorimotor activities" as well as "the autonomous activities of the agent whose identity is based on emerging, endogenous configurations (or self organizing patterns) of neural activity" (p. 272). Interpretively, enaction implies that learning happens by "…having a body with various sensorimotor capacities [and…] these individual sensorimotor capacities are themselves embedded in a more encompassing biological, psychological, and cultural context" (Varela et al., 1991, p. 173). It is important to note that these couplings, which I will show are describable, are not determining or causal of the active (learning) agent.
4. *Neurophenomenology*. Neurophenomenology began as a theory that emerged from the melding of neuroscience with phenomenology, which in turn shaped enaction: "Weaving together…the phenomenological and neurobiological, in order to bridge the gap between subjective experience and biology, defines the aim of neurophenomenology, an offshoot of the enactive approach" (Thompson, 2007, p. 15).

As a theory, neurophenomenology considers the interrelationship between neuroscience and phenomenology as potentially enlightening. It provides a plausible account of the need for naturalizing phenomenology as well as grounding neuroscience in the lived experiences of people. As Thompson (2007) suggests, neurophenomenology is also "experimental" when it "stresses the importance of collecting descriptive first-person reports of experience from phenomenologically trained subjects as a heuristic strategy for uncovering the physiological processes relevant to consciousness" (p. 338; see also Varela & Shear, 1999).

A pedagogical praxis is intended to liberate previously unrecognized styles of learning (e.g., situated, embodied, enactive) thus informing new ways of teaching (Cranton, 1996; Dirkx, 2002; Jarvis, 2005, 2006; Paulson & Paulson, 1994). The term "praxis" is distinguished here as research that puts into action a method for practical and liberatory results (Depraz, 1999; Kincheloe, 2005; Lather, 1986). Praxis also denotes a movement "beyond objectivism and relativism" toward an ongoing critical engagement with knowledge claims (Bernstein, 1983; see also Caputo, 1987; Ihde, 1986, 1993).

A portfolio assessment as described herein will be phenomenological in its approach as it seeks to qualitatively understand transformative learning (Mezirow, 1991). Transformative learning highlights what the adult learning agent interpretively brings to any given learning situation in order to transform previous knowledge paradigms (MacKeracher, 2004). A phenomenological portfolio assessment may emphasize the prereflective lived experiences of learning by gathering first-person, reflexive narratives of the "how" of situated, enactive, and embodied learning experiences in order to better understand the transformative dimensions related to the learning agent as intimately interrelated with the learning situation (see Jordi, 2011).[3] By using the terms "agent" and "agency," I am indicating the ability of the learner to actively and knowingly affect their world (see Burr, 2002; Gallagher & Zahavi, 2008; Martin & Sugarman, 1997). Agency, with regard to learning, is irreducible to any one theory or method and is irreplaceable in that each of us learns in our own way.[4]

Theorists have combined brain-based learning (i.e., insights from brain research) with education focused primarily on the child's development to enhance teaching and learning (Blackemore & Frith, 2005; Caine & Caine, 1991; Healey, 2004; Jensen, 1998, 2008; Sousa, 2010; Zull, 2002); however, studies have not utilized neurophenomenology, which I believe needs to be considered in the secondary education of, and research concerning the adult learner.

Learning, Cognitivism, and Cognitive Psychology

Learning, by its very nature, is a complex and fascinating phenomenon due to its associations with sociocultural norms, formal and informal educational methods, and psychology and neuroscience (Bruner, 1968, 1973, 1996; Gardner, 1983, 1991; Jarvis, 2006; Jensen 2008).[5] These diverse disciplines all have something to contribute to our knowledge about learning precisely because learning is an all-encompassing aspect of living (Illeris, 2008; Jarvis, 2005; Sawyer & Greeno, 2009). Consequently, there has been, and ought to be, many ways of studying the experience of learning using varying perspectives or techniques (Uttal, 2011).

Commonly understood, learning (to learn) means to gain knowledge of and to be informed (informed connotes inward change and formation). Learning can be understood as the collection of facts, instigating of change, and storing of information (Bruner, 1968). Learning may not have a fully formed beginning and end, and it may not be so easily separated from other cognitive activities – nor does learning seem to be, as we will see, a passive process of containment (Gardner, 1983; Maturana & Varela, 1987). Learning might best be described as diffuse (belonging to multiple contexts) whereby any learning experience can be understood as an embedded and emergent social phenomenon (Kincheloe, 2005; Lave & Wenger, 1991; Lemke, 1997; Vygotsky, 1978).

A resuscitation of all theories of learning is far beyond the scope and intent of this chapter. Sufficed to say, learning most certainly can be observed as a behavior. *Behaviorism* began with the premise that mental phenomena should be ignored in favor of overt observable physical actions (see Skinner, 1953, 1974; Uttal, 2011).[6] For behaviorists, the environment and the sensory and perceptual input of the organism were the developmental foundation for learning itself. Learning took place when the sensory and perceptual capacities of the organism responded to stimuli from the environment. Instances of learning, then, could be empirically observed and measured. Behaviorism also assumed that all behavior was rule-based and could be linked completely to causes and effects (Juarrero, 1999). Behaviorism contributed to our understanding of learning by demonstrating that some elementary forms of learning are instinctual (reflexive and associative) and the learner need not be explicitly aware of the responses that have been elicited.[7] Therefore, behaviorism suggests to educators that their main focus should be on environmental stimuli in the form of operant conditioning, rewards, punishments, and so on; as a result, the learner is, for the most part, passive (see Abraham, 2003). Behaviorism fits well with formal education and curricula, especially in the creation of lesson plans, objectives, goals, assessments, and standardizations. Davis et al. (2005) explain, "The problem is that behaviorism rests on the premise that the universe is mechanical and ultimately predictable – that is, complicated" (p. 59). Of most concern to this study, behaviorism isolated people from their everyday existence and presumed to understand learning. Even the supposedly straightforward reflex response must have a qualitative and meaningful dimension and so responses were not to "complex *situations*," but as if we could have "detached parts" responding to "isolated *stimuli*" (Merleau-Ponty, 1942/1983, p. 44). We can see that to understand the *complexity* of learning as enactive in situations, as well as embodied, would be beyond the behaviorist paradigm (Abraham, 2003; see also Merleau-Ponty, 1942/1983).

To further understand learning in relation to cognition, it is necessary to wonder about perception because as Merleau-Ponty (1964) believed, perception is the necessary beginning of all cognitions, affect, and intentions. Cognition is the process or activity of thinking (Neisser, 1976). Gestalt psychology, in part, is credited for widening our understanding of perception in relation to cognition and learning (Köhler, 1947). Gestalt denotes perceptional relationships that are inherently unified. Influenced by Brentano's act psychology, which stressed the holistic and cohesive interactions of the individual with their environment, Wolfgang Köhler (1938) showed that insight learning transcended simple stimulus and response models of learning; it demonstrated a creative, holistic, and synthetical ability on the part of the learning subject (Brennan, 1994; Uttal, 2011).[8] Perception must be more than input recognition of an object or simple response from a conditioned stimulus. Perception, for the Gestaltists, became indubitably tied to active and insightful cognitions, and they expanded our understanding of higher-order mental processes.

Learning is developmental, for example, Jean Piaget's (1975) constructivist epistemology outlined progressive capacities (or "domain-general" modules) within the developing child (Karmiloff-Smith, 1997, p. 7). Piaget's scrutinizing of the ontogenesis of developmental cognitive processes in children presumably demonstrated that there were basic processes of logical thought that emerged in the interaction between the child and the environment. Learning then, for Piaget, emerged from inborn and general schemas, but did not come to logical fruition until the child interacted with the environment in particular ways. Through the cognitive processes of assimilation and accommodation, schemas (see below) facilitated the construction of the real world that adults experience (as opposed to, e.g., the imaginative play world of the child). However, Piaget may have mistaken these logical processes as universal ontogenetic and rational development. Walkerdine (1984) explains that Piaget assumed *homo rationalis* was the pinnacle of development and thus "legitimate[s] and redirect[s] forms of classification of stages of development as regulatory and normalizing pedagogic practices" (pp. 176–177). Simms (1999) relates, "Piaget's bias is clear: the child will be an adult when he or she accepts that thinking is: (a) a matter of brain anatomy, (b) an internal event, (c) a subjective event, and (d) disconnected from the material world" (p. 303).

I will focus on specific, localized accounts of learning that may broaden our understanding beyond nativist or constructivist claims as well as instantiations of what is assumedly rational: "Piaget, however, as a theorist, never seems to have doubted the existence of a pregiven world and an independent knower with a pregiven logical endpoint for cognitive development" (Varela et al., 1991, p. 176).

Karmiloff-Smith (1997) points out, "For Piaget both gene expression and cognitive development are emergent products of a self-organizing system that is directly affected by its interaction with the environment" (p. 9; see also DeRobertis, 2011). This aspect of Piaget's work, as we shall soon see, fits well with the descriptive accounts of teaching and learning that I will provide. Furthermore, Piaget's constructivism, for some, is now critical constructivism, which avoids unwittingly privileging hegemonic ideologies influencing education and includes the role of the teacher as co-constructing the value of what is being learned (Giroux, 2001; hooks, 1994; Kincheloe, 2005).[9]

Early cognitive science postulated that perception is dependent upon mental organizing structures called *schemas* (Bartlett, 1932; Neisser, 1976). Classical cognitive philosophy, which was heavily influenced by René Descartes, imagined the mind as having and manipulating internal representations within a Cartesian theater of the mind (Dennett, 1991; Fodor, 1981). We witnessed the birth of *cognitivism* with Descartes' (1637/1980) focus on "precisely that part…that is a thing that thinks" (p. 76; see also Descombes, 2001; Dreyfus, 1972/1992) and the cogito that manipulates innate and internal ideas that have "their own true and immutable natures" (Descartes, 1637/1980, p. 85). According to cognitivism, the mind is primarily isolated from the living ecosystem (save for linear input/output); it is also disembodied, asocial, and ahistorical (Costall & Still, 1991; Descombes, 2001; Varela et al., 1991).

Cognitivism argued that perceiving, learning, and thinking can be explained as a reflective process that is marked by symbolically rule-governed, procedural operations within the mind (Descombes, 2001; Varela et al., 1991). The world was understood by cognitivism as a source of information (i.e., a series of inputs/outputs). Tim Ingold (2001) tells us that cognitivism made human beings into "devices for processing" knowledge as information (p. 114). Cognitivism began to imagine the cogito as existing somewhere within the mind as homunculi of all sorts: schemas, faculties, modules, and so on (Descombes, 2001). If the cogito works in such isolation and has its own self-evident and innate structure, then, as Descombes relates, "…the cognitive superstructures will all have to be explained by mechanical infrastructures" (p. 176; see also Dennett, 1991).

By the 1950s and 1960s, the cognitive movement began to hold sway, and information processing as learning (and thinking) became a truth that was taken for granted. The idea of schemas fit well with the emerging notions of learning as information processing or computationalism. Cognitive science relied heavily on imagining the mind as a computer that makes sequential and logical operations, and embraced the idea that the human brain is a *complicated* thinking thing or system (Winograd & Flores, 1987). Complicated systems are those that are highly structured and multifaceted (Cilliers, 1998; Davis et al., 2005). For example, the computer is complicated as it has many components with discrete functions that intercommunicate to form a sequential and logical series of events that ultimately drives the computer's representations and computations. Through analysis of these components and their interactions, we can understand all there is to know about the computer. This is partly because the computer lacks embodied experience, emotion, and mood; there is no worldly psychological life experienced by a computer (Dreyfus, 1972/1992, 1982; Winograd & Flores, 1987).[10]

Later, cognitive psychology posited that "perceiving is the basic cognitive activity out of which all others must emerge" (Neisser, 1976, p. 9). The preeminent cognitive psychologist Ulric Neisser explained that within the perceptual cycle, "schemata are anticipations, they are the medium by which the past affects the future" (p. 22). According to A. R. Luria (1976), perception "depends on historically established human practices…it possesses features that change along with historical development" (p. 21). Hence, schemas (or schemata) are "interactive," and as such can "be detached from the cycles from which they were originally embedded," and this leads to "imagining, planning, or intending" (Neisser, 1976, p. 23). Schemas begin to take shape, so to speak, the minute we are born and this ongoing process is inseparable from living itself. Perception, as Neisser believed, is a "constructive process" and complex schemata are full of anticipatory semantics (p. 20; see also Heidegger, 1926/1996). There is always already a perceptual "fore-structure" that prepares our seeing (and other senses) and allows us to recognize and conceptualize what we perceive (Heidegger). Merleau-Ponty (1962/1989) knew this: "…perception and the perceived necessarily have the same existential modality, since perception is inseparable from the consciousness which it has, or rather is, of reaching the thing itself" (p. 374).[11] The cognitive enactivists also understand perception as an anticipation of possible inputs instead of merely a causal reaction to inputs (Gallagher & Zahavi, 2008; Varela et al., 1991).[12]

By the 1980s, cognitive science and neuroscience had blended together to posit a more advanced computational mind. With progress in computer and brain sciences, the brain became an empirical puzzle that would eventually be solved (see Karmiloff-Smith, 1997). As Alva Noë (2009) argues, "Establishment neuroscience is committed to the Cartesian doctrine that there is a thing within us that thinks and feels. Where the neuroscientific establishment breaks with Descartes is in supposing that that thinking thing is in the brain" (p. 172).[13] While neuroscience gathered more evidence of localized function in the brain, the Cartesian mind acquiesced and became, perhaps, singularly reduced to the thing that thinks within the brain (Noë, 2009; Szasz, 1996; Varela et al., 1991). We can see then that an arduous task was taken on by the cognitivists, specifically, to fashion a structured mind that might eventually be placed in the brain (Wilson, 1998).

While we may include a cognitive neuroscientific account of the role the brain plays in preparing for and facilitating learning, such an account must avoid the pitfalls of cognitivism, namely, reductionism (see Notterman, 2000), rigid representationalism and computationalism (Clark, 1997, 2001; Ingold, 2001), and, in general, mentalism: "the premise that learning is a matter of building an internal model or representation of an external, pregiven reality" (Davis et al., 2005, p. 60). Further, our descriptions must take into account the emotions, moodedness, and embodiment of the learner in situations.

Perception is bodily and only with our human bodies (and brains) and actions (Noë, 2004) can we perceive the world (Gallagher, 2005; Merleau-Ponty, 1962/1989). Generally then, despite differences, we perceive like humans do, and this fact (*facticity*) facilitates a shared understanding of the world (see Heidegger, 1926/1996). Although we are not determined by the schemas in any strict sense, to be fair, schemas lead us into a good deal of conformity, and as such we tend to form culturally bounded, natural attitudes about life, learning, and living (Noë, 2009).[14] The aforesaid is an important part of our considerations in what follows.

In fact, for John Dewey (1938), "continuity," or the "experiential continuum," meant that the student brings to bear their previous learning on to future learning experiences (pp. 44–45). Dewey related that if we do not take into account the continuity and emergence of learning, then the "experience is treated as if it were something which goes on exclusively inside an individual's body and mind" (p. 39; see Gallagher, 2009; Koestenbaum, 1997).[15] The gradual shifting in education and pedagogy from strictly cognitivist (and nativist) to constructivist (Bruner, 1996; Kincheloe, 2005) has renewed interest in Dewey's work. Dewey foresaw the need to assess learning as immediately experienced. Dewey's account of learning mirrors cognitive ideas about the cyclical mode of perception as discussed above (see Dewey & Bentley, 1949; Neisser, 1976). For example, Neisser (1976) explains: "Perception and cognition are usually not just operations in the head, but transactions with the world. These transactions do not merely inform the perceiver, they also transform him" (p. 11). Dewey knew that to understand learning experiences, one must analyze the transactional relations between a student and their environment (Bateson, 1972/2000; Bredo, 1994; Clancey, 2008; Koestenbaum, 1997); likewise, Dewey and Bentley (1949) understood perception as a transactional relationship. This relationship happens in the midst of intention and meaning-making such that they each emerge in unison. Dewey recognized that through a complex involvement with others and the environment, learning could be analyzed beyond a simple stimulus/response model (i.e., behaviorism).

Dewey's advocacy for an experiential assessment of learning is commensurate with the educational movement toward situated learning (Lave & Wenger, 1991; Sawyer & Greeno, 2009) and constructivism (Poerksen, 2004). Dewey argued that the student is not in an objective situation and that "the conceptions of interaction and situation are inseparable from each other" (p. 43). While constructivism and education are indebted to Dewey (Vanderstraeten, 2002), theorists Lave and Wenger (1991) brought constructivism into particular learning community contexts.

Furthermore, Dewey's experiential description of the learning experience, generally, is an apt precursor to Varela (1996), Varela et al. (1991), and Maturana and Varela's (1987) analysis of learning as well as their depiction of experience as embodied and enactive (Bredo, 1994; Gallagher, 2009). And finally, we note that Dewey understood enactive perception long before the cognitive movement (see Gallagher & Zahavi, 2008).

We have seen that learning has been understood by behaviorism, mentalism, computationalism (cognitivism and information processing), as well as constructivism. What is discovered, or uncovered, about learning depends on ones' perspective and/or technique (see Gadamer, 1976; Heidegger, 1926/1996). Critical pedagogy (Freire, 1971; Kincheloe, 2008; Wink, 2010), existential learning theories (Jarvis, 2005), and critical constructivism (Kincheloe, 2005) have rightly pointed out the need for valuing the lived experience of learning while considering its embeddedness in sociopolitical constructions, gender and culture differences, power relations, and competing philosophical foundations (Breunig, 2005; Giroux, 2001; Kincheloe, 1991, 1999, 2005; Lather, 1991; Pinar, 2004).

We will look to enactivism whereby learning is a complex interrelationship and negotiation between the knower and the known (Bernstein, 1983; Davis et al., 2005; Maturana & Varela, 1987). Explained differently, we will see that the learning situation cocreates what the brain will do, and the brain actively engages and cocreates the learning situation. We will likewise consider the definition of learning broadly as meaning-making activity that accomplishes a goal, completes a task, or is a shift in one's perspective on life (Bateson, 1972/2000; Maturana & Varela, 1980; Varela et al., 1991). Davis et al. (2005) put forth that "learning is coming to be understood as a participation in the world, a co-evolution of knower and known that transforms both" (p. 64). By defining learning in these ways, we are opening the door, so to speak, for recognition of embodied, enactive, and situated learning as a "meaning-making journey of [adult] experiential learning" (Jordi, 2011, p. 195).

A method is needed that describes the immediate and present (en)active construction of learning while addressing the cutting-edge findings of cognitive neuroscience. Such a method should remain grounded in experience to recognize and value learning activity and skills that may be unrecognized and devalued in our formal educational system (Davis et al., 2005; Kincheloe, 2005; Sacks, 1999). When formal education too often adheres to the methodological positions of Cartesianism and cognitivism, teachers run the risk of ignoring other ways of learning (see Handley, Sturdy, Fincham, & Clark, 2006; Kincheloe, 2005). Despite their liberating potential, these forms of learning (enactive, embodied, and situated) can be considered to be *subjugated*. By subjugated, I denote ways of knowing that have been hidden or devalued by our formal educational systems (see Foucault, 1980; McInerney, 2010).

The brain is perhaps the final frontier and ontological ground upon which formal brain-based education will likely continue to stake its claim (see Rose, 2005; Uttal, 2011). With this said, critical pedagogies and praxes must meet at these crossroads: neuroscience and phenomenology. And so, in the remainder of this work my task is threefold: first, to introduce neurophenomenology to psychologists and teachers; second, to use neurophenomenology to demonstrate how learning can be described as situated, embodied, and enactive; and third, to discuss how neurophenomenological praxis leads to a pedagogy that recognizes and liberates embodied, enactive, and situated learning.[16]

Phenomenology and Cognitive Neuroscience

Phenomenology is a specialized method of reflection and description that attempts to understand experience as it is immediately given, that is, not mediated by scientific constructs, axiomatic presuppositions, common sense, or experimentation (Gallagher & Zahavi, 2008; Husserl, 1913/1998).[17] Phenomenology wants to recognize the constitutive role of human consciousness within existence; how does the way we perceive the world as human beings contribute to the way we experience a phenomenon?

If we adhere to the idea that knowledge is simply passively received by the learner, then phenomenology will have little to say about learning. But, we will recognize how important phenomenology is to learning if we consider learning to be a phenomenon that happens differently in certain contexts (i.e., learning *extended* out to the world), or that we actively take part in (i.e., *enactive*), or that we are inextricably part of (i.e., *embedded*). Phenomenology tell us about how some experiences are born of the living body (i.e., *embodied*).

The reader will note the insinuation of cognitive terminology, parenthetically, in the above phenomenological interests regarding learning. That said, what is the cognitive connection with phenomenology? As Gallagher and Zahavi (2008) correctly point out, “Cognition is a secondary modification of our primary being-in-the-world, and it is only possible and attainable because we already are in the world” (p. 154). If we ignore existence and experience, and begin with only the cognitive domain or facts about the brain, we will have little more than abstractions that are devoid of a meaningful relatedness with our lives (Fisher, 1997; Winograd & Flores, 1987).[18] And, after all, what is learning if not a meaningful relatedness to the world? Therefore, we must ask if cognitive theories can find grounding in worldly and bodily everyday learning experiences.

The answer to the above is affirmative when we consider that phenomenology and some subdisciplines in cognitive science mutually reject cognitivism

(Clark, 1997; Costall & Still, 1991; Dreyfus, 1972/1992; Ingold, 2001; Varela et al., 1991). For example, Fred Wertz (1993) writes: "Phenomenology rejects cognitivism, the dogma that reality can only be experienced through cognitive constructs, whether they be units of information, neural networks, or schemas" (p. 20).[19] The extended, enactive, embedded, and embodied forms of learning mentioned previously are also based on this rejection of cognitivism (Osbeck, 2009).

Some of what cognitive science has postulated, such as dynamical systems (Juarrero, 1999; Thelen & Smith, 1994; van Gelder, 1998), embodied cognition (Gallagher, 2005), self-organizing systems (Maturana & Varela, 1980), enactive and distributed cognition (Pea, 1993), and complexity theory (Cilliers, 1998; Globus, 1995; Waldrop. 1992), all make sense with the ongoing work in cognitive neuroscience and phenomenology. Combining phenomenology with neuroscience leads us to the research method of neurophenomenology (Gallagher & Zahavi, 2008; Lutz & Thompson, 2003; Thompson, Lutz, & Cosmelli, 2005).

Neurophenomenology as Methodology

Epistemology, by its very nature, is conciliatory. What we know, how we have come to know it, its value, and whether there is more to know surely is a negotiation of theoretical backgrounds, expertise, reliability, and validity. In part, epistemology searches for the best methodology and method for understanding a phenomenon because epistemology is concerned with the relationship between the knower and the known (see Kincheloe, 1991). When an epistemological search settles on a method (i.e., applied epistemology), this is called methodology, namely, the philosophical and theoretical foundation that supports and validates a method (see Hoshmand & Martin, 1994). One must carefully consider methodology before the details of a method are laid out, or the method itself is used. My epistemological search has led me to consider learning as an act of intentional consciousness; in other words, as a unique meaning-making activity that is deeply interrelated with the proprioceptive-knowing body in action within particular situations. I suggest here a potentially productive negotiation between two parties: phenomenology and cognitive neuroscience. In an egalitarian and synergistic approach, both working together may provide some insight into learning experiences (Changeux & Ricoeur, 2000; Gallagher, 1997; Varela, 1996).

Following Francisco Varela (1996), neurophenomenology is defined as a way to understand first-person consciousness and lived experience through the use of phenomenological method and while relating the resulting discoveries of potential phenomenological invariants with third-person neurological findings. At first glance, neuroscience and phenomenology seem like an odd pairing. Admittedly a gloss, cognitive neuroscience values truth obtained deductively via objective methods; phenomenology values understanding obtained inductively through a subjective (and intersubjectively validated) method (Depraz, 1999). As with most dualisms held by theorists, when one or both sides begrudgingly (or not so begrudgingly) take the brave step toward the other, there can be a fruitful partnership and praxis (Changeux & Ricoeur, 2000; Depraz, 1999).[20] Some aspects of phenomenological research may be amenable to cognitive neuroscience, and vice versa, as long as we take heed that neither phenomenology nor neuroscience ought to give up crucial aspects of their methodology (Barclay, 2000; Ellis, 1999).

However, what do we make of the ontological differences between neuroscience and phenomenology? Phenomenologists reject the *naturalizing* of phenomenology that makes natural science *prior* to phenomenology and the sole method of generating truths about both the human condition and the world we live in (Clegg, 2006). On the other hand, phenomenologists may accept naturalizing that recognizes "that the phenomena it studies are part of nature and are therefore also open to empirical investigation" (Gallagher & Zahavi, 2008, p. 30).[21] Moreover, from a neurophenomenological perspective, there is an (inter)relationship between the brain and the world, and in some way or the other, the brain represents the world. If we concede that the brain, to some degree, represents the world, we have to add the caveat that this representation is not merely straightforward, easily objectified, or transparent (Clark, 1997; Ingold, 2001). True enough, phenomena, represented in human consciousness and the brain, are a part of nature, but the phenomenologist will insist that we co-constitute any phenomenon in question through the act of uniquely experiencing it (much less, studying it).

In fact, human consciousness' contribution to phenomena (i.e., acts of consciousness) was Edmund Husserl's (1913/1998) chief methodological concern, and the constituting acts of consciousness have been the starting place for neurophenomenology. This method must look beyond the Cartesian *I think* (i.e., beyond a study of consciousness) and additionally deal with, as Heidegger (1926/1996) and Merleau-Ponty (1962/1989) did, the Cartesian *I am*, namely, the person as embodied, intentional, mooded, and maintaining an active agency.

We may take seriously the oft quoted "mutual constraints" (Varela, 1996) and "mutual enlightenment" (Gallagher, 1997) affiliation that has been neurophenomenology's banner of sorts. Neurophenomenology is, at times, a rough road full of negotiations; but, it is an inroad nevertheless and one that may offer descriptive clues to the brain and to "learning environments as complex social systems" (Davis et al., 2005; Sawyer & Greeno, 2009, p. 354). With this beginning sense of methodology, let us now move on to phenomenology and neurophenomenology as a method and relate these methods to an informed pedagogical praxis.

Neurophenomenology as Method

The Epoché. Within the phenomenological tradition, what Husserl called the epoché is an attempt toward bracketing, or putting aside, the *natural attitude* (Husserl, 1913/1998; Spinelli, 1989; Zahavi, 2003). This bracketing is not easily done, for the natural attitude reveals that "I always find myself as someone who is perceiving, objectivating in memory or in phantasy, thinking, feeling, desiring"

(Husserl, 1913/1998, p. 54). We seem to assume, within the natural attitude, an "actuality" of existence (Husserl). This attitude makes existence factual, self-evident, and a "theory-independent reality" (Zahavi, 2003, p. 44) in which existence, or lived experience, is made into a concrete, taken-for-granted reality. According to the natural attitude, the real world is merely there; we do not construct it or co-constitute it—we simply perceive it accurately or inaccurately depending upon our perceptual capabilities (neurobiologically or interpretively).

If not for the epoché, the researcher would believe that a phenomenon could be explained simply through objective experimentation or reflection (i.e., gathering empirical data and applying statistical analysis and inference). In other words, bracketing does not lead to objectivity, quite the opposite; it leads to a recognition and intensification of subjectivity, which undercuts the object/subject dualism. For example, we assume that objects have properties that exist naturally within them and it is the accurate work of our sensory apparatus and reasoning that discovers the truth of these preexisting properties (Churchill & Wertz, 2001). Likewise, we stay within the natural attitude when we suppose we can discover the truth about people by examining their pre-given, innate, properties or the laws contained within genetics or the brain. We can see then, how the epoché helps the phenomenologist-researcher to avoid such diversions found within all that is posited through the natural attitude including subject/object dualism.

We may be tempted to think that the epoché, because of its relationship to the natural attitude, is bracketing *natural* science alone. However, this is not the case; Husserl (1913/1998) explains, "*All natural sciences and cultural sciences*, with their total stock of cognition, *undergo exclusion* precisely as sciences which require the natural attitude" (pp. 131–132). The epoché is ultimately a radical correction in our commonly held apperceptive experience in general; these experiences include our familial and sociocultural prejudices as well as the presuppositions that lie within the human sciences of sociology, psychology, and philosophy (see Moustakas, 1994). As Gallagher and Zahavi (2008) explain, "This realistic assumption [natural attitude] is so fundamental and deeply rooted that it is not only accepted by the positive sciences, it even permeates our daily pre-theoretical life…" (p. 22).

Note then that in terms of understanding the brain, we are not simply putting into abeyance the scientific explanations of the brain that have been postulated for centuries, but bracketing the prescientific and assumed natural folk wisdom about the brain as well. For example, that it must be the seat of the personality and learning, or that it must work like something encountered in nature, or mechanically like a clock, loom, piano, or computer (Gordon, 1988; Szasz, 1996).

Human perception is always alterable and, in fact, exists in a flow of alteration; thus, the epoché does not *transcend* human perception or even *my* subjective perception, but it does, or at least attempts to, transcend the natural attitude as apperception (Depraz, 1999; Moustakas, 1994). The epoché does not deny reality (Gallagher & Zahavi, 2008; Ihde, 1986); within phenomenological psychology it *transforms, radicalizes,* and prepares one's perception. There is no obscurity here, only discipline and practice (Ihde, 1986).[22] Bracketing is what the phenomenologist-researcher does to prepare herself or himself to be able to investigate a phenomenon. It is, in this way, no different than a researcher taking the time to set up safeguards for neutrality and objectivity in an experimental design.

When the phenomenologist-researcher begins the epoché, she or he creates a portal or entrance, if you will, in which to gain access to experiences as lived in the moment (Zahavi, 2003). As Depraz (1999) elucidates, the phenomenologist does not transform perceptions in isolation; there is an "intersubjective sharing of the reductive experience" (p. 105). Depraz inserts intersubjectivity, not in a member-checking validation toward the end of a qualitative study, but directly into the beginning stance and disciplined method of the phenomenologist (see also Lutz & Thompson, 2003). The epoché may be performed over a period of time, and in dialog with others.

An effective procedure in which to perform the epoché is to keep an ongoing autoethnography (Cho & Trent, 2006), or what Maso (2003) calls a "why interview." When the phenomenologist asks why take for granted this way in which to understand a phenomenon (i.e., questioning methodology) and asks why use such a method, she or he begins the epoché. However, more is needed as the researcher must explore his or her personal desires regarding the phenomenon (Maso).

Finally, we will keep in mind that the epoché cannot entirely wipe clean our presuppositions (Merleau-Ponty, 1962/1989). But, the researcher will eventually feel that she or he is sufficiently prepared and embark upon a systematic and thorough analysis of the interrelationship between the constituting structures of consciousness and how the *givenness* of the phenomenon ensues (Giorgi, 1975, 1997; Merleau-Ponty, 1962/1989). Givenness refers to the potential aftereffect of the epoché that has cleared a path, as best as possible, and in turn allows the phenomenon to emerge as presented in a new way (Churchill & Wertz, 2001).

The Phenomenological Reduction. An additional aspect of the phenomenological method is called the "phenomenological reduction," which involves richly descriptive accounts of the givenness of experience (Churchill & Wertz, 2001; Giorgi, 1975; Moustakas, 1994). It is important to note here that "reduction" does not mean to condense down to some elemental form, but to return to immediate apperceptions that have existed before the natural attitude. In fact, when the phenomenologist returns to experience as immediately given, it is complexity that is discovered, not minimalism. Often phenomenological descriptions seem poetic. Rightly so, for once the phenomenologist-researcher moves away from the natural attitude, their language becomes less wedded to objectified criteria and all that is prosaic or hackneyed in matter-of-fact explanations. The phenomenologist's poetic language should not obfuscate; rather, the descriptions should offer an improved acumen, intensity, and fidelity to shared experiences.

The researcher must stay with the act of perceiving an object or event, and if the object calls the phenomenologist away from this act, she or he must return to perception as given (Depraz, 1999; Finlay, 2009; Gallagher & Zahavi, 2008). Every time the researcher-phenomenologist takes for granted that the object of study is plainly this or that, the assumption must be called into question. Again, to demystify this method, recall that the epoché has put aside some presuppositions that have not been immediately given by the thing itself (or person), but given by the natural attitude and our social constructions generally (Berger & Luckmann, 1966; Gergen, 1995). Therefore, as the researcher performs the phenomenological reduction, she or he invariably comes to basic sensory descriptions that are prior to ad hoc conceptualizations. By the aforesaid, it is not meant that the reduction leads to raw sensory input, which presumably would be lacking in meaning. Using the reduction, the researcher moves away from what has been given about the phenomenon and toward the act of meaningful construction of the phenomenon (Dreyfus, 1982). Using the phenomenological reduction, researchers may expect to get to a language that has *more* fidelity to the phenomenon and a socially constructed perspective *less* indentured to the natural attitude (Ihde, 1993).

The reduction includes avoiding making aspects of experience better or more primary; it *horizontalizes* all experience (putting all experiences on one level; Husserl, 1913/1998). As Spinelli (1989) explains, "phenomenologists urge us to treat each bit of initial experience as if we have been given the task of piecing together some gigantic jigsaw puzzle without the prior knowledge of what image the completed puzzle depicts" (p. 19). The point of horizontalization is not to deny the reality that some things, especially in terms of potential danger, may be more important than others, it is to avoid over-conceptualizations that get in the way of the experience.

Imaginative free variations (*eidetic reduction*), which are part of the overall method of phenomenological reduction, remove that which is not essential to the phenomenon being studied and ask (explicitly, meticulously, and methodically) what differentiates the phenomenon being studied from other phenomena (Husserl, 1913/1998, pp. 147–164; Ihde, 1986). For Ihde, "the use of variations require obtaining as many *sufficient* examples or variations upon examples as might be necessary to discover the structural features being sought" (p. 40).

The phenomenological reduction ought to include a constant attempt to assure that the descriptive accounts presented remain grounded in the experience itself and, as such, not solely formulated from already existing theories. As Petitmengin and Bitbol (2009) conclude, "…becoming reflectively conscious of one's experience and describing it is a process which does not consist in observing or reflecting upon a pre-existing experience, but in an unfolding of experience elicited by precise acts" (p. 400). Further, every phenomenological description that appears out of the study of the phenomenon must be intersubjectively verifiable (Gallagher & Zahavi, 2008). According to Ihde (1986), "Intersubjective phenomenology is necessarily interdisciplinary phenomenology" (p. 133), and so to continue understanding any phenomenon will require a triangulation of methods.[23] Methodological triangulation simply shows that the researcher employs many (at least three) ways in which to understand the phenomenon (c.f. Robbins, 2006). These accounts, or protocols, can be analyzed using different types of phenomenological analyses and content analysis (Moustakas, 1994); for example, the reports may be reduced to "meaning units" and use free imaginative variation, so that invariant and essential structures may be found (see Giorgi, 1975, 1997).

With the aforesaid in mind, third-person objective studies of the brain are used in neurophenomenology. These can be obtained via fMRI and PET scans (Lutz & Thompson, 2003).[24] However, without narrative phenomenological descriptions (van Manen, 1990), we run the risk of leaping ahead of our phenomenon of study and prematurely providing theoretical and presumed essential features of the phenomenon (see Uttal, 2011).[25] As Wertz (1993) makes clear, "In phenomenological psychology, one starts with description and only resorts to construction after extensive intentional analyses have established first principles and fundaments of knowledge in the discipline" (p. 22).

Wertz's contention is of paramount importance in this study. Phenomenological data in the form of observations and first-person, reflective narratives may be front-loaded (Gallagher, 2003) into third-person methods. Front loading denotes having phenomenological insights drive a particular experimental design. As Gallagher and Sørensen (2006) explain:

> Just as experimental designs can be informed by specific theories, experiments can also be informed by phenomenological insights—that is, insights developed in independently conducted phenomenological analyses, or in previous neurophenomenological experiments. In such cases phenomenology is 'front-loaded' into the experimental design. (p. 125)

Ultimately, to explicate situated, enactive, and embodied learning, we may train participants in first-person phenomenological reflection, provide phenomenological observations using the phenomenological method, and front-load this data into an experimental (neurological) design.

Neurophenomenological Praxis

If people were merely complicated, our learning and our ways of teaching could easily be standardized. But, we are not complicated; we are complex. *Complexity* is a concept coming from, in part, current enactive and dynamic cognitive science. Complexity means that "the interaction between the system and its environment, are of such a nature that the system as a whole cannot be fully understood simply by analyzing its components" (Cilliers, 1998, p. viii; Waldrop. 1992). Complex systems are usually organic and are delineated by an interaction with the environment that is difficult to define simply as an enclosed input/output system. Cilliers (1998) tells us, "A complex system cannot be reduced to a collection of its basic constituents, not because the system is not constituted by them, but because too much of the relational information gets lost in the process" (p. 10).

The method of neurophenomenology, in part, seeks to uncover the characteristic features of *autopoiesis*. Autopoiesis denotes self-creation and self-organization of living systems (note that language is a complex and autopoietic system). Autopoietic systems transform and self-organize because of recurrent interactions with other dynamic, complex systems. Autopoiesis is a process that maintains and constitutes the system's unity (Maturana & Varela, 1980; Rudrauf et al., 2003). An autopoietic system is marked by multifarious connections that are transient and are temporally adhered to, or clustered with, other systems as they interact with each other in such a way as to continually produce and maintain the system's interrelationships (Maturana & Varela, 1987; Thompson et al., 2005).

The theory of autopoiesis can tell us how a complex system evolves and learns.[26] The relationship between self-organizing systems (autopoietic systems) and complexity is as follows: "The capacity for self-organization is a property of complex systems which enables them to develop or change internal structure spontaneously and adaptively in order to cope with, or manipulate, their environment" (Cilliers, 1998, p. 90).

Here our interest is basically concerned with two autopoietic systems. First, we can circumscribe the lived experiences of learning (situated, enactive, embodied) as a complex, autopoietic system. Second, we can understand the brain as an autopoietic system deeply interrelated with the lived experiences of learning as situated, embodied, and enactive. If we combine the method of neurophenomenology with an understanding of dynamic systems theory, we may outline autopoiesis and its multifarious connections as follows:

1. *Operational closure*, which designates that internal operations of the brain work in such a way that the by-product of its development remains within the neurobiological processes in the brain (Maturana & Varela, 1980). Notice that to say that the brain is operationally closed is not to say that it is isolated from the external world; instead, neurophenomenology argues that the brain is in harmony with its surrounding environment. By *closure* we note that the human brain is endogenous; the brain is openly in synchronization with the world. Juarrero (1999) relates, "Over time, that is, both phylogenetically and developmentally, people establish interdependencies between the environment and their internal dynamics such that the formal becomes part of their external structure: their boundary conditions" (p. 197).
2. *Structural coupling*, which indicates the observance of two or more autopoietic systems (people with other people, people within the ecosystem) that experience a reciprocally constituting interrelationship. Structural coupling denotes that "Two or more systems are coupled when the conduct of each is a function of the conduct of the other" (Thompson, 2007, p. 45).
3. *Attractors*. We can observe this conduct when we look for attractors, that is, that which is in the environment that draws the agent toward it. Juarrero (1999) tell us, "Attractors therefore represent a dynamical system's organization, including its external structure or boundary conditions" (pp. 152–153). Note that the attractor is part of this self-creating immediacy of autopoiesis because the attractor emerges uniquely within the situation and in a semiotic relation to the agent.
4. *Perturbations*, or triggers, actuate, but do not determine changes in consciousness and behavior (Thompson et al., 2005). The human brain is unintelligible without serious consideration of the way it is always already primed and expectant of any triggering stimuli (Gallagher & Zahavi, 2008; Thompson et al., 2005). Perturbations are also part of the autopoietic structural coupling, and their role in the enaction and experience of learning can be observed. A perturbation then is

anything in the environment that triggers, but does not necessarily determine reactions from the agent (Maturana & Varela, 1987). An *affective* perturbation is any trigger that is emotionally imbued and affects the emotional outlook one is in (see McInerney, 2010; Rietveld, 2008). Again, the perturbation does not act causally; it does not determine action or thought. A perturbation is observable, and only takes part in the inception of action and thought (Cox & Smitsman, 2008; Maturana & Varela, 1980).

5. *Affordances*. We also can observe the performance of structural coupling by noting emerging affordances within the self-creating immediacy of learning situations (Costall, 1995; Gibson, 1979; Good, 2007). J. J. Gibson (1979) described affordances as things in the environment that emerge as potentially useful beyond the assumed or normatively intended use of the thing; using the affordance *affords* an action or accomplishment. It is important to note that the affordance is considered as existing in an implicit, tacit, or liminal place in the environment (Gibbs & Van Orden, 2003; Polanyi, 1966; Rietveld, 2008). An affordance then is anything in the learning situation that by virtue of its interaction with the learning agent, and the demands of the situation, may transform to something that facilitates coping, adaption, and, generally, learning. Again, the affordance can be seen as emerging within the semiotic field of attention and intention and in relation to a previous history of structural coupling (Juarrero, 1999; Thibault, 2004).
6. *Trajectories*. The learner is attracted to the affordance by virtue of their previous trajectories. Thibault (2004) explains, "A trajectory is a persistence-in-time that arises through the organization of processes" (p. 4). A trajectory is a line of action or attraction that can be located and traced by an observer.

A *semiotic* trajectory is when autopoiesis produces a signification process, or meaning-making activity. Thibault (2004) explains that a "trajectory is a self-organizing system" because it is traceable to consciousness and the self, but without making either a concrete and completely knowable entity (p. 182). Trajectories are autopoietic because they are distinctively situated in and emerge from the complex interrelations of open systems; thus, any trajectory is self-creating and self-assembling in relation to open dynamical systems that structurally couple. The trajectory is the direction one learner takes in order to complete a task, move on to a new task, or bring into significance any sort of learning possibility (Thibault).

The semiotic trajectory, because of its meaningfulness to the learning situation and the learning agent in the situation, can be helpful in recognizing experientially situated, enactive, and embodied learning experiences. As Juarrero (1999) states, "Explaining why the agent took this path rather than that after forming the prior intention will require reconstructing the agent's background, circumstances, particular frame of mind, and reasoning, whether self-conscious or not" (p. 227). In fact, Juarrero tells us that when trajectories come together in a typical pattern, we observe the person's attractors within the socio-ecosystem.

Now, complex systems are dynamic and self-organizing (Juarrero, 1999) and as such maintain "structural congruence" with events, things, and others; this means we can follow, or describe, ontogeny as "the history of structural changes in a particular living being" (Maturana & Varela, 1987, p. 95). And yet, we can certainly agree that human beings are distinct from their eco-social systems and "operationally independent" (p. 95). In other words, while the process of the brain's organization (i.e., autopoiesis) is unchanging, its structure is ever changing during bottom-up, global synaptic transmission (Rudrauf et al., 2003). Remember that if we define learning as meaning-making activity, then meaning-making is "a distributed activity between body-brain systems and their ecosocial environments on diverse scalar levels of spatio-temporal and semiotic organization" (Thibault, 2004, p. 316). The "distributed activity" of meaning-making as learning may be described, but not reduced and concretized. Juarrero (1999) relates, "It is important to keep in mind that many complex systems and certainly the human neurological system are describable only by a manifold of mindboggling dimensionality" (p. 154).

How can "teachers as researchers" (Kincheloe, 1991) systematically observe autopoietic learning in action? As Kincheloe (2005) puts it, "Critical constructivism wants to return the sanctity of autopoiesis to the scholarly act, to pedagogy" (p. 109). I believe that teachers will both enhance their teaching, as well as advance our understanding of the brain and different learning experiences, if they set up deliberate praxes as an additive to their regular curriculum. Pedagogy becomes a collaborative praxis, which is then emancipatory (Greene, 1995; hooks, 1994). Therefore, let us now examine some praxes of learning (i.e., teaching strategies and examples) and move toward a pedagogical assessment that is informed by neurophenomenology as well as situated, embodied, and enactive learning.

Neurophenomenological Pedagogical Praxes

A Social Construction Pedagogical Praxis. I teach social psychology and social constructionism to undergraduates.[27] During class we do the following exercise: I ask students to take out a blank piece of paper and to fold the paper so that they can tear it into six pieces. Once the students have six, small, blank pieces of paper in front of them, I ask them to think about six of the absolute most important people, ideas, things, or events in their lives. I compel the students to wonder about these in relation to how they have come to be who they are. And so, each student proceeds to put one thing, person, event, or idea on one of six pieces of paper. I then ask them to fold the pieces of paper in half so they cannot see the response. Once this is complete, I ask the students to do the following: (1) allow the person next to you to randomly take one away; (2) without knowing what is on the paper, tear one up; (3) knowingly choose one and put it at arm's length; (4) knowingly share one with the person next to you; and (5) knowingly give one of your six pieces of paper to the person next to you.

As we do each aspect of the exercise, we imaginatively discuss the implications of each action taken in terms of the degree to which these people, things, ideas, and events socially construct us. Caine and Caine (1991), writing on brain-based learning, note that this "orchestrated immersion" of "dead" content into lively context makes the content metaphorical and thematic to the students' lives and at once concretely felt and experienced. The students ask, "Who are we without these people or events?" and "How our identities would have changed?" and, conceivably, "How would these losses and gains have come about?"

What this praxis does is quite fascinating: in essence, the students were asked to reflect upon previous attractors and trajectories, but we have brought them to life, if you will, in the form of current perturbations. We will remember that a perturbation is anything in the surrounding socio-ecosystem that triggers action or thought (Maturana & Varela, 1987).

Each part of the exercise is an affective perturbation, which is an emotional trigger that brings forth thought that is emergent from, and embedded in the situation. Having a significant person in one's life randomly removed, for example, creates an affective or emotional perturbation (Rietveld, 2008) that in turn provides increased reflexive focus on the learning experience (see McInerney, 2010; Paré, Collins, & Pelletier, 2002). The students in this example are more or less ready for these perturbations (or rules of this exercise) because of preceding experiences, or previous action-effects (Cox & Smitsman, 2008; Rietveld, 2008).

Emotion, far from being simply an impediment to learning and thinking, gives the learner insight into their actions. According to Freeman (1999), "We can begin to make sense of emotions by identifying them with the intention to act, and then to note their increasing levels of complexity" (p. 125). This praxis, consequently, has generated an affective-dispositional intentionality and awareness (Freeman, 2000; Lemke, 1997; Lewis & Todd, 2005; Rietveld, 2008), as well as prereflective and embodied skillful adaption and accomplishment (Gallagher, 2005; Merleau-Ponty, 1962/1989). In this praxis, each student expresses their adaption to the changes that take place when the six events, people, things, or ideas are altered. Language, people, and the environment (milieu) are "semiotic resources" and are available for learning as meaning-making and "in relation to the architecture and dynamical processes of the body-brain complex" (Thibault, 2004, p. 236).

When in the dynamic and situated circumstances of this exercise, students learn at the edge, or Vygotsky's "zone of proximal development," (see Daniels, 2008) of what they might know. Perturbations, I believe, help us to understand this learning experience beyond representational theory:

> Dynamic-system explanations focus on the internal and external forces that shape such trajectories as they unfold in time. Inputs are described as perturbations to the system's intrinsic dynamics, rather than as instructions to be followed, and internal states are described as self-organizing compensations triggered by perturbations, rather than as representations of external states of affairs. (Thompson, 2007, p. 11)

Moreover, the reflections upon the experience that are shared with the other students provide describable trajectories leading to attractors that, in turn, help the teacher-researcher to better understand the student's unique learning style.[28]

As Rietveld (2008) outlines, the skillful coping and prereflective bodily engagement with the world that Merleau-Ponty describes are comparable to the self-organization of brain and behavior. The adult brain, especially in terms of its higher-order perceiving, learning, and thinking, remains neurally plastic (Caine & Caine, 1991; Gross, 2000; Hill, 2001). From a dynamic systems perspective, the brain then begins a synchronizing neural appraisal of perturbations that are mediated by the autopoietic coupling (internal) with the external situation (Varela et al., 1991; Varela & Thompson, 2003). It is likely that the brain's cortical and subcortical areas become more actively engaged in a way that they would not be if, as teachers, we adhered to Cartesian and cognitivist paradigms of pedagogy (see Lewis & Todd, 2005). When the students are in the situation of this social construction praxis, there is, theoretically, a phase synchronization involving the prefrontal lobe, the limbic system, and the brain stem (Lewis & Todd; Varela, Lachaux, Rodriguez, & Martinerie, 2001).

Sabotage as Pedagogical Praxis. *Sabotage* is a naturalistic environment teaching strategy in which the teacher as researcher (Kincheloe, 1991) sets up a learning situation so that something the learner wants is in the immediate environment as a possibility, but potentially unattainable.[29] This is often done with young children, or children with learning differences. However, the teaching strategy can be performed with adult learners in the form of improvising praxes.

In one of my classes, I ask students to tell a story to each other using limited language: only a few gestures are allowed and mostly props; therefore, the props come into view as an *affordance*. In this praxis, the teacher-researcher may follow the attraction a particular student demonstrates for a particular prop and a particular *line of action* in using the prop. As the students struggle to communicate with each other through a good deal of laughter, they come to realize the nuances of interpersonal communication and the role of *signifiers* (not necessarily formalized language) in the production of meaning. If a student wants to continue the story, the student is attracted to certain props, which in turn emerge as affordances. An attractor, although certainly related to a perturbation (see above), does not impinge upon the learner but, instead, draws the learner in toward it. This *drawing in* toward the affordance is meaningful (a "semiogenetic trajectory") in a way that the learner is likely not completely aware of (Thibault, 2004). Likewise, the trajectory is bound to the attractor, but the trajectory is the traceable action or gesture toward the attractor, which may, or may not emerge as an affordance.

Thibault (2004) relates: "interpersonal meaning orients interactants in terms of the given phenomenon's value-laden salience for action" (p. 212). In the pedagogical praxis described above, the learning agent will only be attracted to certain props that may allow an affordance; this attraction is, in some ways, unique to that learner. Put simply, the prop does not only trigger or act upon the learner; rather, the learner is drawn to the prop based upon previous experiences and, theoretically, previous trace-synaptic clustering and strengths of neural connections ("weights," according to connectionism; see Globus, 1995).[30]

The sabotage, then, is the limitation deliberately constructed within the environment by the teacher-researcher (i.e., only allowing props). Overall, this meaning-making activity as learning emerges not from a preplanned schemata or Cartesian cogito, but from a complex array of affordances, trajectories, perturbations, and in relation to the autopoietic closed system.

Actions (and "action learning"; Jarvis, 2005) are embodied in this exercise; "… the biological body is not a structure through which one learns, but a structure that learns" (Davis et al., 2005, p. 66). Each time a prop is used, the teacher may note the autonomous learning agent's adaption within the complexity of the learning situation. The embodied learner becomes the learning body, which molds itself to the prop at hand, fits itself into the situation, and stretches to communicate (see Gallagher, 2005; McInerney, 2010).

We can additionally witness the role of emotion and mood in this learning experience (see Dirkx, 2002; Goleman, 1995; LeDoux, 1996). As my students report, this praxis is viscerally felt. The sabotage obstructs habitual patterns of interpersonal relations; it obstructs the students' deliberate intention and plans. In terms of the emotional brain, "…it may be during states of obstructed and extended intentionality that emotions become the object of explicit awareness and refine present intentions or establish intentions of their own" (Lewis & Todd, 2005, p. 219; see also Freeman, 2000; Gibbs & van Orden, 2003). Because each prop represents the students' desire to communicate, the prop-perturbation acts as an affective obstruction and compels the students to rethink and adapt to the changing dynamics of language, signification, and communication. The lesson plan, then, is to teach a sophisticated understanding of communication beyond direct transmission of information.

The Identity Game. In one of my classes, we play what I call the identity game. Many student volunteers come up before the class and sit in chairs approximately 2 ft apart. I then ask each student to take turns and identify herself or himself using any sort of label or experience including things like gender, ethnicity, race, occupation, likes or dislikes, and habits. One of the simpler objectives of the identity game is to get students to move their bodies, which, of course, in turn facilitates thinking and learning in terms of embodiment (Sheets-Johnstone, 1990).

Lave and Wenger (1991) tell us that "A person's intentions to learn are engaged and the meaning of learning is configured through the process of becoming a full participant in a sociocultural practice" (p. 29). As the volunteers identify each other, the rest of the students respond as to whether they believe the identification is *relational* (i.e., the meaning of the identity is born of a particular interpersonal relation), *positional* (i.e., the meaning of the identity is born of some social position, usually connected with power and hierarchy), or *contextual* (i.e., the meaning of the identity seems to be more about the context).

For Varela et al. (1991), what they refer to as "context-dependent know-how" is the "essence of creative cognition" (p. 148). It is this know-how that emerges when we follow the learner as situated. The learners' abilities are, as Varela et al. say, "rooted in the structures of our biological embodiment, but are lived and experienced within a domain of consensual action and cultural history" (p. 149).

And so, I ask students to physically move either closer or farther away depending on our interpretation of the identity; in other words, do the students identify with each other, and if so, how is this identification represented in terms of their physical proximity, sense of closeness, and community? The point here is to *feel* the *enacting* of interpersonal connectivity and community. The students are put in a situation of learning that is both participatory and social (Handley et al., 2006; Lave, 1988; Lave & Wenger, 1991; Siegel, 1999). Autopoiesis thus becomes a living social process (Ingold, 2001; Luhmann, 1990; Toren, 2001).

As outlined above, Maturana and Varela (1987), interested in the biological and neurological maintenance of identity, describe structural coupling as observable interrelationships between two or more autopoietic systems (people, students) and the surrounding socio-ecosystems that have not been preprogrammed and therefore cannot be predicted. They outline social, *third-order coupling*, in which a given person's unique ontogeny pairs with others creating "co-ontogenies," which then form "third-order unities" (p. 193). Here "ontogeny" refers to the diverse origin and historical development of people (Maturana & Varela). Third-order structural coupling then becomes a social phenomenon of communication: "the coordinated behaviors mutually triggered among the members of a social unity" (p. 183). Note that the unique learner is not lost in this; she or he brings to the exercise a unique ontogenic history, which is, in part, why there can be infinite variation in this simple demonstration.

Because of the complexity (see above) of our development, and our privacy and individuality, the teacher-researcher may observe ever "new dimensions of structural coupling" (Maturana & Varela, 1987, p. 176). This exercise brings forth a fascinating tension between privacy and sociality, the student's sense of intersubjectivity, and an excellent example of "distributed cognition" (Hutchins, 1995) in which thinking is distributed among the things and people of a distinct and complex situation.

Captivatingly, each student becomes an *attractor* of the other when they reveal themselves. Once attracted to a particular description of identity, the student moves toward the other. For Gallagher (2005) we understand others in an "embodied practice" and "…in most intersubjective situations we have a direct understanding of another person's intentions because their intentions are explicitly expressed in their embodied actions, and mirrored in our own capabilities for action" (p. 224). If we accept learning as an enactive social phenomenon that can be set up, if you will by the teacher, then we will do well to describe learning as attentional and intentional in the learning situations. We can know when someone has learned based on their responses or as actions observed. In what follows, we will recognize the learner's attention and follow their intention because perception *as* attention and action *as* intention are hermeneutically cyclical (see Gibson, 1979; Juarrero, 1999) and can be observed and described. According to Ingold (2001), Gibson's (1979) "education of attention" shows us that we learn to attend through a "fine-tuning or sensitization of the entire perceptual system, comprising the brain and peripheral receptor organs along with their neural and muscular linkages, to particular features of the environment" (p. 142). Theoretically, there is an inseparability of intention and attention: thus to observe and interpret one's intentions is to interpret meaning and experience in relation to one's perceptual and apperceptual attention (Merleau-Ponty, 1962/1989). Cox and Smitsman (2008) argue that our intentions and observable choices "emerge in a self-organizing way from the coupled dynamics of all contributing subsystems" (p. 329).[31]

Thus far we have looked at pedagogical examples regarding society and community as well as intra- and interpersonal relations. What can we say about embodied experiences in relation to neurophenomenology and pedagogy?

Saliva or Spit? In another class, I ask for brave student volunteers to spit, or let their saliva drip into a small cup. Of course, this act is considered gross by the students. But it gets worse; I then ask the volunteers to drink their own saliva! After much uneasiness and laughter, most of the students invariably refuse and our discussion begins.

Although one might think that physiology holds the essential truth of saliva as something objectively present, this is insufficient. In fact, saliva understood this way would be the purview of science in terms of reality (what is assumedly really real), but we are interested in existence, that is, how saliva is experienced as meaningful. Meaning, as we discuss in class, is generated socially and interpersonally. The saliva becomes spit when it is out of the mouth and out of the mouth in certain contexts.

Husserl viewed all human consciousness as intentional (Husserl, 1913/1998), that is, there is always already some direction and intent, some implication of, and toward the world within consciousness. Caputo (1987) believes that Husserlian intentionality *is* interpretation because intentionality is a prestructure (i.e., a pre-intention) for the possibility of human understanding and experience. We bring to all experiences a *fore-structure* of understanding, which has been, for the most part, socioculturally constructed (Caputo; Heidegger, 1926/1996). Therefore, the intentional object, spit or saliva, makes sense only by way of a relational hermeneutics—socially interpreting together. Larkin, Eatough, and Osborn (2011) correctly point out the need to include hermeneutic phenomenology as a qualitative research methodology to enhance the enactive and embodied research program (see also Gallagher, 2004). And so, in an interesting twist in this work, the truth about saliva, like the truth about the brain, emerges as interpretive, value-laden, and meaningful in relation to the social world.

Note, as in above, the emotional content of the learning situation facilitates a better understanding of the lesson being taught, if you will. As both Heidegger (1926/1996) and Merleau-Ponty (1962/1989) would say, we are meaning-makers in that we unify the relation of our bodies to the world: "Thus experience of one's own body runs counter to the reflective procedure that detaches subject and object from each other, which gives us only the thought about the body, or the body as an idea, and not the experience of the body, or the body in reality" (Merleau-Ponty, pp. 198–199). The disgusting aspect of this praxis provides the necessary tension, born of our bodies, to experience the pre-languaged body in relation to the social and discursive body that *becomes* for others (see Yakhlef, 2010).

In that saliva is not an objective matter, how it matters is meaningful. Saliva is potentially erotic, functional, disgusting, and venomous in a spit; it is drool from a deep sleep or illness, and it clears the mouth of unwanted tastes. Ingold (2001) explains ways of learning as “guided rediscovery” and “To show something to someone is to cause it to be made present for that person, so that he or she can apprehend it directly, whether by looking, listening, or feeling” (p. 141). The saliva demonstration as a pedagogical praxis of “guided discovery” helps students to understand the many ways in which, like saliva, their perceived biological sex type, ethnicity, race, and, in fact, general size and shape are meaningfully shared and constructed through our social interactions and changing beliefs (see also Greene, 1995). Following Merleau-Ponty (1962/1989), we see that what is *natural* about our bodies is made intelligible intersubjectively (i.e., familial, social, and cultural) and is indubitably linked to pre-languaged existence, which is our essential embodiment.

Engaging the learner in active, embodied, and prescribed situated activities is to provide a phenomenological and pedagogical praxis in the classroom setting. First-person qualitative data is then collected from the students and front-loaded into third-person methods (Gallagher, 2003). Thus, we have the phenomenological and the neurological as mutual constraints (Varela, 1996) and mutual enlightenment (Gallagher, 1997) providing teachers with thoughtful and ethical accounts of the relationship between brain, body, and world with regard to adult transformative learning in higher education.

Back to the Brain Itself

What might the adult learner’s brain be doing, so to speak, during these praxes? As Juarrero (1999) believes, “From a dynamical perspective, then, learning is the recalibration (in both people and neural nets) of their internal dynamics in response to training” (p. 165). In fact, these learning praxes described above, as part of an ongoing experiential pedagogy, will likely enrich neural connectivity (neural plasticity) in adults through an increase in myelination and in regard to growth-associated proteins and neurogenesis (Gross, 2000; Shaoyu, Chih-hao, Kuei-sen, Guo-li, & Hongjun, 2007; Skene, 1989).

Through excitatory and inhibitory neuro-synaptic processes, neurons assemble and interrelate (LeDoux, 2002); in effect, they collectively generate meaning when in a complex and dynamic interrelationship with the world (Cilliers, 1998). Varela et al. (1991) explain:

> It has, therefore, become increasingly clear to neuroscientists that one needs to study neurons as members of large ensembles that are constantly disappearing and arising through their cooperative interactions and in which every neuron has multiple and changing responses in a context-dependent manner (p. 94).

As Freeman (1999) maintains, “Because brains are composed of interconnected neurons there must be some way in which meanings arise through the activities of neurons” (p. 22). Neural networks may represent the material “prior knowledge” the learner brings to any given learning situation (Zull, 2002). But, we must be careful not to reify the neural network as an unchanging paradigmatic structure. Networks, perhaps, are best interpreted as predispositions that change and evolve in a harmonic interrelation with worldly endeavors.

We remember that Varela et al. (1991) warned against the computer metaphor in cognitive science as perpetuating cognitivism and reductionism, and Davis and Sumara (2000) note that in education this metaphor leads to simple input/output representational theory. Thompson (2007) suggests:

> To describe the brain as a computer in the head whose function is 'information processing' is to reify information into something that preexists 'out there' is 'picked up' and 'processed' by representational systems in the brain, and is independent in principle of the body which serves merely as its 'vehicle.' (p. 186)

If global communication in the brain were restricted to pathways or the "wiring" metaphor, we would not be able to skillfully cope, respond, synthesize, and basically learn with such incredible immediacy. Further, if we adhere to *homunculism*, we would be saddled with the untenable notion that a "little person's" brain inside of us must do some arbitration before *we* can act or think (Descombes, 2001).

Rather, the modus operandi of the higher-order learning and action of the brain is probably facilitated by the phase synchronizing of the frequency of neural oscillations (measured by electroencephalography, EEG). Disparate areas of the brain likely communicate through oscillatory phase locking; the brain has a multiplicity of cadences: waves of rhythms that commune and inform (see Buzsáki, 2006; Varela & Thompson, 2003). Buzsáki (2006) argues that "cortical activity is in perpetual motion and every motor and cognitive act is a synthesis of self-generated, circuit-maintained activity and environmental perturbation" (p. 335). Additionally, Immordino-Yang and Fischer (2011) explain the neuroscience of learning as follows:

> …learning involves actively constructing neural networks that functionally connect many brain areas. Due to the constructive nature of this process, different learners' networks may differ in accordance with the person's neurological strengths and dispositions, and with the cultural, physical, and social context in which skills are built. (p. 11)

Neurophenomenological Portfolio Assessment

From these praxes described above, teachers as researchers (Kincheloe, 2005; van Manen, 1990) can gather first-person reports of "how" learning took place (an ongoing portfolio) and add these reports to the phenomenological observations carried out by the teacher. A student portfolio assessment can contain student (trained) descriptions of learning experiences, teachers' ethnographic narratives of the learning experience, and third-person corroborative studies (Paulson & Paulson, 1994). This, then, is a phenomenological portfolio assessment based upon these particular praxes and pedagogy. To front-load (Gallagher, 2003) the aforementioned data into an experimental design using third-person methods leads us to a neurophenomenological portfolio assessment.

We can design curricula and assessments based upon phenomenological findings and subsequent evidence from neuroscience. Using these methods, we have attempted to move from the *educable* subject (i.e., the subject of positivism, Cartesianism, and cognitivism) to the *learned agent* understood from a phenomenological and neurological perspective. The value in this is to better understand other ways in which we learn and to expand pedagogy in order to recognize enactive, situated, and embodied forms of learning.

Notes

1. Note that my interest herein is not to reduce learning to categories, types, and styles or to discover learning in the presumed nature and order of the brain. Learning, as I see it, is unique to the person and thusly irreducible and irreplaceable (i.e., no other learns exactly like another). But the aforesaid does not mean learning is simply mysterious, ineffable, and unknowable. Instead, I am interested in expanding notions of learning itself by using neurophenomenological praxis as pedagogy. I choose "praxis" to highlight the hermeneutic aspect that permeates this work. As Bernstein (1983) says, hermeneutics is not "an intellectual stepsister to the methods of natural science" (p. 136). And so, this work makes no claims for advancing an essentialist, objectivist, or positivist account of learning (see also Larkin et al., 2011).
2. This synthetical assessment is highly indebted to the work of Joe Kincheloe (1991, 2005) who has theorized the potential benefits of combining critical constructivism with autopoiesis.
3. In contrast, an objectivist pedagogical assessment of learning categorizes and quantifies the "what" is learned and does so primarily through standardizations of learning (Davis et al., 2005; Kincheloe, 2005).
4. *Educable subject* is the term I will use to describe the subject of power and knowledge within pedagogy (and in some sense in contradistinction to the learning agent). Learning agency then is seen in contrast to the modernist educable Cartesian subject (Davis et al., 2005; Kincheloe, 2005). See also Fendler (1998).
5. For a comprehensive account of learning theories in relation to cognition and education, see Aukrust's (2011) *Learning and Cognition in Education*.
6. Edward Thorndike was a forerunner to American behaviorism. Thorndike examined problem solving by experimenting on animals and extrapolated to humans (Brennan, 1994; Thorndike, 1931; Uttal, 2011). He put animals in experimental conditions that created rewards for specified behaviors. Thorndike noted the measured acquisition of successful responses by trial and error learning. He surmised two basic principles of learning, which he called *exercise* and the *law of effect*. Exercise meant that certain associations were strengthened by repetition and would deteriorate when not used. Thorndike's law of effect stated that when a response was rewarded, it would likely be repeated. However, responses that were punished lessened that particular response. Thus, responses were associated with rewards and punishment. Thorndike, later in his career, adapted the law of effect to show that rewards strengthened associations, but punishment tended to make the learning subject move on to other possible responses. Thorndike's conceptualizing of associative learning left control to the learning subject, whereas Pavlov's (1927/1960) behavioral pairing and conditioning of stimulus and response was in control of the experimenter and so the learning subject (e.g., dogs) would respond and then be given a reward. Thorndike's associative learning, as opposed to Pavlov's reflexology (1927/1960), required the learning subject to be aware of that which reinforced certain responses. Interestingly, Thorndike's learning associations had a cognitive element to them (Brennan, 1994; Uttal, 2011).

7. Pavlov is credited for discovering the essential principles of associative conditioning. He believed that the brain and the nervous system were integral to reflexology. Thus, all learning, for Pavlov, could be reduced to the conjoined relationship between stimuli from the environment and the arbitrating cortex (Brennan, 1994; Uttal, 2011). Tolman's (1922, 1948) understanding of learning was influenced by the behaviorists. However, he offered a gestalt notion of "molar behavior" that described a comprehensive act that was more than the sum of a collection of "molecular" stimuli. For Tolman, "gestalt" described holistic and insightful learning experiences. Tolman is best known for his understanding of learning in terms of the development of cognitive "field" maps, which, presumably, existed in the brain like cognitive schema of the learned environment (Brennan, 1994).
8. For Franz Brentano, psychology was best understood as a science of psychic life as demonstrated in terms of acts (i.e., act psychology). Brentano understood consciousness as a unity recognized by its acts. The psychological act then was intentional in that it pointed toward an *aboutness* within consciousness. The gestalt movement and phenomenological psychology both owe a debt to Brentano (Brennan, 1994).
9. To be learn*ed* is an apt term because it encompasses the noun and action-verb of learning. To be learned means to have had a "history of interactions" in which this "tacit dimension" (Polanyi, 1966) shapes ongoing and future perceptions and thinking (Maturana & Varela, 1987) and provides a "tacit foreknowledge of yet undiscovered things" (Polanyi, 1966, p. 23). This tacit learning dimension is the potential foundation of all further cognitions, and it does not assume, as Piaget's model has, that learning proceeds logically.
10. Today's super computers that model neural networks do learn and are autopoietic (see Winograd & Flores, 1987). But, of course, the computer lacks mood, ethical commitment, value, embodiment, desire, and passion (see Dreyfus, 1972/1992).
11. See also Gibson (1979) on "mutuality."
12. This is why Derrida (1973) says "there never has been any perception" (p. 93).
13. While it is true that Descartes implicated much in his philosophizing of the mind (e.g., the res cogitans beyond res extensa and God), toward the end of his *Sixth Meditation* he looks, briefly, to the brain. Descartes (1637/1980) explains: "…my mind is not immediately affected by all the parts of my body, but merely by the brain…namely, by that part in which the 'common sense' is said to be found" (p. 98).
14. See Husserl (1913/1998) on "sedimentation."
15. William James (1890), John Dewey (1938), and Maurice Merleau-Ponty (1962) all believed we could outline the associations related to biological, neurological, and embodied habit like a path in the woods routinely trodden (see Nöe, 2009; Thompson, 2007). Amazingly ahead of his time, James (1890/2007) explained that "If habits are due to the plasticity of materials [i.e., the brain] to outward agents, we can immediately see to what outward influences, if any, the brain matter is plastic" (p. 107).
16. Neurophenomenology is humanistic and person centered in that it seeks to liberate people from the, more often than not, oppressive strategies of reductionism, objectivism, and determinism sometimes found in neuroscience's accounts of human experience. Phenomenology alone, through its explication of our unique lived experience and shared experiences (as opposed to normalizing and standardizing experiences), is a person-centered methodology and method.
17. Phenomenology is ontological when it is "the science of the being of beings," and it is interpretive and fundamentally hermeneutic when describing is understanding and is always already interpreting (Heidegger, 1926/1996, p. 33). Don Ihde (1986) writes "Thus the *epoché* and *phenomenological reductions* may also be called hermeneutic rules, since they provide the shape or focus of inquiry" (p. 32; see Finlay, 2009).
18. Barclay (2000) explains that "Cognitive neuroscience seems to have appropriated phenomenological insights but ignores some of the philosophical cautions regarding the influence of the 'scientific' perspective when it functions as a presupposition" (p. 142).

19. Wertz (1993) goes on to point out, “Phenomenological psychology does not dismiss the findings and theories of cognitive psychology a priori as untrue or useless. It places them in abeyance while essential insights concerning the psychological sphere are pursued to their limits” (p. 22).
20. I say fruitful, not necessarily equal (see Clegg, 2006). For Clegg, “Both naturalism and phenomenology are foundational ontologies whose conglomeration can result only in the ultimate subjugation of one or the other” (2006, p. 341).
21. For an exhaustive account of the issues regarding Husserlian phenomenology and naturalization, see Roy, Petitot, Pachoud, and Varela (1999).
22. The early Husserl (1900/1973) embarked upon a “logical investigation,” which prescribed a way of putting aside prejudices that would allow the phenomenologist to get closer to the pure phenomenon. I take this beginning version of the epoché to be akin to experimental and disciplinary objectivity (Megill, 1994), where steps are taken to remain neutral to the investigation of a phenomenon. Later Husserl (1913/1998) introduced recognizing and putting aside the natural attitude. Rather than merely putting aside prejudices, the phenomenologist now transcends their entire presumptive framework about reality itself. The phenomenologist then wakes up, if you will, to the transcendental ego that takes part in constituting reality. I suggest transcendence of this sort is a continuum, especially in light of postmodern and post-phenomenological (Ihde, 1986, 1993) assertions (see Finlay, 2009).
23. Phenomenology is not the first-person report itself. One must enact phenomenology before first-person reports are attempted. So where is phenomenology in first-person reports? It is in the phenomenologically informed preparation of the questions that participants are asked; it is in the phenomenological analysis of the responses, which must include the epoché and phenomenological reductions. As van Manen (1990) explains, “From a phenomenological point of view, we are not primarily interested in the subjective experiences of our so-called subjects…the deeper goal, which is always the thrust of phenomenological research, remains oriented to asking the question of what is the nature of this phenomenon…as an essentially human experience” (p. 62). In a phenomenological investigation, first-person reports are not intended to empirically verify a correspondence between subject and object; rather, participants are trained to authentically report the constitutive meaning-making that they contribute to the experience (see Petitmengin & Bitbol, 2009).
24. Gallagher and Zahavi (2008) point out that neurophenomenology began as “an approach to the neuroscience of consciousness” that used phenomenology and later became “any kind of appeal to first-person data in combination with data from neuroscience” (p. 41). One critical issue we encounter is that brain scans are not themselves veridical, apodictic truths. As Fisher (1997) succinctly explains, “The problem is that brain facts are not self-evident. Because no such facts can be found in one’s practical, lived experience, a method is required to reveal them” (p. 49).
25. At this point, it is important to note that phenomenological reflection, the epoché, and phenomenological reductions ought to be the necessary foundation to neurophenomenology. Barclay (2000) questions “if the realm of cognitive science and philosophical cognitivism might have subsumed phenomenological insights into its empirical approach while leaving aside the aspects of phenomenology, which emphasize the reduction of the ‘natural attitude’ by epoché” (p. 162; see also Clegg, 2006).
26. See Cilliers (1998) for a clear and thorough understanding of the relationship between self-organization (autopoiesis) and complex systems.
27. These teaching strategies have been adapted through the years, and, in general, I have picked them up from conversations with colleagues through the years. They are not original to me.
28. Compare these pedagogical observations with “tracking” as described by Siegel (2010).
29. Sabotage is a “naturalistic environment teaching strategy” that is usually done with young children and often with children with certain learning problems and differences (see Ostrosky & Kaiser, 1991).

30. Compare to Hebbian learning and synaptic plasticity (See Freeman, 1999; Hebb, 1949; LeDoux, 2002). Basically, Hebb (1949) suggested strengths and weaknesses of synapses form from use. Changeux and Danchin (1976) further suggested a "use it or lose it" notion regarding an ongoing synaptic pruning.
31. To assess learning is inseparable from the interpretation of learning. Once observed by a third-person (e.g., teacher), learning may be interpreted as knowing, and "knowing is effective action" (Maturana & Varela, 1987, p. 29). Further, the teacher as an interpreter of learning becomes part of the dynamic system of learning, namely, as being a perturbation or attractor within the learning situation (see Juarrero, 1999).

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