The Enactive Mind
An Epistemological Framework for Radically Embodied Didactics

GIANLUCA BOCCHI, LUISA DAMIANO

Abstract: The main aim of this article is to promote, at an epistemological level, the development of radically embodied didactics, that is, didactics which conceives the agents involved in the learning process – scholars and students in primis – as radically interdependent brain-body-environment(s) units involved in a constructive and creative cognitive process. This article proposes the radically embodied view of the mind introduced by Evan Thompson and Francisco Varela to the theoretical debate in didactics. Through the reconstruction of the basic structure of this theory, and its contextualization within the radically constructivist epistemology, this article brings attention to some of the most specific and interesting aspects of this theory: (a) the overcoming of merely anatomical conceptions of embodiment, as well as merely spatial operations of cognitive extension; (b) the convergences with the insights produced by neurophysiological research on mirroring mechanisms; (c) the proposal of a “legitimate questions maieutic practice”, grounded in the radically constructivist thesis according to which cognition is a participative process of construction of a shared world.

Riassunto: L’articolo intende promuovere, a livello epistemologico, lo sviluppo di una didattica radicalmente incorporata, ovvero di una didattica che concepisce gli agenti coinvolti nei processi di apprendimento – insegnati e studenti in primis – come unità cervello-corpo-ambiente radicalmente interdipendenti e coinvolte in processi cognitivi intrinsecamente costruttivi e creativi. A questo scopo l’articolo propone al dibattito teorico della didattica la teoria radicalmente incorporata della mente introdotta da Evan Thompson e Francisco Varela. Attraverso la ricostruzione della struttura teorica di base di questa teoria e la sua contestualizzazione nell’ambito del costruttivismo radicale, l’articolo mette in evidenza tre degli aspetti più specifici e interessanti dei questa prospettiva teorica: (a) il superamento di concezioni meramente anatomiche dell’embodiment, nonché di operazioni meramente spaziali di cognitive extension; (b) le convergenze con gli esiti della ricerca neurofisiologica inerente ai meccanismi di mirroring; (c) la proposta di una “pratica maieutica delle domande legittime”, basata sulla tesi radicalmente costruttivista secondo cui la cognizione è un processo partecipativo di costruzione di un mondo condiviso.

Keywords: Radical Constructivism, Radical Embodiment, Legitimate vs. Illegitimate questions, (inter-individual) Mind, Mirroring Mechanisms.
I. The idea of a legitimate questions maieutic practice is one of Heinz von Foerster's more interesting inventions. This pioneer of the epistemological **radical constructivism**\(^1\) had been very critical towards common stances in pedagogical and didactical issues. His critic focuses in particular on the teaching practice in which the teacher asks her students *illegitimate* questions, instead of exchanging with them *legitimate* questions (von Foerster, 1987A). According to von Foerster, illegitimate questions already have a predetermined answer in the “teacher’s head”, or in some easily accessible paper or electronic record. Instead for legitimate questions nobody in the classroom, and maybe even outside the classroom, has an answer. Moreover, for some of these questions there will never be, and even cannot be, a definite and univocal answer. The specific characteristic of the search for legitimate questions is that it does not aim at generating states of static agreement. It is directed to produce evolving states of dialogue, involving both agreement and conflict. It provides teacher and students with the necessary conditions for the production of knowledge, in such a way that, in every step of their dialogues, they create knowledge, instead of trying to examine, from an external and detached point of view, the way in which knowledge is produced (von Foerster, 1987A).

Von Foerster asks to reflect about situations challenging the teacher’s belief that her authority is grounded in her knowledge of the answers to (illegitimate) questions. Let’s consider one of his examples. A teacher asks her students for Napoleon’s date of birth, and receives an unexpected reply. Instead of “1769”, a student answers: “Seven years before the United States’ Declaration of Independence”. If this answer is considered as a “alternative” answer, the educational process does not progress very much: it remains statically linked to the original illegitimate question. The outcome is significantly different if we use this nascent dialogue as an access to legitimate questions. One of these questions could investigate the nature of history. As we are used to the interplay of omissions and inclusions which characterizes old and modern chronicles, we easily see that writing natural or human history is always a selective operation, and that the positivistic ideal of representing facts as they are is radically implausible. A second legitimate question can lead us to reflect about the nature of historical time. It can be observed that the linear chronology universally adopted by our scholastic historical narratives is shaped by the concept of absolute time proposed by the Newtonian

---

physics tradition, while other narrative chronologies exist. For example, there are relational narrative chronologies, which probably are more attuned to the artistic and scientific trends of the 20th and 21st centuries. A third question could investigate the nature of knowledge. In fact, the dialogue sketched above introduces the distinction between two conceptions of knowledge. The first is a view of knowledge as neutrally objective and externally imposed. The second is a view of knowledge as intrinsically intersubjective, that is, co-built through a dynamics of co-evolution involving different interlocutors. This second view introduces the idea that knowledge emerges from an intersubjective dialogue characterized by convergences and misunderstandings, and unstable balances between open and closed attitudes among the dialoging actors. While the first view — an objectivist epistemology — grounds the game of illegitimate questions, the second — a radically constructivist epistemology — proposes the game of legitimate questions, and promotes the development of a radically constructivist teaching practice.

To implement this practice, the teacher has to propose her students legitimate questions, and positively utilizes the cognitive breakdowns arising from the novelty and unpredictability of some of her students’ perspectives. She needs to involve them and participate with them in the process of generating new intersubjective knowledge, that is, a transitory and local (class-related) knowledge expressed by new relationships between contents, ideas and perspectives that the teacher-students community creates through dialogue.

Stephen J. Gould, another protagonist of the contemporary radically constructivist philosophy and science, helps us to develop this radically constructivist idea of the teacher’s role. Let us consider Gould’s stance with regard to traditional conceptual issues in the fields of evolutionism and geology and, more specifically, his answer to the classical question concerning the discontinuous or continuous nature of change in natural history. Gould replies that it is impossible to give an answer located in a point on the one-dimensional line implicitly supposed by this question. The answer can’t be located in one of the two extreme points on the line, since this would mean that change is only continuous or only discontinuous. Nor can the answer be located in an intermediate point, since this would mean that change is an invariant combination of continuous and discontinuous aspects. What Gould proposes is to go “off the line”: transforming the one-dimensional line implicitly postulated by the question into a bi-dimensional surface, or even (in principle) into an n-dimensional space. The idea is that the question has not and cannot have a univocal answer: there are many answers (and many possible combinations
of answers), depending on the periods, the kind of system, and the specific changes we intend to consider. Thus Gould proposes a concrete strategy of transforming the usual search for illegitimate questions in a fruitful search for legitimate questions.

The teacher has to use precisely this sort of strategy. She has to consider that her students may not perceive their educational pathways as necessarily situated “on the line”. When a question presupposes a static and unique answer in a shallow mode, but receives a reply in a “off the line” mode or, as we can call it, a relational mode, the teacher-students community is re-located in a multi-dimensional space of legitimate questions. Within this space the primary task of the teacher is that of exploring, and helping her students to define a thick and tangled set of creative trajectories, in which each trajectory opens the possibility of producing new relational knowledge.

There are many spaces that a relational answer of a student can open to a teacher and to a teacher-students community. The example proposed by von Foerster opens the space of global history: a first globalization was already under way during Napoleon’s time, when the world was shrinking more and more, and the history of the United States was developing a strong coupling with the history of France. Within the new space of global history defined by the student, the teacher is invited to remind and to link various disconnected elements of her cognitive and professional background, and to weave them together through the dialogue with the students, making the students aware of the emerging new relationships: for instance, the idea that the French Revolution was significantly influenced, in its origins and developments, by the exemplum of the American Revolution; the idea that Napoleon was significantly attuned with the possibilities opened in and by the age of revolution, without which he probably could not have risen so remarkably quickly; the idea that this age of revolutions began to develop into a global process, which had very relevant consequences not only in Europe, but also in Latin America (Simon Bolivar as Napoleon’s disciple) and in the Caribbean (Haiti); the idea that Napoleon’s history and the history of the United States are connected in many ways, and that, if Napoleon would have not sold the Louisiana Territory to the United States, they would have never become what they are now; the idea that the most careful observer and prognosticator of the new role of the United States within the world was French -Alexis de Tocqueville; and so on.

Of course, not all the elements needed by the teacher to open a new space of search are easily attainable. The teacher has always to “learn how to learn”
to enter and embed herself and her community in a new space. Besides reconsidering old contents and creating or learning new contents, the teacher has also to understand that her professional role – both symmetrical and asymmetrical with regard to the students – requires her to undergo a permanent learning process in the deepest and strongest sense. The teacher has to follow the path of life-long learning based on her daily maieutic dialogue with her students (and other interlocutors), her proactivity and her psycho–physical availability (openness) to novelties. It is impossible to trigger epistemological revolutions involving didactics without activating epistemological revolutions at the level of the individual subjects involved in didactics – teachers in primis – and their conditions of learning.

The following pages aim at stimulating teachers and professionals of didactics to embrace and (cre-)actively develop this idea of a radically constructivist teaching practice by introducing one of the most advanced epistemological frameworks which currently support it. We refer to the enactive theory of cognition developed by Francisco Varela and Evan Thompson within the context of the paradigmatic shift towards embodiment that, since the 1990s, is affecting the cognitive sciences and philosophy of mind.

The next part of our contribution focuses on the radically embodied theory of the mind that Thompson and Varela proposed in Radical embodiment (2001), an article that they published ten years after the book The Embodied Mind (1991) written with Eleanor Rosch. As the title indicates, their article emphasizes the distance between “simple embodiment” and “radical embodiment” (Clark, 1999), that is, between the mainstream operations of embodiment of the mind, still shaped by the computationalist paradigm, and the emerging forms of embodiment which, following the epistemological lines defined by the pioneers of radical constructivism, depart from computationalism and propose genuinely new concepts of the cognitive mind.

A notion of the mind expressing a radical form of embodiment is what Thompson and Varela introduce in Radical embodiment. In this text recent insights from neuroscience, interpreted through Varela’s theory of autonomous systems, ground the concept of knowledge at the basis of von Foerster’s proposal for didactics. Knowing is not representing a predefined external reality, nor projecting an arbitrary reality, but co-constructing a world – participating with our interlocutors and our environment(s) in the process of construction of a shared world of experience.
In Radical Embodiment Thompson and Varela (2001) propose a “neurodynamic” solution to the issue of the embodiment of the mind. Their hypothesis is that the location of the mind is not in the brain, but in the processes which define the “participation” of the nervous system network to human cognitive activity. They characterize these processes as the cyclic dynamics through which the nervous system interconnects and regulates the different organizational levels of the body, and couples the cognizer – the self – with her environment(s) and other cognizers – other selves.

This approach to the embodiment of the mind is significantly different from the mainstream embodiment approaches proposed within the fields of cognitive sciences and philosophy of mind – approaches which can be defined as “neuro-anatomic”. Thompson and Varela refuse to situate the mind statically in the cerebral matter platform. They discard the traditional thesis according to which the central nervous system is the “central unit” in which the essential part of the cognitive process take place. Their neuro-dynamic solution characterizes the nervous system network as the material support of complex dynamics of co-evolution which involves body, environment and other cognizers as irreducible and radically interdependent agents (polari-ties) of the cognitive processes. Grounded in this view of the nervous system, the radically embodied mind breaks free from the dominant theoretical topology which determines the possible locations of the mind in reference to the boundaries given by “skull and skin” (Clark, Chalmers, 1998). Furthermore, it breaks free from the traditional divisions through which the cognitive sciences define the objects of research that are pertinent for the exploration of human environmental and intersubjective cognition – “brain, body, environment”, “self and other”.

Thompson and Varela’s enactive mind occupies the spaces where the co-evolutions of these objects take place. It has to be conceived as a structure of coupling – a relational structure – which recomposes the classical divisions proposed by the cognitive sciences. It re-organizes – interconnects – the classical objects of research of these sciences, following not the spatial logic of “internal” and “external”, but the emergentist logic of “mutual embedment” – “enmeshment” through co-determination.²

The relationship between neural dynamics and conscious situated agents can be described in terms of the participation of neural processes in the
‘cycles of operation’ that constitute the agent’s life. Three kinds of cycles need to be distinguished for higher primates:

1. cycles of organismic regulation of the entire body;
2. cycles of sensorimotor coupling between organism and environment;
3. cycles of intersubjective interaction, involving the recognition of the intentional meaning of actions and linguistic communication (in humans) (Thompson & Varela, 2001, 424).

The first of these three cyclic processes – the first connection between the mind and the activity of the nervous system that Thompson and Varela make – defines the general lines of the enactive approach to the embodiment of the mind. Through this cyclical dynamics, the *radically embodied mind* is connected to the processes through which the nervous system regulates the complex dynamics of the human organism, and thus is distributed throughout the human body.

The mind is not in the head (Varela, 1999, 74).

The enactive description of the human organism proposed in *Radical Embodiment* is prototypical for Varela. It presents the body as a set of interconnected closed networks densely connected among each other and with the nervous system network. The idea is that of interdependent and mutually embedded autonomous systems: “emergent selves” manifesting themselves in each of the different networks that can be identified within the body.

The pioneers of radical constructivism – Paul Weiss (1971) and Gregory Bateson (1972) in particular – defined this set of networks as an “ecology of mind”. Varela advances the idea of a complex of “local cognitive identities” in co-evolution. They are “cells, tissues, organs, apparatus…”, but also “bio-mechanic networks, bio-chemical networks, physiological networks […]”: *A Meshwork of Selfless Selves* (Varela, 1991) which are coupled with the nervous system, and dynamically participate in defining the cognitive identity of the conscious agent during her co-evolutive interactions with her environment(s) and other agents.

Through this first theoretical step Thompson and Varela locate the *enactive mind* in the deepest layers of the human corporeality. They locate it among the rhythms and regimes of the basic dynamics of the body: its activity of
self-production, realized through the co-evolution which couples the neural network with the somatic networks.

This radical view of the embodiment of the mind is significantly enriched by Thompson and Varela’s analysis of the second kind of cycles of operation mentioned above – an analysis which defines the gnoseological model that they choose to support enaction. The two researchers characterize the dynamics through which the nervous system network interconnects the human organism and the environment as “sensorimotor coupling”. This way they link enaction to the theoretical framework of radical constructivism, which describes the nervous system as a closed network of neurons interconnecting sensorium and motorium (sensory and motor surfaces), and maintaining their coordination during the interactive dynamics with the environment which continuously destabilize the internal self-productive dynamics of the body\(^5\).

The specificity of this constructivist view of the nervous system is that it discards the classical computationalist hypothesis of a representational phase mediating between perception and action conceived as first perception, second representation, and third action. The identification of the nervous system with the sensorimotor closure of the human organism substitutes the computationalist representations with neuronal schemes of regulation. They are conceived as patterns of activity of the central nervous systems which do not code internally the external reality to allow the computational planning of effective actions, but associate sensorial perturbations to conservative actions – actions able to warrant the organism’s re-equilibration through interactions with the environment. This theoretical shift leads to the typical radically constructivist view of human cognition, according to which the supposed external objects with which we deal cognitively are not externally predefined entities that we can internally represent, but “symbols of stable self-behavior” (von Foerster, 1987b). They are expressions of the self-regulative capabilities of the sensorimotor closure: possibilities of adaptive actions that the nervous systems projects on the dimensions of the environment which are sensorially perceived. This is the thesis that Varela condenses in the idea of enaction as “embodied action” which “bring forward a world”: the nervous system network reacts to exogenous perturbative events through patterns of self-regulation which project on the environment objects expressing our contextual possibilities of action – our “readiness-to-action”\(^6\).

The innovative enactive contribution to the classical radical constructivism view of human cognition consists in Varela’s description of these dynamics of
regulation. He characterizes the transitory neuronal schemes supporting the sensorimotor coupling with the environment as products of a spontaneous activity of self-organization taking place within the network of the nervous system: collective behaviors which emerge in the neural network when it experiences perturbations. In other words, Varela understands the functional coordination of distant areas of the brain as a phenomenon of large scale “neuronal integration” mediated by processes of “synchronization”: “resonances” among the oscillations of the neurons. The image is that of a quick and flexible dynamic coordination among neurons – the adoption of the same phase of oscillation by neurons that can be very far from each other – which connects them in temporary and coherent functional units.

Varela has been working on this hypothesis since the late 1970’s, with an original approach. He does not emphasize the ideas of neuronal “resonant groups” or “ensembles”, but rather that of neuronal “assembles”, which “interpret” the organism’s multiple activities of coupling and orient their future developments. As previously suggested (Damiano, 2009), this theoretical view can be seen as another implication of Varela’s general theory of autonomous systems (Varela, 1979). Using this theory to read the neuronal dynamics, Varela identifies the processes of neuronal integration as dynamics generating transitory cognitive identities: cognitive subjects creating their own worlds of experience. Varela thinks them as “micro-identities”: fragile, contingent, temporary cognitive units. He describes them as “emergent selves” which express contextual possibilities of action on the environment – readiness-for-action. Their self-distinction within the neuronal dynamics corresponds to a specific way in which the agent cognitively copes with the environment. When one of them arises – through exogenous or endogenous perturbations – a related “micro-world” arises at the level of the subjective experience, and the cognizer experiences a new situational context, coupled to the readiness-for-action that her current cognitive micro-identity supports.

You put your hand in your pocket [...]. Breakdown: you stop, your mind setting is unclear, your emotional tonality shifts. Before you know it a new world emerges: you see clearly that you left your wallet in the store where you just bought cigarettes. Your mood shifts now to one of concern for losing documents and money, your readiness-to-action is now to quickly go back to the store [...] all attention is directed to avoiding further delays. This is the essence of our life (Varela, 1992, p. 11).
Varela’s description of the dynamics generating the cognitive micro-identities of our conscious experience uses notions and theories developed by the early research on self-organization. The basic idea is that every transitory cognitive identity realized by a neuronal assembly is generated by a destabilization— a “breakdown” — affecting the nervous system. This “fluctuation” leads to a situation of instability: a dynamic singularity in which the neural network can accede to different dynamic solutions. These are different patterns of activity in front of which the system briefly “hesitates” before it chooses one of them. Its “choice” is determined by a wide variety of factors. One of the most important is the history of the system: its past co-evolution with the organism and the environment.

This is an innovative interpretation of the dynamics of the brain, able to propose a new way of grounding conscious experience in neuronal activity. It offers an alternative to the computationalist notion of the conscious agent, which, as Hofstadter and Dennett critically emphasize (1981, 13), is grounded in “non-conscious bits of organic machinery, as utterly lacking in a point of view or inner life as a kidney or kneecap” 10. Varela’s theoretical description of neuro-dynamics introduces a conscious agent which is not only intrinsically situated, but is also able to experience the permanent attentional variations and context redefinitions which are typical of our subjective experience. According to Varela’s view, the dynamics of generation and succession of this agent’s (micro-) identities cannot be dissociated from a dynamics of definition and variation of contextual points of view on the environment — (micro-) worlds.

Adopting this approach means to impose a specific condition to the scientific comprehension of the self. It means to require cognitive scientists and philosophers of mind to renounce to the traditional view which identifies the self as the stable — “coherent and permanent” — center of the subjective experience. 12 When we ground the individual identity in neuronal patterns of activity which are structured and de-structured in the dimension of micro-temporality, we have to conceive this identity as permanently changing and essentially discontinuous — a flux of micro-identities punctuated by micro-sequences of breakdowns. The idea is that of an individual identity undergoing a process of intense redefinition, constantly re-triggered by the perturbative interaction between the connectivity of the nervous system and its double ecology — organism and environment. In this perspective the conscious agent’s identity appears as an intrinsically transitory and contingent result of a highly distributed event — a brain-body-environment event.
The mind is [...] the non-place of the co-determination of inner/outer [...] (Varela, 1999, 74).

According to this view, the identity of the self changes not only in reaction to the continuous transformations of the cognitive identities of the body – the “selfless selves” emerging from the somatic networks. Its identity changes also with the permanent transformations of the environment, in a radically interdependent way\(^\text{13}\).

Thompson and Varela’s **radically embodied mind** cannot be located in the intra-individual space. It arises in the dynamics of co-specification involving the somatic networks, the neural network and the environment. It occupies the relationship of dense coupling which interconnects not only brain and body, but also organism and environment. It involves brain, body and environment in a process of permanent and interdependent constitution which they cannot control. The agent of their co-transformation is their relationship itself – that is, the unit which is dynamically formed by them, and which permanently transforms them through their co-determination.

The thesis that Varela grounds on empirical basis and expresses through the language of self-organization is the intuition of the pioneers of *radical constructivism*: the effective evolutionary unit is the “flexible organism-environment unit” (Bateson, 1972) – more specifically: the *brain-body-environment* unit\(^\text{14}\). Together with these pioneers, Varela thinks it as the effective cognitive unit – the mind.

Neural, somatic and environmental elements [...] interact to produce (via emergence as upward causation) global organism-environment processes, which in turn affect (via downward causation) their constituent elements. Although speculative, these points gain plausibility from considering the dimensions of embodiment [...] (Thompson e Varela, 2001, 424).

The three primary objects of the cognitive sciences are redefined as inseparable. They cannot be conceived as entities which are constituted before structuring relationships between each other. They produce each other, and thus are linked by a radical form of co-dependance. Their location is their interdependence, co-emergence, co-evolution within the unit defined by their permanent co-determination. Their connection is a mutual embedment: a form of dynamic co-specification which exceeds the descriptive power of
conceptual dualities such as “inside/outside” and “internal/external”, and, to be conceptualized, demands us to re-think these classical dichotomies as complementarities\textsuperscript{15}.

This is not a merely speculative stance against the classical “naked mind” theorized by classical gnoseology and computationalism – the notion of a set of cognitive resources essentially independent from the cognizer’s body and environmental context. The idea that brain, body and environment are essential and irreducible dimensions of the mind intends not only to revoke all theoretical plausibility to the Cartesian \textit{naked mind}, but also to express a concrete methodological indication. When we exclude body and environment from the inquiry about cognition, we obscure a fundamental part of the cognitive processes, that is, a part without which all cognitive processes inevitably collapse – even those cognitive processes involving the so-called “representation hungry problems”, which have to be treated “off-line” (Clark, 1997).

Within contemporary research in cognitive sciences, the thesis of the crucial role of body and environment in all forms of cognition is increasingly accepted, especially in emerging applicative research domains such as cognitive, developmental and situated robotics. These \textit{avant-gard} domains strongly support the enactive notion of the inseparability of brain, body and environment at a methodological, theoretical and operational level. The synthetic models of cognition that these domains propose emphasize the idea that these three classical objects of cognitive sciences can offer a good scientific accesses to the phenomenon of cognition only if they are considered as complementary. That is, only if they are conceived and built – both theoretically and artificially – as “enmeshed” – “mutually embedded” – systems\textsuperscript{16}.

Despite the philosophical fiction of a ‘brain-in-a-vat’, it is doubtful (even as a thought experiment) that one can ‘peel away’ the body and the environment as ‘external’ to the brain processes crucial for consciousness. The nervous system, the body and the environment are highly structured dynamical systems, coupled to each other on multiple levels. Because they are so thoroughly enmeshed – biologically, ecologically and socially – a better conception of brain, body and environment would be as mutually embedded systems rather than as internally and externally located with respect to one another (Thompson, Varela, 2001, 422-424).
Thompson and Varela indicate how to extend this view to the field of intersubjective cognition. In *Radical Embodiment* they briefly consider the third kind of cyclic dynamics of the nervous system, and define it as a process constituted by “cycles of intersubjective interactions” consisting in specific forms of sensorimotor coupling. It is a very short, but dense indication, which expresses an implicit reference to the self-organizational and autopoietic characterization of the intelligibility of the other. It refers to the autopoietic notion of “behavioral coupling”: a form of intelligibility which connects the cognizers by coordinating their sensorimotor closures, and thus links them into inter-individual cognitive units (Maturana, Varela, 1973, 1984, 1988) of which they are then sub-units.

This mind is that mind (Varela, 1999, 81).

Some decades ago this thesis might have been discarded as a merely speculative hypothesis. Today it appears significantly pertinent for the interpretation of the emerging neuro-scientific insights about intersubjectivity.

Intersubjectivity involves distinct forms of sensorimotor coupling, as seen in the so-called ‘mirror neurons’ discovered in area F5 of the premotor cortex in monkeys (Thompson, Varela, 2001, 424).

We refer to recent neurophysiological research on *mirroring mechanisms*, neuronal structures which are recognized to support inter-subjective cognition through neuronal co-activation. Scientific evidence indicates that they might constitute the neurophysiological mechanisms of a kind of intersubjectivity whose characteristics are different from those that are classically ascribed to inter-subjective knowledge. The “mirror intersubjectivity” does not rely on logical or linguistic abilities; it is not based on observation or on analogy with self-knowledge; it does not take place in the intra-individual space. The specificity of this form of inter-subjective knowledge is that, through the neuronal co-activation, it “harmonizes” intentions, sensations and emotions of different individuals, and leads them to inter-individually share intentional states and affective experiences. Vittorio Gallese emphasizes that, since it supports mutual intelligibility through neuronal co-activation, it violates the limit between self and other, and generates a convergence between the inter-individual and the intra-individual space.
[...] Much of what we attribute to the capability of formulating theories on the other’s mind [...] is the result of the capability of creating a shared «us-centered» space. The creation of this space is the result of an activity of «embodied simulation» (embodied simulation), defined in subpersonal terms by the activity of mirror neurons, which allow to map on the same nervous substrate actions which are performed and actions which are observed, as well as sensations and emotions which are personally experienced and observed in others (Gallese, 2003B)\(^\text{19}\).

There is a significant match with the theory of the enactive or radically embodied mind. When we extend the latter in the domain of intersubjective cognition, we can reach the following theoretical view. Intersubjective encounters, as they imply intersubjective sensorial interactions, link the agents’ individual sensorimotor closures into a dynamics of co-evolution. The agents’ nervous system networks develop resonances which generate dynamical coherences and symmetries between the intra-individual processes of regulation. The agents’ neural networks deal with their double ecologies of organism and environment in a coupled way. They project operational meanings on the environment together, and coordinately express their readiness-to-action. They couple the agents’ cognitive identities in a process of interdependent constitution which, by generating symmetries among their micro-identities, supports the agents’ mutual intelligibility and their shared intelligibility of the environment.

This is a process that the individual agents cannot univocally control. The action distributing the micro-identities and generating the related micro-worlds belongs to the relationship in which the agents are involved: the unit which is formed by the agents, and that transform them into self-other events – that is, coupled brain-body-environment events.

The radically embodied mind is grounded in the body, but exceeds the boundaries of the individual organism. It is a structure of coupling which interconnects somatic networks, nervous system and environment, but not only. During intersubjective encounters, it coordinates the individual organisms’ networks in a coherent dynamic complex, linking self and other into a unit: a transitory inter-individual dynamic unit which, while it defines itself, defines its world of experience – a world shared by its sub-units.

It is one of the most avant-garde views of the mind among those produced by the embodied cognitive science, able to overcome not only merely anatomical conceptions of the embodiment of the mind, but also merely spatial
operations of cognitive extension. Through these characteristics it offers a significant support to von Foerster's message for didactics, emphasizing that, in intersubjective contexts, the cognitive process is inevitably the process of becoming part of a creative inter-individual unit: a community which incessantly redefines our cognitive identities and our worlds of experience by making them radically interdependent on those of our interlocutors.

This view of intersubjective cognition is the epistemological space that radical constructivism and radical embodiment offer to didactics: a space in which teaching practices directed to enhance the creativity of radically embodied communities can be developed.

A field in which today the development of this kind of teaching practices is increasingly urgent is that of didactics of languages.

III.

All social and cultural artifacts find their origins in a “collective” or inter-individual mind in continuous co-construction with its individual minds. This strong relationship between inter-individual and individual minds suggests a less territorial view of our ideas, and helps us to avoid endless discussions about the progeny of ideas. Looking at historical developments supports what the constructivist epistemology proposes: new ideas don’t have an absolute origin, nor are simply in the spirit of the time. They are drifting in an unaccomplished circle of reinterpretations and reattribution of meaning through which they can interact in the most various ways. Of course for a scientific theory or a literary work we can point to a specific person (the “author”) who has contributed more intensely to a collective production. But for other cultural artifacts, like a language, we cannot point to anybody. A language is prima facie a collective creation, even if in the particular history of a language there may individual relevant contributions.

John McWhorter, a linguist interested in linguistic change, describes how the spontaneous modalities of transformation of oral natural languages are basically of two kinds. Most of the world languages can be defined esoteric, in the precise etymologic sense: they are languages with a narrow territorial base, and thus they belong to a small group of people who share a relatively homogeneous culture (as is still the situation in many areas of Africa, Indonesia, the Pacific Ocean, New Guinea, Caucasus, and even in the remaining indigenous people of Australia and the Americas). The tran-
Transformation of these languages can be understood as a natural drift, in the context of which phonetic, morphological, and syntactical aspects keep the same level of complexity. However, the situation is totally different when we deal with languages spoken in wide territories by many people. At a certain stage of their respective evolution, these languages have to undergo a significant simplification, due to the fact that many people with different linguistic backgrounds learned these languages originally as a second language, and adapted them to their communicative needs. Usually during their interaction some traits of the second language – the traits that were too idiosyncratic to be shared by everyone – have to be eliminated in order to make the communication easier. This has been the situation for English, which, at a certain phase of its development was also spoken by Celts and Scandinavians. A similar type of linguistic development can also be found also in: Mandarin (i.e., the dialect originally spoken in Beijing, which is at the basis of the language now spoken in all the PRC); the modern Arabian “dialects” (modern in comparison with the classic Arabian); the modern Persian; Malaysian-Indonesian; many European languages, such as the modern Neo-Latin and the old Germanic ones. Currently the process of globalization is intensifying this kind of linguistic change, as many European languages are used for intersubjective communication between strangers with different native languages.

The diffusion of written languages introduced a significantly novel situation in language change. The written languages are now more or less governed by highly invariant grammatical codes and thus their transformation is by far slower and more strictly channeled. The new global situation exposes them to various and heterogeneous change trends, due to their adoption by a huge number of new speakers stemming from very different linguistic backgrounds: the results of interactions between old, very static codes and grammars and new multifarious contexts and pragmatic situations are quite original, and promises to have totally unpredictable consequences on further evolution of these languages.

Up to now the educational system was in general not aware of the relevance and the subtleties of the processes of linguistic change. On the opposite, when it had the goal of building a very homogeneous (in principle) national language to make the reciprocal communications of millions of people as easy as possible – in a sense a noble goal – it often acted against the variety and diversity of local codes – dialects, regional and minority languages – which were the habitual oral form of communication of the most of the students.
Interestingly enough, this repressive politics of the educational system in this respect had been shared by totalitarian and democratic countries (e.g., Italy during the decades of fascism, and France during most of its development). In the current age of globalization, the educational system seems still to be inclined on behaving in the same way.

As in the case of history, mentioned at the beginning of this article, it is time for the school to shift from illegitimate to legitimate questions also in linguistic issues. In other words: a mono-linguist attitude cannot anymore be a monolithic attractor in which the school has to converge the plurality of the linguistic experiences of the different individuals. In this respect, the most urgent goal of teachers has become the facilitation of the linguistic code-switchings of the individuals, making the plurality of their codes and modes of expression stronger, and emphasizing the crucial relationship between contexts and forms of communication. (It should be added that this is the only way to enhance the value and preserve the cultural languages of Europe: they must be conceived as resources able to fertilize many other linguistic modalities, and not as an imposition to achieve homogenization).

However, the issue at stake goes even deeper than the linguistic education in the age of globalization. The challenging issue is enhancing the value of the people in the collective construction of social objects. What happens in the classroom is not and cannot be a mere replication of processes already realized by literary, academic, political or multimedia authorities. The learning process happening in the classroom has to be understood as a process of permanent innovation, which has the same value as the ones realized by these authorities. Both at the level of the construction of a shared history and at the level of the construction of a shared language, we can never exclude that some innovative process happening in the classroom might have a butterfly effect, with relevant macroscopic implications. In any case, what happens in a classroom is always part of the collective construction of our social tools and artifacts. In the construction of our collective world, everybody should be responsibly involved. One of the teacher’s tasks is to point out and to support this responsible involvement.

This could be considered a first goal of the nascent dialogue between a radically embodied epistemology and the educational perspectives: to give to people and groups of people a stronger empowerment to build a world which, as Heinz von Foerster used to say, is able to maximize our possibilities – the possibilities for us and for the others. As reality resists to us, we can resist to reality: if we do not like it, there is always a way for a collective action
directed to make our world a better world for our development as essentially multiple and interconnected brain-body-environment-others units.

**Author’s presentation:** Gianluca Bocchi is Full Professor of Philosophy of Science at the University of Bergamo, where he also teaches Global History and Epistemology of Human Sciences. Luisa Damiano (Ph.D.) is a Research Fellow in Philosophy of Science at the University of Bergamo (Italy).

**Notes**

1 With the expression “radical constructivism” we refer to the line of research in epistemology founded by Jean Piaget, and developed by epistemologists and scientists such as Heinz von Foerster, Gregory Bateson, Ernst von Glasersfeld, Humberto Maturana, Francisco Varela himself, Paul Weiss – here “the pioneers of radical constructivism”. Cfr. Bocchi, Ceruti, 1981; Ceruti, 1989, Glasersfeld 1995, Damiano L., 2009, 2012.

2 We refer to a general theory of autonomous systems introduced by Varela in Principles of Biological Autonomy (1979), which proposes the “conversational unit” model of cognitive system, that in Varela (1995) he re-dined as “emergent self” (Damiano, 2009).

3 Varela (1979, chapter 10) proposes a “framework of complementarities” which formalizes the logic of mutual embedding.


5 The idea of “sensorimotor unit” was developed by Maturana and Varela (1984, 1988) to describe a system which interacts with the environment through “perception-action cycles”. The basic functioning of this kind of system is described by them in these terms: an exogenous pressure triggers a compensative reaction in the nervous system network; the latter develops an endogenous pattern of activity which produces a series of related modifications in the somatic dynamics, and generates a motor action which implies a change in the contact between the sensorial surfaces and environment, and thus activate a new cycle perception-action. At the level of the human being the relationship between perception and action is more complex, as the activation of a neuronal pattern does not imply immediately the execution of the action. It implies what Varela calls “readiness-to-action”. As showed e.g. by the neuro-scientific research on canonical neurons (Gallese, 2000, 2001), the perception activates a motor pattern apt to act on the perceived dimension of reality, as if the system was acting.

6 Varela et al., 1991. On Varela’s acknowledgement of the debts of enaction with regard to Piagetian radical constructivism cfr. for example Varela 1992: «Piaget introduced the idea that cognition […] is grounded on the concrete activity of the whole organism, that is, on sensorimotor coupling. […] This is what I call enaction […]» (Varela, 1992, p. 11).
7 Cfr. Varela et al., 2001; Rudrauf et al., 2003.
9 Varela's description of the dynamics generation of the micro-identities, introduced here in a simplified version, is directed to show the aspects of this process which are analogous to less complex phenomena of self-organization, such as those related to Prigoginian dissipative structures. Cfr. per es. Capra, 1982, Prigogine and Stengers BBBB.
11 This view re-proposes the autopoietic thesis according to which the (biological) dynamics of self-production in interaction with the environment cannot be separated by the process of creation of a world of experience (Maturana, Varela, 1984, 1988). According to the Varelian general theory of autonomous systems, a cognitive agent is an entity which, while defining itself, selectively perceives external events and generate for them operational meanings, building a meaningful scenario for its interactions with an environment which, in itself, is perceived only in terms of perturbations.
13 Varela describes the dynamics generating the micro-identities as a dynamic of “competition” among different possible micro-identities. The idea is that every breakdown opens a fan of different possible cognitive micro-identities, and that the emergence of one of them is grounded not in a process of adaptive optimization, but in a process of solution of a dynamics bifurcation whose outcomes results from the complex interplay of a wide variety of endogenous and exogenous factors. Cfr. Varela, 1991, 1992. Cfr. Varela, 1991, 1992.
16 Cfr. Chiel, Beers, 1997; Froese, Ziemke, 2009; Metta et al., 2012.
17 Very schematically: mirroring mechanisms' functionality implies that, when an individual is observing another individual executing an action or expressing an emotion, in the observing individual fire the same neurons which fire in the active subject of the action or the emotion – that is, the individual observed. This neuronal co-activation is supposed to support the observer's intelligibility of the observed's behavior. Cfr. for example Gallese, 2005.
18 During the co-activation phase the nervous system can not determine if it is “actor” or “observer” in order to find out it has to wait for sensory feedback [12, 19, 21]. This convergence can help to explain many aspects of our everyday experience of the other, such as its immediateness – its “unmediatedness” – and the feeling of identity that comes with the recognition of the other people's affective state.
20 This epistemological space hosts innovative research programs such as the Enactive Didactics program proposed in Rossi (2011), despite the fact that often
these programs do not acknowledge the close connection among enaction and radical constructivism – a connection explicitly admitted by Varela himself (cfr. Footnote n. 6).

References


Telfener, U., Casadio, L. (2003), (Eds.), *Sistemica*, Torino, Boringhieri.
Varela, F., Thompson, E., Rosch, E. (1991), *The embodied mind*, Boston, MIT.