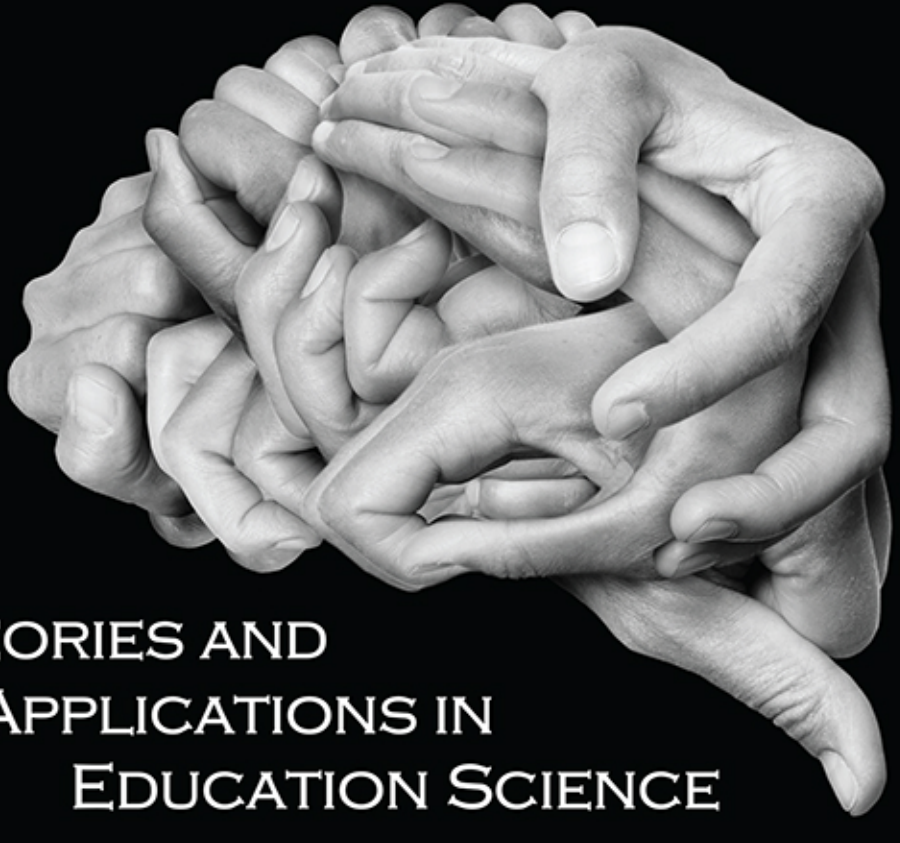
Filippo Gomez Paloma
Editor

Embodied Cognition



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EDUCATION IN A COMPETITIVE AND GLOBALIZING WORLD

EMBODIED COGNITION

THEORIES AND APPLICATIONS IN EDUCATION SCIENCE

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CONTENTS

Introduction

EMBODIED COGNITION AS INTEGRATIVE BACKGROUND BETWEEN NEUROSCIENCE AND EDUCATION SCIENCE

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ABSTRACT

This work was carried out with the intention of showing the peculiarities of the scientific paradigm of Embodied Cognition (EC) (Gallese, 2005), by highlighting its application in the practices (Sousa, 2010) especially in the world of education. The new perspective proves to be significant, mainly for the importance of learning about brain development in evolutionary age, understanding children and adolescents' behavior and preventing possible problems at an early age; moreover, it proves to be significant for highlighting the particular impact of social environment and cultural climate on learning, as well as on brain's ability to generate new neurons until the late age, along with its changeability (concept of plasticity understood as modeling of the morphology and the function of neural networks mainly induced by experience). These key aspects have led to a multi-perspective view of human mind functioning: we speak of psychobiology, neuropsychology, cognitive psychophysiology and others, grouped under the label of neurosciences. There are many contributions of neurosciences in pedagogy and didactics, but they all start from the assumption of considering body as an integral part of learning, since "...not only must the mind move from a nonphysical cogitum to the realm of biological tissue, but it must also be related to a whole organism possessed of integrated body proper and brain and fully interactive with a physical and social environment" (Damasio, 1995).

It is in this scenario that the body, understood as a scientific mediator of the learning process at neurobiological (Rizzolatti, 2005) and neuro-phenomenological (Gallese, 2006) level, has created a fertile field of study which focuses on scientific evidence (Margiotta, 2013) that EC, through its embodied actions (Gomez Paloma, 2013), can offer to the world of didactics (Borghi, Caruana 2013), and on how to develop methodologies that effectively meet students' educational, and also special, needs (Ianes, 2013).

The goal is to define and validate an "EC-Based model" (Gomez Paloma & Damiani 2015) in an attempt to enhance individualities in learning processes (Cottini, 2014) and implement didactic methodologies adapted to students' needs.

Keywords: Neurosciences and education, Neuroplasticity, Embodied Cognition, corporeality, learning.

INTRODUCTION

Basic scientific justification

The rapid developments of educational sciences, together with the contributions of biomedical research, although seemingly far from the “humanistic” dimension, have certainly contributed to emphasize the role of bodily experience in didactics, especially in relation to childhood and adolescence.

Clearly this is not enough to understand its value and potentialities, but it needs to "focus on a post-cognitive and neuroscientific training dimension, which sees education as a process transforming both the individual's internal dynamics and his social, cultural and contextual directions... " (Frauenfelder, Santoianni & Striano, 2004, p. 24).

This perspective, which takes account of the endless potentialities that this research field can develop for the world of education and school (Gomez Paloma, 2014, ed. by), and the fact that there is no certainty of determining educational sciences phenomena according to cause-effect deterministic scientific models, however, entails the risk of falling into detrimental "neuromythologies" (Rivoltella, 2012), not allowing the teacher to qualify and regulate his didactic activity in line with the above mentioned principles and, at the same time, to consider the functioning mechanisms of our nervous system.

The peculiarity of the EC approach, in fact, is the meeting point between what is biochemically happening (for example: cortisol salivary analysis) and the learning responses recorded on a psycho-pedagogical level (didactic checks).

In this sense, EC represents today one of the scientific approaches that is mostly influencing the emerging research field of Educational Neurosciences (Gomez Paloma, 2009). The body, in fact, respecting two key elements of the EC, perception and action, acts as a biological and cultural mediator for the learning process, overcoming its classification as a mere object of assessment, to gain the dignity of subject of cognition. The awareness of this new revision of the body is the basis of future research that will be carried out in the field of Educational Neurosciences (LeDoux, 2002).

For a scientific understanding of the EC and its contextualization with the world of Educational Neurosciences, it is essential to deeply understand the scientific degree of reliability of this new line of research, and analyze the type of relationships it develops with the world of Didactics, Special Education and the concept of embodied cognition.

At international level, much research carried out on educational neuroscience have shown that there is a circularity between environmental stimuli and brain adaptation (synaptogenesis) (Siegel, 2001), and that many stimuli from the environment may change and increase, especially in the early years of life, the number of synapses (we speak of sprouting,

Frauenfelder, 2002), the connectivity of which underlies learning. It'll be up to memory to consolidate these changes over time (LeDoux, 2002).

It is in the body, therefore, that there is an uninterrupted activity of information exchange, processing and storing between groups of neurons (Maturana & Varela, 1987). It needs that this circularity, which underlies Educational Neuroscience (Oliviero, 2008), gets first metabolized by those working in the world of education (teachers, trainers, educators, etc.). […] Firstly, it is a matter of reflecting on: 1) those changes that are more likely and that will see neurosciences and education cooperating; 2) educational matters related to neuroscience that may arise even in the absence of such positive cooperation; 3) the effect of such changes on teachers' professional development" (Howard-Jones, 2008, p. 1). At the same time, it is essential to plan research protocols which employ neurobiological parameters to analyze and investigate these space-time patterns, thanks to which we perceive ourselves in an environment, in relation to other bodies and objects (Lakoff & Johnson, 1999), and deepen human behavior during a learning process; in short, the way the brain learns to learn (Rivoltella, 2012). Memory, Attention, Perception, Action, Learning, etc. are some of the processes to be studied thanks to the research field in the development of EC (Gallese, 2003). From their fruitful debate, we are certain that a better understanding of the mechanisms underlying cognition and the human mind will emerge, as many scholar assert. (Miller et al, 1960; Lindsay, Norman, 1972; Posner,1973; Norman, 1976; Simon,1978).

The Revolution of Embodied Cognition

Recent scientific studies agree in pointing out that a large part of cognitive and linguistic processes are rooted in the perceptual and physical interactions of human body with the world (Barsalou, 2008; Wilson, 2002). This dimension involves the concept of Embodied Cognition, according to which mind would be incorporated into a body considered in its entirety, which in turn is situated in a broader biological and cultural context (Ling, Clark & Winchester, 2010).

Cognition, in fact, is not only embodied, but it is also contextually determined and situated. We speak of "body in action", that's why we consider this reflection of main importance not only for the world of psychology, but also for the world that intentionally and methodologically activates and stimulates such cognitive processes: school.

In the person being educated, in fact, mental processes due to the different circuits between neurons that carry out educational and learning experiences through the body to which they belong, are activated.

Already in 2002, Wilson claimed that: “There is a movement afoot in cognitive science to grant the body a central role in shaping the mind. Proponents of embodied cognition take as their theoretical starting point not a mind working on abstract problems, but a body that requires a mind to make it function "(Wilson, 2002, p. 625).

Researchers working in the perspective of the embodied cognition offer a range of specific indications about the features of the EC (Barsalou 2008, Wilson, 2002). First of all, the fact that action itself shapes perception, the self, and language (Glenberg et al., 2013).

Indeed, many cognitive tasks are performed “by employing sensory and motoric resources, even when the tasks themselves are well far from space and time "(Wilson, 2002). The examples include the use of mental imagery (Shepard & Metzler, 1971), simulation of

actions during language understanding (Glenberg & Kaschak, 2002), the building of mental models during the reasoning process (Johnson-Laird, P.N. 1983) and the reading comprehension (Glenberg, 1999; Van Dijk T.A. and Kintsch 1983 w., 1983). We could speak of a real revolution of EC, which supports the body as "part the world", able to define our thoughts and identity.

Towards Educational Neurosciences

Reflecting on the complex mind-body issue, any theory of knowledge cannot but take into account the mental processes and their implications on men's thought and consciousness (Oliviero, 2008).

Avoiding unnecessary forced and meticulous considerations, we consider it important to retrace, although briefly, the main historical stages that have led neuroscience to play a privileged role in the field of education, since its study mainly focuses on the organ enabling us to think, reason, feel emotions and relate to the world: brain.

We must emphasize that, however, since the beginnings, the focus is on the mental operations that separate reality from those that tend to consider it a single dimension, thus attributing to mind a fully immaterial entity (in terms of soul or spirit), linked to the body but, at the same time, separate from it (Occhipinti, 2009).

One of the pioneers in this context is certainly René Descartes who, in the Seventeenth century, proposed his famous dogma: "Cogito, Ergo Sum": "I think, therefore, I am!". According to the philosopher, soul and body are clearly separate. The mind (res cogitans) was created before the body (res extensa), while the latter, with its purely mechanical properties, turns out to be something different from mind (Turbiglio, 1866).

Hampered more than once the imposing Cartesian dogma (remember, for example, Baruch Spinoza, David Hume or Daniel Dennett, a more recent scholar), as opposed to the psychophysical dualism, in the Eighteenth century, the concept of mind develops, which identifies the set of mental states dominated by perception, thus paving the way for the "unmasking" of Cartesian theater (Dennett, 1991), going beyond the metaphysical issue of a soul totally detached from its physiological processes.

For a renewed attention to physiology and brain structure, it needs to go back to the early Nineteenth century. In that period, thanks to studies carried out by Franz Joseph Gall, many debates on phrenology were sparked, according to which every psychic function depends on specific brain areas or regions, thereby from the assessment of morphological peculiarities of a person's skull, such as lines, depressions and bumps, the individual's psychic qualities and personality could be determined. Considered as an atheistic and materialistic view, it was finally abandoned, but to establish the localization of brain functions and the discovery of the morphological-functional asymmetry of the two cerebral hemispheres it needs to wait for the mid-nineteenth century and the studies carried out by the French scholar Paul Broca.

A turning point came from histological research carried out by Camillo Golgi (1886) and the Spanish Santiago Ramon y Cajal (1894), who were both awarded the Nobel Prize in 1906. According to the two scholars, in fact, with their famous "Neuron Theory", the nervous tissue is made of morphological units, i.e., neurons, which do not constitute a tissue network but, on the contrary, adjoining cells communicating by contact and not by continuity, so nervous impulses can be transmitted also without the fusion of the cells, between anatomical elements

brought into simple contact. In addition, with the development of dynamic polarization law, it was highlighted that some neuronal fibers, the dendrites, conduct impulses towards the cell body, while a single fiber of the neuron, the axon, conducts them outside towards other neurons. Therefore, it is a great mistake to believe that neurons connect together without any logic in line with scientific principles.

Studies on neurons will be deepened by further theoretical discoveries: the synapses (Berne & Levy, 2002) and chemical mediation of nervous impulses, carried out by Otto Loewy (1926). In this way, there's an increasing need to link the events of mental life to those of the body movement, something supported in 1916 by Margaret Floy Washburn, the first woman to obtain a PhD in psychology.

This attention for the body and the action (Sibilio, 2002), already existing at the beginning of the twentieth century, has long been opposed by classical cognitive psychology, and the predominance of its scientists believes that action (and body) is secondary to knowledge.

With the passing of the decades, the reason why cognition depends on the body is becoming clear: we perceive in order to act, and what we perceive depends on how we intend to act (Glenberg et al, 2013). We take account of this in the cultural climate at the end of which it is questioned, that is, the cognitive approach from the Fifties until the mid-Eighties.

Cognitivism, in the Sixties, tried to analyze the processes occurring in the mind, focusing attention for the first time on an active individual who lives, moves in the world and acts by virtue of his mental abilities.

The central element of cognitivism concerns the fact that the main functions of the mind can be accounted for in terms of the manipulation of symbols according to explicit rules (Anderson, 2003). Already in 1948 E.C. Tolman (1886-1959) suggested the existence of cognitive maps, hypothesis, spatial representations, mental representations, highlighting that learning always occurs in the presence of a reinforcement (reward or penalty), and that unavoidable variables come into play.

Two basic approaches revolve around cognitivism:

- Human Information Processing approach (HIP), which supports the analogy between the operations of the human mind and the data production processes performed by computers;
- The environmental approach of mind, which affirms that the human mind receives information from the environment without requiring a particular re-elaboration, emphasizing, in this way, the plastic and adaptive function of the psychic systems.

This approach maintains a strong dichotomy between mind and organic substrate (the Cartesian res cogitans - res extensa difference prevails once again), so there is great difficulty in understanding how the individual attaches meaning to the information he receives.

Probably, nowadays, a few scholars would adopt that position, and therefore the idea that cognitive processes can be separated from the body or the social environment within which these processes occur, totally disregarding their dynamic nature (Jedlowski, 2001). An attempt to respond to it is represented by the prevalent cognitive "revolution" (Baars, 1986), that is, constructivism.

To define the "nightmarish landscape" (Phillips, 2000, p. 7) - i.e., the complicated paradigm of constructivism, is quite complex, since it is characterized by a marked transdisciplinarity and the difficulty that many disciplines find in integrating it their modus operandi.

Body starts to be considered as an integral part of learning, since "... not only must the mind move from a nonphysical cogitum to the realm of biological tissue, but it must also be related to a whole organism possessed of integrated body proper and brain and fully interactive with a physical and social environment " (Damasio, 1994, p. 123).

Scholars such as Ernst Von Glaserfeld, Francisco Varela, Humberto Maturana, Edgar Morin, deny the possibility of an "objective" consciousness, since individuals come into the world with pre-stocked and pre-embedded "cognitive data banks" (Phillips, 1995), and memory is not a mere "warehouse" where to store and recover data. So the idea that the very overt behavior depends on the specifications of the body in action, cognition depends on the body (Berthoz, 1998) and the synthesis of past experiences that reworks the ongoing ones for the future (Bartlett, 1954).

The emerging exploratory direction rejects the image of an abstract knowledge, free from emotional nuances and independent of the action, eliminating also the vision of a cognitive apparatus detached from structures in which it is embedded (Boella et al., 2006).

The first theories correlated to the model of the embodied cognition concern James Gibson's ecological approach to perception, which attaches primary importance to perceptual systems for their ability to grasp moving objects directly, in relation to the motor possibilities associated with them (Michaels & Carello, 1981).

The psychological concept that underpins Gibson's pragmatism is called "affordance" (Gibson, 1979). This terms the physical appearance of an object that allows the user to deduce its features or functioning mechanisms. The affordances that a subject is able to perceive on a given object depend on his previous experiences, his current needs, his awareness of what that object can offer him. According to this principle, the individual does not receive a copy of what the outside world shows him, but captures a series of information useful to his action.

Three fundamental consequences can be presumed:

- perception is direct, i.e., it doesn't require mental representations;
- perception is needed to guide the action and not to collect information;
- if perception is direct and functional to the action, then the environment must offer sufficient and adequate information to guide the action (Gomez Paloma, 2013).

Thanks to the scientific discoveries and the increasing amount of available information, the need to investigate the biological basis of behavior and of the main cognitive functions is increasingly emerging. Thus the concept of neuroscience (Bears, Connors & Paradiso, 1999) emerges in its full meaning, which was coined in 1962 by Francis Otto Schmitt who, through the Neurosciences Research Program Project, proposes a multi-system approach to the study of the nervous system by using the anatomical-histological, physical-molecular and biological contribution, developing, in this way, a new corpus of disciplines, precisely neurosciences.

He has provided many contributions. First of all, a further study on the mind-body relationship, which has always been the core of the reflection on human existence; the way the individual learns and reaches his emotional balance; the strengthening and weakening of

the synaptic connections which constitutes information storage (Ferrari 1996) and the contribution of the socio-cultural background, since what the individual is, depends on those processes allowing to shape brain: it depends on learning (Siegel, 2001).

The concept of EC fits into this context, highlighting that knowledge requires the involvement of brain, body and environment, and that our thought depends on the type of body we have. Corporeality, in fact, acts as the first learning, communication and relational development tool "(...) the primordial memories of human experience are imprinted on it through the perception system. The experienced remains in our mind, although as far mnestic discovery, as an expression of our past events "(Galimberti, 1983, p. 67).

In this sense, Alva Nöe (2009) reminds us that: "[…] Consciousness is not something that happens inside us. It is something we do or make. Better: it is something we achieve. Consciousness is more like dancing than it is like digestion. The idea that the only genuinely scientific study of consciousness would be one that identifies consciousness with events in the nervous system is a bit of outdated reductionism [...] "(p. 12).

Nöe argues that brain, behavior and world are the foundations of consciousness. Mind is not the brain or a part of it, but it's rather a complex object to be investigated in its relationships with the body and the social and cultural environment in which the body is situated. Therefore, the embodied culture stresses that organisms have a body, in addition to a brain; that mind is not something separate and cognitive processes are based on those sensorimotor ones. Now it is necessary to look whether it is sufficient to consider the body as a situated device of action or, as we think, to configure this vision according to a constructivist perspective in the educational and didactic field, a more complex element (Jeannerod, 2007).

In this direction, educational research can support neurodidactics by paying attention to both the complexity of human system dimension as a biodynamic entity being trained, and the consideration of the issues involved in the unfolding of living reality, adopting a heuristic and synergistic approach adjusting, from time to time, its goals to individual's complexity and uniqueness. The scope of this approach is such as to impose a review of theories and methods supporting our job of teachers, revolutionizing the patterns of evolutionary psychology, and therefore those of psychopedadogy and psychopathology, allowing for a reflection on the multiple opportunities of an educational-didactic path that meets everyone's needs.

Neurobiologically speaking ...

Neurosciences teach us that mind and brain are in a dynamic relationship. This concept has been deepened by Kandel (2005), Nobel Prize for medicine in 2000, who demonstrated for the first time that neurons "mutate" if stimulated, underlying that the body determine the organization of our conceptual system (Lakoff and Johnson, 1999).

However, notwithstanding the great progress achieved in the field of studies on brain, its learning mechanism is not still absolutely clear, but it is the reinforcement and weakening of the synaptic connections that lead to an information memorization (Khanna, 1991). In fact, thanks to the development of the brain imaging technique, it has been possible to "see" human brain in action, the internal processes of the brain in activity (Pettinelli, 1998), identify what brain regions are linked to particular ways of thinking and how they interact with each other. So it was showed that, during learning, brain is willing to change and "reform" itself, since it's

not a mere static organ, but a mutable flow where every experience involves an increase in neuronal activity (Baxter et al, 1992).

In 1965, thanks to the discoveries by Altman and Das, the dogma that brain consisted of a fixed number of neurons and that no other new ones could be generated started to crumble.

The concept of "plasticity" (Konorsky, 1948) developed, according to which brain changes are caused by the rearrangement of neural connections after an experience.

This means that the physical structure of our brains changes in response to brain activity. Brain loves activity! Just like our muscles grow stronger when we engage in physical exercise, so it now seems that our synaptic connections become more numerous and better organized when we use them a lot. When we interact with the environment, synaptic connections start to change: new ones are created, the useful ones are strengthened while those used infrequently are weakened, until they disappear. Active synapses and those that actively change are maintained, the others are pruned. The principle according to which we shape the future of our brain is a sort of "If you don't use it, you lose it." In short, learning implies the modification of synaptic connections, while memory maintains them over time (LeDoux, 2002).

Since one of the main objectives of school is to try to anchor contents in memory, in order to employ them actively in the context of belonging, it is essential to understand its biological foundations and the way it works (Siegel, 2001).

The complexity of memory requires, in fact, an intricate system of nervous nuclei and structures which code its different aspects. The stimuli from the environment are recorded as sensory memories that, lasting only a matter of seconds, are stored in the Working Memory (WM). If this information remains for a longer time, then long-term memory (LTM) comes into play, which records the information in a more stable way, promoting synaptic functional changes. This is further divided into:

- episodic (or autobiographical) memory, which relates to specific events and experiences of everyone's life and contains spatial-temporal information defining ' "where" and "when"; in short, elementary grammar for decoding the desire for relationship and reciprocity (Leone, 2004);
- semantic memory, which transcends the conditions in which knowledge was formed and detaches from the original context of the learning episode.

Research in neurophysiology and psychobiology, including those carried out in 1960 by George Sperling, have led us to consider other types of Memory, as well as the aforementioned Working Memory: Declarative Memory, or Explicit Memory, which refers to the ability to access consciously to certain information, and Procedural Memory, linked to the carrying out of a task that can only be evaluated by performing an action.

In this way, mind learns and simultaneously builds itself up, learns, is willing to learn, develop itself; to process and memorize experiences (...) learning involves their 'reading', their processing and the storage of such processing as a memory (Imbasciati, 1998).

From a physiological point of view, when we store information, two structures are involved: the hippocampus and the amygdala. The first is a nervous structure located above the cerebellum in the limbic area (which includes, inter alia, amygdala, septal area, preoptic area, hypothalamus, aqueductal gray matter, midbrain), responsible for the main primary functions (hunger, thirst ...) and the regulation of basic emotions (Fabbro, 2012). The

amygdala, a complex formation in the temporal lobe, is the primary center of unconscious processing of visual stimuli from the outside, crucial for the activation of bodily states. Its importance is due to its central position and the connection with other parts of the brain: hypothalamus, autonomic nervous system, orbitofrontal cortex, and hippocampus in particular, for its connection with visual memory.

To put it another way, when data are received, visual (iconic) and auditory memory retain information for a moment, and then discard the irrelevant ones. The remaining 1% is stored in short-term memory. By means of continued repetition, it can be stored in long-term memory, according to structured orders integrated with past knowledge (Craik & Lockhart, 1972).

Since the brain is a dynamic system consisting of neural networks that can be reactivated indefinitely, it is strongly influenced by the processing and organization of lived experiences, having their own sense over a time sequence. New experiences will be then integrated with the existing ones, changing or highlighting those relevant ones.

Mind's typical ability of integrating time and space reminds a fundamental aspect of human growth: the autonoetic consciousness, a basic element of the episodic memory that allows to particularly remember a specific moment of one's own life. This allows to integrate new data with the existing ones, giving a space-time continuity and making the overall control of brain processes possible (Siegel, 2001), in short, what has been defined the sense of self and others.

It is a lifetime process, which impacts on memorization and learning moments, as well as on cognitive and social skills (Baddley & Winlkins, 1984).

In this sense, a key role in memory, thought and learning is mainly played by social interactions, as well as the ability to narrate and self-narrate, which allows the individual to express and manifest itself, on the basis of the building of personal and social stories (Smorti, 1994). Also because sharing thoughts and stories means sharing their cultural and social conditions, understanding reality and interacting with it (Trzebinski, 1997).

Although it is true that it's the complex neural connections making the brain structure up and making memorization and learning processes possible (Bruner, 1987), it is also true that man is a social animal (Aristotle, Ethics, Book I, Politics) and social life is crucial in thought development, memory and learning.

This means that cognition is not a unilateral process arising from mental activity, but it is situated in the incessant flow of interactions between mind, body and world. We speak of embodied mind. The awareness of this helps human being intervene constructively in the complex educational field, fostering the need for alternative ways that community requires us today (Gomez Paloma, 2004).

We speak of Neurodidactics, about which we will discuss in the next paragraph.

Neurodidactics: understanding brain in order to "educate" it

The attempt to understand the biological basis of learning is a great opportunity for school today, in order to get to a deeper understanding of the biology of human mind (Kandel, 2008) and rethink its teaching practices by adapting them to real students, and not to ideal students.

Understanding how our brains enable us to think in education is central to Educational Neuroscience, that is, the cognitive neuroscience which deals with the research issues raised

by education (Geake, 2009). Neurodidactic research is thought of as the intersection between Psychology, Pedagogy and Neurosciences, for what concerns the study of brain with its structures and functions, the mental processes responsible for cognition and learning, and the art of the teaching training. What are the contributions that such an approach can provide? (Rivoltella, 2012)

We have asserted so far that perceptions, contrary to our personal experience, are not at all reproductions of the world surrounding us. They are abstractions, and the changes of subject's behavior reflect changes in brain circuits (Kandel, Schwartz, Jessel, 1994). However, although the biological components play a salient role in the understanding of brain functions, it is also true that the social, cultural and educational factors impact predominantly on "shaping" brain development and on the individual's emotional balance.

This shows that the educational process cannot be a matter of intellect, but it must integrate mind, emotion and corporeality; a path that needs to be stimulated globally in relation to any growth objective we want to achieve (Trombetta, 1991). According to this classification, therefore, cognition can be easily enriched also with emotions, social psychology, clinical analyses and development (Iacoboni, 2008).

According to the neurodidactic perspective, education (ex ducere = to bring out) is a process that leads to a change in the structure of neurons, entering into the depths of the brain and activating specific genes. For this reason, the educator can be seen as a kind of "surgeon" of mind stimulating the formation and strengthening of neural networks in students.

An important aspect of the student-educator relationship concerns the exchange of emotions and knowledge that is established in the dialogue, and that leads everyone to "transfer" his own experience, beliefs and values in the relationship itself. This is a vivid element that leads to the development of habits, ways of doing and relationships that evolve in that doing itself (Rossi, 2011), and which will influence the individual all his life long, leading to emphasize a point that is often overlooked in the educational dynamics: the attachment to the reference figures (Bowlby, 1983).

Attachment is a mechanism explained as "a form of behavior that entails an individual attaining or maintaining proximity to a particular other" (Bowlby, 1969). As it happens for the development of tissues, also for mental evolution it needs a smooth path (Bowlby, 1951), and this would seem to be linked to a stable and harmless relationship with the reference figures.

During childhood, the child is highly dependent on his mother, whose attachment relationship helps his immature brain better coordinate his activities. This implies that the adult is ready to respond promptly and adequately to the child's needs, conveying confidence and sense of security by trying to reduce the impact of unpleasant situations such as fear, stress, and frustration. "The infant and young child should experience a warm, intimate, and continuous relationship with his mother (or permanent mother substitute) in which both find satisfaction and enjoyment" (Bowlby, 1951, p. 13).

To describe qualitatively the attachment bond, two concepts are used: "secure" and "insecure", which then lead to their intermediate characteristics: the first refers to the mother's ability to respond positively and coherently to the child's needs, making him feel protected and loved, and leading him to create a stable and long-lasting model of caregiver; on the contrary, an elusive mother who pays little attention to her child's needs will lead him to a form of insecure attachment, characterized by anxiety, fear and distrust of the other.

In the educational relationship, also the person being educated develops ways of interaction and attachment in the relationship with his educator. The increase of a secure attachment between educator and the one being educated is a prerequisite for the development of a mature and stable identity. An incoherent educator who ignores the needs of his students does not facilitate the development of self-esteem and sense of confidence in the other, and that typical intellectual curiosity essential to understand the surrounding reality and interact with the social context they belong to (D'Alessio, 2009). Conversely, if the one being educated perceives security and coherence in his educator's care, this will involve the development of a good exploratory capacity that will spill over into his future and working relationships. Furthermore, attachment relationships profoundly influence the development of neural circuits and have direct effects on the development of brain activity which mediate fundamental mental processes: narrative memory, autobiographical memory, emotions, mental states and representations. Having a secure relationship with an adult will then lead him to do the same with others. In fact, many studies have shown that the physiological bond of the attachment is oxytocin, a hormone fundamental in perceiving and responding to maternal care. Animals that received adequate maternal care show very high levels of this hormone; conversely, poor maternal care lead to its low, if not absent, presence (Ridley, 2005). A secure and calm child will very probably be so when he will become a teenager and an adult, able to adopt, in turn, pro-social and anti-aggressive behaviors.

We believe that being aware of all this is fundamental to believe in a social formation that represents a kind of long-term investment, and this is why the educator, in addition to having strong psychological qualities to establish meaningful relationships with the one being educated, must be facilitated by school to do it. Only in this way he will make eye, mind and body prone to understand the needs of his students. Therefore, it is worth highlighting the wide scope of application of neurodidactics.

A great contribution is related to special education, in order to deal with the developmental disorders like those related to behavior, or the specific learning disorders (i.e., dyslexia and dysorthographia), but its contribution to general and disciplinary didactics is of great importance, so that it can be proposed as a search for an easy and secure route that guarantees access to human culture for all (Cottini and Rosati, 2008).

As for the study of learning and its factors, therefore, it guarantees the search for techniques to activate and manage attention and emotional and stress causes that can impact memorization.

Finally, it needs to take into consideration the relationship between neurodidactics and the complex world of emotions, since: "they provide an emotional rudder to guide judgment and action.... the original purpose for which our brains evolved" (Immordino-Yang and Damasio, 2007, p. 4).

Indeed, every interpersonal relationship implies the sharing of experiences, emotions and feelings, and the neurobiological systems which underpin our actions and interactions are involved in the complex decision-making process that represents the basis of our thought.

To understand why this happens, we mention the outcomes of Antonio Damasio' studies about subjects with damages to the orbitofrontal cortex (Young, Bechara, Damásio, Tranel, Hauser, Damasio, 2010).

In particular, these patients are no longer able to govern their behavior, to plan appropriate responses by virtue of their prior experience or decisions worked in contingent contexts (Cristini & Ghilardi, 2009), proving to be, moreover, insensitive to others' emotions.

This sort of "myopia" for the future linked to the fact that memories are unable to be kept very long in our memory, to the point of keeping the attention alive on them and act appropriately (Bechara, Damásio, a., Damasio, h., Anderson, 1994).

But what does this all mean at an educational level? Many studies point out that the ability to learn is greatly influenced by our emotional state. Emotional stimuli are among the most powerful activators of brain systems (LeDoux, 2002) and learning. The wider is the range of emotions that a baby experiences, the greater the emotional spectrum of the developing mind will be. This happens especially in the early periods of life in the development of brain structures, keeping influencing the activities of mind throughout men's existence (Siegel, 2001). In this sense, emotions represent the primary means through which the brain elaborates the value to be attributed to the information resulting from sensory channels.

The task of school should be to help students build their repertoire of strategies and options of behavior, in addition to developing the ability to recognize the complexity of the situations and reacting appropriately, sophisticatedly and creatively to it. Clearly, there is no single answer to all these aspects, nor we intend to indicate it in this work. It's about having a thorough knowledge of students, their aspirations and motivations, and starting from this to find the most appropriate paradigmatic model, such as that of Embodied Cognition.

Embodied Cognition: body and mind, one the mirror of the other!

The ability to establish a secure relationship which cares about the needs of the other is not certainly linked to linguistic-mental skills, but to relational skills.

When the educator responds appropriately to the relational needs of his students, he is also able to be in line with his emotional register, by fully understanding his emotions and needs.

In this sense "his" being and that the other are complementary elements, almost as if their images were reflected in the mirror. The reference is to the mirroring mechanisms identified by the team of neurophysiologists in Parma, led by Giacomo Rizzolatti, discovered in the F5 area of the premotor cortex of monkeys (Thompson, Varela, 2001), therefore the complex system of mirror neurons.

We schematically remind that the function of the mirror neurons implies that in the individual observing another individual performing an action, these neurons supporting the performance of the action in the observed individual are activated. The same neural structures involved in the analysis of feelings and emotions experienced firsthand are active also when those emotions and feelings are recognized in others.

This would allow to create an internal representation, a sort of "embodied simulation" (Gallese, 2007) of a specific real and concrete action, whether it's linguistic or socio-behavioral (Gallese, 2005). An embedded knowledge which does not arise from calculation, but from the attunement and the sharing of subjective experience (Damiano, 2006); a body as an extension of our brain which allows for connections between neural systems facilitating an uninterrupted activity of exchange, of processing, as well as the attunement of the emotional registers of participants.

All this would seem to be true in relation to learning too, which is also a fundamental mirroring mechanism implying that, in the observing individual, the same mechanisms of

body states representation associated with emotions and feelings are activated, as if he were experiencing them firsthand (Gallese, 2007).

All this seems like a certainly exciting challenge within daily teaching practices, where the mind-body-world interaction requires integrated approaches between psychology, pedagogy and neurosciences, in which brain is studied not only at a strictly physiological-anatomical-chemical level, but as something made up of further interactive systems. The fact that, in order to understand the behavior of others it needs to translate it into the language used by our neurons when those actions are carried out by us, implies that mind and body are strongly intertwined entities, just like we are interweaved with our fellows.

Finally, using the words of the famous neuroscientist Antonio Damasio (2003): "The human mind is special—special in its immense capacity to feel pleasure and pain and to be aware of the pain and pleasure of others; in its ability to love and to pardon; in its prodigious memory; in its ability to symbolize and narrate; in its gift of language with syntax; in its power to understand the universe and create new universes; in the speed and ease with which it processes and integrates disparate information so that problems can be solved".

Embodied Cognition: a perspective of synthesis

The American psychologist Endel Tulving has recently affirmed that recalling means traveling in time, marking the passing of our lives and determining the continuity of our personal identity. In fact, we are the only living beings able to recall past episodes and predict future events, by consciously planning our actions.

The idea of memory as "mental journey through time" highlights a fundamental aspect of human memory functioning: what we call "memory" is made of different elements (images, sounds, smells, emotions) arising from the functioning of mnemonic systems, which are different but in interaction among them. Our subjectivity and us are the bond. In order to be lived as a "memory" the information must be recovered at a specific time and place, and with a reference to the persons themselves as participants in the episode.

Mind, body, environment and emotions have never been so interconnected. In this direction, the very latest neuroscientific research shows that embodied cognition represents a new way of conceiving cognition (Damasio, 1995). In particular, his research program starts from the principle of an "embedded cognition", according to which human mind, thought, perception and concepts would be somehow shaped and/or influenced by the bodily configuration.

Within this framework, environment plays an important role too, thus it promotes changes in interneural connections together with culture and education. In addition to many stimuli coming from the outside there's increased brain density and volume (think about researches carried out by Rosenzweig & Alii, 1963 and those by Kempermann, Gast & Gage, 2000). These properties, however, don't entail that we are linked to our mental skills by a cause-effect relationship, since one of the most important features of our brains is to adapt to the task it performs (Doidge, 2008). So when one of its parts stops functioning, as far as it’s possible, another part intervenes and replaces it by shaping and changing brain anatomy, and therefore our behavior (Kandel, 2005).

This leads to highlight another important element of the EC dimension, i.e., neuroplasticity. The scholar Grafman (1999) has identified four types of neuroplasticity:

1. adjacent maps expansion: neuroimaging techniques have shown that it's the areas adjacent to that function that are particularly activated in every brain activity, while the "border" areas would be much less involved. When dealing with a task, the objective is to determine which neurons will play a central role in that case and which, instead, become border neurons;
2. sensory reassignment: when a brain region is highly compromised (for example deafness in blind people etc.). brain works to assign that task to another area, which will act as a substitute for that function;
3. compensatory masquerade: if the brain is in difficulty or part of it doesn't carry out its task anymore, strategies that are not compromised are employed and substitute them;
4. mirror region takeover: this function occurs when one of the hemispheres doesn't works as it should anymore, so the other one comes into play to "fill the gap" by acting as a substitute as best as possible.

The four types of neuroplasticity can be strengthened by an education full of stimuli and exercises aimed at enhancing it. Although it is in the first years of life that there is a considerable growth of synaptic connections, neurogenesis continues in adulthood too (Shorts, 2009) with different methods and times, so that the brain can preserve its ability of adaptation and flexibility.

At this point, wishing to offer a quick and careful examination of the different forms of EC, we may distinguish three scientific forms.

A first model is that phenomenological, where the enhancement of perception prevails; Caruana and Borghi (2013) assert that: "... crucial pages of phenomenology, of great interest for the cognitive scientist, are dedicated to perception - think about the analysis of touch developed by Husserl (1952), or the" Phenomenology of Perception "by Merleau-Ponty (1945). This predilection for the "primacy of perception" can be also found in contemporary phenomenologists, who clearly claim that "in relation to cognition and action in general, perception is basic and has priority" (Gallagher and Zahavi, 2009, p. 23).

A second model is that pragmatic, where, instead, attention to motor action prevails. According to this view, the result of American pragmatism (Dewey, 1949), the Gibson's environmental approach and Ryle 's logical behaviorism, the concepts are not simple representations of objects "but something more similar to the useful instructions to interact with those objects and, therefore, aimed at the action" (Gomez Paloma, 2013, p. 33).

As stated, there is a third "form" of the EC, namely that of logical behaviorism. Gilbert Ryle (1949) and Ludwig Wittgenstein (1967) focus their criticism on the concept of representation by claiming, also in its absence, the possibility of the presence of intelligence. Ryle (1949), in particular, bases his criticism on the distinction that knowledge makes between "know-how" and "know that" by promoting the first, based on the experience, and contrasting the second, centered instead on operating procedures and rules, thus representational. If we analyze teacher's competence, for example, it is at least interesting to reflect on the possibility that it is based on action strategies which involve complex cognitive skills. These skills, which are difficult to verbalize and illustrate during a "classic" training course, makes us think that the concept of "know how" breaks down the boundaries between "knowing how to be" and "knowing how to do", approaching those of tacit knowledge, or rather, of "practical knowledge" (the result of experience, of the ability critical reflection on

experiences, intuition, understanding of the specificity of the contexts, etc.) (Margiotta, 2014 ed. by).

Therefore, although we are aware that the theoretical framework of EC would require much more attention, we think it's appropriate to start a more contextualized reflection on school as soon as possible and, above all, on teachers' category (Ianes, 2014). It's about considering the plurality of the Embodiment in the world of knowledge; an analysis that, as Fischer (2012) shows, merges with the need to document more precisely the terminology. In fact, the German scholar suggests to organize hierarchically the concepts of "grounded", "embodied" or "situated" and "enacted" cognition (Pezzullo et al., 2011). Although these labels are often used generically and interchangeably, they hide slightly different theoretical positions.

In short, we could state that there are three interesting strands on which to develop, in the near future, paths and research protocols useful to the pedagogical community (Gomez Paloma & Damiani, 2015).

- Bodily cognition

Educational Neurosciences is now a reality and Embodied Cognition is the most scientifically discussed paradigm by international scientists who deal with in cognition. As experts in Didactics, Special Education and Motor and Sport Sciences in education, we cannot but recognize the need to carry out studies and publications which start from this interdisciplinary research field (Gomez Paloma & Tafuri, 2014).

- Integrated skills

The awareness of the neurobiological mechanisms of student's cognitive process, now aimed at identifying the cognitive representation as embodied, is an indispensable justification of certain behaviors for the teacher, especially if they're related to special educational needs (Damiani, 2012). In this context, it emerges the strong need to build new skills, which could be defined as integrated, aimed at the enhancement and inclusion of the emotional-bodily areas, nowadays discovered and rarely stimulated.

- "EC-based" teachers' training

An EC-based training (Gomez Paloma & Damiani, 2015) gets deep into the subject, works on the person and sees the phenomenon of education and inclusion as an opportunity, and not as an obstacle. At the same time, it is essential to develop an intense sensitivity to others, understood as a bodily presence.

Indeed, learning develops within an emotional relationship that forms the basis for the structuring of one's own identity.

In the era of Special Educational Needs (SEN) and complex classes, it's surely necessary to rethink didactics by taking these perspectives into account, starting from teachers' deep and authentic knowledge of students (Gomez Paloma, Santaniello, Damiani, 2015). In particular, research on animals suggests that motor activity involves an increase and a proliferation of cells in the hippocampus, and higher performance at a synaptic connection level (Chaddock et al., 2010).

By extending this research to humans, first to elderly persons and then to a group of preadolescents aged 8-10 years, it has been highlighted that, in line with the predictions of the research, the subjects who performed more physical activity showed a better structure and function of the hippocampus involved in learning processes. This allows us to understand that there is no cognitive experience without the connection with body and emotions, which, in fact, have a huge impact on the way we learn and consolidate our knowledge.

It is a very strong consideration: body and culture shape learning and everything occurs by means of emotions. These are very important aspects for educators who aim at the formation of qualified, informed and ethically trained students as they're citizens of the world (Nussbaum, 2006).

Therefore, we hope that EC could become a "modus operandi" for the building of knowledge, so that everyone, from a mere passive spectator, could turn into the true protagonist of his own success.

Learning by moving!

We know that there is a close relationship between the body and the analogous cognitive movement referred to (Rivoltella & Carenzio, 2012) and this is already pointed out by the use of expressions denoting abstract cognitive behaviors which, in order to be accomplished, require the use of the body: for example, opening mind, or developing reasoning, entering into the merits of something, etc. (Gibbs, 2005).

Therefore starting from this assumption, it seems very interesting to propose the project developed by Eduard Buser, renowned teacher from Biberist, Switzerland, who made these concepts the peculiar elements of his educational work.

According to the famous teacher, it's possible to promote long-term learning, since movement represents a child's innate desire and instinct through which he expresses himself, his emotions and gets in touch with others. By using different instruments, such as beams, balls, clubs, handkerchiefs, little balls, music instruments and staffs, Buser promotes movement interdisciplinary, proposing to kids to get on balance boards and walk freely in the classroom by repeating words or talking to their classmates.

The movement related to a topic can concern, for example, the representation of letters, numbers and concepts in movement, verbs conjugation, and experimentation of shapes like a circle, a triangle and a square through large motor movements in the classroom. Certainly, it would be incorrect to reduce lesson to simple movement sequences; these, in fact, are alternated with quiet moments in which children remain seated at their desks.

The most striking elements concern the ability to personalize and individualize their lesson on the basis of the needs of the class. It would seem that the very interactions and mediation processes occurring in the classroom hold that transformative potential that leads to learning. A learning process involving all participants, although each one with his own path.

In this direction, the educator's role should be to promote, through movement, the ability of self-observation, empathy and morality, which seem a sort of utopia in the current context. In fact, young people seem to be increasingly immersed in a world which is far from human interactions, those interactions declared as decisive for the evolution of the species and that are drastically reduced today. All this has led to live hectic a chaotic and little stimulating life, which has made lose sight of the possibility to be attuned with ourselves too (Siegel, 2001).

Then it seems essential for school to be able to recover its leading role as educational agency orienting students on a personal a community level. All this goes through the ability to understand oneself and others since childhood, developing sensitivity and curiosity towards something new, caring for one's own mood and that of others, the ability to describe one's own internal experiences without judging, and to act consciously and with concentration.

All these aspects lead to highlight a fundamental practice, described by Siegel (2001) with the concept of mindfulness. The term is the translation of the Sanskrit word "sati" ("mindfulness") (Fabbro, 2011). This derives from a series of Buddhist meditation practices that relate to the teachings of Siddhartha Gautama, the Buddha, and involves different forms: anapanasati, which is based on the concentration of attention on a given point of the nostrils, through which the subject becomes aware of the different stages of breathing, trying to maintain a relaxed and loving attitude towards himself, even when the meditator realizes he has lost concentration. Another key issue concerns the body scan practice, through which the subject is invited to achieve greater awareness of his own body' sensations. The first step is focusing attention on a specific part of the body (e.g., the left foot), and then moving to another segment, until all the body will be explored. In this way the subject is able to raise awareness about every sensation released from his body.

Finally, another key aspect of mindfulness technique concerns vipassana meditation, critical to understanding the states of one's own mind. The subject is invited to focus on the natural tendency of mind to get distracted and, when this happens, to carry out a series of instructions:

- recognizing that mind is wandering;
- understanding where it's going;
- trying to refocus, always with friendly and nonjudgmental attitude, on the breath or the body.

Many studies have shown that this technique is crucial to facilitate self-healing internal processes, help people live in the present and not entrenching themselves in the future, managing to keep distance from negative thoughts or moods. This would allow to become more relaxed, improving self-esteem and strengthening immune system (Fabbro, 2012).

An educational and relaxing proposal!

From what we have pointed out, an educational proposal based on the principles of mindfulness is a very interesting perspective.

An education which should improve this faculty would be the education par excellence. But it is easier to define this ideal than to give practical directions for bringing it about (James, 1848).

However, adapting different approaches to the students' ages, together with teachers' helpfulness who must be ready to accommodate also negative feelings, different individual and group courses can be activated in order to help increase attention on their own emotional states and those of others, coming into harmony with the other and becoming, at the same time, aware of themselves.

For example, it's possible to activate paths based on the use of the five senses, since learning occurs mainly through this aspect. So:

- carrying out sensory stimulation activities, by highlighting their underlying neural connections;
- becoming aware of our breath by becoming attuned to that of the other;
- reflecting on our emotions and those of others by acquiring knowledge about the limbic and the autonomic nervous system;
- attaching a name to emotions by associating them to colors;
- localizing emotions by recognizing their intensity;
- identifying the strengths and weaknesses of certain emotions in specific contexts and using them for everyone's wellbeing.

Therefore, multi-sensoriality is a strategy we can employ in teaching, since it allows for the approach of biology to learning through the senses, primary channels for student's interaction with the environment.

These processes can be applied to many educational practices. For example, reading or music, motor and drama activity with the ability to adapt them to students' characteristics and ways of learning. According to Siegel (2001) educational programs based on these principles really lead to improved school climate, which becomes more proactive, dedicated to the listening and understanding of the other, inclined to forgiveness and pro-social behavior (empathy, receptivity, self-observation and reflexivity). In short, a truly stimulating opportunity which we consider as the spirit of research on EC should be seriously taken into account in schools.

CONCLUSION

Contributions from neurosciences, together with those from psychology, medicine and pedagogy, have highlighted the uniqueness and extraordinary nature of the human being.

Unlike in the past, where it was possible to talk about mind, body and brain in literary and philosophical sense, nowadays, thanks to cutting-edge tools such as PET, CT, MRI, fMRI, it's possible to understand what happens in the brain of the individual who thinks, acts and feels emotions, with a certain scientific specificity and knowledge of the facts (Boncinelli, 2008).

Starting from the brain's ability to learn through synaptic connections and disconnections in interaction with others and the environment, it has been widely proved that thought, learning and action are able to shape and change brain structures (Kandel, 2008). This typical feature is known as neuroplasticity and implies the fact that, through learning and the relationship with the environment, the individual is able to strengthen his own synaptic connections or build new ones. This is particularly clear in the early years of life, but it's a feature that keeps existing also during adulthood, especially if the individual is immersed in a context rich of stimuli.

From an application point of view, therefore, it will need to try to adopt methodological procedures able to change continuously the ways of approach, the tones, the times, the employed material and space, thus avoiding the need to stimulate always the same neuronal circuits, and jeopardizing others that, if stimulated, could be to the atrophy over time.

These concepts are significantly recognized by neurosciences which scientifically justify the already known pedagogical principles, in an attempt to activate a meaningful learning

(Ausubel, 1965), assuming that students show a certain disposition to relate new material, in a non-arbitrary way, to their cognitive structure and the knowledge they already possess. All this going through their emotional and empathetic involvement, in a purely corporeal sense, which creates the conditions necessary for the understanding of new meanings and an autonomous learning (Domenici, 1999).

In this direction, the body is seen as the main vehicle for the exchange of meanings and information, in which the movement is the protagonist. In fact, it can be seen as a sort of sixth sense. Perceiving what surrounds us is not just an interpretation of sensory messages, but it is conditioned by the action, being it an internal sensory anticipation of its consequences (Berthoz, 1998). Moreover, it is also worth mentioning the studies by G. Rizzolatti on mirror neurons system. This is activated when we act or simply observe others' behavior (Rizzolatti and Sinigaglia, 2008), and allows us to understand both how we are able to empathize and how we learn by imitating.

In this direction and with this scientific and cultural framework, we are sure that the relationship between neurosciences and education sciences is anything but a purely rational and deterministic relationship. Knowing what biologically happens when we learn and relate to others is a very important scientific foundation for implementing educational interventions which take into account everyone' special needs (Ianes, 2005).

The adoption of a curriculum based on the EC dimension would be desirable, and would represent a first functional step for the real growth and development of this synergy between the two disciplines.

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Chapter 1

AN EMBODIED AND GROUNDED VIEW ON CONCEPTS AND ITS POSSIBLE IMPLICATIONS FOR EDUCATION

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ABSTRACT

In the last years, Embodied and Grounded Cognition (EGC) Theories have been proved to successfully account for a great variety of phenomena pertaining cognitive processes as diverse as perception, action, and language comprehension. In this chapter we will overview and discuss recent evidence favouring an EGC approach to language and concepts, keeping in mind that one of the greatest problem that EGC has to face is the representation in mind of abstract concepts, such as FREEDOM or FANTASY. Since abstract concepts lack a single and concrete referent, the re-enactment of the different experiences connected to each concept could be more difficult than for concrete concepts. We argue that language can be the tool that helps us to keep together the variety of heterogeneous experiences evoked by abstract concepts. The input of others, who can help us to understand the word meaning, for example explaining it to us, can be more crucial for the acquisition of abstract than of concrete concepts. In the last part of the chapter we discuss the implications for educational theories and practice of an EGC view that highlights not only the importance of sensorimotor information but also of the bodily and social aspects of language. In our view not only sensorial and motor processes, but also linguistic and social experiences may be considered as constitutive for the individual cognitive development, in order to improve abstract reasoning and categorization.

Keywords: embodied cognition, grounded cognition, abstract words, concepts and action, language and action, education

EMBODIED AND GROUNDED THEORIES

In the eighties and nineties of the last century, a new scientific perspective emerged within cognitive sciences: the Embodied and Grounded Cognition (from now EGC) Theory (for recent reviews, see Barsalou, 2008; Borghi & Caruana, 2015). Embodied cognition

studies have seen an impressive growth in the last years, as recognized by many scholars (Chatterje, 2010; Gentner, 2010). This view stressed the importance of sensory-motor processes as constitutive for the experience and for the cognition itself. The underlying idea is that our cognitive system is influenced and controlled not only by our mind, but also by our brain and our body.

For many years, the dominant view had been the cognitivist one, according to which the so-called "higher" cognitive processes, like language and thought, consist in the manipulation of abstract and amodal symbols, detached from sensorimotor experience. This point of view took inspiration from the Cartesian conception of dualism, according to which mind and body were strictly divided, and was in line with strong modular accounts of cognition, as those proposed by Fodor (1983).

In the last 15-20 years, with the spread of Embodied Cognition theory, the idea that cognitive processes, such as those involved in language and memory (the "higher" processes), are grounded in the same systems as those of perception and action (the "lower" processes) has received a lot of empirical support. The embodied approach contributed to reintegrate the body in the general system of cognition, together with the mind and the brain. The novelty of embodiment is to consider psychological and physical phenomenon as two sides of the same unit.

In the past times cognitive sciences has been largely dominated by the cognitivist paradigm. Only recently the emerging EGC research field, that pointed out the need to reconsider the relation between mind and body, is becoming increasingly influential. Under the name of embodied and grounded cognition there are many theories, that differ in points of view and perspectives (for example, some EGC theories are representational, other reject the notion of representation), but are connected by the idea that cognition is multimodal and constrained and controlled by the body. One of the leading assumption of the embodied cognition theories is that our mental contents are represented and internalized through simulation (Barsalou, 1999; Gallese, 2009). With simulation is intended the re-enactment of inner states, perceptions and experiences acquired during and through the experience with the external world and environment. Simulations have also a predictive role, since they help us to prepare ourselves for acting in a situated world.

The neural basis that accounts for the theory of simulation, is constituted by the recently discovered canonical and mirror neurons system (Rizzolatti and Craighero, 2004). Mirror neurons are a specific class of visuo-motor neurons that, together with canonical ones, are responsible for simulation processes. While canonical neurons fire when observing an object that might be acted upon, mirror neurons fire whenever an individual sees an action performed by another individual with an object or entity. Many neurophysiological and brain imaging experiments indirectly suggest that the homologous of the mirror-neuron system could have an active role in the comprehension of actions also in humans; importantly, these neurons would be located in the Broca's area, typically activated in a variety of tasks related to language production and sequencing (Buccino et al., 2004). The importance of the discovery of mirror-neuron system consists specifically in the attribution to generally defined "motor neurons" of characteristics which are strictly bounded to cognitive dimensions, like the prediction or the anticipation of an intent.

The relevant aspect, for the purpose of this work, is that according to EGC theories, simulation arises not only when observing an action, but also during the comprehension and the production of language.

The aim of this chapter, which moves from an EGC perspective, is to focus on a novel view on language and on abstract concepts. In the final chapter we will discuss the possible implications of this EGC approach for theories of learning and more generally for educational science and practice.

EGC Approach and Language

How does the EGC approach consider language?

Beside the fact that we can speak thanks to our phono –articulatory apparatus, language has been considered for long as an abstract process, learned in infancy, and refined during adulthood, with no affection from the external world. According to the theories of simulation proposed by the EGC view, instead, when speaking or understanding we are not passively exposed to a flow of information. Our responsiveness to linguistic stimuli is greatly influenced by our previous experiences with the environment, so that the linguistic code acquires meaning in our brain by simulating relevant aspects of the referent of the word.

For a while, proponents of EGC criticized the view according to which language is a mere form of communication, as well as the traditional cognitivist view according to which concepts and words are represented through abstract and amodal symbols. In contrast with distributional views of language, according to which the meaning of words is given by associations between words, EGC scholars propose that the meaning consists in the relationship between the words and their referent in the world. For example, when we see a chair, neural areas supposed to be responsive to the object's shape and colour are activated. Moreover, according to Barsalou, the past experience of sitting on a chair, and the consequent sensation of comfort co-occur to form the idea of a chair, simultaneously. To highlight the idea that concepts and words are multimodal, rather than amodal, consider the following example: when hearing, reading or pronouncing the word "book" we would reactivate the visual experience of seeing a book, and the tactile one of flipping its pages (re-enactment) (Barsalou, 1999). The meaning of the word "book" consists in the re-enactment of this multimodal experience, clearly grounded in the sensorimotor system, not in the association between "book" and other associate words, as "pages", "reader", etc., as assumed by the distributional theories of meaning (e.g., Landauer & Dumais, 2007).

For many years, EGC theories have tried to show that words are grounded in sensorimotor experience. Some studies have shown how simulation intervenes consistently in the comprehension of utterances, and the most important evidence focused on the elaboration of verbs related to motor effectors. Some influential examples: Pulvermüller et al. (2005) developed a set of studies that confirmed that, when people were asked to read an action-referred word, their sensorimotor system was activated as to represent the meaning of the action. Specifically, verbs that convey action meaning involving arms, hands and legs activate neural areas accountable for effectors' movement (see also Buccino et al., 2005; Scorolli & Borghi, 2007). In a behavioural study, Glenberg and Kaschak (2002), reported for the first time the so called *action-sentence compatibility effect;* according to the authors, sentences are understood by constructing a perceptual simulation of the events being described: specifically, participants were faster to respond moving away from the body when reading a sentence like "Open the drawer".

At an evolutionary level, embodied cognition theories rely on theories of reuse: the assumption is that some mechanisms and structures originally evolved for lower level systems, as the motor system, are used by higher level systems (Anderson, 2010; 2014); for example, Gallese (2008) with his neural exploitation theory proposes that key aspects of human language and of human social cognition are underpinned by brain mechanisms originally used by the sensorimotor system. Importantly, in the last years evidence is starting to emerge, that shows that processing words is not exactly the same as processing the objects or situations or actions they refer to. The mechanisms of the motor system are re-used but also transformed and modified, while passing from the sensorimotor experience to the linguistic one (Borghi, 2012). For example, in a variety of studies we have shown that during language processing we are sensitive to objects affordances (e.g., while reading the word "pencil" we simulate the possible way to grip a pencil), but that language recruits specific kinds of affordances, as those related to size and grip, and not those related to orientation (Borghi & Riggio, 2015; Flumini et al., 2015).

As argued elsewhere (Borghi, Scorolli, Caligiore, Baldassarre & Tummolini, 2013), showing that words activate their referents has been important to contrast traditional cognitivist views, but it has somehow led proponents of EGC to consider language only in its "referential" aspects and to conceive words as simple pointers to their referents.

Only in the last 5 years this limitation is starting to be overcome and a different view is beginning to emerge. Consider that the experiences of listening and of talking, just as the experience of walking, are corporeal experiences: we use our body to listen and to talk. EGC studies have shown that the same motor areas are involved during comprehension and language production: they are two sides of the same coin. Moreover, talking is a social and relational experience (Borghi & Cimatti, 2010; Borghi & Binkofski, 2014). But this is not the whole story: language - and internal language - is an important tool helping us to organize our thought and to control our actions (Dove, 2014; Lupyan & Bergen, 2015; Lupyan & Clark, 2015).

These issues bring us to reconsider the nature of language, and its method of acquisition: acquisition cannot be reduced to pointing a word to its referent, but it implies a holistic social and relational experience.

EGC AND ABSTRACT CONCEPTS

Do we acquire concepts as "telephone" and "truth" in the same way? Intuitively, we are all tempted to answer "no" to this question. Here we will focus our attention on the acquisition of abstract concepts; indeed, it seems that to account for their acquisition, more questions arise, than to explain the acquisition of concrete ones.

According to the standard EGC approach, we comprehend concrete concepts through simulation. Many studies have collected a large amount of data showing that sensory and motor activation accompanies conceptual processing, so that, for instance, when we use the concept of HAMMER or comprehend and produce the corresponding word, the motor information connected to the use of the hammer is retrieved. But consider concepts such as FANTASY or FREEDOM, the so called abstract concepts. For a theory assuming that concepts are strongly based on the sensorimotor system things become difficult if we want to

know how concepts with no single and concrete referent, as FREEDOM, are represented. FREEDOM is an abstract concept, and like all the concepts that could be so defined, it lacks of a unitary definition, and it would be difficult to refer it to a single and concrete entity. A concept like BALL, on the contrary, refers to something perceivable, and we can experience it through our senses. Even if we do not assume that a dichotomy between concrete and abstract concepts exist, we can well consider FREEDOM and BALL as two good examples of abstract and concrete concepts, respectively.

Obviously, if we consider a concrete concept like BALL, we know that it implies a process of abstraction too. In fact, we know that balls can be very different: they can be rounded or elliptical, depending on the sport in which they are used, and of course they can be black and white, red or whatever other colour. So, the point is, what are the common features that allow us to assimilate all these exemplars to the concept of a ball? Maybe, one step back could be useful.

When we were child, someone has likely told us what a ball is. She/he probably indicated us a ball nearby, saying "this is a ball". With the growing experience with balls, we learned that a ball can be different from the first one we saw, but we have understood that a ball is something we use when we want to play. We can use it with hands, feet or whatever, but its primary use is connected to the dimension of playing. Differently from BALL, FREEDOM can indicate a higher variety of different situations, involving reasoning, experience and emotions. This really makes a difference between abstract and concrete concepts: the variety of experiences and situations referred to by an abstract concept, as well as the complexity of such situations: consider, for example, the difference in complexity between CAUSE and BOTTLE. It is due to these peculiar characteristics of abstract concepts, that explaining them is currently a crucial challenge for theories of embodied cognition. In fact, while for concrete concepts or words theories of simulation can explain how we reactivate the same neural areas involved during the use of the referent of the object, what happens with abstract ones is still unclear. A clarification should be made. We do not intend to claim that abstract concepts do not activate experiences and situations that involve the sensorimotor system. Even if such concepts and words do not possess single and concrete referents, they activate experiences and scenes that involve the sensorimotor system (e.g., for freedom, running on the grass, or flying in the sky), but these experiences are very heterogeneous and differ greatly depending on the participants and on the particular moment in which they use these concepts.

How can such diverse sensorimotor experiences be put together? Through language. Recent studies have shown that for the acquisition and representation of abstract words, linguistic and social experience plays a major role (Bergelson & Swingley, 2013), while for that of concrete concepts, the physical experience of the object referent is more crucial. In sum: there is no reason for not considering the comprehension of abstract words as an embodied and grounded process too, just like that of concrete ones. But their acquisition and representation at least partially differs. Recent evidence mimicking acquisition of novel words in adults has shown that during the acquisition someone has helped us in understanding what the word HAMMER and the word FANTASY stand for, but in the first case they typically accompanied the description with the object itself, creating a direct and observable link between the word and the referent. In the latter case, instead, they just explained to us what the word FANTASY means, and what is its use in the language (Borghi et al., 2011; Granito et al., 2015). As we will discuss below, this is due to the different nature of concrete and abstract concepts. Aside from these important differences, the acquisition of language, be it

concrete and abstract, is a situated experience: situated in the body and in the society and culture. This should be a starting point for an embodied view of education.

CURRENT VIEWS ON ABSTRACT CONCEPTS

Given the importance of the challenge to explain abstract concepts, researchers proposed many ECG theories trying to account for abstract concepts. Below we will briefly review the ones that we consider the prominent ones. Specifically, we will focus on the theories that, starting from the assumption that abstract words are embodied and grounded in perception, action and emotional systems, like concrete ones, seek at the same time to emphasize and underline the differences between concrete and abstract concepts.

Barsalou and Wiemer-Hastings (2005) argued that abstract concepts share with concrete ones some important similarities. Specifically, the authors claim that both kinds of concepts are grounded in a situational content. The main difference consists in the type of situations that they retrieve: concrete concepts would mostly refer to objects that we experienced, while abstract ones would be mainly based on events and social aspects of situations, and would elicit reflections and introspective properties. This theory points to a very interesting mechanism; its main limitation is that the evidence in its favour is still mainly limited to feature production tasks.

In the Vigliocco's (2013) and Kousta's (2011) AEA (Affective Emotional Account) proposal, the novelty is to consider emotion as central in learning and representing abstract words. While this recent theory is supported by evidence obtained with different paradigms, one possible limitation of it is that it included emotional concepts within the subset of abstract concepts, and this might create biases in the results (see Altarriba et al., 1999 for distinguishing between abstract and emotional words).

The influential theory of conceptual metaphor proposed by Lakoff and Johnson (1980) can represent a viable alternative. The authors think that metaphors can help explaining our conceptual thought: for example, the abstract notion of "category" would be represented through metaphorical mapping referring to the concrete concept of "container" (Boot & Pecher, 2011). The evidence supporting this theory comes both from cognitive linguistics and cognitive psychology; a lot of crosslinguistic evidence supports it. However, one important limitation is highlighted by the fact that children learn to use metaphors rather late, later than abstract concepts (Dove, 2009). Furthermore, it is difficult to think how to extend the evidence in favour of this theory: for example, how is it possible to account an abstract concept as FREEDOM in terms of the conceptual metaphor theory?

While these theories have inspired the planning and execution of clever experiments, we believe that it is important, in order to account for abstract concepts, to take into account the role played by language in their acquisition and representation (see for a similar but not fully embodied view Dove, 2011; 2014; see also Prinz, 2012). As described earlier, language cannot be reduced to associations between words, and words cannot be simply intended as pointers to their referents. Instead, in our view words influence the formation of concepts (Lupyan, 2012), in particular of abstract ones, since they help keeping together the various and diverse sensorimotor and emotional experiences abstract concepts refer to. In a nutshell, following the WAT (Words As social Tools) view we propose that both sensorimotor and linguistic experience play a role, but that the second is more crucial for abstract concepts

representation, while the first for concrete concepts one (see Borghi & Binkofski, 2014, for a thorough overview, and for description of supporting evidence).

IMPLICATIONS OF THE WORDS AS SOCIAL TOOL VIEW ON EDUCATION

Overall, the EGC perspective leads to reconsider the modality of learning, in terms of exchanges of information between body and mind. Educational sciences, considered as a necessary basis to constitute the individual identity, should be highly influenced by the EGC theories. Indeed, the role of the sensorimotor system and, in general, the role of the bodily experience doesn't improve only our motor ability, but seems crucial in the development of linguistic and social capabilities too. This is not surprising, if we consider ourselves as a complex unity of systems performing different tasks, mutually influenced one by another. The embodied approach is nowadays quite popular in developmental psychology, since for example the seminal work by Linda Smith and collaborators (Thelen& Smith, 1994; Smith, 2005), and by Tomasello and collaborators (e.g., Tomasello, 2002), showing a strict bond between sensorimotor processes, social processes and the development of cognition in toddlers. In contrast, its applications in learning, education and teaching, have not yet been fully explored (see for an exception Gomez Paloma, 2013).

The standard educational practice tends to focus on the intellectual part of learning, putting aside the importance of the physical experience. It seems to be implicitly assumed that the constitution of the self is only based on cognitive capabilities, forgetting that those are influenced and -we shall say- implemented by physical processes. In contrast, the idea underlying an EGC approach to education is to consider the psycho-physical unit of the self in its own entirety. As we have seen, most of our cognitive abilities, even the "higher" level ones, such as the capability to use abstraction, are strongly grounded in our systems of perception and action. But this is not the whole story: what is important to note, is that the role of the body is not reduced to the activation of perception and action systems. With an EGC view of education and learning, we mean the awareness of being part of a community that shares a peculiar tool allowing us to act in the world and with others: language, together with cultural and social attitudes provided by the experience and whatever is considered to construct the self-identity. We will report below a few examples showing how language and higher cognition learning is facilitated when adopting an EGC approach.

The role of the body for the growing of cognitive and social abilities is crucial since the first years of life. The idea is not entirely new: in the second half of the past century, Piaget argued that in early infancy sensorimotor experiences are essential aspects of learning, and that later cognitive processes develop from these sensorimotor abilities. He defined this period "sensorimotor stage", an initial phase of development in which children experience the world and gain knowledge through their senses and motor movements. While interacting with the environment, children go through an amazingcognitive growth in a relatively short period of time. The general idea emphasized in the developmental literature is that children are embodied learners, and that they use sensorimotor information to gain knowledge about the world.

More crucially for our view, in partial contrast with Piaget, Vygotsky has emphasized the importance of the social acquisition of language, and the fact that, once acquired in the social context, language can become an internal instrument, guiding our thoughts (Vygotsky, 1986).

In a more recent work, Iverson (2010) argued that the development of motor system contributes to the development of language in at least two ways: first, the acquisition of motor skills such as the rhythmic hand and arm movements allow infants to practice rhythmically actions of the sort required for babbling; second, during the period of the first word onset, the fact of playing and manipulating toys, and their naming gesturally, let the children practice with meaning through action. In sum, Iverson claims that "the acquisition of motor skills provides infants with opportunities to practice skills relevant to language acquisition before they are recruited for that purpose". Of course, we are not assuming that motor development is sufficient for language acquisition, but we are stressing that a strict relation exists between the motor abilities and communicative capacities, that are related to each other by social skills, such as those involved in the development of joint attention.

Further evidence reveals the crucial role of motor-exploratory experiences for the development of sophisticated high cognition abilities. Bornstein et al. (2010) predicted that more advanced motor-exploration competence in early infancy would result in more advanced academic achievement in adolescence. In their 14-year longitudinal controlled study, they found that motor- exploratory competence in infancy affects subsequent levels of children intellectual functioning, shaping academic achievement in adolescence. "A more motorically mature and actively exploring baby seems to elicit more opportunities for interactions, richer contacts with novel aspects of the environment, more joint attention and more exposure to referential language."

Some other motor-related processes, such as joint attention and intention reading, emerge in the first years of life, and play an important role for the acquisition of social abilities, of language and of abstract concepts. Prelinguistic infants appear to use attributed intentions as a basis for word learning, through eye-gaze. When children (9-12 months) hear a word, they will take it to be the label for what the speaker is looking at (Baldwin, 1995), and they're sensitized to the presence or absence of joint attention, using it as a guide to establish new word-object mappings. Moreover, it seems that the amount of time infants spend in joint engagement with their mothers predicts infants' earliest skills of gestural and linguistic communication. (Carpenter et al., 1998). Most crucially for us, the acquisition of the ability to comprehend and use abstract words has been recently related to the development of social abilities, as those necessary to engage in joint action (Bergelson & Swingley, 2013).

Embodied effects can also appear in early reading comprehension and recall: specifically, 6- and 7 year-olds' accuracy in comprehension and recall of stories is enhanced when they are allowed to interacting with physical objects and characters of the story compared to when they simply have to rehearse the story (see Glenberg et al. 2011). This higher accuracy in story recall is also present when children are required to interact with objects on a computer screen.

The influence of motor experience does not end after infancy: embodied effects on cognition can be also seen in adulthood, and a wide range of studies has recently investigated the relation between motor processes and educational sciences. It has been demonstrated how gestures can influence thought and subsequent learning, and how motor experience can facilitate the understanding of complex concepts such as physical or mathematical ones.

Recent research has tried to apply an EGC approach to the learning of complex matters, as physics and numerical cognition: for example, Kontra et al. (2012) attempted to use specific motor training to simplify the learning of a physics item, the angular momentum and torque. Undergraduates were pre-tested on a torque judgment task to evaluate their starting knowledge about angular momentum. Researchers created two groups of students, and gave a motor and experiential training to the first group (together with a verbal description) during which students had to manipulate a pair of bicycle wheels on an axle under various conditions. Students in the second group were only given the verbal description, and they observed another student manipulating the wheels. Both groups then completed a post-test to verify what they had learned during the training session. Results showed that students in the "action" group improved significantly in accuracy at post-test, while students in the "observation" group did not. It seems that motor simulation offered support in understanding a non-experiential concept like angular momentum.

As to math, Nuñez and collaborators (1999) have stressed the idea that, as all the cultural and social products, mathematics should not be considered as completely abstract; rather, since basic mathematical ideas showed a surprising stability over thousand years, a common set of neural and bodily structures with which to connect mathematical concepts to everyday experiences are required. Authors identify those structures in the embodied conceptual structures provided by the experiences of the surrounding environment. Concepts like motion, spatial relations, space and time can account for mathematical concepts like the continuity of a function (for a recent review, see Winter, Marghetis & Matlock, 2015). According to the authors, the mathematical definitions of continuity given in textbooks are misleading, because they lack of the experiential part of the definition; consistently, they claim that mathematics should be conceived as a product of adaptive human activity, made meaningful through language, but ultimately based on our biological and bodily background. The crucial point, in the perspective of the authors, is to consider how the human creation of mathematics is not arbitrary, but is rather bodily grounded.

CONCLUSION

In this chapter we have presented and defended an EGC perspective, focusing in particular on language and abstract concepts. We have tried to show that language is grounded in perception, action and emotional systems, and that, in line with theories of reuse, language reuses structures and mechanisms of the motor system. However, we have shown that this is not the whole story. Words are not only grounded, as first EGC theories seemed to claim. Words are not simply pointers to their referents: they are tools, allowing us to interact with the physical and social environment. Language provides us with a sophisticated means that guides our actions. We have shown that the challenge to account for abstract concepts, critical for EGC theories, can be solved thinking that not only sensorimotor information, but linguistic and social experience matter too.

Which implications has this view for educational sciences and practice? The implications are many and pivotal. As we have seen, since our infancy our action capabilities, constrained by our peculiar kind of body, influence the development of cognition. Sophisticated cognitive abilities, such as those involved in abstraction, are grounded in our bodily, social and

linguistic experiences. The time has arrived, that educational practice takes into account this simple but crucial fact.

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Chapter 2

EMBODIED COGNITION AND SPECIAL EDUCATION

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ABSTRACT

In Special Education, the close and articulated relationship between body, learning activities, use of skills and replacement of problem behaviors can be expressed in the two general frameworks of *Universal Design for Learning* (UDL) and *International Classification of Functioning, Disability and Health* (ICF). According to UDL, a global and comprehensive use of the body increases the chances of receiving, understanding and processing various inputs, expression and production of significant outputs, and motivational engagement related to learning tasks. On the other hand, ICF is a global, systemic and multidimensional vision of the individual and their different levels of functioning. Along with these frameworks, in this chapter we will overview and discuss other aspects of *Embodiment* related to the teaching-learning dynamics, such as the use of physical contact and physical prompts, which assume a particular relevance for Special Education. Special Education is also involved in psycho-educational interventions for overcoming behavior problems. During both the initial phase of analysis and evaluation, and the training phase of positive alternative behaviors which will functionally replace the problem behavior, the bodies of both the educator and the learner play a key role. We will also discuss the importance of using Assistive Technologies within a universally designed environment, in order to improve inclusion of *all* students. In the last part of the chapter we will overview the evidence supporting an embodied representation of math concepts and processes.

Keywords: special education, embodiment, universal design for learning, functioning, problem behaviours, self-regulation, assistive technologies, finger representation.

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INTRODUCTION

Education and Special Education should rely on an increasingly close and articulated relationship between body, learning activities, use of skills and replacement of problem behaviors. In the various interventions of Special Education, the attention to the body (*embodiment*) and the movement can be expressed in two general frameworks.

According to the *Universal Design for Learning* framework, which will be examined in detail in a later section, the specific attention to a global, comprehensive and varied use of the body, and to its possibilities of perception and action, increases the chances of receiving, understanding and processing various inputs – including the memory, which increases its effectiveness if accompanied by bodily experiences, both proprioceptive and emotional. A global and comprehensive use of the body, and of its extensive possibilities of action, increases the chances of expression and production of significant outputs (in the various attempts to achieve the objective-competence) and increases the chances of a positive motivational engagement related to the learning tasks.

The second general framework, essential for Special Education, is the framework of the *International Classification of Functioning, Disability and Health* (ICF), a global, systemic and multidimensional vision of the individual which allows us to understand and define their different levels of functioning, and objectives about their skills development. The ICF anthropological model recognizes the body, in its functions and structures – both anatomical and physiological, a key role and a continuous reciprocal interaction with personal activities, social participation and contextual factors, both environmental and personal.

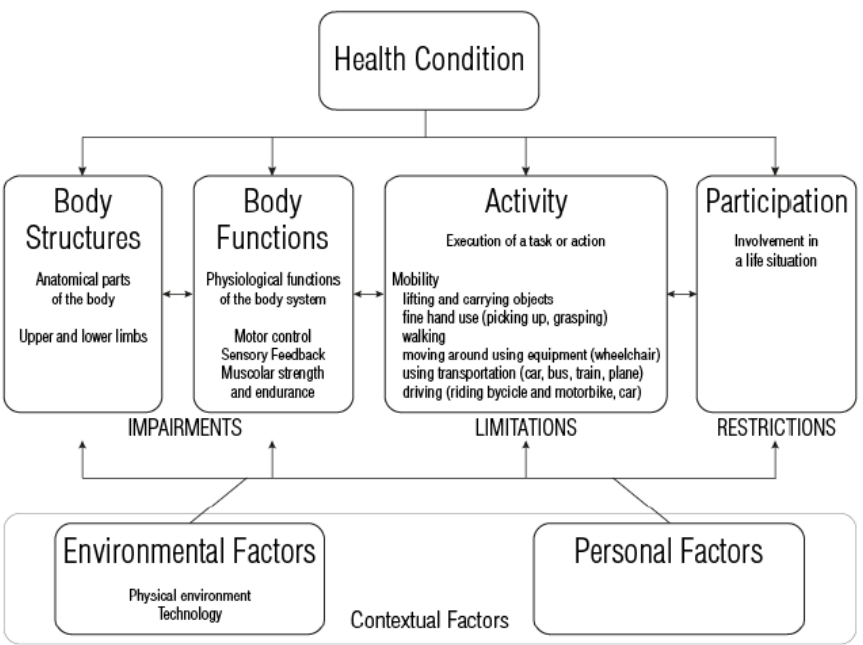

Figure 1. Bodily aspects in the multidimensional model of ICF.

As Figure 1 illustrates, in this multidimensional model all components are important and interact reciprocally. Each component contains hierarchically arranged domains which, in

turn, are sets of related physiological functions, anatomical structures, actions, tasks, areas of life, and external influences (WHO, 2001).

Among the activities related to body functions, the domain of *mobility* is articulated in categories arranged in different levels, as shown in the following section.

Mobility

(Taken and adapted from WHO, 2001)

This section is about moving by changing body position or location or by transferring from one place to another, by carrying, moving or manipulating objects, by walking, running or climbing, and by using various forms of transportation.

Changing and Maintaining Body Position (d410-d429)

d410 Changing basic body position

Getting into and out of a body position and moving from one location to another, such as getting up out of a chair to lie down on a bed, and getting into and out of positions of kneeling or squatting.

Inclusion: changing body position from lying down, from squatting or kneeling, from sitting or standing, bending and shifting the body's centre of gravity. Exclusion: transferring oneself (d420).

d4100 Lying down

Getting into and out of a lying down position or changing body position from horizontal to any other position, such as standing up or sitting down.

Inclusion: getting into a prostrate position

d4101 Squatting

Getting into and out of the seated or crouched posture on one's haunches with knees closely drawn up or sitting on one's heels, such as may be necessary in toilets that are at floor level, or changing body position from squatting to any other position, such as standing up.

d4102 Kneeling

Getting into and out of a position where the body is supported by the knees with legs bent, such as during prayers, or changing body position from kneeling to any other position, such as standing up.

d4103 Sitting

Getting into and out of a seated position and changing body position from sitting down to any other position, such as standing up or lying down.

Inclusions: getting into a sitting position with bent legs or cross-legged; getting into a sitting position with feet supported or unsupported.

d4104 Standing

Getting into and out of a standing position or changing body position from standing to any other position, such as lying down or sitting down.

d4105 Bending
Tilting the back downwards or to the side, at the torso, such as in bowing or reaching down for an object.

d4106 Shifting the body's centre of gravity
Adjusting or moving the weight of the body from one position to another while sitting, standing or lying, such as moving from one foot to another while standing.
Exclusions: transferring oneself (d420); walking (d450).

d4108 Changing basic body position, other specified

d4109 Changing basic body position, unspecified

d415 Maintaining a body position
Staying in the same body position as required, such as remaining seated or remaining standing for work or school.
Inclusions: maintaining a lying, squatting, kneeling, sitting and standing position.

d4150 Maintaining a lying position
Staying in a lying position for some time as required, such as remaining in a prone position in a bed.
Inclusions: staying in a prone (face down or prostrate), supine (face upwards) or side-lying position.

d4151 Maintaining a squatting position
Staying in a squatting position for some time as required, such as when sitting on the floor without a seat.

d4152 Maintaining a kneeling position
Staying in a kneeling position where the body is supported by the knees with legs bent for some time as required, such as during prayers in church.

d4153 Maintaining a sitting position
Staying in a seated position, on a seat or the floor, for some time as required, such as when sitting at a desk or table.
Inclusions: staying in a sitting position with straight legs or cross-legged, with feet supported or unsupported.

d4154 Maintaining a standing position
Staying in a standing position for some time as required, such as when standing in a queue.
Inclusions: staying in a standing position on a slope, on slippery or hard surfaces.

d4158 Maintaining a body position, other specified

d4159 Maintaining a body position, unspecified

d420 Transferring oneself
Moving from one surface to another, such as sliding along a bench or moving from a bed to a chair, without changing body position.
Inclusions: transferring oneself while sitting or lying.
Exclusion: changing basic body position (d410).

d4200 Transferring oneself while sitting
Moving from a sitting position on one seat to another seat on the same or different level, such as moving from a chair to a bed.

Inclusions: moving from a chair to another seat, such as a toilet seat; moving from a wheelchair to a car seat.
Exclusion: changing basic body position (d410).

d4201 Transferring oneself while lying
Moving from one lying position to another on the same or different level, such as moving from one bed to another.
Exclusion: changing basic body position (d410).

d4208 Transferring oneself, other specified

d4209 Transferring oneself, unspecified

d429 Changing and maintaining body position, other specified and unspecified

Carrying, Moving and Handling Objects (d430-d449)

d430 Lifting and carrying objects
Raising up an object or taking something from one place to another, such as when lifting a cup or carrying a child from one room to another.
Inclusions: lifting, carrying in the hands or arms, or on shoulders, hip, back or head; putting down.

d4300 Lifting
Raising up an object in order to move it from a lower to a higher level, such as when lifting a glass from the table.

d4301 Carrying in the hands
Taking or transporting an object from one place to another using the hands, such as when carrying a drinking glass or a suitcase.

d4302 Carrying in the arms
Taking or transporting an object from one place to another using the arms and hands, such as when carrying a child.

d4303 Carrying on shoulders, hip and back
Taking or transporting an object from one place to another using the shoulders, hip or back, or some combination of these, such as when carrying a large parcel.

d4304 Carrying on the head
Taking or transporting an object from one place to another using the head, such when as carrying a container of water on the head.

d4305 Putting down objects
Using hands, arms or other parts of the body to place an object down on a surface or place, such as when lowering a container of water to the ground.

d4308 Lifting and carrying, other specified

d4309 Lifting and carrying, unspecified

d435 Moving objects with lower extremities
Performing coordinated actions aimed at moving an object by using the legs and feet, such as kicking a ball or pushing pedals on a bicycle.
Inclusions: pushing with lower extremities; kicking.

d4350 Pushing with lower extremities
Using the legs and feet to exert a force on an object to move it away, such as pushing a chair away with a foot.

d4351 Kicking
Using the legs and feet to propel something away, such as kicking a ball.

d4358 Moving objects with lower extremities, other specified

d4359 Moving objects with lower extremities, unspecified

d440 Fine hand use
Performing the coordinated actions of handling objects, picking up, manipulating and releasing them using one's hand, fingers and thumb, such as required to lift coins off a table or turn a dial or knob.
Inclusions: picking up, grasping, manipulating and releasing.
Exclusion: lifting and carrying objects (d430).

d4400 Picking up
Lifting or taking up a small object with hands and fingers, such as when picking up a pencil.

d4401 Grasping
Using one or both hands to seize and hold something, such as when grasping a tool or a door knob.

d4402 Manipulating
Using fingers and hands to exert control over, direct or guide something, such as when handling coins or other small objects.

d4403 Releasing
Using fingers and hands to let go or set free something so that it falls or changes position, such as when dropping an item of clothing.

d4408 Fine hand use, other specified

d4409 Fine hand use, unspecified

d445 Hand and arm use
Performing the coordinated actions required to move objects or to manipulate them by using hands and arms, such as when turning door handles or throwing or catching an object.
Inclusions: pulling or pushing objects; reaching; turning or twisting the hands or arms; throwing; catching.
Exclusion: fine hand use (d440).

d4450 Pulling
Using fingers, hands and arms to bring an object towards oneself, or to move it from place to place, such as when pulling a door closed.

d4451 Pushing
Using fingers, hands and arms to move something from oneself, or to move it from place to place, such as when pushing an animal away.

d4452 Reaching
Using the hands and arms to extend outwards and touch and grasp something, such as when reaching across a table or desk for a book.

d4453 Turning or twisting the hands or arms
Using fingers, hands and arms to rotate, turn or bend an object, such as is required to use tools or utensils.

d4454 Throwing
Using fingers, hands and arms to lift something and propel it with some force through the air, such as when tossing a ball.

d4455 Catching
Using fingers, hands and arms to grasp a moving object in order to bring it to a stop and hold it, such as when catching a ball.

d4458 Hand and arm use, other specified

d4459 Hand and arm use, unspecified

d449 Carrying, moving and handling objects, other specified and unspecified

Walking and Moving (d450-d469)

d450 Walking
Moving along a surface on foot, step by step, so that one foot is always on the ground, such as when strolling, sauntering, walking forwards, backwards, or sideways.
Inclusions: walking short or long distances; walking on different surfaces; walking around obstacles.
Exclusions: transferring oneself (d420); moving around (d455).

d4500 Walking short distances
Walking for less than a kilometre, such as walking around rooms or hallways, within a building or for short distances outside.

d4501 Walking long distances
Walking for more than a kilometre, such as across a village or town, between villages or across open areas.

d4502 Walking on different surfaces
Walking on sloping, uneven, or moving surfaces, such as on grass, gravel or ice and snow, or walking aboard a ship, train or other vehicle.

d4503 Walking around obstacles
Walking in ways required to avoid moving and immobile objects, people, animals, and vehicles, such as walking around a marketplace or shop, around or through traffic or other crowded areas.

d4508 Walking, other specified

d4509 Walking, unspecified

d455 Moving around
Moving the whole body from one place to another by means other than walking, such as climbing over a rock or running down a street, skipping, scampering, jumping, somersaulting or running around obstacles.
Inclusions: crawling, climbing, running, jogging, jumping, and swimming.
Exclusions: transferring oneself (d420); walking (d450).

d4550 Crawling
Moving the whole body in a prone position from one place to another on hands, or hands and arms, and knees.

d4551 Climbing

Moving the whole body upwards or downwards, over surfaces or objects, such as climbing steps, rocks, ladders or stairs, curbs or other objects.

d4552 Running
Moving with quick steps so that both feet may be simultaneously off the ground.

d4553 Jumping
Moving up off the ground by bending and extending the legs, such as jumping on one foot, hopping, skipping and jumping or diving into water.

d4554 Swimming
Propelling the whole body through water by means of limb and body movements without taking support from the ground underneath.

d4558 Moving around, other specified

d4559 Moving around, unspecified

d460 Moving around in different locations
Walking and moving around in various places and situations, such as walking between rooms in a house, within a building, or down the street of a town.
Inclusions: moving around within the home, crawling or climbing within the home; walking or moving within buildings other than the home, and outside the home and other buildings.

d4600 Moving around within the home
Walking and moving around in one's home, within a room, between rooms, and around the whole residence or living area.
Inclusions: moving from floor to floor, on an attached balcony, courtyard, porch or garden.

d4601 Moving around within buildings other than home
Walking and moving around within buildings other than one's residence, such as moving around other people's homes, other private buildings, community and private or public buildings and enclosed areas.
Inclusions: moving throughout all parts of buildings and enclosed areas, between floors, inside, outside and around buildings, both public and private.

d4602 Moving around outside the home and other buildings
Walking and moving around close to or far from one's home and other buildings, without the use of transportation, public or private, such as walking for short or long distances around a town or village.
Inclusions: walking or moving down streets in the neighbourhood, town, village or city; moving between cities and further distances, without using transportation.

d4608 Moving around in different locations, other specified

d4609 Moving around in different locations, unspecified

d465 Moving around using equipment
Moving the whole body from place to place, on any surface or space, by using specific devices designed to facilitate moving or create other ways of moving

around, such as with skates, skis, or scuba equipment, or moving down the street in a wheelchair or a walker.
Exclusions: transferring oneself (d420); walking (d450); moving around (d455); using transportation (d470); driving (d475).

d469 Walking and moving, other specified and unspecified

Moving around Using Transportation (d470-d489)

d470 Using transportation
Using transportation to move around as a passenger, such as being driven in a car or on a bus, rickshaw, jitney, animal-powered vehicle, or private or public taxi, bus, train, tram, subway, boat or aircraft.
Inclusions: using human-powered transportation; using private motorized or public transportation.
Exclusions: moving around using equipment (d465); driving (d475).

d4700 Using human-powered vehicles
Being transported as a passenger by a mode of transportation powered by one or more people, such as riding in a rickshaw or rowboat.

d4701 Using private motorized transportation
Being transported as a passenger by private motorized vehicle over land, sea or air, such as by a taxi or privately owned aircraft or boat.

d4702 Using public motorized transportation
Being transported as a passenger by a motorized vehicle over land, sea or air designed for public transportation, such as being a passenger on a bus, train, subway or aircraft.

d4708 Using transportation, other specified

d4709 Using transportation, unspecified

d475 Driving
Being in control of and moving a vehicle or the animal that draws it, travelling under one's own direction or having at one's disposal any form of transportation, such as a car, bicycle, boat or animal-powered vehicle.
Inclusions: driving human-powered transportation, motorized vehicles, animal-powered vehicles.
Exclusions: moving around using equipment (d465); using transportation (d470).

d4750 Driving human-powered transportation
Driving a human-powered vehicle, such as a bicycle, tricycle, or rowboat.

d4751 Driving motorized vehicles
Driving a vehicle with a motor, such as an automobile, motorcycle, motorboat or aircraft.

d4752 Driving animal-powered vehicles
Driving a vehicle powered by an animal, such as a horse-drawn cart or carriage.

d4758 Driving, other specified

d4759 Driving, unspecified

d480 Riding animals for transportation
Travelling on the back of an animal, such as a horse, ox, camel or elephant
Exclusions: driving (d475); recreation and leisure (d920).

d489 Moving around using transportation, other specified and unspecified
d498 Mobility, other specified
d499 Mobility, unspecified

Within these more general frameworks, other aspects of the *Embodiment*, related to the teaching-learning dynamics, assume a particular relevance for Special Education.

- The use of *physical contact* and *physical prompts* in order to build a positive relationship of mutual trust and support and to convey specific information, useful in learning a particular skill or response. An obvious example is the educational work with *Physical Guidance* aimed at developing basic self-help skills in people with profound intellectual deficit; educational work in which the physical contact plays an important role and, in the case of people with low-functioning Autism spectrum disorders, is particularly delicate and difficult. A more complex form, embodied alike, of this "help-guide" function, is the use of *Modelling* and direct observation of the educator/teacher/parent who acts as a model and demonstrates, in a complete and comprehensive way, with the body in motion, how an action, of a specific learning objective, should be performed.
- The use of physical touch, with people with a severe intellectual deficit, as a basic component of the dynamics of affective and reassuring positive reinforcement through caresses, hugs and other contacts.
- The appreciation and enhancement of the body even in people with severe malformations in order to build a positive image of themselves and a bodily based self-esteem.

Special Education is also involved in psycho-educational interventions for overcoming behavior problems, even serious ones, such as various forms of self-harm and repetitive actions, as well as aggressive, destructive or isolationist behaviors. In all these situations, the early stages of the educational work are qualitative and quantitative observations, and functional behaviour analysis. In particular, during the functional analysis of problem behaviors, practitioners should seek antecedents and consequences that systematically recourse before and after the related problem behaviors, as well as clues in order to understand communicative or self-regulatory bodily functions. In the case of some SIB (self-injurious behaviours), for example, it is of paramount importance to identify if the body, as a source of positive or negative feelings, plays a role like the antecedent or consequent stimulations of positive or negative reinforcement. In the case of stereotypes, this inexhaustible source of sensory and proprioceptive stimulations of the body is able to explain the self-stimulation function of almost 90% of stereotyped and repetitive behaviors.

After the phases of analysis and evaluation, psycho-educational neo-behavioral interventions, aimed at overcoming problem behaviors, provide a set of positive training strategies for various adaptive behaviors which are able to functionally replace the problem behaviors and, in case of need, even physically block (short restriction of movement

possibilities) the person, as a result of a problem behavior particularly difficult to change. During the training phase of the positive alternative behaviors, an important role is played by physical guidance and a possible response interruption and redirection of the problem behavior. In this type of psycho-educational interventions of Special Education, the bodies of both the educator and the learner play a key role, both in the analysis phase and in the modification phase. Along with this dimension of the body as instrument and object of interventions specifically aimed at the development of positive behaviors, there is another strand of embodied interventions for problem behavior, namely that of *physical exercises*, that is the systematic use of physical activities to counter the various problem behaviors.

THE RELATIONSHIP BETWEEN THE LEARNER'S BODY AND THE HELPER'S BODY AS A FORM OF COMMUNICATION

The physical contact with an adult is the primary source of information for developing body image and self-awareness of the child.

The answers that a child receives in response to her/his activities allows him/her to build a gradual understanding of the body as an instrument through which they influence others and their surroundings, too.

However, in some cases, between the adult who takes care and the child, there may arise difficulties of communication. For example, this can happen when a child reacts in a different way from what we expect. In such cases, we often can risk to not understand or misunderstand what the child is trying to tell us and react in such a way that causes confusion and mutual misunderstanding.

To put a new basis for the development of a positive contact and communication, it is necessary to think about the "quality" of the interaction, rather than the "quantity."

It can be useful to choose fewer opportunities, carefully selected, of interaction and repeat them regularly and frequently for longer periods of time. We may also find it useful to choose situations that allow us to develop our sensitivity to better understand the communicative interaction and actively participate in co-building a positive relationship.

This type of work requires much effort, sensitivity, flexibility and, not the least, patience.

The development of a positive communication requires a mutual adaptation between the operator and the partner, which depends on the ability to perceive and respond to the reactions of each other's signals (Knill, 1992).

This is particularly difficult when working with children with special educational needs and severe disabilities, where a wide variety of behavioral problems are used as a form of communication.

In this way, we will discuss some educational and instructional strategies taken from the experience in the analysis of behavior (Applied Behavior Analysis - ABA). This approach belongs to an operating field of research which includes various educational methods, teaching techniques and methodologies (Devany and Nelson, 1986).

At the same time, these people may be particularly sensitive to how we communicate: the way we are talking, our facial expressions and our body movements.

When we work with people who have severe communication difficulties, the awareness of how we use our repertoire of behaviors and body language become one of the most

important requirements for developing a good contact and effective communication (Knill, 1992).

WHAT IS APPLIED BEHAVIOUR ANALYSIS?

Applied behavior analysis (ABA) is an evidence based and validated approach to understand a person's behavior (actions and skills) and how it is affected by the environment all around (that includes the physical and/or social influence that might change or be changed by the person's behaviour).

The principles and methods of behaviour analysis are focused on the aim to explain how learning takes place and are used to bring a meaningful and positive change in a person's behavior. Its application is in real-world settings (Baer, Wolf e Risley, 1968).

Positive reinforcement is one of these principles: when a behavior is followed by a reward, this behavior is more likely to be repeated. Function-based treatments involve altering the environment to minimize problem behavior, establishing and reinforcing adaptive behaviors, and withholding reinforcement for problem behavior.

Behavior analysis approaches have developed many strategies for increasing useful behaviors and reducing those not desirable, like behavioral problems in people with severe communication difficulties and autism. Indeed, ABA is widely recognized as a safe and effective treatment for autism, aiming to produce significant changes in specific skills that impact the person's global functioning.

These programs provide the use of clear instructions, reinforcements, teaching small units of behavior (task analysis) experienced in repeated trial sessions to maximize learning opportunities (Positive Behavioural Support).

When applied to younger children with disabilities, these programs are referred as "early intensive behavioral interventions."

ABA-based treatment for persons with problem behaviors such as "Disruptive Behaviour Disorder" and "Stereotypic Movement Disorder with Self-Injurious Behavior" requires a preliminary functional behavioral assessment to identify the variables involved in problem behavior (i.e., the cause or the antecedents of the behavior) and an analysis of behavior-environment relations.

The functional behavioral assessment is fundamental for setting up and developing an individualized treatment, based on the person's needs.

Many studies have shown that ABA-based treatment approaches are effective in reducing problem behavior and establishing appropriate skills with children and adults in various contexts and with different types of intellectual and developmental disabilities.

A CORRECT WAY TO USE PROMPTS AND OTHER STRATEGIES IN THE TEACHING-LEARNING PROCESS

Behavioral problems can affect a child's development and, in some cases, they can heavily interfere with their ability to lead a normal life in different contexts: school, family, peer relationship, etc.

The aim of several behavioral treatment and programs is designed to decrease these problem behaviors and to increase functional alternative behaviors.

Many researches have demonstrated that prompts are an effective and useful teaching tool for people with disabilities, severe disability, autism and, in general, people with special needs. Prompting is an important tool in teaching children with disabilities, especially when there is a significant effect on their ability to learn functional or life skills, an important part of ABA - Applied Behaviour Analysis programs.

Prompts are instructions, gestures, touches, demonstrations, etc. used by educators, teachers, therapists and parents to increase the likelihood of getting correct responses.

Applying an errorless approach and a correct use of prompts is a positive way of teaching that stimulates students to improve and experience success.

There are many different types of prompts and it is important to choose the prompts in relation to the abilities and disabilities of the student and the type and amount of assistance the student requires. We can place prompting across a continuum, from the most invasive physical prompts, to the least invasive gestural prompts.

Table 1 shows the most commonly used different types of prompts.

Table 1. Different types of prompts
Gestural prompt
Full physical prompt
Partial physical prompt
Table 1. Different types of prompts (Continued)
Full verbal prompt
Partial verbal prompt/phonemic prompt
Textual/written prompt
Visual prompt
Auditory prompt
Positional prompt

Gestural and Physical Prompts

We here analyze more specifically, those that relate more directly to the body: gestural and physical prompts.

A *gestural prompt* can include pointing, nodding and other types of action the learner can watch his teacher/practitioner do.

Physical prompting is a kind of prompt or cue used to teach children with disabilities new skills using direct physical contact between the teacher/practitioner and the child; the teacher provides a kind of physical contact to guide the learner through the entire requested activity/task (Webster, n.d.).

Children with significant disabilities frequently have difficulties mimicking or copying a behaviour that is modelled by another person.

Physical prompting is considered the most invasive and the easiest way to create prompt dependence; so, the practitioners have to be careful to gradually fade to less invasive prompts. Physical prompting begins with a *full physical prompt*, also called "Hand over Hand prompting."

In a p*artial physical prompt* the practitioner provides some assistance to guide the learner through part of the requested activity, for example guiding his/her hands to complete the task, and then, gradually, it becomes a physical reminder and no more a direct prompt (Webster, n.d.).

An important rule is to use only prompts that are useful and sufficient to the student, really necessary for him/her to get the activity/action/task done; this is fundamental to avoid becoming "prompt-dependent." Indeed, it is not uncommon that some students with disabilities respond only in the situations where they have the full assistance of the prompts; the direct consequence of this behavior is a significant decrease in the student's independence.

So, to avoid prompt dependency, it is recommended to use only prompts that are less intrusive whenever possible and fade prompts (before reduce, using less intrusive prompts and then eliminate) as soon as possible, related to the student's success in the task/action required.

Before fading and eliminating a prompt, it is important to keep in mind the basic rule that a goal should always be to reduce at first, to avoid an incorrect or absent response.

Modelling

Another effective strategy often combined with prompting and reinforcement strategies in the behavioural analysis programs is modelling (Rosenthal e Bandura, 1978; Morris e Kratochwill, 1983). In a modelling session adults or peers provide a demonstration of the target behavior and the student is expected to imitate this behavior and learn it by observing. Imitation skills are required as a necessary prerequisite to the modelling application.

According to the social learning theory of Bandura that emphasizes the importance of observing and modelling;

"Learning would be exceedingly laborious, not to mention hazardous, if people had to rely solely on the effects of their own actions to inform them what to do. Fortunately, most human behavior is learned observationally through modelling: from observing others, one forms an idea of how new behaviors are performed, and on later occasions this coded information serves as a guide for action" (Bandura, 1977, p. 22).

Task Analysis

Task analysis is a very important tool, in particular in special education for teaching life skills and to help students (in particular those with processing disorders or difficulty with organization) gain independence.

Task analysis is a process by which a task is broken down into its component parts (sub-tasks): some tasks need to be broken down into chunks for being completed.

A task analysis helps to promote independent performance by providing a "checklist" of steps required to complete the chosen task. Using this "checklist" the student is able to monitor his/her own progress and, at the same time, the teacher/practitioner can monitor student mastery of a task and identify specific skills that need continued practice or further instruction.

A task analysis consists of a written list of sequential steps required to complete a task, such as functional activities like washing hands, brushing teeth or setting a table; motor tasks such as using scissors, social skill behaviors and academic tasks, too.

Task analysis components are:

- Identify the task to be analysed and you want the student to perform
- Figure out what steps will be required to complete the task.
- Break this high-level task down into the necessary subtasks (specified in terms of objectives).
- Teach the student one step until he/she displays mastery of it (you can work from the first step to the last as in "chaining").

The student begins the routine from the first step and check if he/she is physically able to perform each part of the task. The different steps can be supported with prompts or modeling.

An Example

A Task Analysis for Brushing Teeth

Student removes toothbrush from tooth brush case
Student turns on water and wets bristles.
Student unscrews toothpaste, and squeezes some paste onto bristles.
Student opens mouth and brushes up and down on upper teeth.
Student rinses his teeth with water from a cup.
Student opens mouth and brushes up and down on lower teeth.
Student rinses his teeth with water from a cup.
Student replaces toothpaste cap, and places toothpaste and brush in tooth brush case.

THE FUNCTIONAL ANALYSIS OF PROBLEM BEHAVIOUR

Functional Analysis observes and evaluates the circularity of interactions, communications and actions-reactions related to the problem behavior, the behavior of others and the level of stimulation that the subject produces. The problem behavior, indeed, manifests itself in the presence of some stimulus conditions that precede and/or are contemporaneous, and that in some way influence it.

The behavior then produces effects and reactions at various levels, which have feedback impact on the initial conditions, varying them generally in the subject's desired direction.

In this case, we can speak of *functional behavior*, namely that it is able to produce the desired effect in those given conditions. Initial condition, behavior, reaction, new condition, behavior, reaction, etc. in a continuous interactive cycle, which has to be articulated and analysed in detail in order to be understood.

Traditionally, the role of antecedent conditions on problem behavior and the role of the effects on the behavior itself have to be distinguished and searched for. By systematically comparing these two categories of information, gathered through numerous observation, it is possible to formulate a hypothesis about the functions performed by that problem behavior (Ianes and Cramerotti, 2002).

The Role of Antecedent Conditions

Before a problem behavior there is always something, and when this "something" widens and becomes the context, things that exist, happen and have an influence on behavior become so many, and with very different influences. In order to understand the dynamics of a problem behavior, we have to understand if there are antecedent conditions that somehow ease the problem behavior.

Antecedent conditions can be classified according to three criteria: the temporal proximity to the problem behavior, their location and type, and the quality and type of their influence.

Regarding the time dimension, there can be antecedent conditions directly related to the behavior (a person enters a crowded and noisy room, he/she immediately begins to beat his/her ears with the palms of the hands), conditions a bit more distant in time or even very far (a few days) in time.

Clearly, the more remote conditions are, the less "readable" they are and also have a different influence on behavior, as we will see shortly.

With respect to location and type, it is useful to use the following classification:

- Conditions of the physical state of the subject (disease, comfort, fatigue, level of sensory stimulation, etc.).
- Conditions of the affective-emotional state of the subject (anxiety, anger, sadness, excitement, etc.).
- Conditions of the cognitive status of the subject (thoughts, expectations, assumptions and evaluations, rules, etc.).
- Conditions of relationships with significant practitioners (hate, tension, lack of closeness, frustration, etc.).
- Conditions of extended relationships (Group) currently underway (wellbeing, proximity, lack of attention, aversion, competitiveness, annoyance, etc.).
- Context conditions:
  - in a physical sense (environment, light, noise, temperature, etc.).
  - activities (pleasant, aversive, poor, etc.)
  - relations in a global sense, not ascribable in the previous two points (supporting, stimulating, aversive, confirmation, acceptance, etc.).

In these various areas we can find different aspects that act "in favor" of the problem behavior but at different levels of influence and facilitation. For example, if a subject is in a context of difficult and frustrating tasks, in an unpleasant and punitive relationship with the teacher and in a physical state of headaches and fatigue, we can legitimately assume that the sum of these three antecedent dimensions has a negative impact on him and stimulates him to reduce, or terminate, these unpleasant conditions (Ianes and Cramerotti, 2002).

So there are at least two broad areas of facilitative roles, played by antecedent conditions: a motivating role, which gives the push, the why, the need and the goal to be reached (negative and positive reasons, of course), and a more orienting role to specific action, which indicates the forms of behavior, the most appropriate time to act (there are many people, the educator is distracting, etc.), the most "receptive" people, etc.

At this point it might be said that the problem behavior is a mode, simultaneously wrong and effective, to deal with a condition in which the subject is situated. The Functional Analysis helps us to define, as exactly as possible, what the antecedent conditions are and what facilitating roles they play in relation to the problem behavior.

We take into account other aspects: the very strong and special relationship that exists between emotional issues and problem behavior. The emotional reactivity of a disabled person, especially of those with psychiatric, personality or emotional disorders, may reach significant levels, in some cases completely disruptive.

A trivial uncertainty about the things you can do in the afternoon can cause a high level of anxiety and agitation: indeed, an individual could not have the cognitive skills necessary to control the emotion (or even, there could be distortions that magnify it) or the communication and interpersonal skills for managing emotions in daily relations, seeking help, discussing, planning. Then, a highly aggressive and destructive behavior shows up, and it forces operators to meet the requirements of predictability and security of the programs for the afternoon, reassuring and forcing the situation to the benefit of the person who handled his emotional problem with aggression. In such a case, the emotion plays the lion's role. There are many cases in which the causes of a problem behavior, especially if aggressive or destructive, have little control over the emotions.

What areas of the body are more "advantageous" to hit?
How self-injury is localized in positive self-regulation function?

Currently we have little specific information about the location and distribution of body parts that are affected preferentially in situations of self-harm.
Symons and Thompson (2000) talk about the parts of the body which are objects of self-injurious behavior. Information was collected by the authors in a study conducted with 29 school children with mental retardation who were demonstrating daily severe SIB.
The observations were carried out by specialized teachers, each of whom recorded, independently from the others, the parts of the body that were the object of self-harm by their students.
Among SIB, about 80% was directed to the head and hands. 75% of those directed to the head, involved the face, and 83% of those directed to the hands, involved the back.
32% of the parts of the body, to which self-injury was directed, were located in areas of the body which produced analgesia when properly stimulated (e.g., acupuncture).
The implications of these findings were discussed by the authors in the wake of the opioid hypothesis related to self-injurious behaviors; the fact that the self-injurious behavior is mediated by opioids, or other neurochemicals, can depend, in part, on its topography, intensity and bodily location. In fact, given the preferences observed about parts of the body that were objects of self-harm, it is possible that some people may learn to hit areas of the body that cause an increased release of neurochemicals (Symons e Thompson, 2000).

This leads us to another consideration: the relationship between problem behaviors and skills gaps. It is obvious that a problem behavior should not be confused with the inability to

do things, or to do them with unacceptable accuracy, but these two aspects are sometimes in a close relationship (Ianes and Cramerotti, 2002).

The practitioner who works in this area should keep an eye on another issue, that is the directly causative role of the biological condition of individuals related to their specific problem behaviors.

The two "fathers" of Functional Analysis, Edward Carr (1994) and Brian Iwata (1994), describe very well the possible the interaction between learning mechanisms and biological factors. In some cases of SIB, it is correct to consider the endogenous opioids hypothesis, according to which SIB produces a release of endorphins that act as an automatic internal reinforcement and eliminate the "punitive" factors, which typically consist of the pain you feel when you obtain an injury, raising the pain threshold. This is an explanation that perfectly links together physiological mechanisms and learning processes.

The specific form of the problem behavior is shaped by experiences and by learning, on the basis of abilities and motivation: biological characteristics certainly play a role, but it is not the key role. But we must not fall into the error of psychologism, that is the belief that the behavior does not have a body that motivates it, someway, that conditions it, that makes it suffer, in pathological conditions. It is true that the disabled person, as such, is not sick, but often he/she has a body that reacts in very problematic ways, that hurts, and poses insurmountable constraints.

EMBODIED TRAINING AND BEHAVIORAL SELF-REGULATION

In order to overcome daily self-control dilemmas, most people try to firm their willpower (Muraven, Tice, and Baumiester 1998) by, for example, suppressing temptation or thinking about long-term achievements (Gollwitzer and Moskowitz 1996; Metcalfe and Mischel 1999). But, as many studies claim, willpower is a limited resource, also difficult to manage (Baumeister et al. 2008; Baumeister, Heatherton, and Tice 1994).

In accordance with the research on embodied cognition, a growing body of research shows also how the body is fundamental in *self-regulation*. Usually, some bodily actions, such as gritting teeth and clenching fists, are used to strengthen willpower. Others, such as stiffening the tongue to resist the temptation of an ice cream, are aimed at achieving long-term benefits. Such actions, though, are effective only if individuals firm their body when they have to exert self-regulation (Hung and Labroo, 2011). The process by which the body helps and influences the mind is, indeed, strategic and depends on whether an individual desires to engage in a self-control dilemma in relation to situational cues (Dewitte et al. 2009; Williams et al. 2009).

The term self-regulation refers to the process whereby individuals deliberately use their skills in order to respond to environmental demands in a contextually appropriate way (Aksan and Kochanska, 2004; Blair and Razza, 2007; Cameron Ponitz et al., 2008; Cole, Michel, and Teti, 1994; Kochanska, Coy, and Murray, 2001).

In particular, *behaviour self-regulation* is the ability to appropriately behave, by integrating several sophisticated cognitive skills (i.e., attention and awareness, working memory, inhibition and monitoring of behavior, thought and strategies), in response to the

contextual demands of the environment (Bronson, 2000; McClelland and Cameron, 2012; McClelland et al., 2007). In other words, it is the ability to inhibit first responses, control impulses or do something against one's own will, manage emotions in socially acceptable ways, and deal with stressful situations. Behavior regulation also allows to respect the rules, adapt to the new, pay attention to important information and not be influenced by distractions.

Although children may be unaware of many self-regulation processes, the intentional ability to control thoughts, emotions and behavior is critically important for success in school, work, and later in life (Galinsky, 2010; Mischel, Shoda and Rodriguez, 1989; Zimmerman 1994). Indeed, self-regulation is positively correlated with better academic performance and social interactions, improved intrinsic motivation, self-esteem and self-efficacy, and also fewer behavioral disorders and psychopathologies (Eisenberg, Smith, Sadovsky, and Spinrad, 2004; Grolnick, Kurowski, and Gurland, 1999; Howse, Lange, Farran, and Boyles, 2003; Kochanska, Murray, and Coy, 1997; Ryan, Connell, and Grolnick, 1992).

Many regulatory functions, after a preliminary period of intentional use, become automatic. Others, such as coordinating the movements needed to ride a bike, require a prolonged intentional practice, but eventually they also become automatic (*internalization* process). Some others always require intentional effort (Florez, 2011).

The development process of behavior regulation initiates early in life, as demonstrated by infants who turn away from excessive stimulation sources, and continues during childhood with the development, during the first five years of life, of more sophisticated skills (Blair 2002; Blair and Diamond 2008; Galinsky 2010; Kopp 1982). Children, as young as one, are aware of social demands and can voluntarily start or stop an action, especially in contexts they are familiar with. By the age of five, children develop the ability to inhibit first responses and this growth continues on until adolescence (Gerstadt, Hong and Diamond, 1994; Kochanska et al., 1996; Kopp, 1982; Simpson and Riggs, 2005). At this point, older children and adolescents are also able to self-regulate learning strategies, to improve their comprehension and performance, and emotions, by managing negative ones for example (Brown et al., 1983). Cognitive self-regulation is indeed an active, intentional process which affects emotions as much as it is affected by them (Blair and Diamond, 2008).

These developmental trends in self-regulation are consistent with the biological maturation of specific areas of the brain, especially the frontal lobes, during infancy and childhood (Hudspeth and Pribram, 1990; Luria, 1973). Nevertheless, self-regulation skills are not completely innate. Along with temperamental tendencies, environmental factors also have a strong influence (Rothbart and Bates, 2006). In fact, as most psychologists believe, it is possible that self-regulation is elicited by others, for example when children imitate, practice and internalize other's behavior thanks to the use of modelling strategies, and then becomes internalized (Schunk and Zimmerman, 1997).

Due to this early development of self-control skills, the role of parents, teachers and caregivers is critical to help young children regulate themselves during ordinary activities. The way in which adults direct this development appears also to be crucial. Children are indeed more inclined to effectively modify their behaviour, and internalize this adjustment, if they agree with a request, which means that reason-based control strategies (e.g., explanation of rules, involvement in the establishment of objectives and rule, etc.) used by adults are more effective than power-based ones (e.g., compliance with direction, learning to sit still, etc.) (Kochannska et al., 2001). Because it depends on both internal and external factors, behavior

regulation requires an environment where children understand requests and expectations, feel relaxed, can burn off steam, make choices and face challenges of their daily life.

In order to promote children's behavior regulation, parents should collaborate with teachers and practitioners by putting some simple everyday interventions into action.

Three teaching strategies can be mentioned for helping children in the development of self-regulation skills, and they are:

- Modelling – adults should show children the correct behavior and actions (directions, gestures, touch) in order to accomplish a task.
- Use of hints and cues – hints and cues can be provided not only as guides to correct answers, but also to suggest when and how to ask for help, for a break or to try a different strategy.
- Gradual withdrawl of adult support – as children increase their ability to act independently, adults should withdraw their support, while continuously monitoring them, should an intervention be needed (Florez, 2011).

In addition to these measures, the careful observation of the child, in response to different situations and activities, is useful in figuring out which factors favor a calm and focused behavior and which cause and under- or over-stimulation (Shanker, n.d.). Adults should also demonstrate self-regulation themselves, by managing frustration or controlling impulses, and use self-talk strategies in order to verbalize and express thoughts and emotions (Perry, n.d.). Children who have difficulties in regulating their behavior could also benefit from modelling strategies by playing games, preferably with rules, with peers good at playing fairly, following rules and taking turns. Moreover, during pretend play, children have to imagine someone else's reaction and therefore need to suppress their first reactions, as well as needing to plan and act out different feelings (Bodrova and Leong, 2008). Physical and outdoor games are also preferable as they encourage playing with people and, therefore, improve regulation abilities (Shanker and Nichols, 2011). The creation of routines, by using schedules and timers, and the clear establishment of expectations favor a better control of children's behavior and minimize stress (Gillespie and Seibel, 2006). Children should also have the chance to make choices and set objectives for themselves in a continuous process of self-control development (Gallinsky, 2012).

"Adults foster children's motivation by being motivated themselves," notes Galinsky (2010) referring to motivational regulation. As already stated, the role of adults is critical for the development of self-regulation skills in children, but fortunately, everyday life offers many opportunities for teaching. Only in this way can children become actively engaged learners and lay down the foundation for future success, in school and life.

EMBODIED DESIGN, UNIVERSAL DESIGN FOR LEARNING AND ASSISTIVE TECHNOLOGIES

We have evidence that the human body can be used not only to act on the world, but it can also be used for cognitive purposes as a model to represent abstract concepts and inaccessible, unseen things (Kirsh, 2013). This is possible thanks to the existence, within the

human body, of two distinct but permeable systems: the perceptual-motor system, and the cognitive system (Piaget and Inhelder, 1969; Vygotskij, 1962).

Traditional epistemologies hold that cognitive processes and "thinking" are psychological activities basically detached from the perceptual-motor system which is based on sensory inputs and action outputs. Yet, neuroimaging research, supporting the findings of many cognitive science studies (Barsalou, 1999), have found evidence of a correspondence between rational thoughts and the activation of sensory-motor areas during specific tasks (i.e., when they hear the verbs "lick", "pick", and "kick", people activate the brains areas which control the mouth, the hands, and the legs respectively; during imagination tasks, individuals activate the same parts of the brain as in actual seeing) (Hauk, Johnsrude, and Pulvermüller, 2004; Kosslyn, 2005).

The vast majority of perceptuomotor activities – the immediate "doing" –, while engaging the highly sophisticated processes of both cognitive and motor systems, they demand little reflection and can be performed unconsciously. When individuals are asked about those activities – the mediated "thinking" –, they engage a different type of cognitive system. In the wake of the *Embodied Cognitive Science*, teachers are urged to help learners to understand this process, that is the transition from any immersive action to a structured reflection (Abrahamson and Lindgren, 2014).

In a learning environment, based on the principles of the "embodied design" (Abrahamson, 2009; Van Rompay, Hekkert, and Muller, 2005), learners can approach any discipline using their bodies and can be lead towards these disciplinary perspectives. Assuming that perception is active and based on the possibilities of interaction (Gibson, 1966), there are three aspects that should be considered when designing a learning environment; activities, materials, and facilitations (Abrahamson and Lindgren, 2014).

First of all, activities should be engaging and foster meaningful learning in which students, thanks to corporeal activity and to their ability to act in a real environment, use their senses to reflect on stimuli, and their properties, and to perform new actions. Figurative, iconic and graphical representations should be preferred to symbolic and abstract stimuli, at least in the initial phase.

All of the activities should take place in an environment without barriers, so that any action – from the bending of a finger to a body pirouette — is not hindered and can elicit feedback loops; the learning environment should also include different artefacts and different media, both for the input and the output phases, so that students have the opportunity to be engaged in a meaningful and purposeful learning process, and to develop new ways to effectively make use of tools and their body.

Moreover, students should be guided, with physical cueing and teachers' feedback, in the movements that elicit conceptual insights, movements that not always occur naturally. Physical demonstration and hands-on coaching are only some of the many pedagogical practices that teachers can use in order to achieve these objectives.

Unfortunately, most general curricula are not designed with these types of activities in mind, nor are they suited for special education students – even less for students with disabilities – who should participate in the regular education curriculum as any other student. Rather than finding an adequate support and effective tools for learning, students find barriers. In many schools, teachers are engaged in the ongoing effort to develop and implement accommodations and modifications to the general curriculum. The purpose of providing to all individuals full and equal educational opportunities has long been hampered

by technological limitations, prejudice and low expectations. The change does not lie in helping students overcome these barriers, but in giving to schools, leaders and educators the means to lower or permanently destroy these barriers (Meyer, Rose and Gordon, 2014). Fortunately, today's society is trying to forsake the medical view of disability in favour of recognizing that the context and the learner's self-awareness both play a critical role in determining whether any condition is disabling or not.

In order to meet the diverse needs of students, the *one-size-fits-all* strategy is not suitable. An inclusive, universally designed curriculum does not address a narrow range of "average" students. On the contrary it is designed to meet the needs of *all* students, with all their diverse sensory-motor and cognitive abilities and disabilities (Hitchcok and Stahl, 2003). Such pedagogical approach, validated by scientific research, is generally known as *Universal Design for Learning* (UDL).

Underlying this approach, developed since the nineties by CAST researchers (Center for Applied Special Technology research), is the Universal Design cultural movement that, in architecture and industry, supports the need to design, from the very beginning, life spaces, workplaces, and objects that are accessible and usable by everyone. In this way, there is no need for subsequent expensive and often problematic accommodations or modifications. This approach, with its "universality," is definitely based on the ethical values of equal opportunity and fairness.

In the Higher Education Opportunity Act (P.L. 110-315, 2008), the Congress of the United States recognizes the UDL approach asa scientifically valid framework for guiding educational practice that, (A) provides flexibility in the way information is presented, in the way students respond or demonstrate knowledge and skills, and in the way students are engaged, and (B) reduces barriers in instruction, provides appropriate accommodations, supports, challenges, and maintains high achievement expectations for all students, including students with disabilities and students who are not proficient in English.

The UDL implementation is a continuous process of change and improvement of learning. The curriculum should be accessible to all, both physically and cognitively (Katzel and Richards, 2013). The UDL, however, does not prescribe a set of protocols that anyone can use in the same way, nor does it require the teachers to make a radical change in their way of teaching. Appealing to different ways to represent and introduce students to the content, the UDL methodological framework, so close to the principles of differentiation, personalization and individualization of *inclusive teaching*, consists of three key assumptions,that are:

- Provide multiple means of engagement in order to meet the diverse interests of students.
- Provide multiple means of representation in order to promote the recognition and acquisition of knowledge.
- Provide multiple means of action and expression to let students express and demonstrate their knowledge as they prefer (Meyer, Rose and Gordon, 2014).

The UDL, in particular, provides a broader definition of curriculum, compared to the traditional set of contents which has to be conveyed through a series of educational materials. According to the UDL framework, the four constituent parts of any effective curriculum are:

- the *goals* - only when achievements are defined, can teachers design methods and materials to accomplish these purposes and evaluate the process. Traditionally, the goals include knowledge, skills and abilities that students should acquire and master. In a UDL perspective, even the effective goals, such as enthusiasm for learning and self-regulation skills, are equally important. As suggested by the research, socio-positive emotional experiences allow students to pursue their goal, even in difficult and challenging situations (Bandura, 1977; Davidson and Lutz, 2008).
- the *assessment* - the two main types of evaluation are *formative* assessment, used during the teaching process to monitor students' progress and make changes based on the findings, and *summative* assessment, which evaluates the results only once the process is completed. Of the two, formative assessment provides an opportunity to improve both teaching and learning and helps students to develop self-regulation skills.
- *educational methodologies* - educational methods can be constantly modified and adjusted to address students' needs. According to the UDL approach, the curriculum should offer a wide choice of content and tools, different degrees of challenge and different learning contexts; continuous feedback and different opportunities to let students prove their skills; and finally, the curriculum should encourage the recognition of information by providing several examples, highlighting content key features and using different media and formats.
- *educational materials* - materials must be diverse and flexible. Teachers should never aim at choosing the right materials, but they should offer a wide choice. Effective materials also allow students to become proactive and content creators (Meyer, Rose and Gordon, 2014).

As for the *media*, educational technologies have recently made considerable progress; wireless and portable devices, such as smartphones and tablets, teaching software that allow teachers to build and adapt the educational content in real time according to students' needs, and even digital games that make learning more engaging and rewarding, are all tools that we can usually find in our schools (Meyer, Rose and Gordon, 2014).

However, technology helps to change the educational process, but it is not the change itself. Teachers should not focus on educational tools and means, rather on methodologies and students' involvement. It is worth remembering how the tools are only effective if used as part of an intentional and scientific design.

Nevertheless, tools, as well as affecting cognition via an incremental adaptation to the world that is the result of the prolonged use of the artefact in response to different needs, make new tasks and activities possible, especially for those with special educational needs or disabilities. Tools can improve perceptuomotor skills, and can also affect neural networks in the sense that they shape the brain map, related to our *body schema*, to include the tool's features and dimensions (Kirsh, 2013).

Some of these tools, specifically designed in order to help individuals with disabilities, are called *Assistive Technologies*. Being specifically modelled on the specific strengths and weaknesses of each individual to help them overcome environmental barriers, assistive technologies are divided in devices and services. Assistive technology devices are defined as "any item, piece of equipment, or product system, whether acquired commercially off the shelf, modified, or customized, that is used to increase, maintain, or improve functional

capabilities of individuals with disabilities" (Amendments to the Individuals with Disabilities Education Act, part A, note n. 6), whereas services directly assist individuals in the selection, acquisition, or use of an assistive technology device (Hitchcock and Stahl, 2003).

Eyeglasses, canes, and wheelchairs are AT which have been in place for centuries, whereas newer technologies, which include diverse items that we will examine in detail later, have emerged only over the last two decades, but they have already had a particularly dramatic impact on education (Behrmann and Schaff, 2001; Edyburn, 2002).

The National Center on Accessing the General Curriculum (NCAC) at CAST and the National Assistive Technology Research Institute (NATRI) at the University of Kentucky, while both focusing on the role of new technologies, are promoting researche about Universal Design for Learning (UDL) and assistive technology (AT), respectively. Two approaches of the same continuum, "much like two sides of the same coin" (Rose, Hasselbring, Stahl and Zabala, 2005). In fact, both approaches extensively rely on modern technology and this commonality often elicits confusion about the relation between the two (Bowser and Reed, 2000; Hitchcock and Stahl, 2003).

As already stated, UDL is aimed at identifying potential barriers to learning and at reducing them by designing, creating and implementing tools, activities and environments that, from the outset, accommodate individuals with a wide range of abilities and disabilities (Myller and Tschantz, 2003; Rose and Meyer, 2002). While AT address the needs of the individual student, strategies based on UDL principles are not unique or personal, but rather universal and inclusive, flexible and designed to anticipate (almost) all students' needs. Nevertheless, UDL and AT can be efficiently combined in order to achieve optimal educational results (Hitchcock and Stahl, 2003).

Consider in this regard, two different examples, one about physical impediments, and the other about cognitive barriers.

Mobility-related problems of a person with a physical disability can be primarily considered unique, *individual* problems. Personal adaptations can be precisely tailored to the needs of that specific person. On the other hand, *environmental* problems, such as movement limitations created by physical barriers, should be considered too. In this way, the need emerges for a properly designed environment with universal solutions, like ramps and elevators, that benefit also individuals without disabilities, including women with baby carriages or travellers with luggage.

Consider, now, the situation in which a student with a reading disability tries to master a history concept presented mostly in text. By addressing the student's specific weaknesses, teachers could suggest remedial reading classes, special tutoring, and several AT such as an audio version of the book. On the other hand, UDL warns about an excessive reliance of the curriculum on the printed text. A possible solution lies in using different media: the speech synthesis of the book may help students with dyslexia; images and videos are an alternative representations of the content for students with language-based disabilities or for students who are deaf; furthermore, alternatives to the keyboard may help students with physical disabilities during navigation of the content. After all, while being provided to students with special educational needs or disabilities, inclusive solutions could also be used by students without disabilities who might prefer them (Rose, Hasselbring, Stahl and Zabala, 2005).

In both cases, both the AT's and the UDL's solutions are needed. An exclusive use of assistive technologies leads to the creation of a poorly designed environment, full of barriers. Moreover, the assumption that barriers must be overcome thanks to specific solutions which

only the interested people have to pay for, is completely antithetical to UDL principles. On the other hand, by excluding the use of AT, customized adaptations that many people need would not be considered. A UDL approach is most effective when it makes use of AT, but teachers, or professionals in general, must be aware of the built-in technologies of universally designed environments so that they are complementary rather than redundant, powerful and cost-effective rather than cumbersome and expensive (Hitchcock and Stahl, 2003).

There are many types of assistive technologies which can significantly improve the learning process of students with various disabilities, ranging from mild to severe, when integrated in classroom instruction[1].

Word prediction and *word processing software* are effective also for children without disabilities as they facilitate the tasks of writing and revising texts and they promote the use of longer and more complicated words by freeing students from the duties of spellchecking and editing and by enabling them to spend more time on contents.

Communication technologies offer students the opportunity to gather information all around the world, by demolishing the classroom walls, and then to compare opinions, thoughts and ideas in collaborative learning environments, addressing both academic and social needs.

Augmentative and alternative communication (AAC) *devices*, paired with either synthetic or digital speech output, help students to overcome problems related to speech and language disorders. AAC devices can also be used by students with physical or mental disabilities if provided with alternative input methods, such as touchpads, switches, or optical pointing devices.

For students with hearing impairments there are specific *assistive listening devices* (ALDs) and *telecommunications devices* which rely on other abilities, such as sight and touch. Captioning is a very common, cheap and helpful practice which promotes inclusion of students, and deaf people in general, at all levels of the society (Foley, 1995; Goldman, 1993; Kind and Short, 1994; Koskinen, 1992; Lewis, 1993).

As for students with visual impairments, there are solutions that rely on at least some useful vision aids (e.g., large print materials, magnifying lenses, etc.), and others, such as MP3 recordings, speech synthesizers, screen readers or traditional translations into Braille, which are aimed at students with no useful vision. There are also new (expensive) software applications which combine Braille with computer technology, providing a more immediate alternative to embossed printed books.

And last, but not least, *switches* are the most common solutions to mobility impairments. Mainly because they can be activated by almost any part of the body (thanks to infrared sensors, even by the movement of a single eyebrow), but also because switches can be paired with any other adaptive device and help overcome the greatest barrier to computer use for students with physical disabilities - the traditional keyboard (Hasselbring and Glaser, 2000).

The integration of new technologies into the classroom can not only be beneficial to students with special educational needs or with mild learning disorders, but also for students with severe disabilities who, thanks to assistive technologies, can become active learners alongside their peers. Although technologies can be very motivating for students with disabilities and have the potential to act as an equalizer, several barriers inhibit educational

[1] For a more detailed description of these technologies, please refer to Hasselbring and Glaser research (2000).

strategies based on applications and devices, especially inadequate training of the teachers, who often do not know how to use technology effectively, and the cost, which often has to be funded independently by the schools themselves. Fortunately, these barriers are not insurmountable. All the actors involved in the learning process, that are teachers, school leaders, parents, as well as students, can work together in order to create a classroom environment in which *all* students have an equal chance to learn (Hasselbring and Glaser, 2000).

Society must embrace a cultural shift, the shift from a focus on access to a focus on learning. People will eventually understand that assistive technologies, rather than being "disabling" tools, are tools that enhance personal effectiveness, just like eyeglasses do. Because no single solution provides all of the accessibility and supports necessary for learning, assistive technologies and Universal Design for Learning must co-exist.

As UDL matures, it will advance by incorporating many features now provided only by assistive technologies, in the same way that text-to-speech, spellchecking, and calculators can be routinely built into office word processing or as captioning is built into every television. As assistive technology matures, it will advance by assuming increasing connectivity with universal designs, taking advantage of the common structures […] to provide highly individualized solutions that are not only sensory- and motor- but also cognitive and linguistic-oriented. […] Human learning will require access solutions that are optimal interactions between what is universal and what is individual (Rose, Hasselbring, Stahl and Zabala, 2005).

EMBODIED STRATEGIES IN THE LEARNING OF MATHEMATICS: FINGER REPRESENTATION AND THE *ANALOGICAL METHOD*

It is generally recognized that very young students struggle writing mathematics symbols and articulating their thoughts. Nevertheless, children can convey information through gestures, for example when they indicate or touch what they want. Such bodily actions are also applied by athletes and musicians in order to master their sport or instrument respectively. A dancer marking a phrase using his hands, one for the movements and the other for the floor (Kirsh, 2013), or a violinist repeating a hard passage with fingers along an imaginary viola before a concert, are just a few examples in which people use their body to learn.

Learning through bodily movements, as conceptualized by the philosophy of embodied cognition, can be also applied to mathematics education as it allows us to use gestures as a source of evidence for more abstract concepts (Nemirovky et al., 2012; Rasmussen et al., 2004; Tabachi and Sinclari, 2013).

As a matter of fact, body parts have been used to represent discrete quantities throughout history and, with differences that do not hinder mutual understanding (Bender and Beller, 2012; Pika, Nicoladis and Marentette, 2009), by people of many cultures (Ifrah, 2000). Fingers, in particular, have been used to represent items in a one-to-one correspondence and as tools to support the teaching of numbers (Ashcraft, 1982; Barrouillet, Mignon and Thevenot, 2008; Butterworth, 1999; Groen and Parkman, 1976; Woods, Resnick and Grocn, 1975), probably because of their transparent representation of numerical quantities.

Generally, the use of verbal and written codes is preceded by the use of fingers as a strategy to manipulate numerical quantities and, as claimed by Butterworth (1999), quantities are perceived even before the recognition of a thing's identity. Indeed, toddlers, who are not yet able to speak, use fingers and gestures to communicate, also numerical information (Lee et al., 2014). In kindergarten, the role of gestures, as important visual cues, is crucial to understand early mathematical concepts and count by reducing working memory load (Alibali and DiRusso, 1999; Barrouillet and Lépine, 2005; Barrouillet et al., 2008; Graham, 1999). As demonstrated by several studies, this relation between fingers and numerical representations, based on the childhood extensive reliance on fingers, is internalized with practice and endures into adulthood (Andres et al., 2007; Berteletti and Booth, 2016; Imbo et al., 2011; Kansaku et al., 2007).

Interestingly, the quality of such early internalized correlation may shape future arithmetic performance (Eriksson et al., 2010). The ability to discriminate our own fingers, that is *finger gnosia*, has been indeed found to correlate with numerical skills (Fayol, Barrouillet and Marinthe, 1998; Noël, 2005; Reeve and Humberstone, 2011). Children with developmental dyscalculia have a deficiency in finger gnosia, along with visuospatial memory (Chinello et al., 2013), and, compared to peers, rely more on fingers in order to represent numerical quantities or to facilitate the execution of mathematical procedures (Alibali and DiRusso, 1999; Geary, 2005). During the preschool period, playing to recognize the fingers could be a good exercise in preparation for mathematics. In addition, many children are labelled as dyscalculic, but they are nothing more than false positives whose problems do not depend on real cognitive disorders, but by bad teaching practices. As demonstrated by a recent Italian research (Santi and Baccaglini-Frank, 2015), in fact, the use of good teaching practices, with a focus on strengthening the use of fingers, decreases significantly the incidence of children at risk. These results suggest that it might be possible to improve the performance on numerical tasks, such as finger counting and subitizing, of those children with mathematical learning difficulties by training finger knowledge (Chinello et al., 2013; Gracia-Bafalluy and Noël, 2008).

Fingers, as also pointed out by the *Analogical Method* theory (Bortolato, 2014), are not only a tool to count and help in understanding numerical concepts. Fingers are an important physical support in mental calculations, as they alleviate working memory load when procedures are not automatized (Alibali and DiRusso, 1999; Geary, 2005), and they act as a computer which helps children "not to count" thanks to a global reading of images (Bortolato, 2014).

According to the *Analogical Method*, fingers act as a computer for three main reasons: the alignment of the fingers; the mobility of the fingers; the grouping of fingers in sets of five. Being *aligned*, fingers act as a model for the establishment of a mental line of numbers, ideal to perform calculations. Being *movable*, each finger possesses a double meaning, depending on whether it is open or closed. Being *grouped* together in sets of five, fingers are organized like computer bits in a byte (Bortolato, 2014).

The question that every teacher or parent raises is whether to encourage or discourage the use of fingers. The one and the other. Today, there are still teachers who forbid children to use their fingers, as if it was a childish strategy to be ashamed of. It is a resounding pedagogical error since it aggravates the anxiety and sense of inadequacy. As modern neuroscience demonstrates, our brain continues to count with the fingers even when we become adults, activating the area corresponding to hand representation even when we do not

physically use our fingers. Moreover, we should not be interested in the use of fingers as unrelated objects, but in the use of the *order* of the fingers.

In the study of hands and finger representation, the culture influences the order. Nevertheless, whatever this order might be, the numbers one, two and three are seen instinctively, without counting. The defining characteristic of this intuitive perception is called "subitizing" (Gallistel and Gelman, 1992) and it asserts that we recognize a given amount of elements without counting when the objects are not more than three or four. Children can recognize immediately even four fingers, because they perceive a closed one[2], and five fingers because they have learned so. Six, seven and eight are again within the span of vision as children consider only the fingers of the second hand. They recognize nine fingers in an instant because one is missing, and in the end ten fingers because it is an easy and symmetrical image of two open hands (Bortolato, 2014).

For each operation process, children, and later on also adults, use a myriad of different representations and go through several developmental steps (Ashcraft, 1982; Barrouillet et al., 2008; Ginsburg, 1977; Goren and Parkman, 1972; Svenson et al., 1976; Woods et al., 1975). When solving addition problems, they start by using the so called "count all strategy": they represent the operands separately on their hands and then count all the fingers raised. Count min/max strategies, by which children select the largest operand to start from and count only the finger corresponding to the smaller operand, occur with practice and understanding of cardinal values (Ginsburg, 1977; Groen and Parkman, 1972; Siegler and Shrager, 1984).

As already stated, the quality of finger representation has been shown to influence numerical processing, as well as performance and spatial-numerical association, and this influence is stronger for situations involving greater working memory load. It is then of paramount importance, for the school and teachers, to ensure that *all* the pupils have an adequate representation of their own fingers.

Moreover, different teaching methods could account for operation-specific processes. While additive and subtractive concepts, which require quantity manipulation and numerical quantity comparisons (Dehaene et al., 2003), are very intuitively represented on fingers (Barrouillet et al., 2008; Butterworth, 1999; Campbell and Xue, 2001; Dehaene, 1992; Sato and Lalain, 2008; Thevenot and Barrouillet, 2006), finger-based strategies in multiplication are impractical. During multiplication problems, children are encouraged to retrieve solutions from their verbal storage by using a rote learning approach (Campbell and Xue, 2001).

Importantly, both behavioural data and neuroimaging studies support a strong relation between finger representation and numerical procedures, and revealed the existence of operation-specific networks.

According to behavioural studies, when faced with subtraction and addition problems, children rely on procedural operations and visuospatial processes, even for very small and frequent problems, whereas when they are asked to solve multiplication problems, children try to access the answer from long-term verbal memory and rely more on language processes (Barrouillet and Thevenot, 2013; Boets and De Smedt, 2010; De Smedt and Boets, 2010; Fayol and Thevenot, 2012; Lee and Kang, 2002; LeFevre et al., 1996).

[2] In some finger-counting systems, such as the Pekai-Alue in Papua New Guinea, the closed fingers are those which represent the numerical value (i.e., number 1 is represented by the first four fingers open and the little finger closed) (Berteletti and Booth, 2016).

Various neuroimaging studies also show substantial differences in finger-related activations during arithmetic problem solving depending on the operation (Andres et al., 2011; Andres, Michaux and Pesenti, 2012; Fayol and Thevenot, 2012; Krinzinger et al., 2011; Prado et al., 2011; Prado et al., 2014; Zhou et al., 2007). In particular, studies revealed that only addition and subtraction problems significantly activated brain areas encompassing spatial manipulation and transformation of numerical quantities, such as finger motor areas. This somatosensory activation is even greater during problems involving larger numbers, suggesting a greater reliance on finger-based strategies as the difficulty increases. Multiplication problems are instead, preferentially solved through a verbal retrieval strategy and activate mainly the verbal network.

A recent study, in which Berteletti and Booth (2015) compared brain activation for subtraction and multiplication problems in finger somatosensory and motor areas, support these findings. The two researchers though, also tested whether brain activation was related to skill and performance in the wake of previous behavioral studies which have found that children with math difficulty rely more on finger-based strategies (Alibali and Di Russo, 1999; Geary, 2004, 2005). Against their initial hypothesis, Berteletti and Booth did not find a general relation between the activation of finger motor areas and skill. The activation in the somatosensory area was related to performance and modulated by problem size (large numbers use more fingers in order to be represented, thus they require a greater engagement of the somatosensory area) only for subtraction problems. A possible explanation, as the two researchers suggest, is that activation in the somatosensory areas is negatively related with the quality of fingers representation. Pupils with greater finger gnosia and a finer representation have lower levels of activation within the somatosensory area and, as shown by another study, the activity decreases after a period of training (Ladda et al., 2014).

This study, as stated by the authors themselves, represents the first evidence for a functional role of the somatosensory finger area in problem solving processes which require quantity manipulation and it supports the importance of finger gnosia in children. Because strategies used in school have been proven to shape neural networks, because children with dyscalculia or difficulties in math show poorer finger gnosia (Strauss and Werner, 1938; Noël, 2005; Costa et al., 2011), and because training refines finger representation, even though it has greater effects on subtraction problems compared to multiplication ones, teachers are urged to adopt educational practices with the aim of encouraging the use of fingers as a link between numerical quantities and their symbolic representation; focusing on finger discrimination as a precursor of numerical and arithmetical skill; and integrating finger representation and finger-based strategies as tools for instilling a stronger numerical sense (Berteletti and Booth, 2015).

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Chapter 3

EMBODIED COGNITION AND COGNITIVE MODIFIABILITY. A NEW DEAL FOR EDUCATION IN THE XXI CENTURY

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ABSTRACT

In this article we propose a critical and reflexive link between the literature on embodied cognition and Reuven Feuerstein's theory of structural cognitive modifiability. We argue that this link underlies the learning constitution of agent that has at its disposal a way of coupling its means of action to expand their personalized strategies of learning and to support innovation and change. Regarding this point, we wish to draw attention to the fact that, in human development, learning anticipates the development of human systems of action. On this basis, and in coherent fashion at the reference theoretical level, we are led to formulate the three following points: (1) With reference to the theory of autopoiesis, the paradigm of enaction shows that cognition implies a generative organization of the self, which involves a characteristic circularity at all levels of evolution of the learning potential in human agents. (2) Structural cognitive modifiability replays the scheme of circularity from the nascent sensory-motor level in terms of enaction for any effort at the successive characterization of the organization and lived experience of learning/thinking agents. (3) Consequently, talent is not a gift, but consists in the multiple, longlife, enactive development of learning potential. Thus, talent's education will improve the future of democracy and education in this century.

Keywords: embodied cognition, cognitive modifiability, talent's education

1. THE CHALLENGES OF EDUCATION: A GLOBAL FOCAL POINT

One issue of democracy is its relationship to welfare. One may legitimately wonder whether representative democratic systems can still grow in parallel with the policies of citizenship and inclusion. What happens nowadays to processes of human qualification – the

proprium of education and training – when policies are themselves going through processes of dismantlement and crisis, if not decomposition?

The classic design or conception of welfare is traditionally based upon a linear sequence of life stages: birth, training, work, wedding, home, family, children, retirement, death. However, every stage mentioned has become more fragile, and the sequence is now more contingent upon socio-economic conditions, as well as, perhaps, more fragile or transient in the lives of the members of society. The relationships within the social fabric, the perception of needs, the genesis of questions and the system of protections have changed considerably. Most people claim that it is easier to agree on the contents of social and economic reforms than on the rules for the social reforms. It is therefore easier to reform many aspects of welfare than its contributions. Is this really the case?

To put at the core of active welfare the right/need to learn during the lifespan has profound implications. The same norm justifies the emergence of social norms and, in everyday language, of new categories of recognition and certification. In particular, let's recapitulate three important and interrelated marks.

1. Is today's economic (i.e., substantially market-oriented) model of learning more likely to provide relevant dynamics of educational and social inclusion? The centrality given to the individual has the side-effect of heavily relying on individual learning, failing which one could be marginalized from the more profitable sectors of the labor market. Furthermore, learning resources are not equally distributed among individuals, whether due to personal characteristics or to the path dependence matured since primary school. Individuals who never "learned how to learn" at school will not, as adults, learn how to come to terms with their own education and needs. This could lead to segregation and deadlocks, especially in the case of unqualified or temporary jobs. Thus, democracy in a globalized society increasingly runs the risk of being organized around a "cognitive watershed", of which the digital divide is just one aspect.
2. The last point raises another problem, namely that of the relationship between the individual and the collective dimension of the right to learn. There is a growing risk of excessive competition among individuals to access to learning resources that may in fact be poor – a situation that is radically different from the original matrix of solidarity in which the level of education is raised for everybody. In order to ensure equal meta-cognitive and cognitive opportunities, we must reconsider pedagogy and the relationship between formal and non-formal learning, beside the entrance mechanisms (i.e., recruitment methods). That requires rethinking the entire educational and training institutions, and considering the consequences of the lack of redistributable technologies of entitlement, which risks to feed the cognitive divide rather than encouraging inclusive processes.
3. As a third issue, the right to learn faces the problem of work quality and its organization, proven that the construction of professionalism happens when the cognitive matches a learning *generative* device. Besides the reforms of the educational and training systems and their integration within the workplace, lifelong learning calls for a learning organization. In a learning organization there are networks of opportunities, the production of goods is associated with the production and circulation of knowledge, and all the workers can take part in these processes.

> With all its ambiguities, the issue of an individual's right to learn is changing our view on active welfare from a perspective of "workfare" to one of "learnfare". While the former perspective fails to account for the contradictions of the growing temporariness of work, the latter ensures the effective access of the individual to learning opportunities that respond to the needs of the market as well as to one's personal life projects. However, nowadays "learnfare" is neither present nor available, even in those countries that legislated on the issue. Using learnfare as a framework for social policies means to interpret the space opened by the Lisbon' strategy in a non-subaltern way. As underlined by Amartya Sen, the point is "to go beyond the human capital definition, after having recognized its relevance". The so-called "welfare of capabilities" should thus be implemented. Moreover, it should be considered as more than just a welfare of competencies, being connected with the collective and individual possibility to exercise the right to learn.

This new perspective urgently calls for a profound change in the methods and research styles of the sciences of education and training. Furthermore, it underlines the necessity to use new paradigms in order to study the problems faced by individuals when asked to constitute their own formative awareness and mindfulness. In other words, the way in which the mind is shaped and the learning processes taking place therein are of growing importance. Here lies the challenge: the fact that the study of any mental phenomenon is eventually the phenomenon of somebody who is experiencing it. In order to study this difficult problem we must claim that education must be submitted to the circularity between empathy, cognition, culture and experience. Furthermore, it must be pointed out that such circularity has its foundation in the modifiability of the mental structure. This in turn paves the way to an *enactive approach*[1] and to a deep and continuous change that makes of every human being a person. Thus, conducting educational research nowadays means that one's *praxis* of thoughts and actions carry a methodological approach that is both rigorous in terms of subjective experience and neuroscientifically founded[2].

The embodied nature of the processes of modifiability should be therefore explored by starting from the empirical evidence provided by cognitive neurosciences. The applications in the educational and training fields can be traced back to the role of simulative mechanism (i.e., imagining to do something) in the learning/teaching processes. When grounded in empirical evidence, research outcomes may provide interesting cues for debates and

[1] The origins of the embodied cognition research program can be traced back to the 1970s. However, the diffusion of studies on embodiment in psychology, linguistics, philosophy and sciences of education took four decades. The slow movement of new ideas in educational research and practice was at least partially responsible for this delay (see Soylu, F., Brady, C., Holbert, N., Wilensky, U. (2014): the entrenchment of the cognitivist perspectives in educational theory and practice probably slowed down the diffusion of research on embodiment. The subsequent vision of learning as a constructivist process, rooted in a social and cultural context, facilitated a pedagogical emphasis only on Scaffolding methodologies and techniques in education and learning design. We argue that cognition is embodied into all levels and forms of the learning activity.

[2] By proposing again what I previously stated in Margiotta U., *Teaching in the society of knowledge* (Pensa Multimedia, Lecce 2007), I would like to point out that 21st century's epistemology calls for educators and teachers to look at the brain to find out about the mind, rather than reducing the mind to the brain. Thus, mental functioning finds its neurophysiological basis in the neural basis but does not end up in them. To know how brain the transforms and renews itself, thus enabling knowledge and experience, not only helps to better educate, but also allows self-education.

suggestions for training and educational activities. As we know, the simulative function of the mirror system allows one to understand another individual's intentions by simply simulating them at the level of the sensory-motor system. Based on that simulative function, processes of comprehension evolve and interact with experience, i.e., with the possibility to imagine (or to simulate) what is being talked about and acted upon. We can therefore connect Feuerstein's theory of structural cognitive modifiability to the Mirror Neurons discovered by Rizzolatti and his research group at the University of Parma. Although these are two different approaches with two different timelines, they both replaced the traditional approach of cognitive functioning (according to which cognition is produced by a manipulation of symbols). Feuerstein, Varela and Rizzolatti are all in favor of the embodied approach, which sees cognition as a generative process that connects body and mind. Consequently, it would seem that the mind works and learns differently from what has been hypothesized so far. In other words, a considerable amount of scientific data is indicating that the mind is rooted both in the body states and in the neural systems of our brain (embodiment). Our view on how the mind "is shaped" should take these data into consideration. The process of teaching and learning should therefore be rethought in light of this newly established relationship among perception, action and cognition. This will ultimately lead to radically transform the school learning environment as well as the organization of teaching.

2. THE QUESTION

How does the brain/mind couple learn throughout life? According with OECD *(Understanding the Brain: The Birth of a Learning Science*, Paris, 2007) neuroscientists have well established that the brain has a highly robust and well-developed capacity to change in response to environmental demands, a process called *plasticity*. The degree of modification depends on the *type* of learning that takes place, with long-term learning leading to more deep modification. It also depends on the *period* of learning. But a profound message is that plasticity is a core feature of the brain throughout life. There are optimal or "sensitive periods" during which particular types of learning are most effective, despite this lifetime plasticity. For sensory stimuli such as speech sounds, and for certain emotional and cognitive experiences such as language exposure, there are relatively tight and early sensitive periods. Other skills, such as mastery acquisition, do not pass through tight sensitive periods and can be learned equally well at any time over the lifespan. Neuroimaging of adolescents now shows us that the adolescent brain is far from mature, and undergoes extensive structural changes well past puberty. Adolescence is an extremely important period in terms of emotional development. We have captured this combination of emotional immaturity and high cognitive potential in the phrase "high horsepower, poor steering". In older adults, many studies have shown that learning can be an effective way to counteract the reduced functioning of the brain: the more there are opportunities for older and elderly people to continue to learn.

By developing the capabilities of our minds and bodies, is it possible to take advantage of the brain's potential for plasticity and to generate, in each cognitive agent, his or her own talents to the maximum of their possibilities trough the longlife learning process? This question calls for holistic approaches which recognize the close interdependence of physical

and intellectual well-being and the close interplay of the emotional and cognitive. In the center of the brain is the set of structures known as the limbic system, historically called the "emotional brain". Evidence is now accumulating that our emotions do re-sculpt neural tissue. In situations of excessive stress or intense fear, social judgment and cognitive performance suffer through compromise to the neural processes of emotional regulation. Some stress is essential to meet challenges and can lead to better cognition and learning, but beyond a certain level it has the opposite effect. The brain is biologically primed to acquire language right from the very start of life; the process of language acquisition needs the catalyst of experience. There is an inverse relationship between age and the effectiveness of learning many aspects of language, and neuroscience has started to identify how the brain processes language differently among young children compared with more mature people. This understanding is relevant to education policies especially regarding formal learning strategies. Dyslexia is widespread and occurs across cultural and socioeconomic boundaries. While the *linguistic* consequences of these difficulties are relatively minor (e.g., confusing words which sound alike), the impairment can be much more significant for *mastery* as mapping phonetic sounds to orthographic symbols is the crux of reading. Also numeracy, like mastery, is created in the mind through the synergy of brain, cognition and experience. Hence, the important role of education – whether as formal, non-formal or informal learning – it's in play. The importance and promise of this new field are not the reason to duck fundamental ethical questions which now arise. Finally advances are constantly being made in combining living organs with technology. The advantages of such developments are obvious for those with disabilities who are thus enabled, say, to control machines from a distance. But the same technology could be applied to qualifying the communication awareness of the critical thinking of people, and to improve the quality of democracy around the world.

3. EMBODIED COGNITION: A COPERNICAN REVOLUTION FOR EDUCATION SCIENCES

According to Nuwan D. Leitan and Lucian Caffey (see their *Embodied Cognition and its applications: A brief review*, 2014) we appreciate cognition as a research program founded on the key assumption that the body functions are a constituent of the mind rather than a passive perceiver and actor serving the mind. The seminal works on phenomenology (E. Husserl and M. Merleau-Ponty) and of the pragmatist tradition (J. Dewey and W. James) inform embodied methodologies and major accounts of embodied cognition research. Recently these different theoretical traditions have been integrated in psychological theories of embodiment (e.g., Barsalou, 1999) and in other theoretical and empirical lines of research underpinned by the embodied cognition paradigm (see Barsalou, 2008; Clark & Chalmers, 1998; de Bruin & Kästner, 2012; Shapiro, 2011; Smith, 2005). In traditional cognitivism, cognition - as Thea Ionescu and Dermina Vasc say (see their *Embodied Cognition: challenges for psychology and education*, 2014)- was seen as symbolic processing; in particular, the human cognitive system was seen as the ability to represent things, and to produce abstract representations. But, according Barsalou (2008) and Gallese & Lakoff (2005) these perspectives failed to explain how this ability arises in the developing cognitive system. Consequently, understanding its connection to the real life of thinking agents is too hard a task. The alternative proposed by

Maturana and Varela is an embodied view of cognition (Barsalou, Simmons, Barbey and C. D. Wilson, 2003; Clark, 2011; Crollen, Seron, Lepore and Collignon, 2013; Maouene and Ionescu, 2011; Riegler, 2002; Schubert, &, 2009; M. Wilson, 2002) that covers numerical cognition (Crollen et al., 2013), conceptual knowledge (Barsalou et al., 2003; Boncoddo, Dixon and Kelley, 2010; Borghi, Glenberg and Kaschak, 2004; Vankov and Kokinov, 2013), learning mathematics (Goldin-Meadow and Singer, 2003; Goldin-Meadow, Wagner Cook and Mitchell, 2009; Wagner Cook, 2011), language comprehension (Glenberg, Sato, Cattaneo, Riggio, Palumbo and Buccino, 2008), and language learning (Maouene, Sethuraman, Laakso and Maouene, 2011). The cognitive system highly depends on sensory-motor processes in a way that makes an intrinsic part of higher-level cognition. Thus, cognition is not abstract and amodal; and we have to include the non-cognitive in the very definition of cognition (Barsalou et al., 2007; L. B. Smith and Sheya, 2010). Emotions and affective processes are a constitutive component of cognition (Glenberg, 2008; Stapleton, 2013). As a consequence, should these claims prove to be true, they will entail important challenges not only for the Education Sciences but also for the Learning Sciences.

The way in which we educate children and adults should change radically. To take a simple example, reading is a deeply embodied learning activity. A vast body of evidence supports this idea: the role of meaningful sensory-motor experiences that result in "stronger sensory-motor memory traces that facilitate learning" (Kiefer and Trumpp, 2012, p. 16); the movements that are involved in mimicking gestural experimentation (Cook, Mitchell, and Goldin-Meadow (2008)); the learning of physics concepts (Kontra, Goldin-Meadow and Beilock (2012)); the awareness of complex thinking that proves to be sense-based (Kiefer and Trumpp, 2012, p. 19). As a consequence, education needs to change not only its teaching methods but, above all, its theoretical vision about the qualification of learning process.

Phenomenology, on the other hand, focuses on experiential meaning, and thus derives explanatory propositions from the subjective experience (Gallagher & Zahavi, 2007). Like James and Dewey, Merleau-Ponty argued that cognitions cannot be understood without reference to the body that engages with the world (Marshall, 2008; Merleau-Ponty, 1962, 1965). He emphasizes body and world as crucial components of cognition from a phenomenological perspective. Another important psychological theory that integrates phenomenological and pragmatist perspectives is James Gibson's "ecological theory" (Gibson, 1979). His starting point is that perception is direct and that the environment is meaningful. Consequently, Gibson argued that there was no mediating "mind" between perception and action, but perception could still guide action. Gibson called this meaningful environmental information as 'affordances', which are opportunities for action given directly by the environment (Gibson, 1979).

Thus, cognitive processing does not occur solely in the brain. And the mind comprises not only brain but also includes both body and world (Shapiro, 2011). The thesis of "extended mind" argues that the world is in fact a microgenetic constituent of cognition (see Gerald J. Calais, *Microgenetic Analysis of learning: Measuring Change as it Occurs* (2008), but also Clark & Chalmers, 1998). So the process of change in learning represents a fundamental aspect of Learning Sciences. Many researchers (e.g., Lavelli, Pantoja, Hsu, Messinger and Fogel, 2005) who have studied the problem of change have focused their attention on answering several key questions: What circumstances tend to hasten the emergence of change in learning? What kind of relation between brain and mind engender educational change? How stable are new educational patterns that evolve due to interventions? How are variability

and stability in learning processes related? Do new educational patterns that emerge typically inhibit or coexist with old patterns? These were the same questions raised by the pioneering position of Feuerstein Theory of Cognitive Modifiability. His Theory offers no glib solutions nor does it claim that brain-based learning is a panacea. It *does* provide an objective assessment of the current state of the research at the intersection of cognitive neuroscience, embodied cognition and learning, but maps research and policy implications for the next decade (See also Howard Rotterdam, *The Taxonomy of Cognitive Objectives and the Theory of Structural Modifiability* (2000).

Reuven Feuerstein presents the view that cognition is a variable. Thinking patterns can change; intelligence is modifiable. He states "we refer to structural changes, or to changes in the state of the organism, brought about by a deliberate program of intervention that will facilitate the generation of continuous growth by rendering the organism receptive and sensitive to internal and external sources of stimulation" (Feuerstein, 1980). In other words human beings can learn to learn how to learn. The human is capable of modifying the underlying structure of his cognition. Haywood (1975) states that Feuerstein's definition of intelligence is "the capacity of the individual to use previously acquired experience to adjust to new situations". Feuerstein, himself, defines intelligence as "a process broad enough to embrace a large variety of phenomena that have in common the dynamics and mechanics of adaptation". "It is this adaptability of the organism... that we refer to as modifiability (1990)". Feuerstein calls the process through which we help humans develop the capacity to adapt to their environments the mediated learning experience. "Feuerstein's theory of mediated learning requires that teachers interpose themselves between the child and his or her experiences. It argues that to a large extent the diversity in student performance reflects the different needs for mediated learning. For many students, meaningful learning and the development of new concepts cannot happen without mediation" (Ben-Hur, 2000). Mediated learning differs from direct or experiential learning because in the mediated learning experience there is the human intervention to filter the environment to the organism. Instead of the direct Stimulus – Response of Skinner or the Stimulus – Organism - Response (SOR) of Piaget, Feuerstein proposes a Stimulus – Human – Organism – Human – Response model (SHOHR). The ability of a person to learn is to a great extent dependent on a variety of factors that influence the quality of the mediated experience. Among these factors are chromosomes, environment, developmental level, socioeconomic status, culture, and the emotionality of both caregiver and child (Feuerstein and Feuerstein, 1991). A quality mediated learning experience has three essential ingredients. These ingredients are necessary for any mediation to occur. They are intentionality and reciprocity, mediation of meaning, and mediation of transcendence (Feuerstein and Feuerstein, 1991). The mediator explicitly conveys to the child his intention to mediate and the child must reciprocate by being aware that he is learning. Intentionality and reciprocation is a vital two-way street. It is true communication. Successful motivation of the child creates reciprocity. Mediation of meaning occurs when the mediator communicates the importance and reason for an activity. Mediation of transcendence is the movement towards super-ordinate goals. It occurs when we convey to the student "far transfer". It's the big picture. Other qualities of mediation that might be present include: mediation of the feeling of competence, mediation of regulation and control of behavior, mediation of sharing behavior, mediation of the feeling of belonging, mediation of challenge, mediation of goal seeking, goal setting and goal planning behavior, and mediation of an optimistic alternative (Feuerstein, 1990).

A major methodology in a mediated learning experience is the skillful use of dialoguing and questioning. The use of questions is one of the major discussion points in the training of mediators. The use of higher order questions is perhaps most obvious in the mediation of challenge. Students crave challenge; challenge prevents boredom. Students who are asked to apply, analyze, synthesize, and to judge are more likely to feel challenged than students who are simply asked to spit back what they have been taught. Having students apply their knowledge also is crucial in the mediation of meaning.

When we examine a particular quality of mediation, we need to observe how the mediator interacts with the subject. Mediation is the process of creating change in the organism. The use of higher order questions is essential in creating that change. Good mediators are constantly asking students to analyze and evaluate their responses, to respond to 'what if' questions, to derive principles from experience and to find examples of principles. Meir Ben-Hur (2000) provides a model for the mediated learning experience that contains five steps: Practice, Decontextualization, Meaning, Recontextua-lization, Realization. In practice, we focus on knowledge; in decontextualizing we analyze. We construct meaning by synthesizing and internalize that meaning by comprehending. When we recontextualize, we generate expansive worlds of learning. In the realization process, we apply our deep knowledge to new situations. Throughout we are evaluating our actions at each step.

4. BEING HUMAN: WHAT DOES IT MEAN?

"Learning flourishes when we take what we think we know and offer it as community property among fellow learners so that it can be tested, examined, challenged, and improved before we internalize it" (Shulman, 1999, p. 12). "The self is not so much a substance as a process in which the conversation of gestures has been internalized within an organic form. This process does not exist for itself, but is simply a phase of the whole social organization of which the individual is a part" (Mead, 1934).

The challenge of defining and assessing the need for cognitive mastery emanates from the nature of the human self. The self is an embodied cognitive process for humans. G.H. Mead, Lev Vygotsky, C. Damasio and G. Bateson elaborated on the relationship of the human mind and the human self to social development. George Herbert Mead and Lev Vygotsky were not known to have worked together (Kozulin, 1999). Yet, their ideas on the development of self are strikingly similar. Both Mead and Vygotsky argue that self and mind arise from the social process. Both concur that language is the primary vehicle through which the mind and self emerge from the social process. From this dynamic, the nature of being human is seen as an inseparable, yet changing process between the individual and society. The relationship between the individual and society is rooted in and sustained by the intergenerational transmission of its past, its values, beliefs, customs, routines, etc. This process of transmission is generally known as culture. The development of culture is rooted in the need to survive. "The capacity for culture is part of our biology and the drive to learn is our most important and central instinct" (Gopnik, Meltzoff, Kuhl, 1999, p. 8).

Humans grow and develop through change processes. Piaget describes these processes as adaptation. Piaget's research on human development focused on the relationship of the behavioral and physical in the development of cognition. He elaborated on: 1) the ideas of

structure and function as important elements in the development of human behavior and human intelligence and 2) the components of structure (schemata) and function – organization and the process of adaptation which is comprised of assimilation and accommodation. Piaget defines intelligence as a dynamic and continual process of the organization and reorganization of structure that is inclusive of previously built structures.

The research of Vygotsky confirms that children's thought and behaviour are qualitatively different from that of adults. Vygotsky's research on children's cognitive development identified the child's interaction with objects is only an aspect of a child's cognitive development within the realm of the social and historical context of a child's world. Both Vygotsky and Piaget acknowledged the systemic nature of concepts and operations in a child's thought process. Piagetian theory highlighted two ideas, the first about a group of operations and the second about the developmental stages. He argued that a single operation does not exist because the inherent propensity of operations is forming systems. Developmental stages are marked by their own structural and operational characteristics of schemata. Vygotsky's thesis contends that mental growth depends on the cooperation between social cognitive functions and the changing relations between them. Moreover, cognitive functions form an interfunctional system that contributes to psychological development through mutual mediation.

5. THE DUAL HUMAN PARADIGM AND FEUERSTEIN ALTERNATIVE

"It is probably true quite generally that in the history of human thinking the most fruitful developments frequently take place at those points where two different lines of thought meet. These lines may have their roots in quite different parts of human culture, in different times or different cultural environments or different religious traditions: hence if they actually meet, that is, if they are at least so much related to each other that a real interaction can take place, then one may hope that new and interesting developments may follow" (Heisenberg in Capra, 1983, but also Gibson 2001).

This quotation brings to mind two issues people and societies over the globe must address as citizens of the twenty-first century: technology and humanity. These issues hold at least two lines of thought that emerge as the technological innovations humans created leave many people feeling in- competent and confused about their own identity as human beings. Why would technology appear to be so harmful when so many individuals, organizations, and businesses have profited so much from its features of efficiency and effectiveness?

In general, what mechanisms do humans possess to cope with or confront challenges to our perceptions, values, routines, etc., especially in these rapidly changing times? What is the purpose of the human self? Neil Postman, with *The End of Education* (1995), argues that humans have an intrinsic need to make meaning in and about their existence. He suggests that this need may be summarized as the creation of narratives. Fritjof Capra, in *The Tao of Physics* (1983), explains that, for western civilization, the pursuit of scientific research and innovations has been a major narrative of our societies. The philosophy of René Descartes had a tremendous influence on Western culture and thinking in general. His famous statement had been interpreted, by western civilizations, that the mind and body are separate entities. Humans see themselves as discrete egos existing inside of their bodies, while the mind has

had the futile task of controlling the body. This belief in fragmentation and separation has led the western mind to a state of continual confusion of the relationships among the individual and social processes, and the natural environment. As a consequence, individual and collective narratives become distorted and confused and people see themselves as separate from other people and from the natural environment. For western civilization, technology has become the major narrative or even "god" (Postman, 1995, pp. 9-10). Technological innovations that emanate from the electromagnetic spectrum-lasers, ultrasound, cell phones, satellites, CAT scans, microwaves, remote control, etc. may be both a blessing and a curse to humanity. The question is: can a real interaction take place between the creator (man) and the created (technology) such that "new and interesting" generative developments may follow? (see Pegoretti G., Apprendere l'intelligenza. Il pensiero di Reuven Feurstein alla luce delle neuroscienze cognitive, 2013).

Feuerstein presents a powerful and far-reaching paradigm with the capacity to provide the needed tools for continued human development, problem solving, and decision making. The Theory of Structural Cognitive Modifiability (SCM) and Mediated Learning Experience provide the means by which humans can gain a greater sense of identity and empowerment. The Theory of Structural Cognitive Modifiability emanates from a belief system that characterizes the fundamental human nature of being human is to be modifiable. For modifiability to be realized, humans need to be acknowledged as open systems that can be meaningfully modified by an intervening environment (Feuerstein, Rand, 1997 p. 5). Feuerstein differentiates between modifiability and change. He contends that modifiability more fully describes the transformative nature of the individual – his personality, thinking ability, capacity and general level of competence, where- as changes within the individual often do not culminate in long lasting transformation (p. 7). Feuerstein takes a very proactive and aggressive stance on modifiability. Everyone needs modification at some point in his/her life. To actively engage in the process of modification, one must confront his/her belief system. One must believe that a person who needs modification can be modified, that belief must extend to oneself, and just importantly, one must see that society, public opinion are modifiable and must be modified. Feuerstein operationalizes Mead's thesis on the relationship of mind, self, and the social process. He states "the individual's modifiability passes through the 'filter' of social conditions. Modifiability of cultural attitudes, social practices, and norms, as well as general public opinion, is always a lengthy process" (p. 7). The modifications that occur at the mental level are modifications to the structure of the cognitive process.

Mead, too, states that the development of the human self is a cognitive process (p. 124). The cognitive process is grounded in social experience. And culture is defined by Feuerstein as a process, not an event or series of events; but as a critical element in the development of flexible cognitive structures, which in turns establishes the process of intellectual development or intelligence. Intelligence is defined as the process by which humans are modified (Feuerstein, 1980, pp. 7-8).

As a result of technology, brain research in education and psychology (Bransford, Brown, et. al, 1999; Gopnik, Meltzoff, Kuhl, 1999; Jensen, 1998) demonstrate the amazing plasticity and flexibility of the brain in human learning, coping, and survival. However, with all of the knowledge about the brain and mind acquired by western civilization and cultures, too many individuals continue to be ignorant about their own cognitive processes.

6. COGNITIVE AWARENESS AND MINDFULNESS

We are challenged to be reflective thinkers: "Human modifiability is not only a belief but also a challenge and a responsibility" (Feuerstein, 1997, p. 11). The label cognitive awareness is offered as a metaphor for a paradigm that encompasses Feuerstein's empowering theories of structural cognitive modifiability, mediated learning experience, with regard to the relationships of the development of self and mind within the social process. The idea of cognitive awareness is an attempt to provide a narrative that leads to what Heschel (1983), describes as "radical self-understanding". Radical self-understanding must embrace not only fruits of thinking, namely the concepts and symbols, but also the empathy and experience of thinking, the depth of insight, the moments on immediacy in the communion of the self with others and the reality.

According to Feuerstein, cognitive mindfulness is delineated as a spiraling, cyclic process of four emergent phases: 1) awareness; 2) internalization; 3) realization; and 4) expansion. The following details of the phases are not exhaustive. Rather they represent a characterization of what may occur in the development at each step.

1. *Awareness – I am conscious of who I am.* I acknowledge the existence of my belief system, I believe that I am modifiable. I develop as a result of a sociocultural process through mediated learning experience. I recognize myself as a thinking, and reflective person capable of caring for others as well as myself. I am aware that I possess a transcendent nature – I am not just body and mind. I believe that because I have a transcendent nature I am capable of being more than I am now.
2. *Internalization – I have and can make meaning in and of my life.* My cognitive functioning is conscious developed. I understand myself as an open system – there's no limit to my growth. I am intrinsically motivated to pursue my goals. I have an internal drive to seek out and complete learning tasks, because they are of value. I appropriate the psychological tools necessary for my continued growth and development. I understand the relationship of my rational self to my intuitive self. I am a part of my culture and community.
3. *Realization – I am empowered and dynamic.* I can influence and contribute to the culture and social process of mankind. I realize that culture is dynamic and multidimensional – I can contribute to culture making. I am a valued part of the culture making process through modifiability and mediated learning experience. I realize that through my intentional interactions with my internal and external environments, I be- come more aware of my transcendent self.
4. *Expansion – I can use it, share it, learn and grow from it.* I make conscious use of cognitive functioning. I make daily use of psychological tools. I use self-mediation to problem solve and make decisions. I am able to mediate others. I have the ability to assess the socio-cultural situation, problem solve and make effective decisions. I am an active participant in my own growth and learning and in the growth and learning of others. I am an effective role model to others. STEM Integration is one of the principal goals of learning in school: students should be able to take the knowledge and skills learned in one context and apply them in another. The related approach to understanding learning involves embodied cognition, the perspective that cognition

occurs in a physical organism interacting with its environment; to understand the structures that mediate learning, one must consider the brain, the body, and the environment as an interactive unit (See also Honey M., Pearson G., Schweingruber H., *STEM Integration in K-12 Education: Status, Prospects and Agenda for Research*, Washington, The National Academia Press, 2001).

7. The Transmission of Knowledge: From the Content-Based Approach to the Training Curriculum

If we combine the embodied cognition paradigm and Feuerstein's approach, it is possible to consider the consequences for schooling policies and training approach to literacy and education in the word. We must consider that the most commonly accepted and widely adopted approach is the one which emphasizes the transmission of knowledge and the teaching of basic school/academic skills. The stress in this approach is on the amount of knowledge transmitted and absorbed. The goal is for the learner to absorb what is taught to be capable of reconstructing it. This goal serves as a criterion of the assimilation (mastery) of the material conveyed. A first concern with this approach is that very little is invested in the processes of thinking that can be learned throughout the confrontation with information and experience. Because of this, for many students, learning is often just an episode, restricted to the student's spontaneous elaboration of the categories (principles, rules, etc.) of the content that is being presented. Typically teachers observe the need to cover a prescribed amount of content, under the assumption that the mental activity required in order to connect things, to classify them, and to create relationships between them evolve automatically from exposure to the content. This is why we believe that thinking about the content and constructing a transcendent understanding moves from the immediate content to different areas of process or content at different times and in different places. Because for some students this does occur, it is assumed that it is an automatic process evolving in each student. We know that this is not true.

Nevertheless the content-based approach is applied to all learning subjects. It has been further applied to processes of diagnosis and assessment, where what is evaluated in conventional psychometrics is the pupil's ability to simply repeat which has been learned through questions referring to the content and not to the thinking processes created during exposure to the content.

Because the content-based approach is limited, very often, to the transmission of knowledge, we argue that we'll never meet students' needs. Considering the range of embodied cognitive functions possessed by individuals – within both higher and lower levels of performance – we believe it is important to devise specialized and explicit interventions in order to promote enactive and generative experiences of thinking. Not only the content will be learned, but embodied cognitive skills will be acquired and will enable the transfer of what is learned to other areas of functioning. This raised the need to create the conditions for acquiring these ways of thinking. However, there remained a split between those who saw intelligence as being modifiable by processes of mediated intervention and those who saw intelligence as fixed, stable, and unmodifiable – among the latter Arthur Jensen (1969) and later Herrnstein and Murray (1994) as expressed in their best-selling book *The Bell Curve*.

Although thinking was acknowledged as an extremely significant factor in human adaptation, it was assumed that there is no way of ensuring that those who need "to think" will in fact acquire such skills, since intelligence – in the opinion of this authors – is determined by heredity, chromosomes and genes.

It is time to disseminate an alternative point of view. Feuerstein considers a person as modifiable. But here the optimists too are divided in their opinions. This is the curricular debate. One point of view maintains that the task of imparting formal logical thinking and all that it implies must be carried out in the course of teaching the content. From the content the learner is expected to extract a system of rules, principles, and a way of organizing the material by using different operations (see also Feuerstein R., Falik L., *Stopping to Think, Part Two*, 2014). Depending upon the nature of the content, the principles might be classification, categorization, logical multiplication, logical and transitive thinking, as in using syllogisms. All this is presumed to be embedded in the content and potentially accessible to the learner.

There is a second perspective on this issue, reflected in a method that has emerged in recent years: the curriculum-infusion approach favours the use of content in order to extract the thinking contained in it – to shape the thinking by means of the content. The infusion approach has gained some prominence in curriculum development and has become the source of both conceptualization and intervention programs developed by a number of well-known educators and scholars of learning: improving thinking skills (Baron & Sternberg, 1987; Perkins & Grotzer, 1997; Swartz & Parks, 1994), creativity (Amabile, 1996), behavioral regulation (Shunk & Zimmerman, 1998), and transfer of learning (Tomic & Klauer, 1996) and so on. The study of Lizarraga, Baquedano, Mongado, and Cardelle-Elawar (2009) summarizes the advantages of the infusion approach, and describes the infusion method as a "direct, explicit, interactive, and parallel teaching of thinking skills along with the syllabus content".

There is, however, a potential problem: the consequence may well be the creation of students who are "wise ignorants": their knowledge is limited, but their wisdom is great. The question is not only limited how to decide what content to include and what to omit, and why: there are other problematic aspects in developing the human being trough thinking and experience while teaching content. For students, the infused content approach can create the functional attributes of thinking and experience. But the success is not the same with students who present a more limited learning ability and who do not undergo processes of generalization, transfer, and change. Feuerstein emphasizes this does not mean they can't. Learners are not naturally or automatically interested in or even aware of the relationship between the content to which they are exposed and the ways in which this content can be transferred to other areas of experience.

Another difficulty Feuerstein observes in applying the infusion method. Conventional and widely adopted curriculum standards in many western countries focus on advancing students' knowledge and school skills standards. Effective instruction is thus measured by the amount of knowledge and the extent of the pupil's ability to remember and utilize what has been taught, with relatively less (if at all) emphasis on the thinking implications that can be drawn from their learning.

The infusion method may be suitable for a population with a higher functioning level and with existing thinking habits unrelated to the specific content, but, according our opinion, those students who have such functional attributes will not necessarily have their thinking

enriched nor they will be able to derive maximum benefit from the way in which the principles, rules, and concepts are presented.

In order to address these concerns, Feuerstein anticipates what actual educational policies in the word are to identify and to launch as a training curriculum. For the global and embodied learning perspective, the instructional curriculum must be expanded in ways that will make their studies more generative, not only more efficient (Margiotta, 2007, 2009, 2011). The central assumption of this alternative is that what is learned becomes a point of departure not only for the study of something else, but also for human and social experience in the enlarged contexts. This suggests a third curriculum option.

Creating an awareness and recognition of the rules, concepts, and principles, that can be applied to a specific or related content of life, is most efficiently achieved by producing explicit and systematic interventions on the same thinking processes. This does not substitute for teaching content, but provides alternative skills/strategies/processes that can be learned formally and informally. Feuerstein' perspective on the Process of Bridging is not a metaphor, if we regard it from the perspective of the embodied cognition paradigm.

All learners, even high performers, have a range of cognitive functions that manifest differential strengths, and even some deficiencies. For example, for a variety of learning tasks, one must have skills in scanning and searching for information, placing it in appropriate contexts of time and space, finding relevant descriptive labels, identifying relevant information and planning appropriate responses, and so on (Feuerstein, Feuerstein, Falik and Rand, 2006). The tasks themselves (the learning activity) have different qualities and demands that must be recognized, mastered, and utilized in plural learning situations. Feuerstein's assumption, that it's possible structurally change the cognitive processes of a person, has won significant support among many research studies conducted on the plasticity of the brain. However, the research on plasticity consistently shows that the changes in the brain require systematic and directed exposure to relevant stimulation, and an organized and focused intervention (see Rizzolatti & Craighero, 2004; Skoyles, 2008). The processes of modifiability in learners and improving learning efficacy – creating better learners and better thinkers – require the study of content material meaningful and "skills" that become the point of departure for learning different and diverse contents. Given the current state of teacher education, this requires the training of teachers in areas that are hardly touched upon during teacher training, and for whom the focus has increasingly been directed toward (and restricted to) the teaching of specific academic skills and curriculum content.

8. TALENT IS NOT A GIFT. A NEW DEAL FOR DEMOCRACY AND EDUCATION IN THE XXI CENTURY

The Embodied Cognition paradigm and the Theory of structural cognitive modifiability give us a humanistic perspective to rethink the link between democracy and education in the global knowledge society. Learning experiments and evidence produced by constructivists, cognitive and neuroscientist, have taught us a lot about how we process information; about different and embodied ways of encoding and developing information; about how to make generating expansive learning, and about the active scaffolding that enhances learning. But we have not yet solved the following problem: how do capabilities generate talent in each

thinking agent? We strongly believe that to continue discovering how the mind learns and how to facilitate learning, an interdisciplinary 'learning science' is needed (see Garavan Th, N., Carbery R., Rock A., Mapping Talent Development: Definition. Scope and Architecture, 2012).

There is surprisingly little published research on global talent development issues and literature that defines the scope and sets the boundaries of the concept (Cohn et al., 2005; Younger and Cleemann, 2010; Garavan et al., 2009; Cook, 2010). However, it is acknowledged that talent development represents an important component of global talent (Scullion and Collings, 2011; Barlow, 2006). We suggest that in order to understand the scope of talent development, the following questions should be posed: What is talent for the purposes of innovation? Does talent development focuses on technical or generic competencies or both? What are the learning needs that are the primary focus of talent development, organizational or individual or some combination? Does talent development occur in an accelerated or normal way? What are the embodied patterns and processes that contribute to the architecture of talent development in each individual's personal life evolution?

Answers to these questions should bring some coherence to the scope of the concept. For the purpose of this paper we define talent development as follows: Talent development focuses on the planning, selection and implementation of development strategies for the entire talent pool to ensure that the thinking agent as both the current and future supply of talent meet strategic objectives and that development activities are aligned with the search of innovation in all life experiences.

Our knowledge base concerning talent development is currently weak. However, the existing evidence suggests that organizations are designing talent development processes unique to their organizations. However, it is also clear that many definitions or descriptions of talent development focus on exclusive models and emphasize leadership talent development. A reading of the talent management literature suggests that, at an individual level, talent is something exemplary that certain people possess. A similar notion is proposed by Ready et al. (2010). They articulate the characteristics of high potentials as follows: they consistently deliver strong results credibly; they master new types of expertise quickly; and they recognize that systemic vision and systematic confrontation with innovation's problem count. They also suggest that high potential talent is hardwired with the drive to achieve excellence, a relentless focus on learning, an enterprising spirit, and a capacity to make careful assessments of risk. But can we view talent as referring only to a limited pool of social members who possess unique managerial and leadership competencies? The embodied cognition paradigm and the theory of structural cognitive modifiability strongly refute this statement. Iles et al. (2010) have highlighted the lack of consensus concerning what talent may fall within the scope of a talent's development process. According to their problematization, we can emphasize four possible scenarios: an inclusive approach that focuses on developing each potential thinking agent; an inclusive approach that emphasizes the development of capabilities more generally in the global society; an exclusive approach that focuses on developing specific élite of individuals; or an exclusive approach that focuses on key positions, roles and develops talent to fulfill these roles. The empirical evidence suggests a mixture of approaches in the organizations and in the schools. However, it's increasingly emphasized that high potential talent must be proficient in working in diverse work contexts (Dierdorff and Morgeson, 2007). As a consequence, there is an increased focus, in national

and international guidelines of policies education, on transversal competencies and soft skills. But is it enough? Unlike technical competence, generic competencies provide more significant development challenges. They tend to be holistic, to overlap, and interweave (Capaldo et al., 2006), and are intrinsically related to the kind of person that one is. They are clearly related to issues such as self-confidence and self-esteem of the learner. It is therefore clear that the new workplace places emphasis on skills that go beyond the technical and include a full spectrum of soft skills.

As a consequence, we argue that talent development must increasingly be capability-based in order to cope with the temporality or the innovation dynamism. Whose talent development needs and whose responsibility? Organizational restructuring, globalization and competition highlight the need for both organizations and individuals to be focused on investment in learning (Garofano and Salas, 2005).

So, we must restart from Howard Gardner. His *Theory of Multiple Intelligences* is a theory of intelligence that differentiates it into specific (primarily sensory) "modalities", rather than seeing intelligence as dominated by a single general ability. Gardner articulated eight criteria for a behaviour to be considered an intelligence: potential for brain isolation by brain damage, place in evolutionary history, presence of core operations, susceptibility to encoding (symbolic expression), a distinct developmental progression, the existence of savants, prodigies and other exceptional people, and support from experimental psychology findings.

Gardner chose eight multiple intelligences to meet these criteria: musical/rhythmic, visual/spatial; verbal/linguistic; bodily/kinesthetic, interpersonal, intrapersonal, and naturalistic. He later suggested, also, that an existential and moral intelligence may also be worthy of inclusion. Gardner rejects the idea of labeling learners to a specific intelligence. Each individual possesses a unique blend of all the intelligences. Gardner firmly maintains that his theory of multiple intelligences should "empower learners", not restrict them to one modality of learning. According to Gardner (1995), an intelligence is "a biological and psychological potential which is capable of being realized to a greater or lesser extent as a consequence of the experiential, cultural, and motivational factors that affect a person" (p. 3). In fact, the theory is based upon a view that intelligence is not only inheritable, but the "potential" is also capable of change.

9. GENERATIVE EDUCATION: FROM CHANGE EDUCATION THROUGH EXPANSIVE LEARNING FOR INCLUSIVE DEMOCRACY

The constructivist approach has several perspectives on learning since it recognizes that human beings use their own personal vision in explaining the acquired experience. In addition, the findings of many educational studies confirm that facilitating or scaffolding the learning process is the trainer's main role. So, we call the traditional, dominant paradigm the "Change Paradigm". Today, most learning is functional or informational learning, which is oriented towards socialization and vocational goals that take no account of sustainability. This has been reinforced in Western educational systems by the introduction of a managerial view of education which has paralleled recent economic restructuring. This modernist educational paradigm derives from a broader social and cultural paradigm, which is fundamentally

mechanistic and reductionist. There is a poor fit between this dominant paradigm and our experience of increasing complexity, interdependence, and systems breakdown in the world. Asserting education for sustainable development within the present educational framework can only meet with limited success, as such forms of educational change are marginalized by the mainstream. The real need is to change from transmissive toward transformative learning, but this in turn requires a transformed educational paradigm. Educators, to change, need a clearer understanding of an ecological, participatory worldview from which a strong ecological educational paradigm and culture can be developed. Realization of a sustainable education paradigm requires vision, image, design, and action from all those concerned with achieving healthy, ecologically sustainable societies. Time is critically short to make the educational changes necessary to ensure a secure future. A disruptive innovation succeeds by focusing on affordability, accessibility, capability and responsiveness.

Sfard (1998) suggested that there are two basic metaphors of learning competing for dominance today: the acquisition metaphor and the participation metaphor. The key dimension underlying Sfard's dichotomy is derived from the question: Is the learner to be understood primarily as an individual or as a community? This is an important dimension, largely inspired by the notion of community of practice put forward by Lave and Wenger (1991) and Wenger (1998). However, an attempt to construct a one-dimensional conceptual space for the identification, analysis and comparison of theories is bound to eliminate too much of the complexity of the field of learning. The potential and significance of a framework of generative learning calls for a more multi-dimensional engagement. According to Engeström (1997, 2016)[3], the theory of expansive learning puts the primacy on communities as learners, on transformation and creation of culture, on horizontal movement and hybridization, and on the formation of theoretical concepts. Even though Felstead et al. (2005, p. 362) write that the theory of expansive learning merely extends the participation metaphor, this theory does not fit into either one of the two metaphors suggested by Sfard (1998). In fact, from the point of view of expansive learning, both acquisition-based and participation-based approaches share much of the same conservative bias. Both have little to say about transformation and creation of culture. Both acquisition-based and participation-based approaches, the latter especially in the original legitimate-peripheral-participation framework (Lave & Wenger, 1991), depict learning primarily as one-way movement from

[3] The theory was initially formulated some 30 years ago (Engeström, 1987) and has been used in a wide variety of studies and interventions. The topics range from adult mathematics learning in workplaces (FitzSimons, 2003) and hybrid educational innovations (Yamazumi, 2008) to the impact of ICT reforms on teacher education (Rasmussen & Ludvigsen, 2009). The theory has been used in a study of the development of a conflict-monitoring network (Foot, 2001), in a study of multi-organizational change efforts in an industry (Hill, Capper, Wilson, Whatman and Wong, 2007), and in an analysis of the emergence of biogas production as a learning process (Pereira-Querol & Seppänen, 2009). These studies also deal with learning in and for interagency working with youngsters who are at-risk of exclusion and have special educational needs (Daniels, 2004), as well as with the uses of weblogs in e-learning (Makino, 2007), and learning among nurses and adult educators who function as 'portfolio professionals' in that they contract their services to multiple employers and organizations (Fenwick, 2004). The theory has been used as framework in a study of simulated clinical experience in university nursing education (Haigh, 2007), in a study of learning as boundary crossing in a school–university partnership (Tsui & Law, 2007), and in a study of promoting new types of transfer between school and workplace (Konkola, Tuomi-Gröhn, Lambert and Ludvigsen, 2007). See Engeström, Y. and Sannino, *A. Studies of expansive learning: Foundations, findings and future challenges*. Educational Research Review (2010), doi:10.1016/j.edurev.2009.12.002). The theory of expansive learning has been found particularly useful in analyses of learning in non-traditional, hybrid and multi-organizational settings.

incompetence to competence, with little serious analysis devoted to horizontal movement and hybridization. Acquisition-based approaches may ostensibly value theoretical concepts, but their very theory of concepts is quite uniformly empiricist and formal (Davydov, 1990).

In contrast, our core idea is qualitatively different from both acquisition and participation. We must focus on the fact that, in expansive learning settings, learners learn something that is not yet there. In other words, learners construct a new object and concept for their collective activity, and implement this new object and concept in practice.

The basic argument for such a focus on work settings is that traditional modes of learning deal with tasks in which the contents to be learned are well known ahead of time by those who design, manage and implement various programs of learning. When whole collective activity systems, such as work processes and organizations, need to redefine themselves, traditional modes of learning are not enough. Nobody knows exactly what needs to be learned. Invention, and not only generalization, is at the core root of learning. Generalization is based on identifying and mastering variation. This led to standardization of key actions and action sequences. Today the life cycles of entire product, production and business concepts are rapidly becoming shorter. Correspondingly, the rhythm of overall concept-level transformations is accelerated. In other words, what needs to be mastered is variation in the sense of constantly shifting product, production and transaction concepts. This is no longer achievable by means of technical optimization of isolated actions and processes. Accelerated concept-level changes in work and require inventive practice and learning *that expand the learners' horizon and practical grasp up to the level of collective activity systems*. There are two additional factors that add weight to the societal need for expansive learning. The first one is the emergence and escalation of social production or peer production (Benkler, 2006) that utilizes the interactive potential of the Internet, or Web 2.0. This opens up a field of possibilities for the formation of new types of activities and use values with huge expansive potentials, such as Linux and Wikipedia. The second factor is the emergence and increasing presence of global threats and risks, or 'runaway objects' (Engeström, 2008), exemplified by global warming, new pandemic diseases and global financial disasters. This opens up a field of tremendous challenges for concept formation and practical redesign in a scale that has to exceed the boundaries of any single discipline, profession or organization.

In important transformations of our personal lives and organizational practices, we must learn new forms of activity which are not yet there. They are literally learned as they are being created. There is no competent teacher or trainer. Standard learning theories have little to offer if one wants to understand these processes. Gregory Bateson's (1972) theory of learning is one of the few approaches that are helpful for tackling this challenge. Bateson distinguished between three levels of learning. Learning I refers to conditioning, acquisition of the responses deemed correct in the given context – for instance, the learning of correct answers in a classroom. Bateson points out that wherever we observe Learning I, also Learning II is going on: people acquire the deep-seated rules and patterns of behavior characteristic to the context itself. Thus, in classrooms, students learn the 'hidden curriculum' of what it means to be a student: how to please the teachers, how to pass exams, how to belong to groups, etc. Sometimes the context bombards participants with contradictory demands: Learning II creates a double bind. Such pressures can lead to Learning III where a person or a group begins to radically question the sense and meaning of the context and to construct a wider alternative context. Learning III is essentially a collective endeavor. Bateson's conceptualization of Learning III was a provocative proposal, not an elaborated

theory. The theory of expansive learning develops Bateson's idea into a systematic framework. Learning III is seen as learning activity which has its own typical actions and tools. The object of expansive learning activity is the entire activity system in which the learners are engaged. So, in our opinion, the expansive learning activity produces culturally new patterns of activity, enrich the strategies of development of talent. Expansive learning at work produces new directions to development of personal talent.

We habitually tend to depict learning and development as vertical processes, aimed at elevating humans upward, to higher levels of competence. Rather than simply condemning this view as an outdated relic of enlightenment, we suggest a complementary perspective, namely that one of sharing or sideways learning and development of talents.

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Chapter 4

EMBODIED COGNITION AND CAPABILITY APPROACH IN EDUCATION

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ABSTRACT

The Capability Approach, both in the original vision of Sen and Nussbaum, both from the point of view of Margiotta, Alessandrini, Costa (in an Italian study) today represents an interesting research framework, not only in the economic and social studies, but also in the psychological, anthropological, biological and pedagogical studies. The concept of "capability" goes beyond the "human capital model" (in a functionalist perspective) to become a "free act", a "creation of new worlds of knowledge" (Nussbaum, 2013); it becomes, in this perspective, an autopoietic process, part of a relational domain, regulated by the flow of the "languaging" and of the "emotioning". In this context, the capabilities arise in the intersection skills/competences, specifying the role of the intellectual skills and cognitive strategies (objectification of learning processes/subjectification of the learning processes; linear didactics/non-linear didactics). The reflection focuses on the synergic intersection skill/knowledge/competence/ capability, retracing the studies of Gagne, Margiotta, Minichiello, Maturana, and Varela studies. The theme of the embodied is dealt from the Embodied Cognitive Science perspective; knowledge strictly linked with corporeality and depends on how the other self is perceived. The consciousness of knowledge (and dynamics related to it) has a decisive role. Here embodied is interpreted in the "radical embodiment view," with reference to "enactive emergentism." On the one hand, the capabilities, the other, the emergence of knowledge in an embodiment view (showing the neurophenomenological approach that sees neural substrates of knowledge/consciousness level of commitment to dynamic emerging models and transient brain activity on a large scale, rather than at the level of particular circuits or classes of neurons). Here emergentism involves, in an auto-referential circle of phenomena, the mind, the body and the world (Thompson, Varela, etc.). The aim of this research is to intersect, in an original way, the themes of the "capability approach," the "enactive/generative perspective" and the "radical

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embodiment", considering the idea of a "trilogy of the mind" (Computational Mind, Phenomenological Mind, Bio-physiological Mind: syntax, semantics and grammar of knowledge).

Keywords: Capability approach, Embodied Cognition, Enaction, Emergentism, Intellectual abilities, Cognitive strategies, Computational Mind, Phenomenological Mind, Bio-physiological Mind.

CAPABILITY APPROACH AND LEARNING PROCESSES

In the last few years, in many areas of academic research, theorists have witnessed that many have taken part in an increasingly lively and complex discussion on the real meaning of the *capability concept* both in socio-economic and anthropological-cultural terms.

By *capability* in education field, generally, one means that particular predisposition of each individual to transform his/her own *cognitive potential* into *behavioral attitudes* or *competences*.

Though the concept underlying the term could already be found in the thought of past time theorists, the Indian economist and philosopher, Nobel Prize winner, Amartya Sen and the philosopher Martha Nussbaum are those who remarkably specify its essentiality in the field of human and social sciences.

A basic premise of their perspective is having considered that the capability approach seen as a strategy to reach the *well-being state* depends on what people are really interested in what they have to do and, consequently, to be up to the standard of life they can really lead.

To sum it up, for Sen "capability" means "the possibility of working made up of the states of being and doing" (Sen, 1992, p. 63) which allows the individual to use complex networks of tangible and intangible resources (share capital). Martha Nussbaum, instead, goes beyond this functionalist approach because she thinks that the capability implies a strictly human action of an ontological nature.

The fact that man is *capable of acting* means that one can expect the unexpected from him and that he can do what is extremely unlikely (Arendt, 1988, p. 131). Therefore, in this perspective, the word *capability* acquires a new, particular meaning that is closely linked to the *human action* and makes man the unique, unquestionable master of his own destiny.

Arent, earlier, identified *human action* as *archein, freedom of action, the principle generating new thought* and definitely moved away from the idea of *action* that was simply meant as a re-proposition or replica of ready-made *behavioral schemes* (Arendt, 1988).

The *capability approach* for Martha Nussbaum clearly follows the same logic underlining the importance of *human dignity, quality of life* and *of the social, cultural and environmental opportunities;* all this allows man to *act*, to *create*, to *imagine* and to *be innovative* and *creative*. In fact, one of Martha Nussbaum's firm ideas is that the respect of *human dignity* is closely linked to *human capability* and to the idea of thinking of the individual as an *end* not as a *means.*

In order to understand this principle better, we have to assume that *imagination* and *feelings* have an outstanding role along with the full use of one's *capabilities* (that she classifies as *basic, inborn* and *combined*), as well as the use of the *human functions* that can make man feel, *free, dignified* and *fully accomplished*.

For Martha Nussbaum, *capabilities* are inborn basic components; these are to be found in every individual as *basic* capabilities and are the essential layer for the development of further, more advanced competences (Nussbaum, 2013). Taking all this into consideration, we can look at the educational actions in a new light and learners will have better chances for *learning* what will make them feel more creative.

Margiotta, cleverly, captures the pedagogical essence, identifying the overcoming of the principle of dependency/subordination of the educational space from economic one, a new way for "models and theories of inclusive education are able to anticipate the real conditions of human development and the post-human in this world" (Margiotta, 2014, p. 48).

"Ciò significa – he says – che il terreno del confronto tra spazio economico e spazio educativo costituisce da sempre il problema peculiare della ricerca educativa, perché da sempre il tema della qualificazione dello sviluppo umano genera, nel tempo della modernità, le aporie tanto dell'economia quanto dell'educazione. Sicché la «pedagogia implicita» della Nussbaum fornisce alla ricerca pedagogica un riferimento euristico significativo"[1] (Margiotta, 2014, p. 48).

In this context of reflection, the learner takes on a different awareness about the possibilities of action, which here becomes generative of *new worlds of knowledge*. Here, learning becomes a process of continuous entropy compensation where *autopoiesis* and mutual *co-evolution* of both the *learning* and *teaching* systems are the basic presuppositions the educational pattern is based on (Maturana, Varela, 1985).

"In this respect, it is necessary to hope for a social formative policy where the structural dimension of the phenomenology (the upbringing and training of the new generations) is not the simple sum of its elements, but it should represent, in terms of competences, the quantity and the quality of its activated relations and finally becomes policy making, where *State*, *Society*, and *School* with their heritage to be acknowledged and consolidated will be able to interact and convey *ethical values* and *meanings* in view of *life-long learning* and pave the way to *learnfare* in which the formative need of the *subject-person* becomes the pivot on which to build and manage the systemic personal complexity within the wider social complexity. Therefore, a Paideia arises that lives the education domain; it arises as a complex network system that can orientate the learning processes and to give the learners the ability to spontaneously create their own cognitive processes to organize the mental patterns procedures, structures and net-like interlinks for new cognitive situations and new working systems (Maturana,Varela, 1985). In short, it is a Paideia that is seen in its *atropo-ethical dimension* as the hard core that *enables* the *individual*, the species and society to interact (in an enactive circuit) with one another" (Pastena, Visconti, Gomez Paloma, 2013, p. 196).

That having been said, the points that one cannot do without for a social and political governance of a school with a *full capability approach* are the teachers' roles, professional orientation of young people, the ways and the value of certifications to give them meaning and proof of their effective worth and the criteria for accessing the formative training courses (Margiotta, 2014).

[1] "This means – he says – that the comparison between the economic space and the educational one has always been the main problem in educational research, because the development of men always brings about the inability to give precise answers both in the economic and educational fields. So, the Nussbaum's "implicit pedagogy" provides to the educational research a significant heuristic reference" (Margiotta, 2014, p. 48).

"In questa prospettiva, la scuola capacitante del futuro supera il modello del capitale umano, volto essenzialmente alla preparazione di produttori efficienti, per assumere quello dello sviluppo umano, teso all'espansione delle libertà personali"[2] (Costa, 2015, p. 183).

Thus a new *idea of school* looms up that can give positive answers to the need for a real, social, cultural and economic development of our country ((Baldacci, 2014).

This, of course, means taking up full *ethical responsibility*, which clearly appeals to all individuals in their *acts of learning*.

"No basta con decir que la educación es una transformación en la convivencia. Tenemos que sentirnos invitados a vivir y convivir contestando responsablemente todas las preguntas que surjan: ¿qué es educar?, ¿cómo estamos educando a nuestros niños, niñas y jóvenes?, ¿qué deseamos de la educación?, ¿qué desean los educandos del proceso educativo?, ¿educar es tarea sólo del colegio?, ¿quiénes son los actores comprometidos en este proceso?, ¿de quién es la responsabilidad de la tarea educativa? Sólo desde un espacio reflexivo que nos abra la mirada a nuestra multidimensionalidad relacional podríamos generar una nueva mirada a nosotros mismos, convirtiéndonos como adultos en un frente transformador, al hacernos cargo responsablemente de la tarea educativa: "educar es un proceso de transformación en la convivencia de todos los actores involucrados y, si queremos que nuestros niños y niñas crezcan como seres autónomos en el respeto por sí mismos y con conciencia social, tenemos que convivir con ellos respetándolos y respetándonos en la continua creación de una convivencia en la colaboración desde la confianza y el respeto mutuos (H.M.R.). No basta con decir que el futuro de la humanidad no son los niños, sino los adultos con quienes conviven, entrando seriamente como individuos en un proceso consciente de continuo cambio que nos lleve a convertirnos en personas adultas, con las cuales los niños, niñas y jóvenes desean convivir y respetar. Es nuestra tarea como comunidad humana"[3] (Maturana, Ximena, 2006, p. 31).

"[…] culture shapes up as a close-knit network of conversations that features, consolidates and preserves a particular way of living. A baby is born and grows within rational domains that define his own life environment, wherefrom he learns the close-knit network of conversations and the dynamics of the relational strategies. […] The education/educability of the young generations is made, in this perspective, through the flow of conversations within the wide conversation network that includes the whole of mankind. Under this point of view, being out of the negative dynamics out of the dysfunctional and

[2] "In this perspective, the capability school of the future goes beyond the human resources pattern focusing essentially on the formation of efficient producers, but concentrates on a human development pattern aiming at giving more personal freedom" (Costa, 2015, p. 183).

[3] Not enough to say that education is a transformation in coexistence. We should be invited to live and live responsibly answering all questions that arise: what is to educate?, how we educate our children and young?, what education we want?, what learners want the process?, educational task only educate school is?, who are the actors involved in this process?, whose is the responsibility of the educational task? Only from a reflective space to open our eyes to our relational multidimensionality we could generate a new look of ourselves, making us as adults in a transformer front, to take charge responsibly of the educational task, "education is a process of transformation the coexistence of all stakeholders and, if we want our children as self-respect for themselves and socially conscious beings, we have to live with them respecting them and respecting the continuous creation of a coexistence in cooperation from mutual trust and respect (HMR). Not enough to say that the future of humanity are not children, but adults with whom they live, seriously entering as individuals in a conscious process of continuous change that leads us to become adults with whom children and young people want to live together and respect. It is our task as a human community" (Maturana, Ximena, 2006, p. 31).

conflictual situations between welfare and its subjects means, above all, a change in the conversations network that governs our daily living. The driving element of this change is the emotional state that guides the domain of the living together" (Pastena, Visconti, Gomez Paloma, 2013, p. 172).

L'EMBODIED COGNITION IN EDUCATION

In order to make it easier to understand the ideas of this dissertation there is another suggestion we would like to give, that is, to refer to the Embodies Cognitive Science paradigm (ECS).

In this perspective, any acquisition of knowledge is strictly linked with the corporeity or physical self and depends on the way whereby the relation between the physical self and the surrounding world is perceived (Wilson, 2002). Thus one goes beyond the dichotomy of *body and mind*, that is, the vision of a mental function that is completely detached from one's senso-motorial activities and not related with the individual's personal experience.

Indeed, in the Embodied Cognitive Approach, the cognitive processes depend on the *senso-motorial* system, that has the important function in the individual's *capability* of transforming his/her own *cognitive potential* into *abilities/attitudes/behaviors*.

Perception and *action* are, therefore, strictly linked and go on together (Pastena, Damiani, D'Anna, Gomez Paloma, 2015).

The Embodied Cognitive Science revalues the role of corporeity in the cognitive processes and reconsiders the essential role that the *embodied* has as a medium to perceive, to elaborate, re-elaborate and to interact with the world stressing the senso-motorial capability function of an organism (Gomez Paloma, 2013).

Thus, referring a principle that enhances the body's biology (Embodied) as part of the mental generator process (Cognition), means focusing the attention on a *neurophysiology of learning*, which can give a positive answer to the so many questions on the *significance/sense* of the education.

It is just trying to intersect aspects of *neurophenomenological nature* and aspects that are more intertwined with the *neuro-physiology of learning*, that Pastena and Minichiello have assumed the existence of *three different ways* whereby the mind expresses itself and interact with one another in an organic way. These three expressions of Mind intersect one another in the hologramatic and fractal way as: *Phenomenological Mind* (semantics of knowledge), that relates to *questions of meaning*, *Computational Mind* (logical syntax of knowledge), that responds to the *logic issues* and *Bio-physiological Mind* (grammar of knowledge), concerning the *bio-evolutionary processes*. (Pastena, Minichiello, 2014).

This conceptual pattern presupposes and justifies an interactive and synergical teaching, that is, between *answer learning* and *deep learning* (which specifies the person's sense and the identity's sense).

"Cogitate is not the same thing as compute. The operations of the calculation result in algorithms that can be processed by any machine capable of operating on the physical symbols (a computer, a brain). The machine computing processes representations following rules that cannot be violated (one of these rules is the logical principle of non-contradiction). In humans, this may be the expression of "Computational Mind." Some organisms, however,

are characterized by the property of possessing different levels of rules: in the lowest level, they are very simple; at a higher level, there are meta-rules, that is, rules of the second level. They consist of the possibility of suspending the application of the rules of the first level in some circumstances. To carry out such an operation must, however, reflect the rules of the lower level. Here the compute takes the form of cogitate. Cogitate can therefore be defined as the set of operations produced by reflexivity. Reflexivity is a characteristic of the human being and the "cogitate" is essential prerogative of system thinking. In humans, the quality of thinking is linked to the ability to question the sense of their own position in the world. In this perspective, the sense is neither in the system nor in the world, but in the relationship that is established between themselves. In fact, the biological substrate of the human component (neurons, atoms, etc.) acts, according to synchronized behavioral patterns (Bio-Physiological Mind)" (Pastena, Minichiello, 2014, p. 2373).

Therefore, it is clear that in order to get good results and to carry out a meaningful and effective educational action plan, it is necessary to start after acquiring a good knowledge of the systemic complexity.

"This conceptual articulation presupposes a unified teaching method (enactive didactic), articulated and harmonized in the three levels of description mentioned above through a dual articulation of learning processes: the "response learning" and the "deep learning." The deep learning is the path that every human being does to maintain its sense unit inside an environment in turn equipped with sense. The purpose of the system is the preservation of their own mental organization (identity) through successive modifications of his own mental structure" (Pastena, Minichiello, 2014, p. 2373).

Looking at it from this perspective, the *embodied* has an interesting speculative interest that leads us to deepen the knowledge of this topic.

"The *embodiment* is a synthesis concept, a bridge that links various areas of research, in a unified whole including the biological, the phenomenological, the socio-cultural and the environmental areas as the relevant starting points to make up the whole. […] The body as form leads to a biological point of view; the body as lived experience leads to a personal phenomenological or psychological starting point; the body actively involved in and with the world tends to a contextual, social, cultural an environmental starting point" (Overton, 2008, p. 3).

"ANSWER LEARNING" AND "DEEP LEARNING"

Minichiello suggests two ways of learning: a *deep* one, that is unpredictable and an *intentional* one, that is predictable. These two ways of learning interact and mutually affect one another. Learning is always the result of a compromise between the two ways of learning (Minichiello, 1995, p. 124).

In this context, *linear teaching methods* interact with *non linear teaching methods* with synergical details of intentional processes (answer learning) and learning with personal answers (deep learning) At the first level, it is possible to single out both the procedures that the teachers use to check the necessary input for the results they want and the ways to choose the answers given by the students to the objective tests. At the second level, that is

hermeneutical/interpretative and *producer of new knowledge*, there is no objective answer, but unpredictability, discontinuity, systemic reticularity and non-causality criteria.

Learning is not an unpredictable process. That means that an observer cannot foresee what the answer will be, not the way it has to be made, nor how long it will take; it is easy for an observer to see the lack of knowledge and skills. Yet, it is not correct because unpredictability expresses discontinuity between the initial disorderly situation (symmetry, lack of information) and the final orderly situation (asymmetry, information). The final order is causal, as it has a linear logic, but the way you get to it is not causal (Minichiello, 1995, p. 122).

In a teaching, program processes of *objectification of learning* and processes *of subjectivation of learning* intertwine all the time and bring about a continuous swapping from using *intellectual abilities* (subject in answer learning) to using *cognitive strategies* (subject in deep learning). In this perspective, the processes and objects of learning take on a dialectical dimension with a creative point of view that produces complex thought and knowledge.

LEARNING BETWEEN "CAPABILITY" AND "PERFORMANCE"

The capabilities are expressed through learning which is here understood as the relation between the self and the other self both, as a non-linear process, essentially founded on the principle of the unforeseen and on the sensorial perceived act.

Learning is meant as the production of new knowledge with a remarkable difference from training which, on the contrary, is figured as a linear process, self-referential, reiterative and repetitive (Minichiello, 1995).

If it is so understood, it takes on the meaning of *semantic codification*, a *re-translation* of the *disturbing impulse* in a meaningful context of the subject; this *new attitude of the mind* seen as the subject's answer is expressed in an attempt to create *order* out of the *disorder* entropy.

All the structures that can create *order* out of *disorder* follow the *non-linear logic*. Going back to the discussion on the reflection focused on the interaction of the teaching-learning dynamism some spontaneous questions arise.

How much of the presuppositions so far taken into consideration can help us figure out an epistemological picture of reference on the learning dynamics of the individuals? How do learning and teaching interact in an educational teaching environment? Anyway, what is interesting to point out here is that the learning process follows logic, strategies and goals that are different from those of the teaching process.

In fact, while teaching involves the epistemological side, follows linear logical ideas and suggests ready-made organized knowledge material in concepts, learning tends to the psychological side, that is, knowledge notions that evolve continuously; here the subject tries to give meaning to the reality around him by using patterns and symbols.

The teaching plan is based on the assumption that all sorts of teaching should absolutely aim at acquiring various and complete forms of knowledge. But, what are the teaching objectives that guarantee real learning?

Gagnè made up a detailed *taxonomy framework* where he lists not only the *learning objectives* but also how they can be successfully achieved, in the *educational system* with the *teaching practice*. The basic principle of his theory is that learning finds its essential premises in translating the human *capabilities* into *performances* (Gagnè, 1978).

Gagnè thinks that the *intellectual abilities* are the abilities to use the *information* acquired by the subject in his/her life environment. The *informations* are just the material to be used for the *intellectual abilities* and *cognitive strategies*.

The *cognitive strategy* is what controls the memory and learning process and allows the *knowing subject* to pass from the detailed particular to the general hypothesis. While the *intellectual abilities* apply to specific learning topics, the *cognitive strategies* refer to learning itself and are to be identified with the learning styles that are inborn in each individual or subject.

In this viewpoint, the attitudes, the value worth trends, preferences and idiosyncrasies inborn in each individual have an important role. In laying out an educational project it is necessary to single out the human capabilities to be developed and the performances whereby such capabilities appear and can be verified and assessed.

The *intellectual abilities* (that are associated to the answers learning) can be learned and taught and refer to *linear processes* and linear teaching; the *cognitive strategies* (that are associated to *deep learning)* can be learned only with *non-linear teaching* and in situations of *systemic complexity*.

The target of the *intellectual abilities* is, in fact, information on which the mind can work; on the contrary, the *cognitive strategies* refer to the *mind itself* and the *thought* and their target is the way whereby they *assimilate, ri-elaborate* and *decodify* information.

Each *individual learns* by using his/her personal style (method) and all individuals can develop personal productive styles; this allows them to develop *cognitive strategies* that are *appropriate* to the various contexts of reference.

Here the discussion seems to be interested with the founding principles of the *Capability Approach*.

"Il suggerimento della Nussbaum - says, in this regard, Margiotta - è sottile. Se il terreno di confronto è dato dal libero, pieno esercizio dei diritti fondamentali della persona, questo terreno è lo spazio della libera piena qualificazione dello sviluppo umano della persona. Con altre parole noi lo identifichiamo come spazio educativo, e assegniamo alla ricerca pedagogica la qualificazione dei processi fondamentali e allargati di qualificazione degli apprendimenti (il sentire, il volere, il pensare, l'inventare) come suo oggetto proprio di analisi e proposta[4]" (Margiotta, 2014, p. 48).

[4] The suggestion of Nussbaum - says, in this regard, Margiotta - is subtle. If the level playing field is given by the free and full exercise of the fundamental rights of the person, this sector of study is the full and free space of the human qualification and of the human development of the person. With other words, we identify it as an educational space, assigning to the educational research the qualification of the fundamental processes of learning (the feelings, the wishes, the thinking, the inventing) as its own object of analysis and proposal.

FROM "CAPABILITY" TO "CONSCIOUSNESS OF CAPABILITY"

During an interview with "Rai Educational" in January 2001 and published in "Enciclopedia Multimediale delle Scienze Filosofiche" on the topic of *consciousness*, Francisco Varela wished that people could speak about conscience and wondered which apparatus could make it possible to live one's experiences or, to say it in other words, the phenomenal world.

He stated: "under certain conditions, the cognitive apparatus, of which we know several things, makes it possible to see this unique phenomenon in the universe viz being aware of one's experiences" (Varela, 2001).

Here, a hard debate arises on the *essence of consciousness*, on its nature and its extent. The topic looms as the hard core for discussing on the general theme of knowledge.

Over the years, a hard talk has been going on; it has been a pedagogical, philosophical, anthropological, sociological, psychological and biological one, that has started a wide range of complex discussions beginning with superficial and materialistic interpretations and to go on to studies of remarkably meaningful importance.

Francisco Varela has, certainly, given to this dissertation an important contribution; in fact, he has elaborated a complex and representative study on the *emergence of consciousness*, that he calls *neurophenomenology*.

In Varela's opinion, *consciousness* does not live within us and is not always "present in our mind" (Varela 2001). It is an *emergency*; to live within us it needs the presence of three particular conditions: *with the body, with the world and with the others.*

By the way, in a hard debate with Varela, David Chalmers singles out two different aspects, that he calls *problems*, on the *essence of consciousness.*

He calls the first one the *easy problem* and is related to the way the brain works in the act of the decodification of sensorial and perceptive stimuli that lead the individuals to the acquisition of *consciousness*; the second problem is the *hard problem*, that deals with the relationship between *consciousness* and experience. At this point, there is something more than the simple *transformation/activation of the neural circuits* in *the act of acquiring knowledge* and in the mind's capability.

In his answer to Chalmers, Varela claims:" This is absolutely not about trying to reduce or cancel the phenomenal into the empirical, because this attempt is doomed to failure. Thought is not "smoke" coming out of the brain (Varela, 2001).

The emergence of a state of *consciousness* acts in a way that is linked to the local components of the nervous system, that is, on the action of neurotransmitters and/or on the synaptic interaction and brings about a causal action circuit between what makes it possible for the action to emerge and what actually emerges.

When we think of this, the *consciousness* of action or, better, the *capability in action* appears as *pure relational identity* in a non-linear phenomenological context related to experience, where *every act of thought* is generated by the *emergence of a state of mind.*

"CAPABILITY" AND "RADICAL EMBODIMENT"

The conceptual warp of our work, leads us to reflect on the assumptions that animate the idea of close interconnection between the founding principles that justify both the *Capability Approach* and *Embodied Cognitive Science* (ECS). The reflection to which this dissertation wants to take proposes to re-evaluate the importance of a set discussion on the idea that the corporeal entity is essential to the activation of a learning process that has a real and meaningful significance in a *capability process*.

The *Embodied Cognitive Science* revalues, in fact, the role of embodiment as a *driving force* for the construction of knowledge and justifies, in this direction, the *Capability Approach* model. The Embodied enhancing the function of the *senso-motorial skills*, is the essential medium, to perceive, elaborate, restructure and interact with the world, creating the foundations for a real *structural coupling*, able to return, in terms of knowledge, to new and more sophisticated *knowledge worlds*.

In this context of reflection, the principle of *radical embodiment* assumes a pregnant meaning; in the perspective of Thompson and Varela it is so identified "Embodiment and situatedness are now common themes in cognitive science. Recently, Andy Clark drew attention to three controversial 'radical embodiment' propositions often found in current research: (1) understanding the complex interplay of brain, body and world requires the tools and methods of nonlinear dynamical systems theory; (2) traditional notions of representation and computation are inadequate; (3) traditional decompositions of the cognitive system into inner functional subsystems or modules ('boxology') are misleading, and blind us to arguably better decompositions into dynamical systems that cut across the brain-body-world divisions. These claims taken together express the viewpoint known as 'enactive' cognitive science. Here we explore the implications of this viewpoint for the neuroscience of consciousness (Thompson, Varela, 2001, p. 418)."

"Here, *neurophenomenology* becomes "methodological proposal" that seeks to study, to observe, to understand and to analyze brain activity (description in the third-person) without neglecting the subjective experience (first-person).

What is, in this perspective, the relationship between neuronal structures and lived experiential? How to put together the subjective knowledge and objective knowledge?

Varela and Thompson explain it in terms of *enactive emergentism* highlighting the presence of a twofold action of causality (bottom-up and top-down), which is clearly evident from the resonance that is established between groups of cortical cells in some given moments of the life of consciousness. The consciousness identity has, in this perspective, a relational meaning and exists only as a relational pattern (consciousness is not smoke coming out of the brain). That is shown through a synchronized rhythmic discharges synaptic well highlighted in the dual pattern of causation. If mapped to the level of individual neurons, the electrical-chemical interactions do not occur in a precise direction and do not have an overview of organic and represent, however, the minimal units necessary for the emergence of a higher level of organization, expression of a state of consciousness that are well-defined and organized and that, once emerged, conditions the functioning of each single neuron synchronizing and ordering the action" (Pastena, Minichiello, 2014, p. 2371).

"The emergence determines the crystallization of a circle of local-global causal dependencies. For Varela this circle of dependency is found in a neuro-physio-anatomical

level, where to each bio-chemical and physiological structure corresponds another structure in the opposite circle. This approach, therefore, aims at mapping the neural substrates of knowledge/consciousness as emerging dynamic patterns and transient brain activity on a large scale, rather than at the level of particular circuits or classes of neurons. Varela's theory is fascinating and considers the emergentism positions as co-determination of reciprocal causes, including, in an auto-referentiality circle, "mind, body, world" " (Pastena, Minichiello, 2014, p. 2371).

In fact "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, p. 424).

In the Thompson and Varela Radical Embodiment Approach, *corporeality* and *human relationships* intersect, creating an original analytical perspective on the *emergence of knowledge.*

CONCLUSION

Finally, education is a moment of personal and cultural transformation and reflection on *social relationships*, with particular attention to the most problematic aspects of *human action*, which often generate powerlessness phenomena with devastating consequences for the harmonious development of personality.

Maturana in this regard says "No basta con decir que la Educación es una Transformación en la Convivencia, tenemos que hacerlo parte de nuestra conciencia cotidiana. Tenemos que sentirnos invitados a vivir y convivir al interior de las comunidades humanas que realizamos, contestando seria y responsablemente a todas las preguntas que surjan: ¿qué es educar? ¿Cómo estamos educando a nuestros niños, niñas, y jóvenes?, ¿qué deseamos de la educación?, ¿qué desean los educandos del proceso educativo?, ¿es tarea sólo del colegio el educar?, ¿quiénes son los actores comprometidos en este proceso?, ¿de quién es la responsabilidad de la tarea educativa? Sólo desde un espacio reflexivo que nos abre la mirada a nuestra multidimensionalidad relacional es posible que podamos generar una nueva mirada a nosotros mismos, convirtiéndonos como personas adultas en un frente de onda transformador al hacernos cargo de manera responsable, e impecable de la tarea educativa, que es tarea de todos: "educar es un proceso de transformación en la convivencia de todos lo actores involucrados, y si queremos que nuestros niños y niñas crezcan como seres autónomos en el respeto por sí mismos y con conciencia social, nosotros los adultos tenemos que convivir con ellos respetándolos y respetándonos en la continua creación de una convivencia en la colaboración desde la confianza y el respeto mutuos" (H.M.R.). Sin embargo, no basta con decir que el futuro de la humanidad no son los niños sino que los adultos con quienes los niños conviven, entrando seriamente como individuos en un proceso conciente de continuo cambio que nos leve a convertirnos en personas adultas, con las cuales

los niños, niñas y jóvenes desean convivir y respetar. A mí me parece que esa es nuestra tarea como comunidad humana[5]" (Maturana, 2005).

In this perspective, education can be considered as a process that involves both student and teacher through an *enactive/generative approach*, where human knowledge (as development of *capability* and *performance*) is an activity in constant evolution, which does not fall within *predetermined* and *pre-arranged patterns*; it tends to constant and continuous search of *well-being* in the *emotional* and *conversational* domains (*languaging* domain and *emotioning* domain).

In this context of reflection: What specifies his being? What are his different levels of awareness and his different possibilities of action? What are the positive elements in the *creation of his worlds* and in the determination of his *well-being*? This implies, inescapably, a sense of responsibility that the *educating society* must acquire (and possess) and that becomes the inspiring element of the action, or rather, of the *ability in action*.

It's clear, at this point, that the formative intentionality of everyone is the acquisition of awareness of their abilities and skills; the environments, the contents and the methods urge all the men to practice what they have learned in one autopoietic dimension.

It's just by making all the above said their own that the learners give meaning to what they know and do. Thus, they can think deeply and achieve a high level of competence and a full awareness of their identity (Pastena, 2012).

The idea that each individual is confronted with the *world system* in proportion to his *structural determinism* and according to his own level of difficulty allows us to consider his situation in a manner commensurate to his needs. In this context, the capabilities assume, from time to time, *intrinsic value* or *structural relevance*.

The concept underlying this statement is to be found, no doubt, in the principle of freedom (freedom of choice and freedom of action).

The individual well-being, in short, is not derived from purely quantitative resources, but by the many dynamics that are established and are defined between the person and his society.

[5] Not enough to say that education is a Transformation in the Convivencia, we must do part of our everyday consciousness. We should be invited to live and live within human communities that do, seriously and responsibly answering all the questions that arise: what is education? How are we educating our children?, what education we want?, what the learners want from the educational process?, is a task only of the school educate?, Who are the actors involved in this process?, whose is the responsibility of the educational task? Only a space for reflection that opens to our relational multidimensionality may be able to generate a new look at ourselves and our responsibility to the educational task, which is the task of all "education is a process of transformation in coexistence of all the actors involved, and if we want our children to grow up as independent beings in self-respect and social awareness, we adults have to live with them, respect them and respecting the continuous creation of a collaborative coexistence of trust and mutual respect" (HMR). However, not enough to say that the future of humanity are not children but also adults with whom the children live to activate a responsible process of education, of conscious respect and of mutual coexistence. I feel that this is our task as a human community.

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Chapter 5

EMBODIED COGNITION AND SECOND LANGUAGE TEACHING/LEARNING

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ABSTRACT

The second language learning is a process by which any language, in addition to the native one, is acquired. The language that must be learned is often referred to as "target language" or "L2". Many studies on the relationships between brain and language suggest that the cerebral cortex areas that process sensory information (objects representation, perception, motor skills) are also involved in different aspects of linguistic memories.

Therefore, the sensorimotor system would play a dominant role, thanks to which gestures can stimulate meaningful and long-term learning. The most important theoretical methods related to language learning generally identify the characteristics of learning itself, the inputs from the external environment, and the methods and quality of communication as essential components of this process. Especially the latter has allowed to introduce a series of studies on this matter, like the Sociocognitive Approach to Second Language Acquisition, by which social factors, as well as individual differences (the emotional aspect) and some fundamental methods in didactics, like the Natural Approach or Total Physical Response, based essentially on the understanding, the physical activity and the little explicit attention to the language form, deeply influence the language learning process. Regardless of the approach adopted in relation to the needs of the students, the thread that leads our work can be attributed to at least three aspects: a) the paradigmatic framework of the Embodied Cognitive Science, in connection with the role of the body, and therefore with the embodied nature of the language acquisition process. In this sense, the studies carried out by Dwight Atkinson highlight the socio-constructivist value of this field of research, and its peculiarities in the SLA (Second Language Acquisition); b) the Success For All method, by which the set up of a supportive environment, full of stimuli and suitable to the children' "special" needs, especially the most vulnerable ones, can promote the educational success of all; c) the adoption of a multisystem, intensive and early approach, since languages should not simply be taught, but they should be used to communicate and live, so enhancing the children' skills and competencies and offering them an invaluable advantage in cultural,

social and relational terms. Therefore, from these elements, it comes to light the need to consider the learning of the L2 not as a threat to the child's identity, but rather as an instrument of openness to new experiences, a modus vivendi that promotes respect for multiculturalism and the confrontation with themselves and the world around them.

Keywords: SLA, Social Constructivism, EC based, English Curriculum School

INTRODUCTION

In the "planetary village" (McLuhan, 1962) in which we are immersed, the benefits from learning foreign languages, especially if this process takes place already in early childhood, is undeniable.

However, its peculiarity, in both personal and social terms, seems to have come to the fore only in recent years, because multiculturalism has in some ways represented the specificity of a small circle of individuals (Aglioti & Fabbro, 2002), an element that divides peoples, instead of bringing them together. But are we really sure that this is how things are? Or is it possible to use the communicative-relational skills provided by the learning of a foreign language to promote cooperation, competitiveness and full participation in the context we are living in?

According to the most recent studies it seems so and, in this direction, corporeality would play a central role too. In fact, there is a considerable interaction between the brain areas responsible for the language and those related to the body and the environment in which it develops (Oliverio, 2009); verbal communication, in particular, involves several interconnected fundamental skills such as motor coordination, both to express oneself verbally and in writing, the acquisition, processing and interpretation of auditory, visual and sensory information, all actions that require interaction between different areas of the brain. In addition to this, there's the fact that communicating in a foreign language requires intercultural mediation and understanding. This necessarily goes through the awareness of the other as my similar and different from me at the same time, and as having a body. The body understood as a learning instrument and original assumption of relationship and communication with each other.

This seems an essential element in the need to create an inclusive school (Dovigo, 2007) if, for inclusion, we mean not so much the adequacy to a specific standard (as Emanuelsson, 2001, would say: "the problem is not the child", p. 15), but rather the subject's full participation in the realization of his life project, learning alongside others and collaborating in shared learning experiences (Booth & Ainscow, 2002).

Certainly it is a still wide open research field, but they are many studies showing that attending a school inspired by the principles of inclusion offers significant benefits. Not only for children who have more difficulties, but also for a didactics that enhances the differences and offers educational benefits for all (Lanfranchi & Vianello, 2011). People with severe multiple disabilities are, in fact, often characterized by the development of limited skills and the minimum or discontinuous involvement in the activities with potential behavioral stereotypes (see, in this regard, Duker & Schaapeveld, 1996; Lancioni, Campodonico and Mantini, 1998; Lancioni, O'Reilly, Campodonico and Mantini, 2001).

The reference framework to which we aim is based on a double framework: one concerning the "Success For All" - Research Success For All and Embodied Cognitive Science (ECS) approach, because, as it will be shown, learning foreign languages goes also and above all through the mind-body-world close relationship, one of its founding principles. Ultimately, we could talk about an English Curriculum School grafted onto the ECS model. The birth of the ECS, or Embodied Cognitive Science, dates back to the late '80s, the era in which a conception of the mind no longer independent of the body, but included in it, started to spread.

BILINGUALISM: A RIGHT FOR EVERYONE OR A PRIVILEGE FOR A FEW?

Recent research has shown that the development of bilingualism in children, already in a very early age, is critical not only for the access to two languages and more opportunities in their future jobs, but because it promotes, at the same time, better tolerance towards other cultures, allowing also to develop different ways of thinking and approaching problems (Sorace & Ladd, 2004).

When we speak of bilingual subjects, according to Grosjean (2010), we refer to those who use two or more languages fluently in daily life, and the importance of this ability, neuroscientifically speaking, was already highlighted by Wilder Penfield.

The multiple clinical and family experiences of the famous neurosurgeon allowed to realize an important reflection on the proper education of multiple languages in children. Although he had studied hard three languages, Penfield could express himself with great difficulty only in German, while his sons, who had learned French, English and German from an early age, showed no problem in speaking and expressing themselves correctly and fluently in all three languages. This allowed the neurosurgeon to publish a series of scientific studies of great relevance, trying to understand why his efforts in trying to learn languages in adult age were not so successful as those made with no difficulty by his children (Fabbro, 2004).

Penfield pointed out that the problem was to be found not so much in an intellectual discrepancy, but rather in the educational modes and in brain plasticity. According to the neurosurgeon, in fact, in the early years of life, the child's brain is plastic. This means that the right hemisphere can carry out, up to a certain age, the functions of the left hemisphere, which constitutes an ideal input for the early acquisition of languages different from their mother language (Lenneberg, 1982). This would explain why children with acquired aphasia (for more details see Association International Aphasia - AIA) are more likely to reach a fast and successful recovery with respect to subjects affected by adult aphasia, where recovery is more problematic (Fabbro, 2004).

Going further into the issue, Penfield pointed out that language consists of two systems: the *verbal units*, or perceptual, articulation, grammar aspects and the basic words of a language, which use increases in the first decade of life, and the *vocabulary*, the development of which accelerates in the second decade. The neurobiological foundations of the bilingual acquisition have also been analysed by Michael Paradis (2004), which led him to confirm what Penfield had previously affirmed.

Thanks to the plasticity, changeability and flexibility of the brain (Doidge, 2007), a system that wants to be defined as truly educational must overcome the typical way in which grammar is taught, which consists in simply providing the rules to be applied; therefore, just a poor, low-quality and feedback-free system (Pullum & Sholz, 2002), providing no information about what is *not* grammatical (Chomsky, 2000).

In order to set pedagogical protocols that optimize the multilingual education, it is very important to know the developmental stages and the plastic potentialities of the brain structures involved in this type of learning. The acquisition of the different language skills (phonological, syntactic, lexical) is linked to the gradual development of their neural substrates. Several behavioral studies show that the full acquisition of the phonological component, both perceptual (e.g., discriminating phonemes) and motor (no foreign accent in speaking the learned languages) can only be achieved if children are in an environment in which, before the age of six, a second language is spoken. In addition, it was noted that, after the age of ten, the ability to mimic the prosody of foreign languages weakens (Aglioti & Fabbro, 2002).

Bilingualism, different from the second language learning (Sorace & Ladd, 2004) as it's learned and used spontaneously and fluently, can be perfectly managed by the child from his birth, involving no overload for the brain, often considered as a mistake by parents and educators. Instead, there are many studies highlighting the positivity of linguistic and non-linguistic bilingualism in children, such as greater knowledge of the language structure, improved meta-linguistic skills, thanks to which they often learn to read before monolingual children and, above all, a better control of the selective attention, due to the natural predisposition to focus their energies on the language they use by inhibiting the interferences of the other language, combined with an improved ability of cognitive decentralization, or better, the ability to see things from a different perspective.

As the neuroscientist Laura Ann Petitto of the Gallaudett University of Washington DC affirms, bilingualism is an extraordinary microscope within the brain, but it's not always so appreciated especially outside of the academic community. Therefore, it needs a joint work by the school and local authorities, so that it can become a modus operandi available to everyone, and not an exception for a few.

BRIEF OVERVIEW OF THE FOREIGN LANGUAGES LEARNING

Given that our goal is not to discuss the theories of learning, it is worth briefly highlighting the main positions that have seen the importance of language learning over the years.

With “Languages in contact” (1953) the theory worked out by the sociolinguist Uriel Weinreich is affirmed, according to which bilingualism is the basis for every inter-linguistic relationship. Together with bilingualism there's multilingualism, which diverges from the first for the multiple combinations that can come into play. Without going too much into the merits, according to Weinreich, the phenomenon of bilingualism has a dual dimension: that one related to the individual who, by talking and alternating languages, produces a contact; that other one related to the community, thanks to which the individuals interacting in the group put more languages in contact. This allows to overcome the typical mentality of the

1950s, which sees bilingualism as an obstacle to the child's mental development, and supporting it as a natural stage of everyone's life. May it be for working reasons or take place over time, sooner or later everybody learns a language or a different form of the one they're already speaking. In the 1960s, developments in linguistics represented a turning point.

In that period, as opposed to behaviorism, the innatist hypothesis of the generative grammar pioneered by Noam Chomsky (1957) emerged. He claimed that man possesses a unique gift: a language with a complex syntax and a semantics that can be enriched indefinitely, which we master as such, that is then internalized (Vygotsky, 1962), creating an internal representation at a cognitive level: thoughts. Therefore, the question is why children all over the world, whatever their natural language is, follow certain steps and show the same linguistic behavior in specific ages (Fabbro, 2012). According to Chomsky. there are neurophysiological mechanisms deriving from biological evolution, and active from the birth, which plan the development of language.

The acquisition of a language is not simply the result of an imitation mechanism, but it is a process led by an innate device, called LAD (Language Acquisition Device) - whose innatist model, in reality, is systematically traced back to McNeill (1970) - which allows every child to acquire almost infinite combinations of phrases and speeches as soon as possible, from finite and fragmented elements. According to Bruner (1983), instead, there cannot be only an innate LAD, but also a LASS (Language Acquisition Support System), which corresponds to the role played by the adult and the social context in allowing the child's entry into the world of language and culture. The metaphor adopted by Santipolo (2012) to explain the dynamics of the LAD is emblematic. Let's think of a tree. When it springs it is leafy, and its leaves represent the LAD. When acquiring the "mother" language (L1) those leaves that do not correspond to the language to which the subject is exposed from his birth are de-activated. Once learned a second language (L2), the leaves that correspond to the structures of the language in question are re-activated, but not in that of the L1. Metaphorically speaking, the sooner the withered leaves are stimulated, the easier will be for the child to learn foreign languages without further efforts.

In short, an effective learning can surely develop also through two languages, rather than only one. Jim Cummins (1992) is well aware of this and refers us to the concept of *linguistic interdependence*, according to which the skills acquired in a language can also be transferred to another one. To better explain this hypothesis, he employs the metaphor of the dual iceberg. Cognitive abilities and deep knowledge are at the basis, while the emerging part is constituted by the superficial language skills. A person who knows several languages has several tips of the iceberg, all connected to the basis that is underwater. To the growth of the superficial part corresponds that of the submerged part, which is the common part, in which the two or more external peaks are rooted.

This involves that the conceptual knowledge developed in a language makes the understanding of the inputs of the other easier (Cummins, 1996). In other words, in a bilingual person, the iceberg emerges with two peaks: a bigger one, that is the mother tongue, and a smaller one, the second language. An important distinction made by Cummins is between: BICS (Basic International Communication Skills), or the basic language skills, or rather the "surface" skills, used to deal with interpersonal relationships and quickly acquired by every student; and CALP (Cognitive Academic Language Proficiency), as the name suggests, which is the basis for a child's ability to meet the academic needs in the different disciplines and, therefore, the expression of a cognitively greater linguistic competence.

Critical to the achievement of the educational success as it promotes comparisons, logical relationships, synthesis and argumentations, the CALP not only allows the acquisition of the cognitive contents of the L2 but, at the same time, it allows its construction as it employs it to be able to learn.

These are some of the many authors who have carried out studies on the acquisition of the L2 language skills. What we wanted to emphasize, beyond the metaphors we have used, is how important the learning of one or more foreign languages during early childhood is, since it helps not only improve the acquisition of the mother tongue, but also of disciplines linked to semiosis, graphical and musical expression, mathematics and computer science (Fabian & Bosisio, 2004).

WHAT IS LAW DOING TO SUPPORT BILINGUALISM?

Many studies and international researches focus around the idea that the best period in which to implement a bilingual education at school coincides primarily with preschool (0-3 years), and secondarily with kindergarten (3-6 years) (Fabbro, 2004).

Finally overcome the conception related to the Threshold Hypothesis (Cummins, 1980), according to which learning a second language should take place after the full acquisition of the first, because of the disadvantage with which the child would deal (mental overload but, above all, difficulty in interacting with his peers), it is agreed that bilingualism and multilingualism are the heart of European identity, and also one of the most ambitious objectives of the European Union.

In fact, European countries are seen as prestigious cultural heritages in terms of study opportunities, internships, concrete work experiences, and it is clear that, among the competences of young Europeans, there should also be the proficiency in one or more languages in addition to their mother tongue.

Especially in recent years, Europe is engaged in stopping early school leaving and ensuring inclusion through quality education, allowing everybody, even those with "special" needs, to reach their educational ideal (Council Conclusion on the Social Dimension of Education and Training,2010; Education and Training 2020 Strategic Framework "ET 2020").

It is appropriate to mention, in this regard: the *Memorandum of Lisbon* in 2000 (European Commission, 2000), for building advanced, competitive, intercultural and solidarity-based knowledge in the European society, which requires new and qualified professionalisms in lifelong education; the *Resolution of the European Union Council* of November 28, 2011, where the strategic value of non-formal education and the related socio-educational instructors, and the *Europe 2020 Strategy* for the smart, sustainable and inclusive growth, incorporating and re-launching the Lisbon Strategy adopted in the European Council of June 17, 2010, are highlighted, thus confirming the key role of lifelong learning.

Aware of the fact that education is not a "magic potion", able to hinder exclusion and social disadvantage, it needs the support of specific social and economic policies with the aim of promoting international competitiveness that requires high professional skills, combined to their ability to create, innovate and work in multicultural and multilingual environments.

In this sense, the "Note of the Council of the European Union" No. 9513/14 of May 7, 2014, invites the Member States to "Adopt and improve measures aimed at promoting

multilingualism and enhancing the quality and efficiency of language learning and teaching, including by teaching at least two languages in addition to the main language(s) of instruction from an early age and by exploring the potential of innovative approaches to the development of language competences "(p. 5).

To speak means to use language correctly not only from a grammatical point of view, but also appropriately to the context and culture of belonging. It is an impressive sight to observe a bilingual young child (Bialystok, 2001), not so much for his ability to quickly switch from one language to another, but above all for his ability to adapt the socio-cultural positions with respect to each of them.

It should be remembered that "children often live in multilingual environments and, if properly guided, they can become familiar with a second language in natural, dialogue, daily life contexts, gradually becoming aware of sounds, tones, different meanings" (National Guidelines, Italian Ministry of Education, University and Research, 2012). An opportunity of invaluable relevance in order to become true citizens of the world, aware and integrated into the multicultural and multilingual context in which we live.

A BODILY-SOCIO-COGNITIVE APPROACH TO THE SECOND LANGUAGE ACQUISITION (SLA)

The body mediates the relationship between self-identity and social identity: as a result, the social meanings linked to the view of the body and the expression are extremely important factors in an individual's sense of self, and his inner feelings (Shilling, 1993).

In particular, more recent studies in the field of cognitive neurosciences and the ECS (Gomez Paloma 2004; 2009, 2013), or better, the trend of thought that investigates the Embodied Cognition, have highlighted the role of the body and the embodied experience, also at school level (Gomez Paloma and Damiani, 2015).

In the perspective of the Embodied Cognition, the body is seen as the main protagonist of the individual's mind development. Therefore, the "experts in this field" are not so much interested in understanding how the mind works on abstract problems, but the role of the body in making it function (Wilson, 2002).

Moreover, we experience it ourselves in everyday actions. In any activity we carry out, the meanings support us even when it comes to manipulate images distant in time and space, simulate actions in language comprehension and during reading, or build mental models during the reasoning (Gomez Paloma and Damiani, 2015).

Brousseau (1990) translates this continuous mind-body-perceptions dynamisms using the term *milieu* as a didactic and educational means of communication for teaching, and related to different situations. An a-didactic situation in which students develop responses based on the needs suggested by the milieu. This research perspective mainly concerns the role of the meanings in the emotional responses. In this way, a cross-educational attitude is realized, marked by the openness to the meanings, and which defines the milieu as *inclusive*, as it promotes the *inclusion* from a perceptual and applicative point of view. Therefore, the thoughts that develop in the brain can trigger emotional states, translated into action by means of the body; at the same time, the latter can change the course of the thoughts (Corona, Cozzarelli, 2012).

A tangible evidence of the close interconnections between a real movement of the body, the representations of a movement and the memories are the emotions and perceptions arising in relation to some aspects of those representations. In the activities and simulations proposed in the educational field, the body becomes the protagonist, experimenting itself in such a way as to enhance the centrality of the corporeal and emotional dimension both in the learning process and in human relationships, and to highlight how the environment influences the expression of one's own emotional states, and is essential to the structuring of empathic relationships (Sibilio, 2007).

In this perspective, we cannot but welcome the discussion concerning the body, understood as an organism not so much from a biological point of view, but in its existential conception, thus linked to a world.

In this work, our goal is to analyze embodiment from a fundamental aspect of human cognition, i.e., language, through its physical association with the gestures associated with its expression in the speech, applying all this to the daily didactic practice (Iverson & Thelen, 1999).

What we are suggesting is the framework of an ECS according to a socio-cognitive approach (Atkinson, 2011) for the second language learning process.

THE ASSUMPTIONS OF THE SOCIO-COGNITIVE APPROACH

There is a much closer relationship than what we may think between the language learning process, body and motor skills. To speak, i.e., to articulate a sequence of syllables, in terms of sequential muscle events, for example, is like to chip a flint or throw a spear. In a similar way, the kinesthetic experiences like up\down, left\right, inside\outside, have gradually provided the physical and concrete basis for the development of symbols and metaphors used in the language.

The motor control depends on a complex hierarchical system consisting of cortical and subcortical structures: among these, of great importance are the so-called basal ganglia (striatum, accumbens), which control cognitive activities such as spatial memories, performance of motor actions in a given context, motivational components of learning. Cortex and basal ganglia are closely connected with each other and control both the motivational aspects of a movement (the preparation for performing the action) the contextual aspects (the performance of the movement), and the state of its performance, also through the involvement of the cerebellum. Basal ganglia and cerebellum are also involved in the language.

Studies on the relationship between brain areas and language are increasingly showing that this depends on our immediate perceptions and actions (the ECS assumptions) and on the memories of objects and actions; so the cerebral cortex areas processing the sensory information and controlling the movements are also involved in different aspects of the linguistic memories (Ferraris & Oliverio, 2000).

Therefore, the language system, instead of being highly specific and autonomous, structures coordination with other brain areas and systems related to the representation of objects, perception, motor skills, thus establishing interactions between the purely linguistic areas and those relating to the body, the environment and the context in which it operates.

To take account of everything in education seems like an essential prerogative, in an attempt to structure an interactive and cooperative didactic approach to the study of a second language, and learning in general. A path that focuses on the concept of identity, providing stimuli able to relate to each other with mutual attention, empathy and shared attention (Corona, Cozzarelli, 2012).

However, if the main legislations, as well as the programming documents, makes everyone agree on supporting the educational, social and cultural distinctions of an early bilingual education (from kindergarten), the didactic activity, instead, is not of much help, since it is mostly dominated by a "cognitivist" scenario (a purely formal and academic study of languages). Cognitivism, in fact, as a psychological discipline developed in the 1960s, provides some key concepts (Atkinson, 2012):

- *mind as a computer:* cognition is information processing, a set of uniform, universal mechanical input-output operations;
- *learning as abstract knowledge acquisition:* learning means extracting information from the environment and turning it into representations;
- *centrality of language and language as a code:* language plays a central role in cognitivism, because it seems to provide the perfect model for how cognitive knowledge is organized, that is, as a set of symbols and rules for their manipulation. Language production and comprehension, therefore, are coding and decoding processes;
- *dualism:* mind, in cognitivism, is seen as radically separate from the body and the world.

Starting from the individual' social nature (man is a social being, said Aristotle in "Politics") and the ability to learn conveyed by the relationship with the other, the environment and the use of the body, the second language learning, in the socio-cognitive approach, is understood in terms of adaptive intelligence (Atkinson, 2012), that is, with the purpose to promote adaptation to the environment and the survival. At the core of this vision is an idea of biological cognition that is deeply 'action-oriented', aiming not at the creation of passive internal models of the world, but at the efficient production of actions in the real world context (Clark, 1999).

The socio-cognitive approach sees cognition as extended (Noe, 2009). The concept of *Extended Mind* is used to emphasize the impossibility of limiting the boundaries within which cognitive processes take place to the mind or the body. The American scientist affirms that the mind is not the brain or a part of it, since this must be understood in terms of interaction with the body and the external environment. According to him, brain, behavior and world are the basis of consciousness. This is possible "as it suggests the existence of bodies that link minds to the world -we experience, understand, and act on the world through the bodies." (Atkinson 2010 p. 1). A form of active externalism is supported, which sees the individual as the active protagonist of the construction of his own cognitive processes, being situated in a specific social context (Barselou, 2008).

Let's highlight some salient points that connect this approach to the SLA (Atkinson, 2011).

1. *The power of the eye gaze:* visual expressions are a great source of information, and human beings have soon realized that, in order to understand the other's intention, when not understanding his words, it needs to look at his eye gaze. Well aware of this are newborn babies who, from the earliest hours of their lives, observe the face of their caregiver (Baldwin et al, 1996) and structure an attachment that is decisive in the interpretation of the outside world. In this way, according to Bowlby (1969), an individual builds some operational models of the world and of himself, thanks to which he perceives events, plans the future and develops his own programs.
2. *Face-Body-Mind:* the face to face contact (see Kendon 1990), the synchronization of the movement of the body with another (Collins 2004), the mutual smiling (Chartrand & Bargh 1999), the linguistic accommodation (Ylanne-McEwen and Coupland, 2000) allow to actively be in step with the other's intentions and his same emotional register. In this regard, the discovery of the mirror neurons in humans, thanks to which we "imitate" an action in our neuronal circuit by simply watching it (Rizzolatti, Sinigaglia, 2008), provides a powerful key to understanding how people can be emotionally in line with each other. What's the purpose of these mirror neurons? According to Ramachandran, it's certainly to be involved in processes such as imitation and emulation. Because to imitate complex actions requires that my brain puts itself in another one's viewpoint. Many studies support the hypothesis that the motor simulation - and the mirror neuron system on which it is based - are involved not only in the understanding of observed actions, but also in the analysis of words or phrases related to actions. The ability to use the language changes our internal processes; language is a powerful way to reconfigure our mental skills and control abilities, as well as to understand the other's emotions.
3. *Gesture and non-verbal communication*: there is nothing new about the fact that body and gestures are the main tool for learning. Let's think about the fact that the manipulation of objects anticipates first their conceptualization, and then their verbalization (think about Piaget's concept of sensorimotor intelligence developed, 1952b). Children learn a language through their whole body. To learn the concept of ball, for example, they touch, smell and grab it. This also happens in the second language learning, if the child is early surrounded and supported by the activity of early socialization and play. A study carried out by the German Max Planck Institute for Human Cognitive and Brain Sciences shows that the memorization of foreign words can be more effective if it is linked to a sensory perception. It is the brain motor system that plays a particular role, thanks to which we are better able to memorize a word in a foreign language, if the one who pronounces it makes extensive use of gestures. Therefore, as the researchers in the German Institute affirm, the language teaching approaches, including different sensory spheres and stimulating learners to express themselves with the body in targeted activities, are undoubtedly more effective than those based merely on reading and listening activities (Von Kriegstein, 2015).
4. *Positioning of body and physical objects:* according Goodwin (2003), the positioning, actions, and orientation of the body in the environment are crucial to make participants understand what is happening and adapt their actions. A rich support for the language learning and use is provided also by the aspects of the physical environment (often humanly designed), allowing for the possibility of forms

of interaction, thus learning opportunities, which might not otherwise take place. It's not about introducing great innovations, or investing expensive resources; it only needs to redesign the traditional classroom spaces, by respecting some fundamental psychological principles which are already known.

5. *Knowing the basics of communication:* every human interaction has some universal characteristics: talking by respecting one's own turn, negotiation, prediction of other people's thoughts, attribution of beliefs, thoughts and prejudices. These elements are often overlooked, their study is little known (Lewis, 1969 Levinson, 2006 Schegloff, 2006) but, if minds were "designed" in this way, to know them is essential to manage social interactions and support a second language didactics.

Language and interaction are often mutually exclusive elements in classroom activities, they're not considered as "founders" of the language use (Atkinson, 2011). For this reason, in relation to the latest findings in neurosciences in the field of learning, it is necessary to differently rethink the main epistemological issues related to the teaching-learning relationship. Designing a school ... in movement could be a possible solution, and it should be a major challenge for today policy.

STUDYING AND LEARNING WITH A CORPOREAL MIND

As we have seen so far, verbal language is at the top of a chain of acquisitions based on moments of relationship, where gestures and senses provide the contact with reality, the significance of words and also their memorization.

All this, typical of childhood learning, is the basis for the gradual internalization of language. In the context of languages learning, it is shown that students (from kindergarten) are able to use intentional movements of the body in the natural interactions in real time, in order to facilitate the learning of words (we could speak of *embodied intention*, as claimed by the studies carried out by Yu & Ballard, 2003; Yu, Ballard & Aslin, 2003).

According to Fabbro (2004), these conclusions can be extended to children with learning difficulties, as the data in the literature do not allow to rule out the possibility of providing them with a bilingual education, except for the cases of severe retardation. However, the possibility of an early detection of children at risk of language retardation or disorder is critical to quickly intervene and offer them proper support for their needs. In view of all this, how to concretely apply this in education for the second language learning?

Already for more than a decade, the Swiss Confederation has been implementing the project "School in movement", a national program of the Federal Office of Sport FOSPO, which promotes the movement in schools and daycare facilities. Classes and groups members have to exercise every day for at least 20 minutes. In order to facilitate the activities, teachers and education responsibles have free suitable material at their disposal, as well as different modules in the form of sets of cards suggesting a whole range of exercises.

"School in movement" is inspired by conceptions of the famous sport pedagogist (Illi, 1991), for which the movement in the didactic activity is key to the student's holistic education. Since the human brain has the great ability to change itself (Doidge, 2007) at the level of each specific function, by improving its circuits to adapt them more effectively to the

task to be performed from time to time, the movement is a privileged vehicle for stimulating the process of neurogenesis, that is, the formation of new nerve cells and their reciprocal connections. In this sense, the movement is essential for learning and memorizing (Kubesh, 2004).

No one can ignore that children, in order to learn, to focus their attention, and for a healthy growth, need be in movement. Learning takes place through the body with all its senses, even those of balance and movement (Berthoz, 1998), which are essential to perceive and control our body in space and in relation to others.

Children and young people spend a significant part of their lives at school. The support of sport and movement substantially contributes to a positive atmosphere, and facilitates students' willingness to learn. If school wants to influence positively the world of children and young people, it must offer movement to his students; following Uwe Pühse's motto, Sport Pedagogist and Professor at the Institute of Exercise and Health Sciences of the University of Basel: "*The body is more than just a support for the head, and at school we do not only deal with the head, but a with human being as a whole*."

Clearly there is no established program, nor we intend to point it out, explaining the times and ways of realization of the movement in the classroom. Every school may organize the movement sequences freely and as it wishes.

Very interesting is the Total Physical Response (TPR) method developed in the 1960s by James j. Asher, a Professor of Psychology at San José State University. Very briefly, the TPR is a strategy that introduces the study of a language starting from the execution of verbal instructions, of orders. The teacher gives an order associated with the corresponding movement; the learner performs the appropriate action (Stand up: the teacher stands up and asks the student to stand up etc.).

As pointed out by Pallotti (1998), methods like the Natural Approach (Krashen & Terrell, 1983) or the Total Physical Response (Asher, 1977), based on the understanding, the physical activity and the little explicit attention to the language form, work well especially with children while, with adults, they provide lower outcomes than the traditional methodologies: adults, unlike children, if unable to produce statements and be corrected, if necessary, tend to develop clear anxiety.

Listening to the instructor and responding through actions (not through words) has two advantages: it passively lays down language structures and gives the instructor the possibility to assess the level of understanding in the student, even before he can speak (without using the bridge-language).

In this context, the student is the core of the learning process, he is motivated, protected against failures and led to the self-realization.

The TPR is based on the observation of the natural mother-child interaction. When the baby is not yet able to talk, he communicates through the gesture. The child decodes the language through the mediation of body movements (Language-body-conversation), stimulated by the expressions used by adults. Moreover, from this observation, Asher points out that the first tool for learning a language is not the exercise, but the listening. The mother-child playful relationship becomes the model of the languages classes employing the TPR.

Among the main exercises carried out with this method, it is worth mentioning the following activities.

- Imperative drills
- Role Reversal
- Skits, dramas
- Role Playing, mini dialogues
- Reading & Writing

Of course, also such an effective strategy like the TPR cannot bear all the burden of teaching-learning and requires frequent changes in rhythms and activities (brain switching), which will be introduced in pre-established moments of the lesson and the course, always by paying attention to the students' response. Humor, fun, games are fundamental components of a TPR lesson, because they help maintain students' attention and motivation, and can learn while having fun and with no stress (e.g.: sit down on the ceiling, write your name with a banana, take a fork and comb your hair ... etc.).

Another interesting method was introduced in 2005 by Eduard Buser at his school in Biberist, Switzerland. The project "Learning in movement" aims at using materials taken from the daily environment (balls, handkerchiefs, sticks, handlebars, but also beams, balance boards) so that children can perform their tasks like calculations, conjugations of verbs (often performed for many hours in a sitting position, a sort of torture according to Buser) while performing movement exercises.

The underlying idea is to significantly change the learning process, to repeat exercises with the didactic object, allowing for a better connection of the different sequences through a multiple load. The movement, in fact, is very important as it acts as a regulator, and even as an inhibitor of adrenaline.

As we can see, there is something suitable for everyone and for every need. It takes very little to introduce movement at school and make it the primary means to promote a meaningful and long-lasting learning.

Employing an EC path is definitely a wise choice for those who are willing to learn a second language in an easy and funny way. In this perspective, school must be able to understand all the difficulties of his students, not only those who can be classified with a diagnostic-clinical system, with no labeling nor medicalization. On this basis, it is possible to develop and use a tool for identifying the different special educational needs in the students (Ianes, 2005), supporting them in achieving their educational and personal success. Therefore, we hope that it may really be a "Success for all"!

CONCLUSION

The Ukrainian poet Pavlo Tychyna (1891-1967) stated that "As many languages you know, as many times you are a human being", and we cannot prove him wrong.

Just as it's not possible to not communicate ... it's not possible to not learn, and that's why, in education, it is necessary to take every aspect into consideration: the ethical, social, cultural and corporeal one.

Educating children to a second or third language does not simply mean offering them a wealth of knowledge and opportunities to be spent one day at work.

It's so much more than this. It means preparing the mind to broaden its horizons, considering that there are also other viewpoints besides the one it has, understanding that two people are equal in rights and freedom, even though they don't use the same words to communicate. It means, of course, educating to tolerance, empathy and emotions. Because learning means also feeling significant emotions that allow us to lay down certain contents in our minds, develop greater awareness of ourselves and others, reflect on our communicative and linguistic experiences.

As Lipman (1991) would say: "Citizens in a democracy should be engaged in thinking ... They should be reflective, introspective, responsible, thoughtful, collaborative, cooperative ... Some, or many, of these qualities could be strengthened while future citizens are still at school. If only we recognized that we must strengthen these students' ability to reflect, instead of increasing dramatically the contents of knowledge to be transferred to them, or believing to have solved every problem through computer literacy... Therefore, *educating to think*, the promotion of a *high level thought*, should be a primary goal for education in the twenty-first century*".*

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Chapter 6

EMBODIED COGNITION AS AN INCLUSIVE APPROACH FOR SPECIAL EDUCATIONAL NEEDS

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ABSTRACT

"There was a time when mental meant nonphysical, but we are past that belief. Mental processes and states are physical products of the brain. "(Le Doux, 2015, p.170). The time has come to rethink education in the light of new scientific discoveries. The proposal for an approach to an inclusive ECS-based didactics doesn't want to be final or prescriptive, and probably it cannot even be defined as a real approach. Our attempt is to systematize some interdisciplinary contributions in order to provide insights for the planning of more effective training courses, able to facilitate learning and participation processes in all students. The ECS approach is in line with the existing models and theories of development and learning, based on a complex psychodynamic and neuroscientific anthropology, which identifies the construct of neurodiversity and casts an eyes over the Special Educational Needs.

Keywords: special educational needs, inclusion, neurodiversity, embodied

INTRODUCTION

Improving educational and social inclusion is a key objective on a worldwide level. Political and economic surveys recognize, in the fight against early school leaving and the improvement of learning-inclusion processes, the factors for promoting the development of individuals and society. School has a fundamental role also, and above all, for its educational and didactic mission. The latter, therefore, must be appropriate, strengthened and renewed, in order to ensure that all students can learn, participate and feel good at school.

Today, the crisis of the school system all over the world and the major social, economic, cultural and scientific changes are slowly but inexorably redefining the paradigms of

individuals' development, learning and training. A point of no return is the recognition of the need of all countries for an inclusive school.

Therefore, the challenge is not so much to promote change towards new models of school and didactics, but to reflect on the directions and meanings of the drivers for change and innovation processes which, from time to time, redefine didactic practices and cultures, in a more or less inclusive sense. A first element to be considered is the problematization of the concept of inclusion and inclusive didactic itself.

WHAT IS INCLUSION? WHAT ARE SEN? FROM THE ITALIAN EXPERIENCE TO THE EUROPEAN APPROACH

Studies and research on students' Special Educational Needs and the inclusion in schools have increased exponentially since the beginning of the new millennium, and have involved different disciplines. The concept of SEN originated in English-speaking countries while, in France, one of its less well-known equivalents was being adopted (BEP: Besoins Educatifs Particuliers). Besoins Educatifs Particuliers). According to what British documents[1] state and most of the English-speaking countries acknowledge, Special Educational Needs and disabilities can affect a child or young person's ability to learn. They can affect their behavior or ability to socialize, e.g., they struggle to make friends; their reading and writing capabilities, since they have dyslexia; their ability to understand things; concentration levels, e.g., because they have ADHD; their physical capacity. “Special Educational Needs” may be considered an umbrella term for an aspect of school education focusing primarily on students with learning difficulties and/or disability. In school documents, it is abbreviated to 'SEN' or 'SEND' – these abbreviations were first used in Commonwealth countries such as Australia and Singapore. The term covers specific learning difficulties such as dyslexia and ADHD, pervasive disorders such as autism, and physical disability such as visual impairment and hearing impairment.

In United Kingdom, education law dates back to the Education Act 1944.In the United Kingdom, education law dates back to the Education Act 1944. Over three decades later, this was followed by the Warnock Report in 1978 an Inquiry into the needs of SEN children. This laid the foundations for the introduction of Statements of Special Educational Needs in England and Wales through the Education Act 1981.We have now entered a new era for SEN with the introduction of Part 3 of the Children and Families Act, the new SEN Code of Practice 2014 and associated regulations. This new legislation now replaces Part 4 of the Education Act 1996 and its associated regulations.

The definitions of special educational needs and special educational provision remain roughly the same as they were before. However, as well as children, ‘young people’ are now referred to in their own right if they are over 16 years of age (at least at the end of the academic year in which they turn 16). It is again still not counted as SEN if a child or a young person has a different home language as before, although now health and care provision can be considered as special educational provision, where it is provided for educational or training purposes. There were many criticisms of the SEN framework between 2006 and 2010, with

[1] https://www.gov.uk/children-with-special-educational-needs/overview.

five different Inquiries on SEN and Disability issues. For example, in 2006, the Education & Skills Committee said that the SEN system was 'not fit for purpose'. One of the final nails in the coffin for the previous SEN system was a critical Ofsted report in September 2010 entitled 'A Statement is not enough'. Section 19 requires the LA to have regard to: (a) The views, wishes and feelings of the child and his or her parent or the young person (b) The importance of the child and his or her parent or the young person, participating as fully as possible in decisions relating to the exercise of the function concerned; (c) The importance of the child and his or her parent or the young person being provided with the information and support necessary to enable participation in those decisions; and (d) The need to support the child and his or her parent or the young person in order to facilitate the development of the child or young person and to help him or her achieve the best possible educational and other outcomes. Authors underline the last part – the need to help a child or young person achieve the best possible educational and other outcomes[2].

The topic of SEN, therefore, is closely related to that of their overcoming/reduction, and that of school and social inclusion. The still-open debate on the more "appropriate and beneficial" model of inclusion for the current school is fertile and full of variously articulated contributions, according to concepts and ways that are not always convergent. All EU countries aim at achieving an inclusive school according to the guidelines set out in Europe 2020, but the daily practices underlie paradigms that may result distant and problematic. The very concept of inclusion is not easy to define and has given rise to different interpretations.

Also the term inclusion originated in England in the 1990s, and is a key concept that has been largely taken up in the following decades by all UNESCO documents and most of the studies and research in this field. In Italy, the word "inclusion" has been acquired and used by the majority of professionals and families only in more recent times, and must be interpreted, within the dialectics, with another key concept own of the national tradition: that of integration. Inclusion should be seen as something we adhere to, in the name of the experience of integration supported by the Framework Law 104/92, "a law that makes all the countries in the world envious of us" (Caldin, 2010).The concept and practices of inclusion are exclusive of the Italian social and cultural context and its historical development (Armstrong, 2007), and are a privileged way for achieving an inclusive process. According to various authors, the study of inclusion is privileged in the Italian context than in other international realities, which have not launched the full integration of children with disabilities in schools and in common classes yet. In fact, although considering the idea of inclusion as full inclusion and inclusion for All, thus not only for SEN students, the focus of the practices and processes related to weak children and young people who need "additional" aid allows to bring out the characteristics (also in terms of strengths and weaknesses) of the models for assessing the needs and those of the adopted interventions.

Among the critical issues related to the use of the SEN construct there is the awareness of using a quite outdated term, always referred to the individual and his difficulties, while it would be more interesting to adopt an expanded perspective that identifies the obstacles to learning and participation related to the context in which the individual lives, studies and works (Caldin, 2010). Indeed, whereas the Italian model of integration / inclusion is an advanced and pioneering model for many countries today, the fact of having the most

[2] https://www.specialeducationalneeds.co.uk/

advanced regulatory framework in Europe does not guarantee the quality of integration and inclusion achieved at school every day (Canevaro, 2016). Unfortunately, in our school and training systems, there's the risk of turning the law on school integration into a "schizophrenic law," which declares excellent principles that are not matched by best practices. The Italian experience has basically taught us that it's not possible to enclose statically and comprehensively a complex and dynamic process like that of inclusion, within a concept and related regulations. "Inclusion is a regulatory ideal and process, a kind of utopia to which we aim, meaning that it retains its unattainable nature: it is something that pushes us to evolve, a sort of driving force that helps evolve" (Caldin, 2010, pp.3-4).

According to Canevaro and Malaguti (2015), the concept of school and social inclusion refers to a sphere of thought and research that cannot be attributed to a single model or the mere school integration, but to a basic theoretical position that wants to put a stop to any form of social, institutional and educational exclusion and segregation; moreover, it requires to focus attention not only on the individual and his disabilities, but on the actions, the skills and the context. From this point of view, it calls for a change in the current social, educational and school system, in order to allow for the full and active participation of all individuals, including the disabled ones. In Italy, and today in Europe and all over the world too, there has been a process of interpretation which may be seen as a continuum from exclusion to inclusion and integration.

In this sense, inclusion can be better described as an ethical imperative that needs no justification: it is a principle and a direction for including all people through a continuous process. From a pedagogical standpoint, inclusion is a value at the foundations of a philosophy aiming at maximizing everybody's participation in society, and minimizing the practices of exclusion and discrimination (Caldin, ibid.).

In line with this perspective, the European Agency for Development in Special Needs Education document (2012), which defines the profile of inclusive teachers, affirms that the imperative of inclusive education is to develop student's autonomy to the highest possible extent, and ensure that all students can develop their social relationships in order to have support networks within local communities. The document includes also the different interpretations of the concept of inclusion by authors from different countries, a demonstration of its inherent complexity and multidimensionality.

The European Agency for Special Needs and inclusive education includes Agency member countries' ultimate vision for inclusive education systems, to ensure that all learners of any age are provided with meaningful, high-quality educational opportunities in their local community, along with their friends and peers. All European countries are committed to working towards more inclusive educational systems, but they do it in different ways, depending on their past and current contexts and histories. Inclusive educational systems are seen as a vital component within the wider aspiration of more socially inclusive societies that all Agency member countries align themselves with, both ethically and politically. More specifically, the document outlines the essential characteristics of inclusive educational systems that will be employed to guide the development and the direction of the Agency's activities in the medium-long term. The goal of this document is to guide the discussions on the Agency's activities supporting the countries in their efforts to develop more inclusive educational systems, in order to ensure that all students of all ages can have high-quality significant educational opportunities in their local communities, along with their friends and peers. In order to have this vision implemented, the legislation governing inclusive

educational systems must be supported by a fundamental commitment to guaranteeing the right of every student to inclusive and fair training opportunities.

The operating principles guiding the implementation of structures and procedures within inclusive educational systems must be those of equity, effectiveness, efficiency and improvement of the outcomes for all stakeholders - students, their parents and families, the education professionals, the representatives of the community and decision-makers - through high-quality and accessible training opportunities. Two strong value pairs that define the frame and the sphere within which to take measures emerge: inclusion and equity, education and community. These are principles/values that assume a strategic orientation dimension: it needs to have significant high-quality educational opportunities, in the local community, to be able to realize them.

IMPLEMENTING INCLUSIVE EDUCATION SYSTEMS

Once highlighted the need for change towards education and training systems that are increasingly and genuinely inclusive, the issue of the effective implementation of such change within a flexible and problematic perspective remains unresolved, which contributes to highlight risks and opportunities of the possible trajectories.

School definition and practice of inclusion can change significantly, not only among cultures and educational systems, but also within them (Dyson, 1999).It is appropriate to speak of *multiple versions of inclusion*, thereby giving meaning and importance to a discourse on "inclusions" considered in the plural. It is essential to maintain openness also towards unexpressed and unexpected possibilities (Canevaro, 2016).Therefore, it needs to broaden the focus from the regulatory framework, which establishes the right to inclusion, to the mechanisms of concrete success of cultures, processes and practices that make inclusion possible and real, in order to try to grasp the complex experiential and still unexplored phenomenological dynamics.

The most mature debate on the meanings and orientations of inclusion process highlights the risks related, in particular, to "utilitarian" and reductive visions of inclusion and training. Studies on the social model of disabilities highlight the trends of neo-Fordist approaches based on the economic and management models of the training systems, aimed at controlling production at schools (outcomes) through an accumulation of controllable standards and rules. With respect to the assessment-reporting systems of the educational systems, the comparisons at national and international level, and also a vision of inclusion strongly centered on early assessment, recovery, rehabilitation and enhancement of the individual's deficit skills, it needs to pay attention to the perspectives reducing education to procedures ensuring to get good grades in some specific areas (language, math, and sciences), forgetting that the most relevant skills for a learning society refer not to technical knowledge (which quickly becomes obsolete), but to the ability to develop meaningful relationships founded on equity (Dovigo, 2016). According to Dovigo, these perspectives are reflected in increasingly stringent curricular indications to be achieved in the form of micro-management of teachers' activities (Hodkinson, 2005; Hyslop-Margison, Sears, 2010), reproposing the idea that "limiting teachers' initiative will provide more control over the learning process, thereby improving schools' outcomes." This direction is drastically far from the objectives of the

European Agency we have outlined before, not only for what concerns the inclusive dimensions centered on the idea of community, co-participation and equity, but also in terms of lack of effectiveness of the teaching-learning processes.

In fact, research seems to show that some significant students' achievement of skills, such as the development of decision- making and problem-solving skills, require a creative and flexible approach by teachers. Not surprisingly, in the world rankings of the educational systems, the most successful countries are not "those obsessed with standardization of curriculum and micro-management of classroom activities, but those that consider curriculum as a fully adaptable platform, give ample room to innovative teaching and flexible learning, and respect teachers as highly qualified and respected professionals" (Tschannen-Moran, 2004, in Dovigo, 2016).

The theoretical and research perspectives proposed by the Disability Studies have been founded on emancipatory methodologies. Such approaches have put radically into question the ideological horizons that guide professional-medical research on disabilities (Oliver, 1991).The social model of disability originates from the distinction between impairment and disability (UPIAS, 1976); the first term refers to a person's condition, while the second shows the constraints that affect the life as a result of a skills-based organization of society (Valtellina, 2011).The social inclusion model focuses on the role of the community dimension and co-participation for the change in complex systems like educational organizations; change is a dynamic activity emerging through a process of social construction based on sense-making and enactment, which allows actors to develop their way of thinking about organization, to bring organizational structures and events into existence, and to put them in action (Weick, 1995; Weick, Sutcliffe, Obstfeld, 2005).

An interesting element for the purposes of our investigation refers to the fact that also in this perspective, according to which the role of society and culture is central, organizational change theories are based on the key dimension of reflexivity as deep personal reflection and often inadequately ensured dimension, about which we will talk in the next paragraph.

WHICH FRAMEWORKS?

Returning to the privileged experience of the Italian model for integration/inclusion, we want to base our work pm the concept of special normality worked out by Ianes (2006), which has provided the background for the framework of the Special Educational Needs of our country (in Italian, BES: Bisogni Educativi Speciali), as it's based on the biopsychosocial model of the ICF and is in line with the most recent European guidelines.

In fact, the assumption of the SEN construct, a pedagogic-political and not diagnostic-healthcare construct, is functional to the reconceptualization of the idea of disability carried out by the ICF.As pointed out by Ianes, what characterizes these students is not so much a medical or psychological diagnosis (a "certification") but a somehow difficult situation that requires individualized interventions; in that sense, the description in terms of Special Educational Needs is more fair and efficient in the assessment and recognition of the student's real needs. Furthermore, the concept of SEN is very close to that of learning disability meant as "any difficulty found by a student during his school career" (Cornoldi, 1999, p.7). Different problematic situations are thought to be due to a varied complex of individual and

contextual causes, according to a model consistent with that of the ICF. SEN students are living a particular situation that hinders their learning and development process: this negative situation can be organical, biological or familiar, social, environmental, contextual or all these combined with each other. The description of the way of acting of SEN student, according to the ICF model, must depend on the description of the relationship between the student and his context. In the biopsychosocial paradigm, the concept of interaction between the subject and his environment, through a multidimensional approach, is central. For the student with disabilities (or impairments), in order to be motivated to learn, it is necessary that learning increases his expertise and provides him with a pleasant feeling of mastery and self-esteem, starting from the changes in the context. Thus the specialized response becomes ordinary: all students are different and everyone can learn; learning intensifies with the cooperation between teachers, parents and communities of which they are a part[3].

In pursuing the inclusive perspective, Special Education sees it as its task to ensure that what a person living in a problematic situation achieves becomes a quality for all. At school, this translates into a commitment of all stakeholders to promoting strong literacy for all students, greater access to education for all school grades, the equal right of all children to quality education, within the same community in which commitment and participation are also required to disabled persons (Caldin, 2010). In fact, it is no longer possible to think of just one instrumental literacy regardless of the common good, or better, without considering the inclusive perspective from an eco-systemic stance. The latter, in fact, implies an anthropological model that protects all the people and concerns all students equally, but, at the same time, it considers them differently, because everyone has the right to be supported in the development of his specific potentialities. Therefore, the anthropological paradigm of the ICF and the eco-systemic approach facilitate the inclusion process of SEN students, but allow us to go further towards the inclusion of all students.

In the ICF model, the attention to the relationship between the person and the context, according to the different conditions facilitating or hindering the overall functioning of the person and its implications for the modification of the context, is a general key principle. This attention can be interpreted as "essential good practice" and, as pointed out by Ianes, "a good practice is not a heroical act, but an efficient modus operandi available to all." So, the problematization of the very concept of "special" applied to didactics and pedagogy seems to be justifiable; inclusion cannot be a "special" value.

Current debates in educational psychology questions whether inclusion must be special or not. Rix (2015) has recently analyzed the broad range of interests linked to the emergence and ongoing development of educational systems across many countries. He pays particular attention to systems associated with special and inclusive provision, and the kinds of pressures under which they operate. He questions the theoretical perspectives associated with them, challenging the dominant focus upon the individual, explaining how and why we must increase our focus on context.

Challenges and possible solutions are evident within many education systems and their wider socio-economic environment. They suggest how educational support might better respond to disparate aims, and be developed within a community of provision. This notion recognizes the interconnectedness of services and the significance of context; encapsulating

[3] Slides can be found at: http://www.unirsm.sm/media/documenti/unirsm_1714.pdf.

the aspiration of much international legislation for participation and inclusion for all. As a tool for describing interrelated contexts, this notion of a community of provision can help us frame necessary shifts in pedagogy, assessment and funding; it can encourage collective learning processes and collaborative outputs; enhancing our capacity to create equitable participation for all whilst responding to predominant socio-economic demands. It emerges from the research base which problematises inclusive, mainstream and special education.

The assumption of the ICF model goes beyond the simple vision of disability and promotes the creation of an education system as a privileged place where to ensure personal development and social inclusion, by virtue of the highest degree of autonomy and freedom to learn and participate. The educational system is the first step towards a society of integration and inclusion (Declaration of Madrid, 2002, Art. 7).

However, we know that the creation of educational systems promoting inclusion is a strategic objective on which it needs to invest so much more culturally and practically. In particular, it needs to promote and support change processes that go down this route. Such a change must be made at macro and micro level; in the pedagogical model, school inclusion must help the student become the promoter of his own project and care, and must stimulate the individual to be himself, without feeling influenced by others as much as possible. Inclusive education employs functions of control, comfort and socialization, but it also employs empowering incentives, aimed at their separation and autonomy, promoted by teachers and school but launched and strengthened in their families[4].

At micro level (of educational institution), an aspect that is still too overlooked refers to the circularity among the learning organization. The advanced models of changes in the organizational learning, such as that on the "double-loop learning" (Argyris, Schön, 1978), contemplate the role of personal deep self-reflection dimensions, which are able to generate new solutions by introducing innovative forms of adaptations; this type of learning always implies a certain degree of subjective reflection that helps the system learn to learn by systematically questioning existing rules and supporting the attitude of "thinking outside the box." Thus it provides a cognitive explanation on the way reflexivity plays a pivotal role in transforming organizational knowledge (Dovigo, 2016).

Other authors tend to place greater emphasis on the social dimension that learning assumes in organizations as a vector of change, involving also tacit knowledge dimension as an essential attribute of organizational functioning and learning (Cohen, Levinthal, 1990; Collins, 2010; Polanyi, 1966; von Krogh, Ichijo, Nonaka, 2000). Unlike explicit knowledge, which is communicated systematically and formally (especially through written documents), tacit knowledge is mainly personal, based on intuition and built with reference to a specific context. Although this kind of knowledge plays a crucial role, it can be difficult to communicate and share within an organization, but many studies agree on the assumption that a smoother transfer of knowledge would be highly beneficial in terms of empowering organizational management and change (Nonaka and Takeuchi, 1995).In addition to the environmental conditions, as explained in the European document mentioned in the previous paragraph, in order to achieve the objectives and principles of an inclusive educational system, a set of essential abilities for all the involved subjects (stakeholders) is necessary. It

[4] http://www.siped.it/wp-content/uploads/2015/08/Caldin.pdf.

needs to effectively develop attitudes, beliefs and reflection capabilities, together with knowledge, skills and behaviors.

To promote the virtuous circularity between learning-change of organizations and learning-change in those who work within them, transnational documents recognize the value of co-participation and community dimension as a strategic principle, able to facilitate the individuals' development of the capabilities to reflect on their own actions and on the produced outcomes, and to use reflections to improve and develop their collective work towards common goals.

The development of the *inclusive mind* of each person can only take place within a network of virtuous connections with other minds (Bateson, 1972; 1979; Bion, 1961; Siegel, 1999), and minds in relation with each other contaminate and build the organizational mind (Jaques, 1955; Hinshlewood, 1987; Perini, 2007), even and especially in an inclusive direction. Developing the inclusive minds (Damiani, 2014) of teachers, students, citizens, and thus organizational contexts, is a conditio sine qua non for the inclusive school.

HUMAN DEVELOPMENT AND INCLUSION BETWEEN DIFFERENCES AND EQUITIES

In the light of what has emerged so far, an efficient inclusion model must involve macro and micro, political, social, organizational and personal aspects, of explicit and implicit nature, and their interconnections. Our work focuses particularly on the personal, mental, implicit and emotional-relational dimensions; in fact, scientific research is now recognizing their role in different fields.

Recent studies on the fight against early school leaving and the promotion of well-being at school are redefining a multidimensional framework able to facilitate the complex interpretation of the phenomena in this area, and the implementation of consistent action plans. Research shows that students who are considered different because they fail to follow and / or behave according to what it is "normal to expect," are students in risk of dropping out. Conversely, the increase of participation and school well-being lowers the perception of diversity and prevents school leaving. As noted by Moreira (2016), to prevent the drop out or promote positive and inclusive paths at school, it also needs to organize positive psychobiological experiences; working on the subjective experiences, emotions, motivations and aspirations is essential to prevent drop out, but it's very difficult to be achieved. It's about developing multidimensional approaches that consider also subjective experiences (emotions, motivations, well-being), which are involved in determining the way we experience (internal and external) reality and live in it, which is our way of relating to reality (Moreira et al, 2013; Fredricks, Blumend and Paris, 2004).According to Kagan (2013), the lack of attention to processes that account for the striking psychological differences between members of divergent social classes is a second barrier to progress in the social sciences (p.XII).

It emerges a focus on the "mental, deep and complex" sociorelational meaning of "inclusion." In the conception of the social sciences, the relational feature of the inclusion concept implies feeling respected and valued for who you are, thanks to the supportive energy and commitment from others (Miller, Katz, 2002). These experiential dimensions are closely correlated with a change in the perception of diversity. A broad definition of the relational

dimension of inclusion considers it in its "complex" meaning of well-being "within something," like being part of a larger community, in terms of a psychological state that meets the social and primary and secondary existential needs (Ghedin, 2009).This definition assumes a pro-active and strategic meaning, which helps identify actions to face exclusion by promoting feelings, moods, privileges, opportunities and rights, gathered under the umbrella term "inclusion."

The Capability Approach (CA) by Amartya Sen (1999), although developed the field of economy, addresses these issues by investigating the existential, social and institutional conditions which make individual differences become disadvantages, inequalities and injustices or, by contrast, can enhance human development. Sen contrasts the "powerful rhetoric of equality," believing that individuals are totally different from each other when they come to the world, and that the project of equality must start from the awareness of a significant dose of pre-existing inequality to be contrasted. This perspective assumes a vision of development which shifts the focus from what an individual or a community can produce to what he is able and has the possibility to choose to produce, as something that is worth producing for him; thus inclusion becomes an essential precondition for development. The drive towards equality is directly linked to everybody's freedom and collective freedom; in the Senian theory, freedom is expressed in beings and doings, what it is believed to have value (functionings), that is, what it is worth being chosen as it contributes to one's own well-being, consisting of a flourishing life, a full self-realization (Santi and Ghedin, 2011). The CA is an approach that includes individual differences, including those corresponding to the personal factors mentioned by the ICF, but which are not coded. Indeed, the approach of capabilities applied to disability is based on an idea of well-being, that is, an extended health condition that includes "what the individual can do or can be" starting from the available means and resources, and in relation to the ability of people to transform the means and the resources available in results, achievements and goals. The actual realization of well-being or functionings corresponds to what the individual has chosen to do or be for himself or for others, by implementing his power to act (agency).This approach constitutes the theoretical foundation of the human development paradigm promoted by the United Nations Development Program in the Human Development Reports.

Thus there's a double attention to the person's characteristics (his differences and the psychobiological aspects) and those of the sociocultural, political and economic context emerging worldwide, centered on their virtuous (enabling and inclusive) and vicious (disabling and exclusive) interconnections. The individuals' opportunities of choice and initiative in the context shall be increased equally, but differently, instead of providing indiscriminately the missing resources to meet the needs defined a priori (Sen, 1993 / b, p.31).

Focusing back on the inclusion and well-being processes at school, we believe it is essential to focus attention on personal resources (capability to choose, agency, emotions-motivation), as they're crucial aspects in the development and "capability" process inadequately explored both at the level of description (in the description of the student's overall functioning) and that of application (in the planning of educational and didactic intervention). As the Senian model points out, the personal factors condition the ability to realize functionings; in fact, these factors are conversion factors, in line with the ICF model referred to the presence of facilitating or hindering contextual factors.

Also the inclusive model of the Index for Inclusion (Booth, Ainscow, Black-Hawkins, Vaughn, Shaw, 2000; Booth, Ainscow, 2014) shifts the focus from the SEN to the barriers to

learning and the social factors concerning people's active participation; they must be attributed to both the individuals and the contexts. It emerges a nonlinear interpretation of the situations, which recalls the epistemological assumptions of reference (cultural, ethical and value-based), the policies and practices to be define and redefined (Canevaro, Malaguti, 2015).The central idea of inclusion as a relational process, a way of understanding and living relationships, is raised once again (Fornasa and Medeghini, 2012).

From this quick overview, two items of interest emerge: the focus on the relational - personal, interpersonal and sociocultural- dimension of inclusion as an important dimension that applies to different approaches, and the consequent enhancement of the differences of all people. In the relational dynamics, the key element in terms of evolution is the divergent element; it's the differences and heterogeneities that make the development of systems possible. Therefore, the relationship seems to be a sort of "bridging-dimension" between the different approaches, able to facilitate the building of more evolved and suitable knowledge and understanding systems (of inclusive processes and systems).The relational aspect of inclusion, enriched in terms of interdependence and reciprocity, is also developed in modern biology, especially in its holistic conceptions related to a complex vision of the living systems, which has led, as we shall see in the next paragraph, to the identification of the concept of neurodiversity. Also in the inclusive paradigms, the strategic orientation moves towards the recognition and realization of the value of differences.

The challenge facing educational systems is, ultimately, to build an approach to differences; the key concept becomes managing and considering one's own way of being with others according to the synaptic dimension, that is, the possibility for contrasting elements to be reformulated in terms of common, individual and social project simultaneously. A social individual knows how to grasp the features of this management, which supports and enhances his learning capacity. Managing means also understanding that there are different learning strategies, and that there is the possibility, even by using time dedicated to others, to increase one's own capacity. In order to manage and function in a synaptic dimension, we need to stay together, in a time qualified time (Ghedin, 2009; Santi 2015).We must head towards new indicators for assessing the well-being (quality of life) and the quality of training systems, as well as the outcomes: the Missing Dimension (Biggeri and Santi, 2012). To assess the quality of life and inclusion it needs complex reading and analysis models but they are becoming more and more intertwined, and so they require appropriate and largely renewed constructs able to best represent the complexity of the phenomena. In school settings, the change of the idea of inclusion is combined with a change of the idea of support, which becomes extended and widespread (Ianes, 2014 Canevaro, 2011): any activity that enhances the ability of school to meet students' diversities. Providing individual support is only a part of the effort to increase students' participation, and when it is ensured, the need of individual support decreases. A widespread support is needed together with a reward/incentive system, and this entails a global reorganization of the school and its structural, organizational and teachers' training aspect etc, including lifelong learning for all those who are part of the school community (Canevaro, 2008; Sapucci, 2007).

Martha Nussbaum has analyzed the Capabilities Approach and has highlighted the complex and constructive role of emotions, according to an interesting theory that overcomes the conception that attaches the difficulty of change in emotions to the habits and the ancient roots of its related knowledge. It is based on the recognition that it is also possible to ignore completely the nature of our emotions-cognitions, and that we can also make many efforts to

leave them unchanged. Our perception, our opinions and beliefs about the object are also determined by not altogether conscious elements. The structures of anger, love, envy, hatred and admiration are very deep, and those of negative and primordial emotions like anger and envy are probably even deeper.

"It would be naive to expect that projections of these negative emotions onto other people will not take place—although we may certainly hope to moderate their number and intensity. My view, then, urges us to reject as both too simple and too cruel any picture of character that tells us to bring every emotion into light with reason's dictates, or the dictates of the person's ideal, whatever that is." The psychological theory of emotion developed by Nussbaum provides the foundation to condemn "those normative approaches as excessively violent toward human complexity and frailty," ranging from an extreme idea of zealous critical surveillance over desire and emotion, including the extirpation of the latter where possible (p.290). It needs to remember that, in the light of scientific paradigms adopted in our work, emotions are also and above all an existential experience of development and knowledge, lying at the foundation of every relational dynamic with oneself, other people and the contexts within which this dynamic develops.

The key point for the pedagogical reflection, which raises the issue of the subject's education in his entirety and uniqueness, is what we should/can do as educators. Today school seems to be ready to accept this challenge. As noted by Cerini (2009), "when it comes to learning context, the idea of school, and consequently that of teacher, has changed: from "didactic teaching" to apprenticeship, tutoring, mentoring and coaching. The daily challenge in the classroom focuses on how to turn the objects of knowledge into objects of authentic and meaningful learning, through an "animated conversation" (or authentic emotional relationship) (Bruner). This not only means starting from the direct and immediate experience, but being on the shadow line between organized knowledge and everyday experience, building a learning environment where to become competent together in a positive group, an "ideal educational community." Planning an "educational" learning environment means connecting educational and organizational knowledge, but it also means rediscovering the centrality of motivation, of emotions, of the action of giving "sense" to the experience in a positive school scenario, in which trust, communication, recovery of communication and support for commitment and efforts prevail "(p).Therefore, the problem of Special Educational Needs can be reinterpreted as "valid reason" for forcing schools to renew themselves in the above-described way, which corresponds to our idea of inclusive education; SEN students "report systemic problems," because their relationship with their school environment makes them "needy" (Rossi Doria, 2013).

Embodied Cognition (EC) can provide significant insights for improving teachers' attitudes and didactics according to the expected inclusive guidelines outlined so far.

Our investigation will focus on those deeper personal factors, which are not very visible and manageable, that are not generally the subject of pedagogical descriptions and policy actions. We have seen how the ability to develop (positive and inclusive) relationships and the ability to choose people are key factors for determining the well-being, but these abilities are based on the development of mind and on complex and deep cognitive processes that are mainly of emotional, corporeal and implicit nature. The awareness of the powerful role played by the emotional-motivational personal dimensions in development and learning is not surprising; however, as well as for inclusion, the knowledge of the deep functionings which come into play is less obvious. As Kagan points out (2013), the puzzle surrounding the

relation between bodily feelings and human emotional states continues to evade satisfying solutions; what is clear is the interconnection with bodily and implicit aspects, in addition to those sociocultural ones. Many definitions of emotions and the popular "emotional" words in all languages are interpretations of bodily feelings, but any word can specify the quality and origin of the feeling and the target of any given behavior (ibid. P. XI).

Adopting the EC model allows us to focus our attention on those aspects that are still very little explored (missing dimensions). Of course, this does not mean ignoring the role of cultural and environmental factors in the capability and inclusion processes at school; however, they have already been investigated and enhanced by approaches that are also recognized in the educational and didactic field today, such as those of the Full Inclusion, the Disability Studies and the Universal Design For All (which focuses more on materiality).

In conclusion, there seems to be two types of justifications for "pedagogically" orienting towards the exploration of dimensions relating to EC, with a focus on the implicit mental system and the personal, emotional and relational, aspects for a reflection on the issue of the inclusion of SEN students:

First of all, an extensive and complex idea of inclusion - in line with the ICF, the Index and the CA models- calls into question the role of deep, embodied and unrecognized personal dimensions (implicit emotional-relational and personal psychobiological factors) as essential elements for achieving the subject's inclusion in society.

Secondly, research on neurosciences and EC provides insights for a better and appropriate scientific evidence-based understanding of the functioning of SEN students and the neuro-differences that characterize all human beings.

In the following paragraphs we will focus on this second direction.

NEUROSCIENTIFIC CONTRIBUTION TO UNDERSTAND DEVELOPMENT, LEARNING AND DISABILITIES

One of the goals of cognitive neurosciences is the study of the most sophisticated aspects of our behavior, the naturalization process of cognition or social intelligence, consisting in understanding the nature of the neural processes that regulate interpersonal relationships, intersubjectivity (Gallese, 2014). The term "Affective Neuroscience" (Panksepp, 1998) outlines a new field of study and research of the neural mechanisms of emotion and their evolution. Specific neurocircuits underlying emotions ("emotional systems") are described, which regulate different aspects of our lives, thoughts and actions. According to this model, the alterations and inhibitions of the emotional systems give rise to the major psychosomatic diseases and psychological disorders. Therefore, the mechanisms activated by the understanding of the world and an adequate and adapted life (intelligence) involve different cognitive processes: sensory, visual, perceptual, motor, emotional and empathetic aspects (Trevarthen, 1997). Bodily and motor dimensions are involved in development and learning processes, and are interrelated to other cognitive and emotional dimensions (Damiani, Santaniello, Gomez, 2013). In brain development all cortical maps are connected, in a code that reproduces the (somatotopic) body structures, to deep sensorimotor systems, located below the cortex, mapped in the same way, which are able to guide and move the whole body

(Lennie et al, 1990); vision is controlled and guided by many of the body parts. Hearing, sight and touch share a common field in which they operate interconnectedly.

In recent years, also because of the growing attention to SEN, cognitive sciences have investigated the central role of attention and Executive Functions (EF); a category which includes groups that are different from each other in etiology and pathophysiology (Sonuga-Barke, 2005), of which there is not yet a clear and definitive definition. As Benso (2013) observes, even scientific literature cannot define the number and the types of the executive functions. Historically speaking, we mainly refer to the concepts of distractibility and perseveration developed after the studies carried out on frontal patients (Shallice, 1988).These concepts have been subsequently replaced with the terms control and flexibility (Baddeley, 1989; Shallice, 1988), inhibition, shifting and updating (Miyake et al., 2000); problem solving (Zelazo and Muller, 2002).McCloskey, Perkins and Van Diviner (2008) have subsequently identified about twenty executive functions only pertaining to self-regulation. In fact, they include a variety of cognitive processes (attention, memory, flexibility ...) that significantly condition the forms and ways in which intelligence is expressed, the behavioral responses and the possibility to learn in a more or less effective way (Benso, 2010).

The element of interest in our work is the emphasis on their relationship with the emotional aspects and the implied dimensions, which are presymbolic and unaware of the learning processes. In reference to the theory of modularization, some theoretical models identify types of module that are fully automated, and some others that, in order to function (as, for example, that of reading understood as reading and understanding skill), require a certain level of attention and motivation. Executive Functions take part in the different levels in various ways; it's not possible to isolate a single function; they are all interrelated and all involved, in various ways and to various degrees, in the development and learning tasks.

The idea of intelligence and intelligent behavior has been so deeply changed, and this leads to significant changes also in the acquired knowledge and beliefs about disability and the way to learn and be students at school. As already observed, the role of the context (including all people who live and work in it) is essential for understanding students' functioning, in terms of abilities or dis-abilities/capacities or dis-capacities. The concept of environmental intelligence (interdependence with the environment) helps us rethink the role of the teacher in his relationship with the development of students' intelligences. We are witnessing the redefinition of the descriptive and explanatory models of health and illnesses conditions and their instruments (PDM-APA, 2006; ICF, 2007; DSM 5, 2015), in relation to emerging complex and multidisciplinary paradigms, which agree on the simple consideration that understanding the symptom depends on the individual who presents it (Westen, Gabbard & Blagov, 2006), thus also on the environmental and personal context with which each person is related.

As highlighted by Karmiloff-Smith, Piaget's position is weak because it fails to explain some specific disabilities that leave other capabilities unchanged (such as LD), and does not aim at the understanding of the possible evolutions and possibilities for preventing disturbs. The comparison between impaired neurocognitive functions and spared cognitive functions suggests that the spared function result from other cognitive processes (Bishop 1997; Karmiloff-Smith et al.1997). Attention is paid to the dynamic interaction between the genetic component and environmental factors, in order to identify the most basic processing levels (potentially at the foundations of the different disturbs as a distal cause) and the possible effects of evolution on high-order processing. During modularization, the same process (i.e.,

verbalization, understanding ...) in the same children can take place at an early age for a microdomain, and at other ages for other microdomains. Learning must be seen as complex processes, both from a diachronic and synchronic standpoint, so they do not lend themselves to simplistic and monofactorial diagnostic and habilitation-rehabilitation approaches.

The neuroconstructivist approach considers environmental factors important for their effects on the cortical plasticity of the neurocognitive system. The study of such effects (of different rehabilitation methods) could provide important information about the causes of disorders, highlighting the causal relationship between trained function and disorder. According to this approach, comorbidity (coexistence of multiple disorders) between different developmental disorders would explain the complexity of the causal relationships between them, contrary to some biological approaches that consider disorders according to monofactorial models. These studies have, for example, helped highlight the monofactorial and probabilistic nature of neuropsychological dysfunctions underlying LD (Pennington 2006), and allow for a re-evaluation of the characteristics of disorder "specificities" (basically, they wouldn't be so specific like other acquired disorders) and new possibilities of prevention, at least when disorders become evident.

According to the multi-competence model by Moscovici and Umiltà, reading, writing and computation can be defined as modules with different degrees of modularity. First-type modules are those defined by Fodor (perception of colors, sound frequencies, sound and music localization, deep perception and human faces, ...) as unassembled modules, which are simpler and have their own specific function; second-type modules, which are innate too, are generated by assembled first-type modules (language, visual perception, motor action of walking), and they do not involve subject's intentionality too. Only third-type modules, which are more complex generated by the assemblage of second-type modules, need subject's awareness and willingness. They are assembled according to the subject's experience and intentions and constitute all the learning processes and complex behaviors of linguistic, perceptual and motor nature (reading a book, playing tennis ...). This model overcomes the dichotomist visions of reading (and, consequently, of reading disability) as the exclusive domain of visuoperception or language, takes into account the underlying necessary attentional resources, and considers also the non-verbal and preverbal dimensions.

From these frameworks, significant implications for educational and didactic activities emerge, which aim at developing skills and knowledge and are important for all students, but especially those with disorders and difficulties. Modules that are not well formed can represent alarm bells for school, as well as the awareness of the multicompetence nature of school skills must aim at acting didactically both on inferior-type levels (to recover the underperforming microdomain) and on parallel levels, working on processes that are not only of cognitive-attentional type. Lower-level type behavioral mastery is needed to consolidate higher and complex levels of competence, and the correlation of EF with emotional and corporeal aspects must be managed somehow, even in learning tasks. The classification of motor actions worked out by Rizzolatti and Sinigaglia (2006) codes the relationship among different cognitive processes: abilities like speaking or calculating require not only attention and other already mentioned EF, but also motor action.

Recent studies have shown that much of the reading difficulties of dyslexic subjects depends on the visual sensitivity and the auditory frequencies of the magnocellular system. The impairment of the magnocellular system impacts also the cerebellum, and then movements and balance. Some research seems to indicate that the degree of wobble is

correlated with the degree of dyslexia (Stein, 2001), showing how our cognitive abilities are closely related to the movement abilities. So the first insights of Rod and Angela Fawcett are confirmed: the awareness of one's own body and of the movement enhances cognitive ability, through the relationship between auditory-visual movement aspects and cognitive skills in general (reading skills in the specific case of dyslexia).

Studies on the possible applications and correlations between neurosciences and educational sciences have just begun to develop and, in some respects, they're ambiguous (Della Sala, 2016); however, an aspect recognized the scientific community concerns the possibility of early identification of developmental disorders. Screening children early is crucial to identifying those who might be at risk of developing learning difficulties. This may help to pave the way towards the provision of interventions designed to prevent/reduce deleterious long-term developmental trajectories caused by such difficulties. Recent evidence, particularly from the study of developmental difficulties in acquiring literacy skills (Developmental Dyslexia) have suggested that neuroimaging measures are not only responsive to intervention but can also be sensitive tools for the prognosis of long-term developmental outcomes (Hoeft et al.2007, 2011).This suggests that neuroimaging methods can represent a significant 'added value' when it comes to screening children who might be at risk of developing long term learning difficulties. In the domain of mathematics, there's also an emerging body of research demonstrating the prognostic utility of neuroimaging for long-term individual differences in mathematical abilities as well as in responses to intervention (Supekar et al.2013; Evans et al.2013; Evans et al.2015) (Ansari e Lyons, 2016).

At the conclusion of this concise and not exhaustive overview, we highlight the centrality of relationship and integration processes as key dimensions of intelligence and overall mental functioning. As claimed by Siegel and Bryson (2012), brain's healthy functioning is a functioning of balanced and modulated relationship and integration between left and right hemisphere, and between "low-level type" and "high-level type" processes. Education and care must provide the possibility to live experiences of relationship, integration and flexibility of the subject's mind and body, between people and environment.

Brain functioning and intelligent human behavior, therefore, are made up of different multiple aspects which influence each other and are underestimated for their developmental and educational implications, which we can conceptualize as "the new missing dimensions." So not considering them, considering only some of them or not considering their interrelations is a fundamental error of any educational-didactic or therapeutic-medical intervention aiming at promoting their development effectively.

The challenge is to think of some form of right for those dimensions to be included in school and training curricula, which does not result in a simple translation of health theories and practices in the educational field. It needs to identify constructs, dimensions, principles and practices – not related to healthcare - to help "enrich and enhance" didactic and educational planning, or better, to make them (a little) more suitable and effective for all (thus inclusive).

THE FOCUS ON INCLUSION AS A RELATIONAL EXPERIENCE. EMERGING PERSPECTIVES: NEUROSCIENCES, PSYCHOANALYSIS AND EC

Going back to our object of investigation (improvement of inclusion processes at school through a didactics adapted to neuro-differences), in the context of the inclusion models to which we have referred in the previous paragraphs, we have identified the relational dimension as the founding dimension, and we have identified some key principles/constructs, such as: capacity, well-being, choice, freedom, implicit, emotions, for which we have chosen to focus our attention on the personal and interpersonal dimensions. Their in-depth knowledge provides ways for recognizing them and enhances school more adequately.

In addition to the contribution of neurosciences, it seems interesting to refer also to the psychoanalytic model for its traditional theoretical and clinical exploration of many of the elements identified (although named and described according to different conceptualities), but even more for the fruitful dialogue it has been developing with Neurosciences.

This is a new field of interconnection between Psychoanalysis and Neurosciences that opens up to "transversal" concepts and paves the way for new studies, which could explain more deeply some of the personal dimensions underlying inclusion processes and, more generally, teaching-learning processes. In Italy, the idea of a possible integration between neurosciences and psychoanalysis is supported by scientists such as Mauro Mancia, physiologist and psychoanalyst, starting from the neuroscientific discovery of the existence of two memory systems: the declarative or explicit memory system and the implicit or non-declarative memory system (Squire, 1994; Schacter, 1996).The mnestic tracks in the implicit memory and in the unconscious, which cannot be removed, constitute the individual's brand, his main thrust, behavior and personality, and will continue to affect the emotional, cognitive, affective life for all his life.

More generally, the increasing comparison of psychoanalysis with neurosciences contributes to redefine the idea of mind and mental functioning.

Our contribution wants to make a small step forward in the definition of this relationship, by introducing the EC perspective as integrator and common background. Indeed, many of the topics, albeit only mentioned, seem to be consistent with the Embodied model and could be better explained and deepened thanks to it. In parallel, as already introduced by Gallese (Gallese, Migone, Eagle, 2007), psychoanalysis helps enrich the embodied approach, with a focusing on the issue of intersubjectivity in development, health, learning and participation processes. According to Gallese (2007), the discovery of mirror neurons and the resulting paradigm shift in neurocognitive research of intersubjectivity it has generated allow to consider, with cautious optimism, the naturalization project – at the level of sub-personal description - of intersubjectivity.

The intentional consonance generated by embodied simulation processes is consubstantial with the reciprocal relationship dynamic that always is subjective and objective pole of established between the interpersonal relationship. So intersubjectivity "ontologically" becomes the foundation of human condition, in which reciprocity defines existence constitutively. Of particular impact are the scientist's words reported below.

To put an end to this relationship I cannot find better words than those by Helmuth Plessner who in" The Levels of the Organic and Man - Conditio humana "(1928/2006, p.325)

wrote: “Each realization of an ego, a person in a single body, is the premise of the sphere of you, of him, of us.[…] In order that a single man gets to the idea of not being alone and not being only a thing, but having other sentient beings like him as companions, he does not have as a basis a special act, that to project his way of life towards the outside, but he belongs to the assumptions of the human existence sphere” (Gallese, 2007, p.208).

As Semi affirms, a psychoanalyst who has undertaken an interesting debate with Giacomo Rizzolatti in Italy, for many years, the dominant model of mind functioning in the scientific field is that of cognitive psychology; however, already the end of the nineties, the limits on some positions of cognitive psychology and on the description of mind as a computer had become clear. The significant increase of knowledge on brain functioning has led to a re-evaluation of the “alternative” models of mental life, like those of phenomenology and psychoanalysis. Several neuroscientists agree with such opportunity; according to Kandel (1999), psychoanalysis is still a consistent and intellectually satisfying model of our mind, while Rizzolatti highlights the strong disappointment of neurosciences with the model of brain as information processor. Among the various objections expressed by the neuroscientist, there is the one according to which computer needs precise concepts and psychological concepts are “false concepts” (Edelman), while the most common criticism, according to which computer doesn't feel emotions, would be less strong because it could also be overcome. Anyway, the most important aspect refers to Varela's view, revived by Rizzolatti, concerning the fact that computer lacks movement and an Ego. So the metaphor of the computer may be supported only in a mental model that does not consider a self and a motor dimension. In this sense, according to Rizzolatti, the model of psychoanalysis for the vision and enhancement of the concept of Ego and its bodily dimension is appropriate and in line with the current model of neurosciences, and research would receive a boost from the use of concepts and constructions which stem from different fields.

In fact, Freud's Ego is first and foremost a corporeal reality, linked to the body and movement (Freud, Ego and Id 1923), consistent with an idea of self that many cognitive neuroscientists tend to share today. In recent decades, the renewed interest in the interpersonal relationships and the conceptualization of the relationship between Self and external objects has taken various forms in the psychoanalytic field, both as a critique of Freud's concept of motivation and as expansion and reformulation of the traditional psychoanalytic concepts. Terms like “interpersonal psychoanalysis” or “relational,” ”two-persons psychology” or “ wo-body psychology,” ”intersubjectivity,” etc., have become popular, and traditional psychoanalysis has been often accused of being “positivistic,” “objectivistic” or too dependent on an overcome eighteenth-century model, implying that different authors have talked openly about the need for a “new paradigm.” However, there are no clear definitions of the different terminologies used to refer to this “new” paradigm, also because they refer to research areas that are not well defined, intertwined with each other and constantly changing (Gallese, Migone, Eagle, 2006, p.545).

There are two important aspects in our investigation: the Ego, as Semi has pointed out, is the key requirement of motor control and is understood as consistent and organized core of psychic processes; a significant part of such mental processes governed by the Ego is unconscious and is unlikely to ever gain a dimension of consciousness. Freud has highlighted how in certain psychic states (like a dream) there are knowledge processes following the specific rules of the primary processes typical of the unconscious system. These processes are not necessarily located in specific brain structures and the Ego uses both primary and

secondary processes. It has the function of mediating between internal and external reality, and ensuring individual continuity (the narcissistic restoration) also during the change. The first function of the relationship with reality entails necessarily, although not exclusively, the use of secondary processes too, while the continuity of the ego implies the exclusive use of primary processes. The unconscious is considered as a function of the mind necessary to know also consciousness and to understand the individual's behaviors, feelings and emotions. These observations allow broadening the concept of unconscious, by playing down the aspect linked to repression in favor of unrepressed experiences. It is a concept of unconscious (unrepressed unconscious) that is quite different from the one described by Freud in 1923, according to which a part of the Ego is unconscious as derives from the Id through the action on it of the perception–consciousness system: it is the result of the storage in the implicit memory of experiences, fantasies and defenses which belong to the presymbolic and preverbal stage of development and cannot therefore be remembered. Nevertheless, they can condition the affective, emotional, cognitive and sexual life even of the adult (Mancia, 2004, p.110).

Transfert, a key concept of psychoanalysis, is reworked by Mancia according to an original perspective that integrates different explanatory concepts and functioning aspects. Based on the relationship between implicit memory and unrepressed unconscious (2006), the author believes that the maternal voice is the first stimulus with which the child relates to the outside world. Maternal voice is a sort of imprinting because, by means of it, the child recognizes his mother's behavior and affective-emotional aspects. The child, already at a very early age, is sensitive to the tone musicality of his mother's voice, since this represents the root on which the first child's affective relationship with his mother is based. This dynamic will reappear in the transfert, and the unrepressed unconscious will be present in verbal and extraverbal components. Therefore, the non-verbal components of relationships will be characterized by behaviors (posture, facial expression, aspect, auditory and tactile sensory elements, etc.), while the verbal component must be grasped in the double semantics of language which allows to attach meaning to the modes of communication of the patient, not so much in the words themselves, but through the rhythm, tone, timbre, sentence musicality, syntax and timing of speech. Voice, in a complementary way, takes on a certain value as experience of one’s self and, at the same time, as expression of the self in the psychoanalytic relationship. The unrepressed unconscious in childhood needs a “reconstruction,” that is, an interpretation, a possibility of representation and “storage”; it cannot be remembered but re-experienced, relived, enacted in the interpersonal relationship.

Neuroscientific research outcomes help learn about structures or better understand how implicit and explicit memory is structured, providing a measure of how the unconscious is structured, pushing for the recomposition of body-mind separation (Damasio, 1995; Ramachandran, 1994). Neuroscientists overcome Freud's classification of instinctual life as a simple dichotomy between sexuality and aggression, and thanks to research on the brain they develop models of instinctual circuits as systems modulated by specific neurotransmitters: the “seeking” or “reward” system, which causes the pursuit of pleasure; the “anger-rage” system, which governs angry aggression but not predatory aggression; the “fear-anxiety” system and the “panic” system, which includes complex instincts (Panksepp 1998). In this dialogue space, although open and problematic in many aspects, we identify aspects of enrichment with and for the EC approach, with reference to the enhancement of non-verbal, bodily, motor, affective and implicit dimensions related to self-awareness in the relationship with

others and with the world. The themes of subjectivity and intersubjectivity are dealt with by the relational perspective, which also involves first and foremost the body; the functional architecture of embodied simulation seems to constitute a basic feature of our brain, enabling our intersubjective experiences, being at the basis of our capacity to empathize with others (Gallese 2013).

According to Caruana and Borghi, (2013), EC has recovered some conceptual distinctions taken over from classical neuropsychology and phenomenology, allowing for a (neuro)scientific study of the bodily experience. The most classical one is the contraposition between the concept of "body scheme" and that of "body image," or the more recent distinction between sense of agency and sense of ownership. These theoretical instruments have led to the development of a new concept of "corporeal self," a concept on the borderline between neurosciences and phenomenology, which has proved to be a fruitful interpretative key also for mental disorders like schizophrenia (Ferri et al., 2012).The scientific study of the phenomenology of the body has opened new psychological perspectives, filling some gaps implied in the classical amodal representational theory.

FROM THE CORPOREAL EGO TO THE COGNITIVE UNCONSCIOUS: THE IMPLIED MENTAL SYSTEM

"Matte-Blanco (1975; 1988) reiterates the concept of unrepressed unconscious developed by Freud in "The Ego and the Id" and comments: a) not all the unconscious is repressed. Thus the Ego has unconscious repressed and unrepressed parts; b) consciousness and unconscious are qualities. This means that the unconscious cannot be regarded as the true psychic reality; c) the Id has both a repressed and an unrepressed part; d) some aspects of the Super-Ego belong to the unrepressed unconscious; e) the repressed unconscious and the unrepressed unconscious are essentially different in their origin, but not in their structure or in the rules governing them. Matte-Blanco's deepest insight concerns the two ways in which the Freudian unconscious operates: the asymmetric way, which characterizes classical or Aristotelian logics, and the symmetric way, which results from a symmetrization process that characterizes another logics. The consequence of this interweave of logics is the organization of a bi-logical structure, which is symmetric and asymmetric "(Mancia, 2006, p.14).

After Freud, the concept of repression loses strength and is replaced by the processes of splitting and projective identification, denial and idealization, in the new theory of unconscious mind worked out by Melania Klein and post-Kleinian authors. The discovery of the implicit memory in its affective and emotional dimension, and its link with the unrepressed unconscious, causes a further change in the psychoanalytic theory of the unconscious mind, and suggests new clinical modalities to bring to light unconscious material that is not subject to remembering. As shown by Mancia, this early unrepressed unconscious is discussed in relation to the biological unconscious described by Matte-Blanco.

Nowadays, we can see how the discovery by neurosciences affirming that there is only one long-term memory that can be retrieved and verbalized (explicit), and that memory is basically a memory which cannot be remembered nor verbalized (implicit), has had a significant impact on psychoanalysis (Oliverio, 2009), but it is still underestimated by educational and didactic research.

From an evolutionary perspective, implicit memory is the only memory that develops early; it is already present in the last weeks of gestation and is the only active memory in the first two years of life. It is characterized by procedural, emotional-affective and perceptual-bodily dimensions; these dimensions allow the newborn baby to store the first relational experiences with the world, and the first is that with his mother-environment. The relationship between mother-newborn baby is substantially bodily. This relationship, the way she touches him, she talks to him and looks at him, conveys feelings and emotions that will be stored in his implicit emotional memory (Mancia, 2004; 2006). This type of unconscious contents are different from the Freudian unconscious contents as they are "primary," i.e., they do not imply any repression process in a dynamic sense, and constitute what it is called "cognitive unconscious." They are based on bodily and emotional-relational dimensions; non-verbal dialogue and non-verbal understanding are the only possible way to communicate with the two "unconsciouses."

Psychoanalytic therapy, based on the verbalization of repressed unconscious contents, is under review in the light of the discovery of the implicit system. Care and improvement processes can no longer be exclusively focused on the verbal relationship (Talking care) between patient and analyst; the improvement factor must be something consistent with the implicit cognitive dimension. So the therapeutic efficacy of the non-verbal cure and of the management of new patterns of relationship, communication and transformation, which cannot be translated into words, and based on the bodily, emotional, gestural, paraverbal, presymbolic and agency dimension, is affirmed. Therefore, the new psychoanalytic approaches are increasingly recognizing the value of inter-actions, actions or enacted intentions (enactment); neural networks are formed if interpersonal relationships have the right emotional (intimate and syntonic) tone, which neurosciences assess as biochemical tone. The implicit relationship\communication, from unconscious to unconscious, changes the brains of both partners in an evolutionary sense, if it occurs in the appropriate dialogue and emotional tone, forming new neural networks and new functional capabilities. Unfortunately, brains are modified dysfunctionally when relationships are not syntonic, but intrusive or dystonic. The role of implicit theories on students and learning by teachers is key, and highlights the need to train them appropriately (for more details see chap. 12). What happens in the teacher-student relationship that the teacher does not know? We all have an implicit theory, but the problem arises when we do not know what of our theory gets into the mind of our child or student. The implicit theory risks profoundly influencing the environment in anti-evolutionary anti-educational sense, making us remain attached to sterile and stereotyped views of both our abilities\possibilities to change it effectively (self-efficacy and self-agency), and of those of our students. The "good relationship" at school is not characterized as an end, but as a means to "displace the energy invested initially by teachers on cultural objects" (Damiano, 2010). A relationship where to trust each other and communicate openly. The essential elements for a good relationship: the mutual interaction process that must be, or at least appear, fair and equal (Schein, 2010). The ethical dimension of the relationships, essential to achieve inclusion, consists in developing a mindset in which it's possible to take care of other people and feel responsible for one's own actions and feelings, whether they're good or bad (Fasoli, 1994). We have already found out that these dimensions are considered to be central in the pedagogical theories of inclusion. Developments in the theory of the attachment have investigated its deep dynamics. The relationships with significant persons are generalized into operational models (of the Self, the Other and the Self-with-the Other) that

attach meaning to the early interpersonal experiences, act as the basis for the assimilation and processing of subsequent experiences with the Other and are the matrix of future interactions.

Focusing back on learning processes, among the useful contributions for an application in education and didactics, in order to improve inclusion at school, we report these "deep cognitive processes" we have knowledge of by way of example but, not of limitation.

- *The implicit memory* - Memory is originally an implicit memory, not subject to conscious memory and not verbalized. Implicit memory is characterized by procedural, emotional-affective and perceptual-bodily dimensions; these dimensions allow the newborn baby to store the first relational experiences with the world. *Explicit memory*, in contrast, can be retrieved consciously and verbalized, it concerns one's own autobiography and allows, through remembering, a reconstruction of one's personal history; it is an essential function so that the repression process can take place, and requires the integrity of the medial temporal lobe, the frontal–basal areas and the bilateral functionality of the hippocampus.

The dimensions of the implicit memory concerning psychoanalysis are the procedural and the emotional-affective ones, as they characterize the first child's relationship with his mother and participate in the organization of his Self (Stern, 1985). The physical contact with his mother, in fact, stimulates emotions and conveys feelings that will be the core elements of a relational learning stored in the implicit memory of the newborn baby.

Not only experiences and positive emotions, but also frustration and disillusionments will be stored in the preverbal and presymbolic implicit memory, and will form the structural elements of an unrepressed unconscious nucleus (Mancia, 2003; 2004). These experiences, in fact, may not be subject to the mechanism of repression, since the explicit memory structures, essential for the removal process, are not fully developed before the first 2-3 years of life (Siegel, 1999).

Educational and didactic research, given the increased attention to learning, behavioral and neurodevelopmental disabilities in general, is precisely analyzing the role of memories, including that procedural or implicit ones, and the enhancing or weakening role for the cognitive processes of the relationship with teachers (in their role as secondary caregivers), with reference to the model of brain plasticity (Lucangeli, 2012) and the neurocostructivist vision of intelligence and learning.

- *The implicit attentional system* - Most of the attentional processes (selection and processing of sensory and proprioceptive information) occurs implicitly, unconsciously. According to the premotor theory of attention (Rizzolatti et al., 1987), attention is "generated" by the same neural circuits involved in sensorimotor transformations; the selection and programming of a motor plan automatically moves attention towards the spatial regions, where the action must be performed. Affective and relational aspects like emotions, stress and motivation, greatly influence the attention capacity, and thus behaviors and cognitive performances. We have already shown that attentional skills are involved in all typical and atypical development learning processes.

- The *ability to choose* - although dealing with problematic issues that affect the ethics of neurosciences (Roskies, 2003), calling into question problematic topics like that of the free will, we cannot but consider, from an educational point of view, that many decision-making processes are realized unconsciously. Recent studies of "neuroeconomy," carried out through neuroimaging techniques, have shown implicit mechanisms also in the formulation of judgments; neurobiological-affective components (emotional and motivational arousal) are the biological spring that mediates perceptual and cognitive processes of facilitation or

inhibition underlying the purchasing behavior (Balconi, 2009, in Balconi, Antonietti, eds.). Emotions, stress, bodily- relational aspects and past experiences largely condition our ability to judge and choose throughout our life.

- *Empathy* - defined as one of the most valuable resources of our world, empathy is an important issue concerning our life in the community (be it our family, school or society). The empathy in the interpersonal relationships and educational and work places is often taken for granted, and this has led to overlook it. The empathetic capacity is critical to the building of inclusive relationships of care and attention to the other's differences. Neurosciences have theorized the lack of empathy as a result of a deficit in mirror neurons (Baron - Cohen, 2011); according to Gallese, Migoni and Eagle, "the integrity of the sensorimotor system really seems critical for the recognition of emotions showed by others (see Adolphs, 2003; Adolphs et al., 2000) because, in line with what proposed by Damasio (1994, 1996), the sensorimotor system allows for the reconstruction of what an individual would feel by simulating the his bodily state. The implication of this process for empathy is obvious "(p. 555). The psychoanalytical front helps describe the behaviors related to the development and expression of empathietic capacity. The baby's early interactions early interactions with caregivers, construct cognitive-affective schemas of self and other and that these schemas regulate and direct a wide range of subsequent behavior, especially in interpersonal relationships (Blatt, Auerbach, Levy, 1997). What is internalized is a pattern which sees the child in relation to others, in an important dynamic and implicit-procedural dimension. Theory and research have attached a role to the early relationships of care in the development of the representations of oneself and others, both in normal and pathological development. These initial Kleinians considerations are matched with the latest developments related to the construct of the attachment. From his birth, the child is part of an interactional system that unfolds over time, preserving an inherent continuity: this continuity is, on the one hand, the result of the dynamic interactive process between the individual and the environment and, on the other hand, an expression of the overall coherence of the individual's relational patterns and sense of self (Stern and Sander, 1980). Research on empathy mechanism also offers a model, albeit still open and under discussion in the scientific community, for interpreting some neurodevelopmental disorders like autism: "It is precisely the mirror mechanism, and in general the set of experiments to which it refers, which is responsible for some of the most interesting predispositions to developmental disorders like autism (Gallese, 2006; Gallese et al.,2007; 2012; Cattaneo et al., 2007; Boria et al., 2009; Fabbri-Destro et al., 2009; Cossu et al., 2012). "

In the field of an EC-based approach, it is finally highlighted the role of action and intersubjectivity. The recognition of the other and the ability to take care of the other, for his well-being, takes place at a very deep level through the movement, and the action of recognizing the other as capable, starting from the use of his kinesthesias, of building the world just like the subject himself does, means that it's possible to establish the relationship with the other not on generic empathy, but with the empathy with others' actions. The possibility of a rich intentional consonance with other individuals is made possible by sharing actions, emotions and feelings with other, as well as the neural mechanisms that underlie them; the shared interpersonal sense space: "space shared diversity" (Gallese) is an enlarged view of the concept of empathy.

Berthoz defines sympathy and empathy as substitutional behaviors of sharing of emotions, and proposes a spatial theory of empathy that identifies the main difference

between the two modes of intersubjective relationship in the manipulation of the individual's viewpoint. Sympathy, according to Berthoz, means "attributing to ourselves what we observe in others. Such an attribution may involve simulating others within ourselves and identifying ourselves with him. But, in the process of sympathy, we don't move and we see the other from our viewpoint "(Berthoz, 2013, p. 33). So, in the relationship based on sympathy we remain in our place, while undergoing a process of emotional contagion. On the contrary, a fundamental characteristic of empathy, in this sense, it is the adoption of the point of view of others and the simultaneous inhibition of emotional contagion. In the author's hypothesis, four processes at the basis of empathic intersubjective relationships are identified: The construction of a coherent perception of our body and its relationship to the environment; the ability to change our own perspective or viewpoint and mentally move our body and brain into the other's body and brain (Einfühlung); the ability to abandon the egocentric or hetero-centric perspective (our own and the other's) to adopt an allo-centric perspective, inhibiting the emotional contagion (Berthoz & Thirioux, 2010). These processes require the contribution, although not exclusive, of different brain mechanisms involved in spatial perception, in mental manipulation of the reference systems and in perspective changing. The problem of empathy cannot be reduced to spatial information management and recruitment position of others in the space. The central problem is being at the same time themselves and the other, living a sort of "out of body experience" which allows us to separate ourselves mentally from our own body and travel into the other's body with our "second self" or mental "double" (Berthoz & Petit, 2006).

In General, the emerging topics agree on reassessing the body, action and emotional dimension in cognitive and learning processes, justifying the openings towards a possible field of interconnection between psychoanalysis, neurosciences, EC and pedagogical and didactic research.

Within this new scenario, there are different spaces for in-depth analysis. Of particular urgency and interest is the exploration of the characteristics of the new (?) relational capacities in the internet era: what peculiarities, what risks and resources do virtual relationships, mediated by new technologies and social networks, involve? How do bodily competences change the virtual era? How does the educational and training relationship change in the era of e-learning and online learning communities? These are open questions which are to be taken into consideration, but we cannot discuss them in this work. We only mention an element of particular interest for our work, relating to research on internet addiction, in which it is observed that the essential dimensions for prevention are those personal ones: self-esteem, ability of self-control and self-regulation are inversely related to addiction (Widyantho and Griffiths, 2011). The hypothesis of the enhancement and compensatory function of lacks in the essential dimensions of development and personality (the functioning of the PF of the ICF), is reported in the literature about addictions both to internet and to substances (Kuss and Griffiths, 2011).

It is easy to observe that these are the same dimensions underlying "healthy," not specious nor manipulative relationship, thus they're vital for the development of social skills and empathetic and relational capacities, essential in students as future citizens, but still and most essential in the trainers of future citizens. A conditio sine qua non for achieving inclusive relationships.

FROM SPECIAL EDUCATION TO SPECIALIZED EDUCATION FOR ALL: THE NEURODIDACTIC HYPOTHESIS

By focusing more on the possible contributions to the improvement of inclusive didactics, we can briefly affirm that an education consistent with the paradigm of neurodiversity can only be a differentiated-type didactics, starting from the features of different students' functionings (and then going beyond ...).

As for SEN students, we adopt a little provocative thought by John Stein, who notices an evolutionary value of magnocellular dysfunctions causing dyslexia and other developmental disorders, as they're such common and frequent problems that cannot be considered somehow beneficial to humanity too. We consider this a very inclusive position that changes the view of the impairments, and we agree with the author by affirming that it is up to school and society to develop mechanisms enabling the understanding of these benefits. The need to differentiate didactics for neurodifferences justifies the use of the construct of "neurodidactics" (Herrmann, 2009; Sabitzer, 2010, 2011; Rivoltella, 2012; Damiani, 2012) founded on different consistent didactic methods. This approach has cleared away any false problem of justice/injustice in not giving/receiving the same educational stimulation and in not requiring the same performances for everyone.

The curriculum must be necessarily dynamic and the educational planning must be differentiated and neurodifferent, otherwise there will be no didactics for learning but something else (certifications, issuance of diplomas and marks, selection ...). School cannot guarantee training and development success for every student if it does not adopt an idea of inclusion that sees diversities as normalities.

Using the discoveries of neurosciences to improve teaching and learning processes is not a new idea; in fact, as noted by Borghi, developmental psychology is oriented to the development of sensorimotor dimensions starting from Piaget, but applications at school were and still are unrecognized by the pedagogy and didactics. The separation between school as a place for education in its "inside" and a place for learning in its "outside" is no longer useful; schools must be a place for learning and must teach how to learn; school is the place devoted to learning "how," but to do this, it is essential to know how to learn, what are learning processes and how they function, with reference to the paradigm of neurodiversity. Neurocognitive research demonstrates connections between intelligence and brain activity related to different cognitive tasks. Neuroimaging research shows that intelligence is associated with the reciprocity of several brain regions within a widespread brain network (Colom et al. 2008; Desco et al. 2011).

There are now many contributions in literature seeking to identify the principles of Neurodidactic research, starting from the Brain Based Learning approach (Caine & Caine, 1995), based on the idea of integration and necessary relationship among the elements as a general principle "neurofonded" on the model of brain functioning. As for didactics, it is about stimulating the creation of connections to teach "how" and not only "what." The Brain Based Learning (BBL) is a holistic and unitary approach stressing the principle that the brain is a parallelor processor, that is, it processes many functions and processes simultaneously; a principle consistent with the idea of inclusive didactics.

Based on these principles, some advice for effective and brain-based learning is given. They postulate that all students learn more effectively when: they are involved in experiences;

their needs for social interaction and relationship are engaged and honored; their interests, purposes and ideas are engaged and honored; they can use their innate capacity of patterning; their learning is accompanied by positive emotions; details are embedded in wholes, that they understand, such as a real life event; their attention is deepened and multiple layers of the context are used to support learning; they have time to reflect on; immersed in experiences that engage multiple ways to remember; individual differences in maturation, development, and prior learning are taken in consideration; the environment is supportive, empowering, and challenging; their individual talents, abilities, and capacities are engaged.[5]

The purpose and methodology of the BBL are centered on teachers' action, which stimulate the search for relationships and connections between topics, but especially between topics and personal meanings, through the collective confrontation for the search for relationships and connections. The mechanism is consistent with students' (and teachers') mental functioning, and aims to "exploit" the physiological tendency of the brain to create connections. Among the strategies used by the BBL, narration, the construction of stories and metaphors help create relationships between the elements in the field (cultural objects and persons).

Among the other contributions of scientific literature, there are Sabitzer's directions resulting from research in the field of memory and cognition: the reduction of demands/requirements during the perception of new topics may increase the efficiency of learning and memory; An overview at the beginning of the lesson prepares the so-called priming, an implicit memory effect, that facilitates the recognition of a stimulus implicitly perceived before; Students shall also structure and organize their material on their own; The teacher should always refer to well-known topics; to integrate teamwork and projects as well as the multimedia. Moreover, there are many principles and proposals given by the knowledge about the functioning and process of the memory which highlight the importance of creating appropriate environment in our lessons (room, positive atmosphere, confidence, enthusiasm ...) to help the students motivate themselves and learn more effectively. It's possible to facilitate the learning process in all steps from perception of new information over the working and the long term memory by using various teaching methods, varied material etc. For the author, one of the main principles of neurodidactics is the following: Knowledge cannot be taught; it must be created newly in the brain of each student. This may surprise and contrast with the traditional view of school education (The teacher must teach something! = teacher centered instruction), but it is well substantiated in neuroscience and cognitive psychology. According to Maria Montessori's "Help me to do it alone!" the neurodidactics also proposes an active student role (= learner centered instruction). This leads to another way of education: self-regulated or self-organized learning which satisfies nearly all requirements of a pedagogy that has learned from brain research. The neurological basis of the statement above is the function of patterning: The brain recognizes and generates patterns and rules itself. The students don't need rules, but many examples, which help them, recognize the included structures. This brain-function is the basis for exploratory or discovery learning, which is one of the basic principles of progressive pedagogy. As our internal valuation-"software," the limbic system, checks all new information and we only memorize what's good

[5] https://www.researchgate.net/publication/228411501 Sabitzer NEURODIDACTICS–A NEW STIMULUS IN ICT AND COMPUTER SCIENCE EDUCATION.

and meaningful for us, learning is especially effective, when it makes sense. Teachers should check the current knowledge and competences of their pupils and start the learning path from there because we are learning by making associations. All new information is linked to existing knowledge. But linking alone doesn't guarantee the storage of the information in the long-term memory. The more often we use the same association, the better we can memorize the learned issues. So the brain research proves another very old saying: Practice makes perfect!

In conclusion, the neurodidactic perspective is consistent with the idea of learning for life, not for school.

EC CONTRIBUTION TO INCLUSIVE DIDACTICS

In view of the various stimulations and possibilities of insights that have emerged so far, in closing our work, we will aim at redefining some aspects that are more related to the topic of inclusion of SEN students at school and of inclusive didactics, in an EC perspective. I am not going to get into the rich and complex debate on the epistemological perspectives and nature of EC, already well explored by different authors in the other chapters of the work, but I'll just focus on the relational and intersubjective key dimension of inclusion, according to the complex and multidimensional vision that involves different evolutionary and educational processes. For this exploration, I have used some ideas offered by the recent dialogue developed between neurosciences and psychoanalysis, in the light of a consistent (and integrator?) background of EC.

The EC approach based on intersubjectivity, according to Gallese, and the current model of psychoanalysis, which tends to intersubjectivity, represent a fertile meeting space and justify the focus on the intersubjective dimension for the building of the individual's mind, emotional-relational and inclusive competences. According to these perspectives, the sociocultural dimensions, although not explored directly, are present as embodied cultural dimensions, that is, they're mediated by the body of subjects in the world. EC contribution to inclusion can be identified mainly in the identification of the dimension of an "enriched" relationship, according to which it would be appropriate to protect the various dimensions that make it up.

Indeed, the discovery of mirror neurons has introduced the adoption of a new model of mind and mental functioning, consistent with "alternative models to those of computers (psychoanalytic and phenomenological), through the enhancement of the missing dimensions: the body and the emotions, or more precisely, the embodied theories on emotions (Caruana and Gallese, 2011; 2012 and Caruana, 2011). However, as observed by Caruana and Borghi (2013), it is undoubtedly the social field, the intersubjectivity and the understanding of other individuals, in which new cognitive science has forced the science of mind to move forward to a higher quality level. "Empathy, emotions, language, art, psychopathology, rehabilitation, are only some of the themes that have dealt with this discovery; recent studies have shown that the activation of mirror neurons is modulated by contextual variables such as the familiarity with the observed action (Rochat et al., 2010), the position in which it is performed, the (egocentric, side, front) perspective from which the action is observed, the value attached to the observed object (Caggiano et al, 2009; 2011; 2012)."

As pointed out by Allen and BekoV (1997), an "all-or nothing" approach to social cognitions is strongly arguable. As Gallese affirms, (2008) it is reasonable to hypothesize that this evolutionary process proceeded along a line of continuity (Gallese et al., 2002; Gallese and Umiltà, 2006). It is perhaps more fruitful to establish to which extent different cognitive strategies may be underpinned by similar functional mechanisms, which in the course of evolution acquire increasing complexity. The data on mirror neurons in monkeys and mirroring circuits in the human brain seem to suggest that the ease with which we are capable to understand others and recognize them as similar to us - in other words, our "Intentional Attunement" to others - may rely on a series of mirroring mechanisms that we have just started.

We believe that the elements characterizing the EC approach and those emerging from the identification of the interdisciplinary connections on the issues of corporeality, affectivity, intersubjectivity and well-being, can be adopted to improve the didactic approaches based on the principles of inclusiveness and innovation; innovation and inclusion necessarily go hand in hand and share an embodied nature. According to Alter (1999), innovation is an action that is simultaneously complementary and opposed to the universe of organization, because it requires the ability to shake up and give up what has ensured success in the past. In this sense, we believe that an idea of an "EC-Based" inclusive didactics is an "enhanced, integrated and updated" inclusive-innovative didactics (Gomez Paloma, Damiani, 2015), able to revolutionize and re-organize itself in the face of differences and the unexpected. Such an approach enables the realization of what pedagogical literature and the policy on integration/inclusion have discussed in recent years, that is, the extension of the need to adopt "special measures," from disabled students to all SEN students and, ultimately, to all students, since they all have specific and different characteristics: from special didactics to specialized didactics for all (Ianes, 2014).

A didactics which is more respectful of all the dimensions making up inclusion and teaching-learning processes must provide moments of narration and building of stories - according to the ways of thinking and building knowledge - the use of metaphors to connect meanings, motivations and pre-verbal and implicit dimensions, and the consideration of the body (in the images of art and thought, through dance, music, drama, motor education), for the sub-symbolic, unconscious and sensorimotor aspects (Deahne, 2014) of the emotional and attentional aspects, and implicit assessment aspects which are at the foundations of the theories and beliefs about people and objects (Damasio, 1996; Nussbaum, 2004). In the previous paragraphs we have highlighted how a learning and didactic model cannot be limited to explicit and rational cognitive constructs, but it needs also to retrieve first-level type (implied) mental representations and embodied processes and contents.

Theoretically, the principles and strategies consistent with a "neurodidactic and EC-based" approach seem to be functional to two previously identified paths for achieving a change of school from an inclusive perspective: 1) for the improvement of didactics according to the principles of neurodiversity 2) for the arrangement and promotion of personal freedom and abilities to learn and participate.

CONCLUSION

Adopting the ECS perspective opens up interesting search areas, also for special education. The identification of the connections between emotional perception, implicit memory and motor system; between the empathetic capacities and the perceptual-motor aspects; between unconscious attention and neurodevelopmental disorders like LSD and ADHD, offers options for further reflection for understanding students' functional profiles and defining new strategies for educational intervention.

In conclusion, it needs to reiterate the attitude of caution we consider necessary to be adopted in relation to the advancement of fascinating theoretical speculations and "neuroscience-based" perspectives of educational and didactic research, which may be more or less innovative and justified. However, it needs to point out an indisputable element of advantage resulting from the adoption of an embodied approach to didactics, or even just its knowledge and consideration by teachers. Basically, this approach helps raise questions; it encourages teachers' reflexive capacities, improves the ability to observe what are the processes involved in disciplinary learning, according to the individual differences of their students but, above all, it helps rethink the subject they teach not as an abstract object, a default product in itself to be provided (albeit through small and wise annual school programming doses), and forces to consider the relationship between the subjects of the teaching-learning processes and the object of disciplinary knowledge.

According to the constructivist paradigm, the representation of reality in the ECS model is not its objective reproduction, but rather the result of a dynamic relationship with the individual who is the beneficiary of this relationship. Thanks to the neural mechanism of the embodied simulation, resulting from the dual executive/observational function of the mirror neurons, in most of the cases, the interpretation of others ' behavior is immediate, automatic, pre-reflexive and pre-conceptual. This may explain the unconscious side- but very powerful for its effects on the possibilities of learning and on the effective changes of people - of the relationship with the subject and the experiences of knowledge of the other and the world, which all originate as a bodily and affective-relational experience, and represent initially unaware "emotion-thought," as described by Nussbaum. The teaching-learning process takes place exclusively through the educational-training relationship with the "relational caregiver" teacher (Blandino e Granieri, 2002; Damiani, 2011). The contents passing through this relationship are very different from the "neutral" and inert contents described in textbooks or observed in the worksheets or in the network. Through the physical relationship with teachers and peers, the cultural contents are embodied in and with real individuals' minds and adopt changing, varied and different configurations, because people's bodies and minds are different and unique too, but always significant and "impregnated."

The embodied didactics of disciplines can only be and individualized and personalized didactics, which restores the individualization and personalization processes in their broadest, more inclusive and authentic meanings and, at the same time, it redefines, differentiates and enhances the "education for all."

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Chapter 7

EMBODIED COGNITION IN PHYSICAL ACTIVITY AND SPORT SCIENCE

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ABSTRACT

The *embodied turn* or *practice turn*, however you want to call it, elicited by the embodied cognition perspective, is starting to involve also physical activity and sport sciences. The physiological and biomechanical aspects related to the specialized performance, hitherto dominating the space for the new cognitive approaches highlighted by neurosciences. The centrality of the person, his embodiment in the environmental conception of the action, is shedding light on the mind-body-environment relationship as an integrated scenario, in which the different cognitive processes adapt to the sensory-motor processes as an integral part of the executive functions. New scientific discoveries help outline educational strategies, approaches and plannings of the physical exercise in physical activity, physical education and sport domains. A vision in which exercise intensity, together with the coordinative complexity and the situational variability, elicit all the physiological and cognitive factors supporting the development of the child's executive functions. At the same time, thanks to the person's unitary involvement, attention is paid also to the emotional and relational aspects, in support of a motivation for the physical and sporting practice able to generate the acquisition of active lifestyles over time. From the reference to the approach of neurosciences to the embodied cognition, with a transversal analysis concerning physical activity in general, the chapter mentions some elements of reflection in the specific areas of physical activity, physical education and sports. These three domains, for their peculiarity of body and motor involvement, represent interesting and intriguing fields of study. In the declination of physical and sporting activities, in fact, it is difficult not to integrate the different orientations that are guiding research in the field of cognitive functions. The concepts of situated action, time pressure, subservience of cognition to action, are declined in the continuous reference between on-line and off-line cognition, making us foresee their

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convergence on the sensorimotor aspects guiding action, in the first case, or the mere reference to them, in the second case. To think of the action or to put what we think into action serve as an integrated mechanism alternating and penetrating into all the activities affecting everyday life or particular moments, such as those referred to physical and sport activity.

Keywords: physical activity, physical education, sports, cognitive process

1. INTRODUCTION

In recent years, cognitive scientists' conceptualization of the mind as an abstract information processor has been reworked to include connections to the body. Theories of embodied cognition suggest that our internal representations of objects and events are not solely grounded in amodal propositional code, but rather subserved by the sensorimotor systems that govern acting on these objects and in the events in question (Beilock 2008,1). Theories like the Perceptual Symbols System (PSS) suggest a close relationship between brain activation and perception/interaction with concrete sensory-motor experiences (Barsalou 1999). Several research lines emphasize the potential role of the movement in cognitive development started in childhood (Robertson and Johnson 2009; Adolph 2008; Sommerville and Decety 2006; Campbell et al. 2002; Thelen and Smith 1994). By emphasizing its importance, Piaget (1952) defined the first stage of development as the sensorimotor stage.

The same human evolution was marked by a cognition mainly focused on the perceptual-motor processing in the immediate interaction with the environment, rather than an abstract cognition, centralized and separate from everything else.

More recently, the application of the dynamical systems theory and the concept of embodied cognition (Smith 2009; Thelen and Smith 1994) have paid attention to the child's action and body, when considering learning and cognitive development.

Like Piaget's theory, the dynamic system considers sensorimotor processes as the basis for the development of representation; however, unlike Piaget's thought, these representations are not part of discrete cognitive structures, but emerge through the complex and non-linear interaction between mind-body-environment (Smith 2009).

As pointed out by Best (2010, 12) these sensorimotor representations are not considered limitations of an immature cognitive structure, but emerge at all ages and allow for coherence and stability within the individual.

In line with this vision, it is clear that the early action experience provides the basis for the subsequent development of cognition and its executive functions (EF)[1].

The embodied cognition approach, thanks to research activity being carried out in this field, clarifies the real relationship that the individual establishes in his continuous relationships with the environment surrounding him. The transition from a conception of the

[1] EF are linked to three basic processes (Diamond 2006): attention-inhibition, updating of working memory and flexibility. They involve complex non-automated processes that coordinate cognition oriented to a target, and that develop more slowly than motor, sensory and linguistic processes. According to Banich (2009) EF is an umbrella term that encompasses the cognitive processes responsible for organizing and controlling goal-directed behavior.

mind as an abstract processor of information to a significant sensorimotor system to understand the central cognitive processes, facilitates the systemic and holistic conception of the human being and promotes the dignity of the concrete action in any context it is carried out.

The emphasis on the sensorimotor functions as crucial in the effective interaction with the environment, has supported the idea that the mind must be understood in the context of its relationship to a physical body that interacts with the world (Wilson 2002, 625).

The literature dealing with the body in the field of physical education and sports, hasn't focused on the subject of the embodied cognition yet, showed no phenomenological approach in which acting, sweating, integrating body-mind – situations, are carried out according to an enactive interpretation[2] of sports practice (Allen Collison and Hockey 2009, 3).

However, neuro-cognitive sciences evidence that sees cognition integrated into action and rooted in the sensorimotor interaction (Ben Soussan et al. 2015; Engel et al. 2014) is stimulating research on motor learning in the environmental areas of physical activity, school physical education and sport (cognitive training).

The cognitive set-up that has prevailed so far, both in human kinesiology and in sport psychology, is now reworked also by praxeological sociology through a paradigm shift called practice turn, that is, the emergence of an alternative practical approach to explain human activity.

A real change from attention to the internal processes, which are purely mental, that attach meaning and intentionality to the action, the attention to practical situations materially embodied in the different human activities, and aimed at the understanding of the real-life practices in which the individual takes part as actor (Schatzki 2001, 2).

Such contexts are so embodied, dependent also on the socio-relational and affective-emotional aspects, that the actors not only may be more or less trained to deal with them, but they may also decide, by supporting the motivational aspect, if to get involved or not (Alkemeyer 2009).

The perception of a movement (the sense of movement) is not limited only to the kinesthetic sensory processes, but it spreads and connects in the extended, changeable and adaptive relationship between body and environment, by supporting the development of EF (Berthoz 2011). The idea of and embodied and situated cognition, thus immersed in the relationship with the context (environment, other people, spaces, objects, etc.), acknowledges the body and movement an important role in the learning processes.

In the physical activities, games and sport, there is a holistic involvement of the whole individual, and becomes an ideal context for the union between mind-body-environment, based on real-life embodied, sensorimotor and situated actions, well far from an action related to the sole normative cognitive processes, centralized in the brain areas and dichotomised by bodily aspects. Doing and thinking, in the motor/sport action, cannot only depend on the internal mental representations because the continuous action, also supported by the motor training, allows participants to develop a high bodily and kinesthetic awareness[3]. Thanks to

[2] The enactive perspective considers mind as one with the body and not situated in specific brain structures, hierarchically dominant the sensorimotor activity.

[3] Contrary to the concept of cognitive psychology, the embodied cognition approach affirms how human cognition depends on the physical state and the bodily processes; bodily skills are suffused with cognition and

which they become able to both act flexibly under time pressure and to reflect on their actions (Sutton 2007, 775-76), also by adapting their actions to the different environmental conditions.

A group or team sports game environment, for example, is characterized by indefiniteness, uncertainty and competition that require the re-interpretation of routine behaviors in specific changing contexts, in which the actor must be able to modulate his behavior in unexpected situations requiring a considerable amount of creativity as a consequence of the other players' way of acting.

Those who participate in a game or a competition are very often subject to factors and events independent of the personal individual control[4]. There is a real social dimension in the playful and sport practice, a set of relational skills and competences that, from the material context of the game, convey their meanings into potential future uses the same activities, or in other domains and activities.

Therefore, there is an involvement of cognition, decision, thought, bodily and kinesthetic skills, which explains the actor's embodied intentionality and not just a mere skillful performance, regulated by the mind and performed by the body, as emphasized by cognitivism. In a study on dancers, Calvo Merino (2005, 2006) showed that increased brain activation was observed when observing skills in which they were more expert, rather than those less mastered. Such brain activity, which covers the parietal, cerebellar and premotor area, supports both the single observation and the production of the action (Rizzolati et al. 2001).

The perception of an action, therefore, is subject to the system involved in the action production, and is proportional to the greater experience held in performing the observed actions. In other words, motor experience can actually have an impact on individuals' ability to make perceptual discriminations among different actions they observe: the more they master or have sensorimotor experience of a given skill, the more they are able to discriminate it on a perceptual level (Beliok 2008, 22; Calise and Giese, 2006).

It follows that the planning and execution of actions involves the neuronal circuits that are triggered in the perception of the action, also when only observing it. This mechanism, allowing to predict the outcomes of the actions performed by someone in the past, is crucial in the observational discrimination of one's own actions, a situation in which the sensorimotor system is more strongly activated, than the perception of others' actions. So, in order to develop an embodied account of how individuals understand and represent the information they encounter, it is important to develop motor experiences of self-perception as fundamental basis, embodied in one's own body, for the development of EF and learning in general. Learning sciences are working hard to assess the alleged embodied, enactive, embedded and extended nature of individual cognition, EF and reasoning (Chandler and Tricot 2015; Wilson and Golonka 2013). This so-called *embodied turn* (ET) in learning devices has contributed to an original criticism of the traditional theoretical models, and has stimulated the design of new technology platforms (Lee 2015) and instructional activities (Lindgren and Johnson - Glenberg 2013). The reference to metaphor in education (Sfard, 2009; Lakoff and Johnson 1980), in this chapter, is called upon as a common example of

intelligence. Instead, in order to interpret the body as one of the many factors influencing cognition, cognitive processes must be defined as constituents of the concrete body action.

[4] These factors are the partners and opponents' activities or the obstinacy of resistant materials, for example.

connection between the abstract conceptualization, and its rootedness in references to real-life, embodied situations, which can help increase the understanding and learning of concepts and knowledge. Abrahamson (et al. 2016, 15) show the transition from the cognitive conception of the mind separate from the body to the embodied perspective, through the evolution of the educational metaphor in three consecutive steps:

- The *analytical metaphor*, linked to the hypothesis that cognitive activity is inherent in the propositional elaboration of the symbol, which is in a brain that is functionally isolated from the sensory action.
- The *conceptual metaphor*, which sees the embodied situation as the root of the complex reasoning, but it's still inadequate to capture the empirical reality of being involved in daily actions.
- The *information metaphor*, with production characteristics projected in the environment as a context that sheds new light on the learning mechanisms, functions and effects.

The reference to the metaphor can allow us to judge what the body sciences, and in particular the theory of the environmental dynamics, could add to the perspectives of learning science and the use of metaphor as a phenomenal context within the dynamics rooted in the relationship in question. On the other hand, educators communicate metaphors verbally, often orally and through gestures, in real time, in order to guide students in finding interpretations or solutions to the raised problem.

Therefore, metaphor embodies the verbal content in the real process or in its sensorimotor reference, in order to generate spatial imaginative (thus situated) and dynamic (thus evolving) structures (Glenberg and Kaschak 2003). The instructional use of metaphors, analogies and similes, allows the educator to introduce production constraints through additional (visual, auditory, kinesthetic) information to stimulate the problem-solving action by the student.

This strategy is documented in sport (Lam et al, 2009), dance (Böger 2012), and seems to have positive effects on the performance. The hypothesis that information metaphors act as constraints in production involving students in the task to be carried out, is a pedagogical implication to think about. This brief reference to the metaphor leads us to the embodied cognitive involvement, also in the absence of real movement, which explains the correlation between the understanding of language and the sensorimotor experience related to the words read or listened to.

In other words, language comprehension is interconnected with the system involved in the actions understanding and planning (Glenberg and Kaschack 2003; Barsalou 1999). By reading or listening to the words that explain a motor action linked to an upper or lower limb, the brain areas involved are activated like in the actual evoked movement (Pulvermüller et al. 2005; Tettamanti et al. 2005; Hauk et al. 2004). Learning stimulated by images projected by metaphors, similes, suggests that some aspects of human reasoning in general can be modeled as a temporary projection of imagination constraints on the embodied knowledge actions.

Therefore, there seems to be a correlation between the cortical areas related to a motor role and the understanding of linguistic descriptions related to bodily actions. Memorization itself is facilitated by the situated bodily action (Casasanto and Dijkstra, 2009) as embodied experience of coding and re-enactment processes. This process is explained by the contiguity

between the creation of mental simulations and practical motor experiences, and by the knowledge that reconstructs, in the brain, the same activations linked to real-life experiences (Taylor and Zwaan 2008).

It means there is an evocation of motor responses also with a verbal recall of the actions related to them, even in the particular details referred to the action features such as, for example, its slowness or quickness (Taylor and Zwaan 2008). Therefore, the information metaphor supports embodied cognition through the interpretation of the executive functions, as a bridge that joins, in the same mental processes, abstract and sensorimotor aspects of concrete human actions.

The chapter will analyze the problems of the embodied cognition within the general framework of physical activity, physical education and sport and, subsequently, it will pay special attention to every single domain.

2. EMBODIED COGNITION: PHYSICAL ACTIVITY, PHYSICAL EDUCATION AND SPORT

Physical Education (PE), Physical Activity (PA) and Sport are experiences where sensory perception is certainly embodied in the most phenomenological sense of the term, thus understanding the body as the starting point from which to perceive and experience the world. In this approach there is the interest in the human experience, lived first-hand in the specific context of the embodied experience. An existentialist approach [5] centered on the conception of human existence based on a dialogic relationship where world, body and consciousness are all fundamentally intertwined, inter-relating and mutually influencing (Allen Collison 2009, 6); in other words, they're situated. In his critical review on the embodied knowledge, Wilson (2002, 626) reflects on the specificity of a cognition with characteristics that are perfectly identifiable in the contexts of PA, PE and Sport.

2.1 Situated cognition

Situated cognition- or better, the cognitive activity develops *on-line*[6], in the context of a real environment requiring the involvement of perception and action. Environment is part of the cognitive system related to physical activity and sport, thanks to the continuous and dense information flow attaching meaning to the action that is being performed. Mind embodies itself in real time, in that space and time in which executive functions are carried out, in order to perform the gesture-action-movement. In short, situated cognition is realized while the cognitive process is implemented simultaneously to the continuous perceptual information

[5] In relation to the studies on the embodiment in sport, the existential phenomenology focuses attention on inter-embodiment, or inter-corporeality. For this reason, it is argued that the experiences of embodiment are never private affairs, but they are always mediated by our continuous interaction with other human and non-human bodies (Weiss, 1999: 5).

[6] The *on-line* context refers to a direct, real, situated and concrete cognition, temporally and spatially involved in an action or process. The *off-line* context refers to a more abstract, indirect cognition, not temporally and spatially involved in an action or process.

flow allowing for the elaboration of the motor action. Any motor activity, however, takes place in the spatial-temporal environment, in ways and with activities which are relevant within an actual and dynamic system (Hotton and Yoshimi 2010).

This condition is distinguished from the non-situated, *off-line* cognition, which is realized in the absence of signals relevant to the task (to remember, to dream, to plan, ...) to build mental representations of non-actual or never lived situations. Without entering into the diatribe still not completely solved on the concept of situated or not-situated cognition, we like maintaining an open view which takes embodied cognition into consideration both in predominantly situated and not situated contexts. During a tennis rally, for example, we are in a situated context due to the time pressure that leaves no room for off-line theories, but requires to pay great attention to the rapid racing signals to which to respond. Vice versa, during the break between sets, the tennis player can employ the off-line cognition to rethink, plan or imagine the possible developments of the situation in the next set. The environmental concept, in situated cognition, is interpreted through an activity carried out in a mind-body-environment interacting situation (Wertsh 1998; Beer 1995; Thelen and Smith 1994).

The fundamental idea of this concept is to consider the cognitive activity as distributed between the individual and the situation with which he's interacting, a cognitive system that is unified and not situated only in the brain. The dispute between obligate and facultative systems (Wilson 2002, p. 631), though is still to be solved, does not concern the motor and sporting field as there are many circumstances making them variable in situations that may arise, but which are constant in their constituent elements. For example: the constants in all ball sports games, or even more, those in a single sports discipline, notwithstanding the variability of situations it may show. The domains of PA, PE and Sport provides an open lab to respond to the embodied cognition approach for its intrinsic characteristics able to reconcile both the off-line and the on-line cognitive approaches in the situation, when the performer is fully involved in the concrete action.

2.2 Cognition and time pressure

Situated cognition associated with a given situation must deal with the time constraints, that is, the constraints that are not often fully controlled by the actor, but which define higher or lower time pressure limits. In the game and in sports this happens systematically in all specific disciplines of competitions or combats (team games, tennis, fencing, boxing, wrestling, etc.). Each of these activities requires response times concomitant with the feedbacks from the environment and in real time, i.e., when they arise.

In time pressure situations, all the executive functions of attention, selection, response choice, response realization, must be carried out in real time, in changing conditions, in short and unpredictable times, with no possibility of action postponement or slowdown. Such a cognitive structure is characteristic of the on-line situated cognition, i.e., the knowledge and experience to provide fast responses by calling upon existing mental models or implementing new cheap and efficient ones extemporaneously (Wilson 2002, 627). Vice versa, when there is no time pressure, in the off-line situated approaches, there's a tendency to increase time, take the time pressure off to act more freely and consciously. Therefore, time pressure is self-imposed or inherently part of the task, because we normally choose to act through off-line cognitive processes.

In the case of competition and combat sports, time pressure is a characteristic of the situation and involves the continuous updating of the response plans to the changing racing conditions, in response to the other participants' acting: actions of collaboration with teammates and opposition/contrast with opponents. So there is an interaction mainly based on the non-verbal communication, embodying even more the player's cognitive action. To respond to the needs of a situated cognition under time pressure, there's the tendency to weaken the perceptual load by means of two strategies:

- the first is linked to the recall of representations learned in previous experiences;
- the second, especially when experiencing new and unknown situations, tends to reduce the workload by carefully selecting the information in order to focus only on those necessary ones, and simplifying the cognitive response processes (minimum memory strategies, Ballard et al. 1997). In the case of physical and sports activities the second approach connects itself very well to the ability of *motor anticipation*, supported by the level of experience acquired in the practice of the activities themselves. Thanks to which it's possible to predict the action spatial-temporal development on the basis of a few crucial information (such as moving of the ball in relation to the players' position). In motor anticipation, as already mentioned above, we can observe an integration between on-line and off-line cognition.

2.3 Cognition for the action

More broadly than the criteria of situated cognition, the most general approach to embodied cognition must broaden the cognitive mechanisms in terms of their functionality in providing adaptive and flexible activities. An example of what we want to affirm can be represented by the realization of visually guided actions, such as reaching and grasping an object. In such situations, it has been found that certain kinds of visual input can actually prime motor activity, and they can even activate covert motor representations in the absence of any task demands, that is, in the absence of the real action execution (Wilson 2002, 632).

In physical activities related to juggling, the sports in which balls are used (e.g., rhythmic gymnastics) or in all games involving the use of the ball, these embodied cognition mechanisms are continuously triggered. To affirm that embodied cognition supports the action means that also the abstract cognitive activities, which are very centralized, may use the sensorimotor functions allowing the activation of motor programs, but without a clear movement. Mental structures, originally evolved for the perception or the action, seem to be co-opted to work off-line, decoupled by the physical inputs and outputs, their original purpose, to help think and learn. This decoupling mechanism, explained by different authors (Glenberg et al. 2003, 2002; Grush 1998), is a sensorimotor resource capable of performing a simulation of some aspects of the physical world with no real action on it, but as a means of information that represents or designs connections. This process, as already mentioned, could serve in motor activity, in game and in sports, as motor anticipator. Although this off-line aspect of embodied cognition has generated less attention than situated cognition, evidence that seems to support it is emerging: sensorimotor stimulations of external situations, mental imagery, visual imagery, kinesthetic imagery, as obvious examples of mentally simulating external events (Wilson, 2002, 633).

Therefore, there is the justified belief that reasoning and problem-solving employ the sensorimotor, embodied simulation, both in on-line and off-line processes. This perspective sees mental concepts as deeply metaphorical, i.e., based on analogies between concrete and abstract domains (Lakoff and Johnson, 1999). To explain it better, mental concepts are rooted in motor and sensory knowledge, even indirectly, in order to simulate the action itself even if it's not carried out, or when observing it being performed by someone else (modeling by imitation). Areas of human cognition previously thought to be highly abstract now appear to be yielding to an embodied cognition approach, where mental off-line simulation of external events seems to be a widespread phenomenon in human mind. Rather than continuing to consider embodied cognition according to a single viewpoint, the need to verify the different on-line and off-line approaches, according to their characteristics and the contexts in which they arise with their characteristics, is highlighted. The embodied cognition in concrete activities, including the situations of time pressure and environmental perception, explains executive functions that are characterized in the immediate interaction with the real and immanent situation. This does not allow to think that such an approach can explain all of cognition, as Wilson states (2002, p. 635).

In the light of research carried out in this field, today we can think of situations of off-line embodied cognition, in which mental action is anchored to sensory and motor aspects whose references are distant in time and space, or even completely imaginary. These are symbolic unloading activities, where external references are used as support in the mental representation of things or actions that are not present or carried out at the moment, real sensorimotor representations in the form of mental simulations. Therefore, it is possible to make a distinction between on-line and off-line aspects of the embodied cognition. The former include the cognitive activities embedded in an external situation, including cases that may involve time pressure and off-loading information or cognitive work onto the environment. In these cases, cognition is embodied to satisfy the needs of a body interacting with a real-life situation. Such mechanisms do not appear to explain all of the embodied cognition as on-line situation, but open up to an off-line conception of the embodied cognition that includes any cognitive activity in which sensorimotor resources are brought to bear on mental tasks which are not directly related to spatial-temporal concrete situations (mental simulations), that is, as mental representations of actions on spaces and objects that are not present.

We might consider two unitary mechanisms in which: the sensorimotor guides cognition, in the case of on-line situations or, vice versa, the mind calls upon the sensorimotor, in the case of off-line situations. Motor and sport activity considers both mechanisms, for example: in a sports game like football there's an alternation of challenging phases of the match, characterized by strong time pressure, requiring fast decision-making in on-line contexts (problem solving), in which there is no time for a preliminary programming (Bottom-up automatic processing), and quieter off-line phases, where the player can manage the situation more calmly by anticipating, programming, mentally presupposing sensorimotor actions that can be carried out in the course of the game (Top-down controlled processing). We can almost think of an embodied cognition in which the mind lives the body during the action, when we are on-line, and a body that brings to mind the experience lived when distant or unrealizable like in off-line situations.

3. THE CONTEXT OF PHYSICAL ACTIVITY (PA)

EF, as mentioned above, are linked to three basic processes (Diamond 2006): inhibition, updating of working memory and flexibility. EF involve complex non-automated processes that coordinate goal-oriented cognition, and that develop more slowly than motor, sensory and linguistic processes. This slow development appears to be guided partly by the child's experience (O'Hare et al. 2008) and is paralleled by a protracted period of cognitive development maturing at some point in adolescence or early adulthood (Best et al. 2009).

Aerobic exercise performed with moderate and vigorous intensity is not only recommended as daily activities aimed at healthy lifestyles, but seems to be able to facilitate EF in children (commitment, knowledge, targeted intentional actions). These effects resulted both immediately after an acute exercise, for example, a physical education lesson or a physical exercise (Ellemberg et al. 2010; Hilman et al. 2009; Pesce et al. 2009; Budde et al. 2008; Tomporowski 2003), and after chronic training, like the continuous participation to a sporting practice (Tomporowski et al. 2008; Davis et al. 2007). Both findings point out the possibility that the level with which an exercise requires cognitive complexity, control and adaptation of the movement can determine its impact on EF.

Best (2010, p.7) mentions three pathways by which aerobic exercise may facilitate EF in children:

1. The cognitive demands inherent in the structure of a goal-directed exercise.

Examples are group activities that require cooperation with teammates (anticipation of the behavior of teammates and opponents), the employment of strategies of problems solution and adaptation to ever-changing task demands. Group activities such as soccer or basketball played by children in the studies carried out by Davis et al. (2007) contain many of those cognitive demands in the same way as children's executive processes by requiring them to create, monitor, and modify a cognitive plan to meet task demands (Banich 2009).

Thus, aerobic games and EF tasks require a similar way of thinking and similar cognitive skills with the difference that, in motor and sport activity, such demands take place under time pressure and seem to be more easily transferable to other cognitive tasks. The mechanism that may explain the increased transferability refers to the fact that these games create cognitive situations requiring flexible behavior and decision-making in new and ever-changing environments. Best (2010, 8) defined it as contextual interference: although the acquisition of skills occurs very rapidly when the task components are presented in a simple and repetitious manner, the retention and transfer of those skills are enhanced when there is contextual interference, when the components are presented in a complex and quasi-random manner. For example, in the game of basketball, the child may need to perform a bounce pass to effectively pass the ball with a straight trajectory in one specific scenario, but may need to lob the ball in another one. The particular pass needed at that time is not predetermined and is rarely repeated over and over, but instead, is determined by a myriad of factors that converge at a particular moment. The contextual interference places demands on the executive processes as a motor action plan must be created, monitored, and modified in the presence of continually changing task demands (Brady 2008).Thus, the processing of pertinent

information is likely more effortful and elaborative, leading to greater learning (Carey et al.2005)

2. The cognitive involvement required to perform a complex movement. The execution of complex motor movements also recruits neural circuitry associated with EF, particularly the cerebellum, which seems to be important for complex cognitive functions as well as complex motor functions (Diamond 2006). Brain and mind operate on a global-default mode, and support both cognitive and motor activities that don't rely only on non-automatic and selective processes (Diamond 2009). Thus, the execution of complex motor movements appears to be an important cognitively-engaging task.
3. The Physiological Changes in the brain due to aerobic exercise. The demand placed on the body's cardiovascular system while exercising induces physiological changes in the brain to impact cognition, and may interact with the cognitive components of the exercise. Several authors, mentioned by Best (2010, 9-11) have showed the following effects of exercise on brain functioning:

- Changes in brain regions critical to learning and memory occurring over several sessions of regular exercise. These changes are mediated by upregulation of several growth factors (insulin-like growth factor, vascular endothelial growth factor and brain-derived neurotrophic factor). Neurotrophines, in particular, are important activity-dependent modulators of synaptic plasticity and, at the same time, mediate exercise-induced neurogenesis, the process by which new neurons proliferate and develop.
- Increased cerebral blood volume in a specific area of the hippocampus, determining the information storage processes.
- Immediate neurochemical changes after intense exercise in relation to increases in peripheral levels of monoamines (dopamine, norepinephrine, and epinephrine) that predicted retention of the learned material.

The changes require an adequate intensity, from moderate to vigorous, to stimulate such adaptations as verified in a study in which learning was superior following a short, intense running effort as compared to a longer, moderately intense run or period of relaxation (Winter et al. 2007).

In general, we are faced with two different ways of involving children's EF, with different employment degrees, through aerobic exercise:

- The repetitive coordinative exercises based on top-down cognitive control, and the ability to use automated behaviors (Budde 2008; Diamond 2009).

Such exercises require less cognitive engagement, so it is necessary to stimulate the action in regards to challenging goals or complex movements coordination.

Hillman (2009) showed that acute movements, such as treadmill walking, have an effect on children's EF; more in particular, they facilitate the inhibitory control but do not show overall effects on the perception and response processes.

- Deliberate play (Pesce, 2009), in which, in addition to a top-down behavior, there can also be a bottom-up control in the strategic planning moments, which require cooperation between other children, strategic behavior, coordination of complex body movements and adaptation to ever-changing task demands.

The modulation of these activities appears very important to stimulate the desired effects in children's EF, in particular:

- The aerobic exercise, which require greater cognitive engagement, has a stronger effect on EF than simple exercises that require a limited cognitive engagement.
- The chronic aerobic exercise, which induces morphological changes to brain regions critical to learning, does not affect the perceptual-motor skills or the visual-motor coordination, but increases children's creativity and their divergent thinking (Best, 2010, p .4)
- In the field of acute aerobic exercise, which promotes an immediate neurochemical response that may enhance cognitive performance, it has been shown that adolescents assigned to challenging tasks (bimanual coordination exercise) improve selective attention tasks than adolescents assigned to a simple exercise (repetitive task) (Budde et al. 2008). The complex coordination exercise requires a cognitive process that enhances prefrontal neural functioning. This does not happen for the repetitive exercise.
- The aerobic exercise of equivalent intensity, but based on the aerobic group games, compared to repetitive tasks in content, has better immediate effects on words-recall memory. For delayed recall, instead, both forms of exercise benefited memory performance. Whereas both forms of aerobic exercise led to a general arousal that may have benefited memory consolidation, only the group games condition induced a more specific cognitive activation that further enhanced mnemonic immediate recall (Pesce et al. 2009). We may think of a union between the two working modes: the work in circuit offers many opportunities to learn motor skills, the work in group games provides more opportunities to apply the skills acquired, in a competitive and strategic way
- The playful activities or deliberate play, based particularly on the object handling skills (to grab, to throw), have positive effects on the executive functions of inhibition, at least in childhood (Pesce et al. 2016)

Aerobic exercise can therefore impact EF through different pathways depending on the nature of the exercise, from the required coordinative complexity, the strategic and goal-directed behavior and its intensity. Such requests, typical of aerobic game, engage many of the cognitive processes normally employed in normal disciplinary learning tasks. Moreover, it not only induces physiological changes to the body (e.g., increased blood flow) but also specific changes in the brain than the neurochemical responses and morphological changes of brain areas crucial to learning. There is evidence that exercising in a context of cognitive engagement has stronger impact on the brain. Thus, an interesting hypothesis is that exercise that impacts EF through multiple pathways would have a stronger effect than exercise that works through fewer pathways. For example, the chronic participation in aerobic games may

impact EF via more pathways (i.e., goal-directed thinking, strategic action, skills based on complex movements, long-lasting physiological changes) than regular walking (which only induces chronic physiological changes)

It needs to remember that the impact of the exercise, then, can be moderated by the child's level of development and the EF component examined. Or there may be a particular sensitivity of one of the EF component at one developmental time point than at another. During late childhood, for example, the inhibitory control function seems to be more sensitive to acute exercise (Hillman et al. 2009; Tomporowski et al. 2008), but during adolescence, it may no longer be as sensitive to such effects (Stroth et al. 2009). Studies on the relationship between PA and cognition, carried out with pre-adolescents, have shown how the strategy based on the combination of qualitative (high coordinated and cognitive content) and quantitative aspects (high intensity or enhancement of activity time) of PA have beneficial effect on EF (van der Niet et al. 2016; Hillman et al. 2014; Chang et al. 2013).

PA, in general, through physical aerobic exercise, can have a positive influence on EF only if the executive demands are in line with certain characteristics that can be summarized in three fundamental aspects: goal-oriented tasks demand, complex coordinative demands, adequate intensity that stimulates the beneficial physiological effects on the body and, in particular, on the brain.

Research is analyzing these aspects with great interest, which can already be translated into guidelines for the educational programming and the teaching of physical activity through aerobic exercise.

4. THE CONTEXT OF PHYSICAL EDUCATION (PE)

Motivating children to engage in adequate levels of physical activity is a major public health priority, important in a society that is anesthetizing the need to be physically active in the current young generation. Several studies indicate the onset of sedentary habits from pre-school (Telama 2009; Tucker 2008), and the tendencies developed in this century in the decline of both the physical form (Runhaar et al. 2010; Tomkinson and Olds 2007) and the main motor skills (Vandorpe et al. 2011; Roth et al. 2010), seriously undermining children's motor competence.

It's precisely motor competence that represents the main support of the motivation for the daily practice of physical and motor activity, both in childhood and in later ages (Barnett et al. 2008; Stodden et al. 2008). In fact, it appears clear that the lack of motor skills development in childhood makes the individual more reluctant, in adult age, to take part in physical and sport activity. For these reasons, an early work on motor skills, on the learning of motor skills and the complete mastery of motor control as elements of motivation for adopting active lifestyle, is becoming important in public health (Robinson et al. 2015; Iivonen and Sääkslahti 2014). Therefore, there is a relationship between motivation for the practice of physical activity and motor competence, it appears natural that children with poor motor skills will be less motivated in taking part in physical activity and sport, and will be at risk of assuming a sedentary lifestyle. Conversely, children who develop a good level of motor competence, along with a positive self-efficacy, are more motivated for practicing physical and sport activities during the following development stages (Pesce et al. 2016, 2). Therefore, a positive

virtuous or negative vicious circle can be triggered, which impacts not only motor development, but also the social, emotional and cognitive one.

Regular physical activity, in fact, not only benefits children's health, but also ensures positive effects on the executive function (eg., attention, inhibitory control and working memory), in accordance with the theoretical framework of the embodied cognition, which supports the close connection between motor/physical/sporting activity and cognitive processes (D'Anna and Gomez Paloma 2014; Mavilidi et al. 2014). In addition to that, in a more general framework, scientific evidence has shown how the development of motor skills in preschool age is positively linked with social-emotional development (Bart et al. 2007; Piek et al. 2008), with cognitive performance and school outcomes in different developmental ages (Marchetti et al. 2015; Van der Fels et al. 2015; Hapala 2014; Roebers et al. 2014; Niederer et al. 2011).

Research has also assessed what kind of physical activity can trigger these positive virtuous circles involving executive functions and cognitive development. Generally, it emerges that educational situations should involve aerobic exercise (moderate or vigorous), oriented to a highly involving cognitive purpose (Diamond & Ling, 2015; Diamond & Lee, 2011). On the other hand, cognitive activities disconnected from motor action (purely theoretical), as well as physical activity without cognitive connection, do not seem to positively influence the development of the executive functions.

The coordinative and cognitive complexity of motor tasks is recognized as a potential mechanism by means of which physical activity produce effects on EF. The cognitive engagement in physical activity occurs in different ways but, in general, it must always be a challenge, in high coordinative control or high environmental changing situations, which forces to constant adaptations in problem-solving situations (Serrien et al, 2007).

The stimulation of the executive functions due to involvement in coordinative and cognitive motor tasks has been proved through the proposal for cognitive tasks based on gross motor skills (Pesce, 2012), on multisport practice (Pesce et. Al., 2013) or on sports characterized by contextual variability (Moreau & Conway, 2014); on sensorimotor training or physical practices based on gentle movements (Ben Soussan, 2015; Diamond, 2015), or, finally, on physical activity connected with language learning (Malavidi et al, 2015). In these educational situations, we are certain that executive functions are continuously tested through high and diverse levels of cognitive involvement.

Starting from the evidence that executive functions and motor skills are fundamentally interrelated both at the level of real-life behavior and at the level of brain substrate (Koziol et. al. 2011), studies carried out by Pesce (et al. 2016, p.3) provide a general guidance on how to organize physical activities that could elicit this relationship, using the term enriched PE, that is, a physical activity that incorporates complex motor coordination within a game or a playful activity.

In this combination of engaging aerobic exercise and game/playful activity, the cognitive and motivational enhancement occurs simultaneously. The most emotionally engaging and enjoying form for children is, in fact, free outdoor play, the one that once was performed in courtyards, oratories and blocks, without adults supervising them. Free play stimulates a great variability of motor experiences and, simultaneously, stimulates children's physical abilities (Ceciliani and Bortolotti, 2013; Fjørtoft 2004).

In the field of PE it is necessary to create educational situations in which to propose features common to the free play, through deliberate play (Cotè 2016). Although there are

different physical contexts characterizing courtyards and schools, it is about making the modalities and procedures of the heuristic learning (typical of the free play) similar, which emphasize the pleasure and involvement in a variety of game activities that may be mutually transferable from one context to another, from school to courtyard and vice-versa (Pesce 2016). A similar approach to the deliberate play maximize the efficiency of PE programs focused on the intentional game. This effect has been pointed out not only in the domain of motor skills, but also in the cognitive domain, so that executive functions can benefit from the physical and enjoyable nature of the proposed activities (Diamond and Ling, 2015; Pellegrini and Smith, 1998).

A concrete example of enriched physical education can be deduced from the information highlighted by Pesce (et al. 2016), recalling the following elements:

- proposal for a physical activity enriched by motor tasks that are more engaging on a coordinative level, and targeted to problem-solving situations: deliberate play, emphasizing exploration, playfulness and fun;
- increased emotional load to elicit the better use of executive functions, through games characterized by complex and age-appropriate abilities.
- proposal for open-ended or close-ended tasks, in which starting point, production constraints and task goal are highlighted, then stimulating children to find multiple solutions to perform it. It may be useful to clarify that the term constraint, which is colloquially used as a negative value and an impediment to action, here gains a positive value of discovery or intervention that creates a frame of action within which the child can freely develop motor responses, situated and appropriate to the achievement of the objectives required.
- proposal for a wide variability in the use of motor skills as a form of enrichment for motor coordination;
- games based on social interactions in complex and emotionally engaging tasks to elicit executive functions, by increasing the relationship with the environment and the context: proactive and activity participation feature.

All the above-mentioned activities have the characteristic of promoting the effects of spontaneous (outdoor) and deliberate (speech) play through situations that require deliberate preparation, motor creativity and inhibitory efficiency (especially in handling activities). In other words, an attempt to generate continuity between spontaneous and deliberate game as enrichment of school PE. Cognitive learning strategies, based on the problem-solving heuristic approach, should be targeted to promote exploration and participation (typical of the deliberate play), and should be carried out with an approach based on propositional constraints ensuring the systematic and free application of motor and life skill competence (typical of the deliberate preparation).

In her study, Pesce (2016, 12) has shown that PE enrichment improves fine and gross motor skills (manual dexterity, ball skills, static and dynamic balance) and EF related to the inhibition process. These findings are combined with other studies that have employed an intervention program for improving motor skills, and reducing hyperactive and inattentive behaviors that rely on inhibitory executive function (Piek et al. 2015). In the results obtained, also the previously mentioned transfer action has been proved, in fact the beneficial effect of

the enriched PE compared to conventional PE, particularly in objects control ability (throw and catch), has proved to be more pronounced for children used to play outdoor, in their free time, than for their peers who were not used to.

From this evidence it's possible to deduce the possibility that acting at school, with an enriched PE, it is possible to motivate children to transfer the enjoyable effects of physical activity also in the extra-school field and during leisure, a transfer effect that brings children to find time to play freely outdoor. This mission of school PE is even more necessary for all those countries where school legislation does not provide sufficient amounts of daily PA, which would solve children's health and wellbeing problems. For this reason, school PE should aim to create, in those countries, conditions to encourage the permanent practice of PA outside of school, as well as the stimulation of motor and cognitive and conscious learning, which could be transferred in extra-school context.

The renewed attention to the link between motor and cognitive development, elicited by the neuroscientific approach of embodied cognition, not only is essential for research on exercise and cognition, but is crucial to the transition from the quantitative view on dose-response relations to a qualitative view on coordinative and cognitive movement task demands that may impact cognition (Pesce, 2012; Best, 2010). The participation in enriched PE activities requires many cognitive processes like in the traditional EF tasks, through strategic, task-oriented behaviors, and the complex skills employed while participating in deliberate play. As for the qualitative aspect, there is no doubt that both the variability of practice and its playfulness are essential determinants to elicit, in children, the joy of acting and the motivation for reiterating active and less sedentary behaviors, as well as embodied participation (environmental, conscious and intentional) that provides cognitive benefits to EF. Thus research has prompted researchers to create PA intervention programs in PE proposing physical activities based on deliberate play, characterized by variability of practice and deliberate preparation, in order to stimulate children's executive functions and promote motor and cognitive development jointly. Then there is also the problem of identifying the different types of activities that can have effects on the different EF processes, for example:

- on inhibitory processes through PE enriched by deliberate play and catching control skills. Inhibitory control, for example, seems to be strongly connected to challenging activities of intentional control and environmental interaction, needed to perform catching tasks. We have also to reflect on the fact that the development of object control skill competence is a primary mechanism that satisfies the child, provides pleasure, and stimulates the desire to perform physical activity (Robinson et al. 2015; Barnett et al. 2008).
- on memory processes through chronic/acute aerobic exercise (Best 2010) or sport (Schmidt et al. 2015).

It must be also pointed out that the type of effects on cognitive functions may depend not only on the type of coordinative and cognitive activity proposed in motor task, but also on the fact that the different executive functions emerge at different time points along child development. So it seems that the inhibitory functions are the first to be fully developed in childhood, and memory functions seem to emerge in later ages (Best and Miller 2010). In the light of this evidence, the coordinative and cognitive complexity of motor tasks is proposed as a potential mechanism through which PA impacts executive function efficiency. The

qualitative PA approach is combined with that of quantitative PA and can provide concrete answers to those working in the field of school education in which, for the few amount of hours provided for PE, it appears extremely important to work with a qualitative approach, which, in the limited time available, engages children in the development of EF through an enriched, engaging, motivating and involving PE. Only through such a process we can try to involve children in enjoyable and rewarding experiences that motivate the desire to transfer them in the extra-school context, and increase the free time for outdoor play in a renewed and active lifestyle.

5. THE SPORT CONTEXT

In sports, in particular, the embodied dimension is highlighted by the environmental characteristics and qualities which situate the athlete in an interactive context with environment, other players and instruments, which should be fully lived, embodied, in order to perform effective actions in it (Hockey et al. 2007). In sport and competition games, for example, it also emerges the awareness mediated by intentionality, that is, by the awareness about what we are doing: to go to, to move towards something or someone. This approach does not only refer to how time and space are experienced, but also to the interpretation of the experienced situation, to whom or what we direct our energy and attention (Ahmed 2007).

It's precisely the great variability and imagination in sport games that explains why different athletes perceive and experience the same environment in a radically different, emotionally embodied way, which explains the need to extend studies in sport from quantitative aspects, of physiological and biomechanical order, to aspects that qualify the way athletes feel when living that experience.

This mutuality and reciprocity between athlete and environment, perception, action and decision-making behavior, cannot be seen as the result of individual skills or internal representations. Being embodied in the concrete interaction with other individuals, in the specific environment and with the constraints in it, generates adaptive responses, the sporting actions, which must be described and examined as emergent behaviors which self-organize under informative constraints that are often variable, and sometimes under intense time pressure. So intentions, decisions or actions may be conceived of as emergent, self-organizing, macroscopic patterns formed as individuals adapt to the ecological constraints of their environments (Brummer 2010, 200). From this perspective, decisions and actions in sport are always jointly produced and not made or planned in advance, but rather under constant situational regulation in the course of an individual's interaction with the environment. Sport is a context that cannot be studied only in the lab, through the experimental artificiality, but it needs to be dealt with also in the real context in which it is realized, where informational complexity, time pressure and involvement of more players are crucial for deciding which behaviors to adopt. We cannot study the single individual by expecting to understand the mechanisms of acting in sport[7], the socially embodied practice,

[7] By describing and analyzing acting in sport as an emerging and relational phenomenon, the ecological system and perspective overcome the rigid individualism and the exclusive attention to the internal mental processes.

instead, considers the collective and relational phenomena involving all participants, and not the single autonomous actor only.

While the biomechanical study of a gesture, or its physiological characterization, can be studied in the lab individually, in artificial contexts, the meaning of the gesture, its intensity, its intentionality, can be explained only in the concept of acting in sport, the one which is realized during the game according to the different factors and constraints characterizing it.

This also applies to acrobatic sports, when realized through collective choreographies, the individual body ceases existing to include other bodies taking part in that sporting action. Motor/sporting action requires awareness of decision-making processes to realize deliberate and effective actions. Precisely the ecological approach to perception and action (Brummer 2010, 199) has supported the concept of embodied knowledge in sport psychology and human kinetics as a further alternative view on decision-making and acting in sport (Araujo et al. 2006; Davids et al. 2006). In sports based on convergent (closed skill) and divergent (open skill) motor performance, the phenomenological concept of embodied action's control and regulation, and the ecological approach that situates action in the relationship and situation, is realized, hence in a context that is not only individual, but distributed across different persons, artifacts and settings (Brummer 2010, 198).

In addition, the embedded and embodied system, in motor and sport activity, highlights the immediacy required in responses, problem-solving, immediate use of feedbacks with respect to the effective achievement of the planned objective or the correction of the errors that could prevent it. In all sports based on competitions or combats (basketball, soccer, judo, fencing, etc.) the cognitive function is activated simultaneously to the action itself, when the athlete is involved in the situation. In this matter, time pressure requires a rapid EF carrying out to respond to changing, unpredictable and immediate situations, according to an on-line, situated cognitive structure.

Time pressure, in these disciplines, is inherently part of the situation and, in team sports, it also requires to simultaneously cooperate with teammates and contrast opponents. A systemic and holistic intertwining of sport skills, coordinative engagement, relationship and problem solving, usually based on non-verbal communication between players.

What other examples of embodied and situated cognition could be mentioned?

The prevalence of on-line cognition should not exclude the embodied participation of off-line cognition too: in a football game, the player, who is directly involved in an action, is involved in an on-line situation, but when he is not involved in it, he can employ off-line knowledge to program or imagine potential developments of the subsequent game situations in which he will certainly be involved.

In individual or artistic sports, compared to team sports, embodied cognition is played out more in the mental simulation of the actions to be performed (motor imagery of the gesture), intimately connected to the sensorimotor processes leading movement. This competence has proved to be based on the correspondence between language and written or verbally described action, and is directly proportional to the subject's experience in that sports domain. If the impact of the competence, on language comprehension, depends on the neural operations activation experience employed in the real motor performances, it means that there is an embodied relationship between knowledge and action, between the motor activation system that allows the action execution and the cognitive perception system of the action itself (Beilok 2008, 26).

This has been also showed in dance (Calvo-Merino 2005, 2006), golf (Milton et al. 2007) hokey and football (Holt and Beilock 2006). These findings add a new piece to the mosaic of embodied cognition referred to sport and athletes' EF.

One last embodied cognitive aspect in sports is related to the studies on mental rotation referred to the observation of others' actions, in some cases also to their anticipation made possible by calling upon cognitive and neural operations that drive our own overt skill execution (Beliock 21, 2008)

Mental rotation is the process of imagining an object when it is rotated away from its original position and is involved in problem solving (Jansen and Lehmann, 2013, 92) in which body aspects seem to play an important role. Some studies have shown that a specific motor training, such as juggling (Jansen et al, 2009) or combat and competition games (Moreau et al. 2012, 2011), improves mental rotation performance than less complex activities, such as a simple race. Other evidence indicates a reduction in mental rotation performance in children who do not perform physical activity or with impaired motor skills (Jansen et al. 2011; Wiedenbauer et al. 2007).

The correlation between mental rotation performance and motor or physical ability has also been highlighted in the comparison between sports and music students compared to a group of students of education science (Pietsh and Jansen, 2012): the greater time spent on sport and music activity contributes to the better mental rotation performance.

This effect could be explained by different brain adaptations due to the training, in particular the increase in gray matter in the intraparietal sulcus, a brain area which is involved in mental rotation, studied in golf experts (Jancke et al. 2009).

Also among gymnasts and non-athletes, a better mental rotation performance of the first compared to the latter, has been highlighted (Ozel et al. 2002). In many sports games, in particular football for the dimensions of the playground, athletes are trained by perceiving space and objects from a non-egocentric point of view, and they seem to be better at object-based transformations. Football players, studied by Jansen (et al. 2012), showed improved mental rotation performance in a time-based task, compared to non-athletes, but only calling upon embodied characteristics (human figures) and not with more general characteristics (geometric figures). This effect can be explained by the fact that team sports athletes are trained to recognize the manipulation of bodies in game space from a non-egocentric point of view. Gymnasts, for example, are more trained to an egocentric relationship referred to their own body transformation around all three axes (Steggemann et al. 2011).

As noted for the players, even the gymnasts are more capable than non-experts in left-right transformations with bodily stimuli (e.g., deciding if a human figure raises the left or the right arm) while this advantage disappears if those transformations are based on other generic stimuli, such as letters of the alphabet. The reference to human figures, in general, facilitates spatial and motor embodiment as it facilitates the use of embodied sensorimotor processes (Kessler 2010). But it is also true that mental rotation training seems to benefit performance in athletes than in non-athletes, in the object-based transformation task (Jansen and Lehmann 2013). This evidence confirms the transfer effect of the embodied cognitive experience in the transition from the sport domain to other non-sport domains, and supports the idea that bodily stimuli involve the same EF processes, both in the motor and in the spatial field.

It can be affirmed that different physical and sports activities influence, in different ways, mental rotation functions:

- team, competition and combat sports, for example, train athletes to perceive objects from a non-egocentric point of view, that is, to expand the possible bodily configurations in the three space dimensions. In this domain, motor anticipation is realized by considering the possible movements in space, also with regard to the other bodies' movement and action in the space. The non-egocentric approach, on the other hand, is also defined by the strategic and tactical aspects, which characterize this type of activity and project mental rotation on other players' body.
- individual sports, in particular the artistic ones, train to an egocentric perception, referred to the real and imaginary bodily transformations in space and around the body axes on which movements are developed. In this domain, motor anticipation is realized by considering one's own body, almost in the third person, in order to complete the expected task. The egocentric approach is possible thanks to the fact that, in these domains, there are no strategic and tactical aspects, but there's only the need to perform perfectly the technical movement required.

The scientific evidence set out above is in addition to those previously analyzed in the domains of PA and PE, making us reflecting on the need to study the effects of mental rotation by emphasizing both the egocentric and the non-egocentric perspective. In other words, it needs to involve young team sports athletes also in activities more linked to individual and artistic sports, in order to have an increased and better knowledge of their own bodies, as the basis for the embodied cognition. At the same time, we should involve individual sports participants in team gaming activities, in order to stimulate in them all the cognitive aspects related to the strategies, tactics and cooperation /opposition relationships with teammates and opponents.

In a sporting context too unbalanced on performance and early specialization, with devastating effects detectable in the other burn-out percentages, it appears necessary to think of an initiation to sport practice mainly based on the care of the embodied aspects of cognition.

6. CONCLUSION

The domain of PE, PA and Sport, such as that of the body culture, is changing in the pursuit of an ever-changing society.

The social and cultural world is home to a rapid and often unclear development which raises a number of problems to which it is necessary to find adequate and constructive responses. The sedentary lifestyle is spreading worldwide, especially among young generations, due to the lack of motivation for practicing physical activity and sports.

The issue of public health, although important, is not a subject that can revive the interest in the adoption of healthy lifestyles and long-term involvement in sport in itself.

The real problems are related to the poor educational consideration recognized to physical activity, and the excessive professionalization of youth sports which tends to become a job long before being an area of enjoyable entertainment and wellbeing.

The motivation for physical activity and sport must get definitely away from the cognitive approach, which sees the body as an object of performance driven by a mind that governs the action, and open up to an embodied conception in which mind-body-environment

form a complex, integrated system in the continuous embedment in all experiences concerning it.

These domains must be considered from an environmental point of view, with strong emphasis on the person and the environment in which he operates by means of his cognition, corporeality, emotions and sociability.

To overshadow the competitive attitude that is characterizing physical activity and sport today, means to give meaning to other desires and motivations linked to the enjoyment of acting in attractive and fun contexts. There is nothing more embodied than this perspective of involvement, based on putting ourselves into play in any proposed or carried out practice. Putting ourselves into play not only means deciding whether to be involved or not in a certain activity, but it also means facilitating a social experience that can confirm our identity as a person emotionally and cognitively embodied in what he/she does.

The neuroscientific approach of embodied cognition has highlighted the strong positive effect of physical activity on cognitive functioning in general and, in particular, on activities that require an effective EF contribution (eg. attention, inhibitory control, working memory, flexibility).

Studies on embodied knowledge have begun to spread in physical activity and sport sciences, through the perspective of the environmental dynamics explaining the learning of motor skills, such as self-organization of the complex subject-environment dynamic system (Stelter and Roessler 2005). Research data are giving a new aspect to the physical activities to be proposed in the domains of PE and Sport, through tasks supported by the embodied cognition impacting executive functions through different physical activities.

From acute to chronic aerobic exercise, from coordinative complexity to executive intensity, from free play to coded sport, what appears decisive and profitable is the need for a high cognitive involvement, although adequate for the child-student-athlete' skills and age.

A new methodology based on the endless challenge of cognitive and motor skills is emerging, through a virtuous circle based on the modified repetition, the approach to flexible contexts, which support situations of exploration delimited by informational-propositional constraints, which means that, although providing a defined frame of action, they leave significant margins of freedom of action to children.

It is precisely cognitive flexibility, as one of the foundations of EF that becomes one of the key points of embodied education, in opposition to the simple associative learning, in which a specific stimulus elicits a predetermined response.

The flexibility to which we have made reference, however, is characterized by the ability to pay attention to relevant stimuli while ignoring irrelevant stimuli, and the ability to form, test and alter the action hypothesis in a strategic way.

As this line of thought develops, it can be applied in other problematic situations based on physical activity or being completely abstract, with similar task parameters (transfer) and through flexible and adaptive thought processes.

In other words, it is about bringing deliberate play, which generally characterizes structured activities, close to the characteristics of free play, which generally characterizes children's outdoor activities when they're not supervised by an adult person. Results show that deliberate plays provide a unique form of enrichment, which influences children's cognitive development through improved motor coordination, in particular through objects control skills, which are generally coupled with children's PA habits in later development.

As recent studies have shown (Best 2010; Pesce et al. 2009; Budde et al. 2008), aerobic exercise alone influences EF, but the interaction between aerobic exercise and cognitive involvement, through the forms of cognitive game or the greater demands of coordinative complexity, has a stronger effect. Then it emerges the importance of the qualitative approach, which should support the quantitative approach in PE and Sport: if cognitive games have a stronger effect on children's EF, then it can be deduced that the determining factor is the context in which to involve EF processes.

The quality of the context is played out on the presence of different executive or resolution procedures, compared to the assigned task, which elicit a greater involvement of EF than situations where there is only one or a few procedures. There are several ways, defined as enhanced physical activity (Pesce et al. 2016), through which to determine the qualitative context with which to engage the child in emotionally involving cognitive tasks, being them enjoyable and entertaining: acrobatic exercise that requires complex coordination, playful activities in content that require motor adaptation and flexibility, team games in which to adopt strategies and tactical behaviors in the continual social interaction with other players. In this qualitative context a certain intensity and duration must be guaranteed anyway, in order to elicit also the physiological and neurochemical changes in the brain, in relation to its morphology and functionality. The proposal for a physical activity enhanced by more engaging motor tasks, on a coordination level, and aimed at problem-solving situations, seems to have a positive effect both on motor coordination (manual dexterity, ball skills, static/dynamic balance) and on children's inhibitory control functions.

We must also remember that the cognitive effects of cognitive aerobic exercise may depend on the children's developmental level, or on the fact that the EF components are distinct, emerge at different ages, and develop at different rates. This evidence should be considered in order to plan appropriate forms of aerobic exercise stimulating appropriate EF tasks in relation to certain samples of children.

In competition and combat games/sports, the involvement between on-line and off-line cognitive processes is highlighted too. The first are simultaneously engaged in the carried out activity, often under time pressure, with instantaneous information and decision processing on the behaviors to adopt to solve the problem. The latter are employed in cognitive activities in which sensorimotor resources support mental tasks not directly involved in real actions, but in their simple representations. Physical and sport activity contemplates both mechanisms, for example: in a team sports game, the player directly involved in an action implements an on-line knowledge through an automatic processing (bottom-up), because of the time pressure that fully embodies him in the actual sensorimotor experience. The same player, when not directly involved in the action, can implement an off-line cognition through a voluntary processing (top-down) to plan or envisage the development of subsequent actions. Therefore, on-line cognition cannot explain all of the embodied cognition, but opens up to an off-line conception of the embodied cognition that includes any cognitive activity in which the sensorimotor resources are brought to bear on mental tasks (simulations) which are not directly related spatial-temporal concrete situations. Situations of competition and combat, therefore, train the athlete to employ the two cognitive mechanisms in which the sensorimotor guides cognition, like in on-line situations, or it is called upon by the mind, in the case of off-line situations.

The continuous transition from one mechanism to another, in competition and combat games, integrates the different cognitive processes in a dual-purpose device that, in line with

the sensorimotor aspects, tends to find effective or more mindful solutions to the immediate problem. Cognitive tasks, therefore, are rooted in action. The cognitive and neural systems supporting the action seem to be engaged also in cognitive tasks that do not imply any intention of acting. This occurs in mental rotation processes involving athletes in the non-egocentric (team sports) or egocentric (individual and artistic sport) imagination than the relationship between three-dimensional space and moving body. Otherwise, mental embodiment is realized in the language or visual comprehension of motor tasks, which activates the same brain areas responsible for motor control even in the absence of movement. In order to apply the embodied cognition evidence in physical activity, physical education and sport, it appears necessary to think of the educational actions that can be implemented to ensure the greatest involvement of the executive functions in physical and sport activity.

In summary and very roughly, the following indications in support of an educational program emphasizing the embodied approach in the different domains of physical activity (PA, PE and Sport) can be proposed:

- A coordinative and cognitive complexity in motor tasks as a potential mechanism through which to stimulate the full involvement of the executive functions.
- The inclusion of aerobic exercise in game and playful contexts, in which a good level of variability stimulates the flexibility of cognitive responses to the various problems.
- The introduction and modification of constraints in the learning environment, in order to support and encourage students to freely find possible solutions to any problem.
- The combination of the playful activities of motor learning (skill) with deliberate play in which to apply the learned skills (competence).
- This process not only supports the motivation for learning, but also guarantees children' satisfaction to feel skillful and competent, increasing the possibility of a prolonged involvement in physical activities and sport.
- The provision of aerobic exercise with an appropriate level of intensity to elicit the physiological and functional changes in the brain, for the benefit of the executive functions

With these features, the student-athlete is involved in engaging and motivating motor tasks, encouraged to discover their motor solution through a goal-oriented physical activity, within a properly delimited learning environment. In addition, research on behavior and development has showed that the involvement in physical activity, such as team sports, implements students' concentration, the compliance with the rules, the cooperative behavior, and the social and intellectual skills. In general, PA, through aerobic exercise with high cognitive and coordinative engagement, can positively impact EF.

The concept of qualitative educational approach, based on the concept of enriched physical activity, should be spread both in schools, in physical education, and in the disciplinary sport field. At school, due to the minimum amount of hours provided for PE by legislation, it becomes important to work with a qualitative approach that, in the limited time available, engages children in the EF development. Simultaneously, it must reawaken, in children, the enjoyment of movement and the desire to transfer it in an active lifestyle in their free time, through the participation in physical and sports activities. In sport, extremely

unbalanced on early specialization and performance, the strategies emerged in this chapter may represent an alternative way of initiation to sport based on the embodied aspects of cognition, and on the motivational support to go on with the sporting experience.

Sport has the task of continuing its educational activity carried out at school, by orienting it towards technical and specialist practices, but without losing sight of the motivational aspects related to enjoyment, personal satisfaction and a sense of recognition of self-identity.

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Chapter 8

EMBODIED COGNITION AND TEACHER'S TRAINING

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ABSTRACT

The current scenario forces to radically rethink the mission and contents of teaching: to have knowledge of knowledge in order to teach to live becomes the main object of this change. As pointed out by Morin (2015), we are constantly threatened by making mistakes without knowing it; we are bound to interpretation and need methods for our perceptions, ideas and worldviews to be as reliable as possible. It needs to introduce, from early grades to university, the knowledge of knowledge; it doesn't need only to teach how to read, write or acquire disciplines and professional knowledge, nor it needs only to facilitate specialized professional training, but it needs to introduce a basic culture including the knowledge of knowledge. The world of school is experiencing a crisis, but teachers have the great power to try to make it better. Our contribution aims to explore some issues and problems related to teachers' training, and to map out options to make it more appropriate and effective, according to Morin's indications, that is, an "EC-based" approach.

Keywords: Teacher's training, Mirror competences, Inclusive competences, Embodied teacher's training

INTRODUCTION

Improving the quality and effectiveness of education and training is a decisive objective for Europe 2020 strategy, and for many other school policy programs worldwide.

There is a growing and shared agreement, both at the level of the scientific literature and international school regulations, in considering teachers as the key figures for increasing the quality of education systems. Many studies show a strong correlation between the

professional quality of teachers and students' outcomes (Darling-Hammond et al., 2005; Rivkin, Hanushek, and Kain, 2005). Therefore, all countries are required to adequately support their teachers' initial and lifelong training, in order to ensure an educational offer that trains students to enter the world of work and contributes to the growth of society.

However, considering a growing and shared concern for improving the quality of education and training of school professionals, we cannot but consider how, at the same time, the criticality level within it is increasing; the levels of the fighting against early school leaving are still far from global goals, and the situations of teachers and students' disadvantage and discomfort seem to be constantly increasing. In Italy, research on the professional status of teachers showed increasing unease and lack of motivation; a situation defined as a real condition of crisis that school and teachers are experiencing.

The adoption of the ECS perspective will allow us to focus on some essential, but still underestimated dimensions, for the development of current teachers' competences, in order to rethink and achieve well-founded and coherent training approaches, able to safeguard such dimensions.

SCHOOL IN THE THIRD MILLENNIUM AND TEACHERS' TRAINING: NEEDS, RISKS AND OPPORTUNITIES

International investigations highlight trends and characteristics of teachers' training programs; they include: the demand for increasingly high levels of initial training for future teachers; the increasing emphasis on the function of mentoring for new teachers; the importance attached to the teachers' professional status; the forms of open and competition-based recruitment as the main recruitment methods; the increasing trend to offer teachers professional development plans; the widespread awareness to adopt measures to attract young people to the teaching profession, which is affected by a general "ageing"; a working timetable very similar to that of other "professionals"; the common evidence of minimum gross basic salaries lower than the GDP per capita; the attribution of the responsibility for assessing teachers to school heads[1].

Indeed, in a growing number of countries, schools are obliged to offer professional development plans for teachers; lifelong education has gained importance in recent years, and is generally considered a professional duty. In most countries, central guidelines indicate that teachers' initial training education programs must develop knowledge and high-level and general competences: entrepreneurial, design, computer, thoughtful, inclusive and research competences.

Recently, in Italy, law No.107/2015 has put teachers' training back at the heart of the policies, which becomes a widespread responsibility of the whole society, and has established its compulsory and systematic nature (art.1, paragraph 124), in continuity with the data emerging from the self-assessments and improvement plans developed by each school.

These first elements demonstrate that teachers' professional role is changing worldwide; a difficult change which is articulating between elements of complexity and contradiction, towards an increasing adoption of professional commitment and responsibility, not always

[1] http://www.indire.it/lucabas/lkmw_file/eurydice/bollettino_insegnanti_UE_2013.pdf.

supported on a structural level, for example, with regard to the economic/rewarding and career level and, above all, the opportunities to benefit from adequate and coherent educational - initial and in-service - systems.

In fact, we have to start from the consideration of a misalignment between the system of demands and expectations and that of offers and opportunities; almost all EU countries has reported gaps in teachers' competences level, and indicate difficulties in their upskilling and training. The gaps relate, in particular, to the lack of necessary competences to deal with the evolution of the model of education and knowledge transfer towards the model of global training, the personalized learning, the autonomy development, the ability to manage heterogeneous groups, the optimal use of technologies, etc. Already in 2005, an OECD survey had detected gaps in teachers' competence and the lack of stimuli in upskilling and in-service training in almost all EU countries (OECD, 2005). These difficulties were later confirmed by other international surveys (c.f. TALIS, Teaching and Learning International Survey), which have shown that, in many school systems, we are spending a lot on teachers' training, but the results are unsatisfactory. In general, these surveys show that teachers are little stimulated to improve their teaching, and the most common activities of professional development at their disposal are not among the most effective, although the majority of them would like more professional development (OECD, 2009; 2014[2]). In this work, we will not enter into the details of the different current training systems, but we will only make a brief reflection on some aspects in order to identify the essential characteristics and the possible elements for improving, in the light of our perspective (ECS).

In addition to the inherent complexity of the current teacher's role, about which we will talk later, we can focus on some characteristic elements of the educational systems that seem to constitute a structural problem; a kind of problem resulting from other problems.

First of all, only a few countries (about a third of European countries) provide for specific methods for recruiting teachers, through aptitude tests or interviews on the candidates' motivation to become teachers. For the admission to initial training courses, the general criteria for having access to tertiary education are followed, without providing selection criteria or specific entrance exams for teachers' training. In addition, the qualifications of teachers' trainers are not different from those of other academic staff. Teachers' trainers have a wide variety of profiles, but in most countries the requirements for becoming teachers' trainers are those provided for higher education teaching staff.

A further element able to explain, at least in part, the difficulties of new teachers refers to the characteristics of the initial training programs; these are programs mainly focused on cultural-abstract aspects. In particular, programs that train to the teaching activity in secondary education generally involve less laboratory and professional training. Practical training in schools is organized very differently from country to country, but it is generally longer for pre-primary and primary teachers, than for higher educational levels teachers.

Therefore, possible ways for improving school in general primarily arise from a rethinking of some training methods for teachers. It is essential to focus not so much on the recognized need for lifelong education for teachers, but rather on the adequacy of the elements characterizing the training models.

[2] ECPS Journal – 10/2014 http://www.ledonline.it/ECPS-Journal/ 191.

Among the common aspects to the different current educational systems there's a particular interesting growing interconnection between different dimensions: teachers' training provides for moments of assessment (of schools and outcomes), self-assessment and reflection on ongoing practices and processes. Indeed, one of the key elements attracting great attention at the level of international cultures and policies is certainly the relationship between training and evaluation. In many countries, the participation in lifelong professional development is needed to get a promotion in terms of career advancement and increased salary; most European schools has, or are establishing, a structured system for teachers' training and assessment[3].

Reforms on school systems invest in the assessment, as it's considered a key factor for improving the quality of teaching, recognizing the merit/demerit and providing reward incentives. Teachers' performance assessment, therefore, is an issue of particular interest as it may constitute a major leverage for improving professionalism (and teaching- learning processes), but it also represents one of the most controversial and "risky" topics of today school. In fact, despite referring to a fundamental aspect to be investigated in order to be able to fully describe the training relationship and its effects, it makes reference to a practice still not widespread in the school culture of some countries (such as Italy). The reasons behind this objective difficulty have deep roots of cultural, social and contractual nature (Castoldi, 2012), and cover aspects related to the complexity of the object to be evaluated – teacher and teaching practice – the multidimensionality of the process – teaching activity – the level and heterogeneity of the variables to be considered for an accurate analysis. Some studies have also highlighted how deep and little-known emotional aspects, such as feelings of envy, shame and fear, play a decisive role in the motivation, acceptance and engagement to be invested in training-assessment practices (Damiani, Di Benedetto, Ernandez, 2010).

It emerges an idea of complex training of which we can identify the basic elements in terms of relationships between different dimensions. This complexity includes the problems detected so far, but it also offers resources and new paths to follow. In fact, the close interconnection between training and assessment brings deep evolutionary and generative dimensions into play, both personally and collectively, like emotions, reflection and self-assessment, the others'recognition, the building of communities of practice and the journey towards inclusion.

As pointed out by Bocci and Travaglini, theories on the communities of practice (Wenger, 2006) and the reflective practice (Shön, 1987) show that training, in order to be truly effective, must devise shared meanings and relationships among all the subjects co-building the same reality, within a perspective that allows the individual to learn how to learn, through a systematic and virtuous circularity between theory and practice (Baldacci, 2015). In particular, this situation calls into question the concept of inclusion, a term which indicates a transformation process of school (D'Alessio, Medeghini, Vadalà, Bocci, 2015, in Vianello e Di Nuovo (a cura di), 2015) that constitutes a collective action (Booth, Ainscow, 2014) mobilizing the resources of the entire school community (Forlin, 2010; Chiappetta Cajola, Ciraci, 2013; Santi, 2014), for everybody's enhancement.

Within this scenario, an integrated idea of "training-reflection-participation-inclusion," requiring complex and innovative methods and strategic paths, is emerging. Traditional

[3] http://www.indire.it/lucabas/lkmw_file/eurydice/bollettino_insegnanti_UE_2013.pdf.

academic and professional paths, centered on abstract and formal educational approaches and often not anchored to real contexts and problems, are not able to stimulate and support co-participative, inclusive and reflective training processes. Therefore, then need to think and develop new, integrated and coherent training models is becoming evident.

In recent years, some experiences in this regard have emerged on the international scenario but, however, they are still limited to some realities, and are poorly formalized and monitored.

We will try to identify some elements we consider essential to re-think training models, according to that direction.

WHICH TEACHERS' PROFILE? WHICH COMPETENCES?

The issue of training is closely related to the issue of defining the professional profile. In Italy, Art. 26 of Law No. 107/2015 explains that teachers carry out the teaching/learning process aimed at promoting students' human, cultural, civil and professional development, based on the aims and objectives laid down by the education systems defined for the different orders and grades of education.

Currently, some aspects of this context are putting a huge strain on those competences: the society of globalisation, of pervasive knowledge, of "existential risk" has led to a loss of the sense of school as a place where knowledge is transferred. In this sense, rather than the knowledge acquisition, of great importance seems to be the mutual willingness to relationship and communication; priority is given to the care, the "being together" and the acquisition of "life skills," for a school that must be able to intercept students' life-worlds. An "alive" school makes all the threads of the relationships, necessary to grow (meetings, fights, injuries, successes ...), "live."

However, as noted by Cerini, to focus on the "quality" of the relationship does not only mean to take care of the other; in the school context, in fact, care is equivalent to listening, assistance, attention, tenderness, empathy, willingness, along with taking care of knowledge, of learning how to reason together by using everyone's contribution, stimulating critical and creative abilities, developing language skills in dialogues, in narration. The challenge is to try to build a learning environment where to become competent together in a positive, outcomes-oriented group, aimed at achieving cultural products making adolescents and young people visible. In an "ideal" educational community young people should become the best fans in their class, teachers should think that their students are the best in the world. The class can become a learning community, structured as a cooperative group with a strong leadership of teachers who ensures the stability of the atmosphere in the classroom, the collaborative work (in pairs, in small groups), the education in the hypothetical-deductive, predictive, imaginative, as well as argumentative thought (Cerini, 2009). To desing an "educational" learning environment means to connect didactic and organizational knowledge, but it also means to rediscover the centrality of motivation, of emotions, of the attachment of a "sense" to the experience of school (a very high percentage of kids does not experience school positively). It means building a positive school environment of trust, restoration of communication, support for the engagement and the efforts.

The awareness of the significance and the complexity of the role contributes to the increasing complexification of the teachers' profile, and the exponential increase of the demands and responsibilities assigned to them. Many studies and experiences have helped shape the framework of the teachers' essential competences. In line with the literature of this field, it needs to take account of the different types of competences: there are transversal competences, meta-competences, specific and general competences, didactic and disciplinary competences, and communicative and relational competences. Competence is never universal, fake and static; competence is complex and dynamic, requires knowledge and skills, but also attitudes and motivations; above all, it requires complex and integrated paths for its development and assessment (Le Boterf, 1997; 2000).

Generally speaking, teachers' professional profiles consist of disciplinary, didactic, organizational, methodological, psychopedagogical and organizational-relational competences, in addition to interrelated and interacting research, documentation and assessment competences, which develop as the didactic experience, the study activity and that of systematization of the teaching practice develop.

All models also emphasise the complexity of the teacher's profile and the need for coexistence of personal dimensions, such as characteristic elements: empathy, relational and communication skills. However, the emotional-relational dimension is taking a central role that cannot be taken for granted, and that must be well governed. Analyses carried out by some authors (Blandino, 1997; Galanti, 2007) highlight the risk of an inadequate management of the relationships, and the damage resulting from teachers' poor emotional and empathetic competence. This type of competence is the result of an arduous journey that begins at university, but it is improved in the specific situation, in the daily relationship with students, in a continuous debate and research with colleagues (Cerini, 2009).

Europe has recently published the Profile of Inclusive teachers (2012), a guidance on the design and implementation of initial training and teaching qualification programs. The intent is to consider it as a starting point for finding contents, methods and learning objectives valid for teachers' initial training. The profile adopts a framework of fundamental values, and specifies its competence areas within which the centrality of the teacher's personal and interpersonal dimensions (relational, emotional, reflective ...) is reaffirmed. Among these values, the centrality of the student's diversity is claimed: the difference is to be considered as a resource and a treasure, the competence areas of which refer to personal opinions on school integration and inclusion, the variety in the group-class, the expectations on students' educational success. Also the ability to work with others is taken into consideration: collaboration and teamwork are essential to all teachers. The competence areas refer to the fact of knowing how to work with parents and families, and with other professionals.

The view of the teacher as a reflective professional is expressed, whose competence is to reflect on his role and his work, from a standpoint of continuous review and improvement. Initial training is the basis of lifelong professional development. Along with the core values and the competence areas, there are a series of general principles linked to the introduction of the Profile. All teachers must be able to better manage the different characteristics of their students in the classroom. The role of teachers is crucial in the creation of a positive atmosphere in the classroom, where the action of learning can find favourable conditions if triggered on threads of classroom social relationships which offer answers to the needs of confidence, belonging, esteem, self-esteem (Medeghini, 2013). The factor of "good relationship with teachers" constitutes the primary variable for students' educational success

and well-being (Hattie, 2012; Hanusheck, 2012), as well as for the development of their social, prosocial (Rimm-Kaufman, Sandilos, 2015) and active and conscious citizenship skills.

THE FOCUS ON THE PERSONAL DIMENSIONS AS THE FOUNDATION FOR THE DEVELOPMENT OF TEACHERS' PROFESSIONAL COMPETENCE AND WELL-BEING

Within this scenario, it emerges the recognition, by the Institutions and the schools Government bodies, of the personal dimensions as essential components of the teachers' professional profile, which could explain both the quality of the teaching-learning processes, and the students' educational success. Psychopedagogical literature identifies them as components of the different areas of teachers' educational unease, here below outlined:

- cultural unease;
- relational unease;
- didactic unease;
- organizational unease;
- personal unease (Triani, 2014).

Relational unease is described in terms of interpersonal effort, in relation to the students' problems: "efforts in building positive relationships with students, especially with those most problematic; efforts in building positive relationships with those families that are absent or adopt defensive or aggressive behaviors." In order to face it, the author identifies the area of the relationship with the student, through the strengthening of teachers' communication-interpersonal competences, to be employed also with families, as possible ways of intervention. The improvement of communication-interpersonal competences is reproposed as a strategy for coping also with the didactic unease, in order to allow for the realization of the principle of personalization as a general didactics, and to support the educational competences of the families of the students following specific educational paths (ib).

Various investigations on the teachers' burnout have highlighted the central role of personal skills as a variable determining (in terms of risk factor or protection factor) the teacher's health condition during the performane of his duties (Blandino, 1997; 2008; Albanese, Daniel, Doudin, 2006). Therefore, personal skills are able to improve both the quality of the school and that of students and teachers' life, in terms of acquisition of skills and well-being.

So it seems essential to focus attention on the conditions facilitating a better development of such dimension in the teachers, also (and especially) within the institutional and systematic learning paths. It should be noted that to shift the focus on training activities at personal level (for the personal skills development) does not mean to disregard the actions at structural level (for the structural skills development, as identified by Triani), but it rather means to try to act upstream, at the founding level of functioning.

In the context of the ICF (WHO, 2001; 2007), the personal dimensions constitute a powerful contextual factor, as powerful as it is complicated to be described according to the

ICF universal vocabulary, therefore they are not coded. The absence of ICF codes relating to personal factors does not correspond to their significance and relevance in the description (and explanation) of the functioning of individuals in relation to the environment. In our case, teachers' overall functioning and that of the teaching-learning processes cannot be conceived and described if not within a complex dynamic between personal factors (biological and psychological aspects) and environmental factors. Although there have been attempts to encode students' personal factors (Ianes, 2005; Gomez Paloma, 2013), the attention to teachers' personal dimensions in professional, training and assessment paths is still not sufficiently and adequately achieved and safeguarded.

To meet, at least in part, the situations of teachers' unease and need, and the increasing demand for professionalisation and improvement of school quality, it is necessary to start from the assumption that there are "objective," structural and material barriers (classes with too many students; extreme variety of students' functional profiles and educational needs; poor economic and structural resources; teachers' advanced age; lack of rewarding ...), and "subjective" or personal barriers, such as possession of adequate inclusive, empathetic and interpersonal skills by teachers. These personal skills, for all intents and purposes, are contextual factors, which could hinder or facilitate teaching-learning processes, subjects' inclusion and well-being and, more generally, school quality. It is therefore essential to consider and develop those skills as a contextual resource, also because it's not subject to cuts by school policy or financial restrictions, as they're always (potentially) available. The complexities of today school, of the socio-familiar contexts and its students (students with growing and varied types of SEN, as noted in Chapter 6) puts an even stronger enphasis on the demand for a renewed and effective training for teachers, able to grasp the complexity by starting from its fundamental elements, and supporting everybody's differences. Teachers, to be really inclusive, must rediscover diversity as positive and necessary condition to "educate," to promote social intelligence. As evidenced by Cerini (2009), a "competitive" environment is characterized by inclusion, solidarity, responsible participation, building a of social quality of life. School as a "public space" is fully within this new function. It is no coincidence that the great maîtres à penser of education invoke the need to take care of the formation of minds that are respectful and ethical, as well as disciplined (by knowledge), synthetic and creative. The value factors seem to prevail again over the function of cultural transfer.

In summary, while the values and competence areas required to compose today teachers' profile are being clarified, according to common and shared visions that identify some personal skills as the essential core, it emerges the difficulty of defining, precisely and operatively, those competences and their indicators and descriptors for their training, monitoring and assessment.

The need to think of forms for identifying professionalism in the classroom is highlighted, which focus the teacher's engagement right in his professional practice, the quality of the action in the classroom, the disciplinary, didactic, personal and relational competences, in addition to the documented professionalism (qualifications, trainings, etc.), but it is not easy to "see" the quality of a teacher within the relationship.

By adopting the EC-based approach, our contribution aims to focus on the training of the mind of "competent teachers," starting from the exploration of the still unrecognized dimensions underlying reflective, emotional, relational, communicative and care personal skills, and that are essential for their development and strengthening. In fact, before raising

the issue of how to detect and assess the possession of these skills in teachers, it is important to work to ensure that all teachers, not just those more talented or those who have followed "special" or fortuitous paths, possess them. If, as repeatedly stated, personal and interpersonal competences are at the heart of teachers' professional profile, it is least convenient to try to "stimulate and strengthen" the possession of a "minimum common level of these competencess" in all teachers. Working on the person of the teacher means trying to improve the quality of the teaching-learning process, starting from a different perspective or, more precisely, form an originary and founding perspective.

"The improvement of an education system goes largely through a policy of good actions towards teachers, aimed at ensuring that competent and motivated professionals work in schools" (Cerini, 2009)

TRAINING MIND

The focus on teachers' empathetic and caring competence (Mitchell, 2000; Boella, 2009) and the qualification of the educational relationship also as ability of caring (Fadda, 2006), together with the recognition of a leading function for the management of the group-class dynamic (Blandino, Granieri, 2004), are a key sharing point between pedagogical and psychological sciences.

It should be also noted that the ability to relate, and any other related abilities: that of observation, listening, communication, uncertainty tolerance, ethics, empathy (Blandino, 1996), correspond, to a large extent, to the skills underlying the so-called Life Skills, which are globally recognised as transversal competences essential for the development of the person, citizen and society.

The priority, and to some extent innovative element, on which to focus efforts, is the attention to the trainers' mind, or better, to the training of trainers' mind as a still unrecognized strategic step.

Psychodynamic studies and research have identified long time ago the need for therapists and caregivers -parents and teachers- to have a relational "capable" mind as an essential element to allow for the other's development and training (Bion, 1962; Blandino, 1996), and have identified original and complex training paths.

The role of teachers' behaviors and mental attitudes to improve students' learning, and consequently the atmosphere in the classroom, is essential: it needs to avoid the errors of attributing success/failure to individual subjects or elements (whether they are deficits, subject's character or the nature of the task), to always consider the environmental and relational dynamic that generates it, as extensively described by research on the attribution styles, motivation and mechanisms of learned helplessness (Seligman, 1942), in full consistency with the ICF biopsychosocial model.

The deep feelings of trust/distrust in students' abilities, the more or less benevolent look at their differences and difficulties, the implicit beliefs and theories about the teaching-learning processes, school and life in general - as evidenced by psychoanalytic research and neurosciences - are communicated by teachers in such a deep way through the dynamic of mirroring (from unconscious to unconscious; from mind to mind; from body to body)

activated during didactics, which is basically a relational experience with the subject-student and with the object-discipline.

Through deep relational, embodied mechanisms, activated and supported by the teachers' minds, also students' feelings and attribution styles are affected, encouraging favourable or unfavourable outcomes: when failure is attributed to internal negative properties, such as the lack of general skills (I don't understand, I'm not smart), the process of perception of poor efficacy and worthlessness is defined, which leads to the expectations of new failures, motivational block and passivity (Medeghini, 2013[4]). Having a mind able to interpret the problems and difficulties from a different perspective represents a cultural and theoretical watershed of didactics. Excellencies, special educational needs, deficits and normality represent the vocabulary that is built around normative data and that, if adopted, will prevent school from entering the teaching-learning relationship, as it shifts the problem on the individual pupil and student (Medeghini, 2013). In the full-inclusion, environmental and biopsychosocial perspectives, the relevant question is not: "What are the students' problems?", but: "What are the barriers impeding participation and learning?" We have already pointed out that the main barriers, the more resistant and hard to remove, are precisely those mental ones.

Recent cognitive neurosciences and its different articulations (Affective Neuroscience; Educational Neuroscience ...) offer an updated and integrated model of mind, able to describe and explain its various functions, in relation to the contextual and environmental dimensions.

In our case, by adopting the EC-based approach, we can try to describe the specific personal skills for a "better" managing of the differences of contexts and students, as a set of knowledge, capacities, abilities, attitudes and behaviors, emotional aspects, having their foundation in the bodily, emotional, implicit, interpersonal and profound aspects, which are the basis of the knowledge of the world and the development of mind.

According to Siegel (1999), mind emerges from brain activity, the structures and functions of which are directly shaped by interpersonal experience. In order to outline the neurobiology of the interpersonal experience, Siegel focuses on three fundamental principles: human mind emerges from processes that modulate energy flows within the brain and among the brains of humans; mind is created in the interaction between internal neurophysiological processes and interpersonal experiences; the development of brain structures and functions depends on how experiences, particularly within interpersonal relationships, shape the development of the nervous system. Therefore, an idea of relational mind is defined, which represents a key concept for deepening the reflection on the possibilities of teachers' relational skills training. As Gallese (2006) reminds us, cognitive development depends on intersubjectivity right from the start: since the early months of life, imitative mechanisms play a very important role in the development of our social skills. Mothers and newborn babies establish systematically coordinated activities during which their movements, facial expressions and vocal intonation are in synchrony. These behaviors allow them to establish an affective consonance that seems to play an important role in the subsequent development of more sophisticated kinds of relationships including the use of language. Scientific literature has long highlighted the recurrence of major affective-relational dynamics also after early childhood and with other significant figures, as in the teacher-student relationship.

[4] http://www.anffaslombardia.it/image/Convegno-inclusionemedeghini_-_intervento_anffas.pdf.

Within this framework, the priority educational objective becomes the development of teachers' adequate relational minds, able to stimulate the establishment of effective educational and teaching relationships and, in turn, support the development of other relational minds (of students, colleagues, parents…).

In the light of the professional characteristics and training contexts outlined before, we may integrate the concept of relational mind by highlighting two essential qualities: it's *extended and inclusive*. Teacher's mind must be extended, since it must be able to stimulate the overall development of the student's person, working on cultural and cognitive processes in the broad sense, and promoting the integration between the different dimensions allowing for the development-learning process: body and emotions, implicit and explicit, individual mind, other minds and artifacts, cultural and collective systems and subjectivity. Teacher's mind must be also inclusive, since it must be a mind able to read and support all differences and promote integration, through personalization and individualization paths.

The extended and inclusive relational mind is open to the unexpected (Canevaro, 2016) and is structured, thus abler to support the personal and professional complexity. We believe that this is an essential requirement for today and future teachers. Indeed, it needs to be well aware that emotional personal difficulties (fear, envy, effort, anxiety, demotivation, resistance, etc.) belong to all people, thus to teachers too, and cannot be considered as accidents or exceptions, but aspects that can never be completely eliminated and that can be latent, mitigated, but always potentially active. Moreover, the situation of uncertainty and criticality that society, school and problematic classes are experiencing influences probably first, and perhaps also more deeply, on this kind of unease (deeply personal) than others (didactic, organizational, structural), according to a vicious circular dynamic.

For example, for what concerns the proposal, advanced by many countries, for the institution of teachers' assessment systems, despite all teachers have rationally recognized the importance of the assessment, the fear of being assessed has been observed to be a common resistance, and mostly implicit, element; a sort of concern to expose themselves to the other's (perceived) "malicious" look, and the need to hide the "weak and fragile" sides of their own emotional universe.

It becomes clear, also in this case, the importance of being aware and knowing how to manage also the most critical emotional aspects (such as fear, envy, disgust and sham, which are inevitably part of the performance of one's own professional life: this would facilitate not only the expression of a new teachers' consciousness of their role, but it would make the management of these dimensions in a constructive and adaptive way possible.

One striking thing is the substantial dissonance between research outcomes and the many in-depth studies on these issues, and the lack of specific and targeted actions and interventions related to training, support and counseling. In fact, after having highlighted the central role of teachers' personal factors (knowing how to be a person) and their interaction with the professional competences (the will, power and ability to be professional) - evidence shared by the literature on professional competences (Perrenoud, 2002; Le Boterf, 1997; 2000) and the international school policy - it needs to bring to light what is both an actual fact and a critical element, i.e., the fact that knowing how to be a person and a teacher is the dimension that is less dealt with in training courses and the most difficult to be trained, modified, and assessed.

FROM MIRROR COMPETENCES TO INTEGRATED COMPETENCES

In the light of what written so far and with reference to the EC-Based approach, we try to redefine some aspects of the personal competences considered essential for students and professionals. These are transversal, personal and interpersonal competences, strictly related to the experience of living, to the "knowledge of how to live in the world," pursuing individual and collective well-being, self-realization, the ability to relate to others, work and participate actively for the sake of the common good.

Among those already defined in the literature and in school institutional documents, there are the Life Skills (WHO, 1993); social, civic and citizenship competences (key Competences, recommendations by the EU Council and Parliament, 2006); emotional-relational competences (Baker, 1996); collective competences (Wittorski, 1997); emotional competences (Salovey and Mayer, 1990).

The core competences identified by the European Commission must form part of school curricula together with disciplinary competences, and should be evaluated in the document for school self-assessment. They are recognized as competences that everyone needs for self-realization and self-development, active citizenship, social inclusion and employment (in other words, for living), and should be acquired at the end of compulsory education or training, serving as the basis for the continuation of learning. In fact, they are related to three fundamental aspects of every person's life: personal realization and growth (cultural capital); active citizenship and integration (social capital); capability for occupational integration (human capital).

These competences, although relating to different conceptual frameworks, share a sort of "meta-conditions" or common characteristics, which we consider important to highlight in order to plan training programs able to enhance them in trainers. The ultimate goal is to promote the development of teachers' *extended and inclusive mind*, an essential condition for their possession and appropriate use.

A first key element refers to the dynamic, bidirectional, contamination and reciprocity nature. The different categories of the above mentioned competences constitute a kind of bridge elements situated transversely between teachers' experience and learners' experiences. Students will be able to use collaborative and prosocial competences if teachers will activate, in turn, collaborative and prosocial contexts – which are first mental and then material – according to a virtuous circularity and fertilization.

At a deep-embodied level, when employing these competences at school, isomorphic dynamics based on the exchange and the contamination between cognitive, emotional and relational experiences of interacting subjects, are realized. These dynamics can explain, at least in part, also conditions of unease and learning difficulties. As highlighted in the literature, "the interdependence between the emotional, cognitive and social dimensions, in case of school failure, often leads to a condition of overexposure to feelings of inadequacy and incompetence leading to measure up with a self-image reflecting failure, involving the whole structure of personality. It needs a good emotional climate and good relationships between adults and children, in addition to didactic strategies that can avoid the frustration of failing at learning" (Cocuccioni, 2011, pp. 110, 111).

Indeed, emotional-affective, existential, relational competences are simultaneously:

1. a necessary precondition for a successful relationship (affective, educational, didactic, formative, etc.);
2. a specific development objective for the improvement of the quality of the relationship itself.

The "double value," peculiar to this type of competence, is a characteristic that is as significant as still underestimated in its heuristics and trans-formative potential. It is clear that an empathetic parent/caregiver supports the development of empathetic abilities in children, as well as a collaborative educator provides an effective model of collaboration and cooperation for his users.

Neurosciences showed the neurobiological mechanism underlying these dynamics: mirroring and imitation are two powerful and often unaware forms of learning, which originate and pass from corporeality and the implicit mental system (Rizzolatti and Craighero 2004, Gallese, 2007).

It is good to point out that we can't think that developing this kind of competences is an exclusive task that belongs to teachers - most of them originate in other contexts, that familiar *in primis* - but we can affirm with certainty that it is much easier and more effective to develop and improve social, empathetic and collaborative competences of students in daily contact with teachers having an empathetic and inclusive mind. An element of great interest, which would deserve greater resonance, is the recognition of the generative, evolutionary and educational nature of those competences, the beneficial impact of which goes beyond the subject that possesses them, for the possibilities of mutual exchange and enrichment with others (and with the contexts), according to a vicious circular pattern. They explain, in part, the realization of those virtuous, or vice versa vicious interconnections between health, inclusion and learning processes in classroom and school contexts, and more generally, at community level.

In relation to the relational-didactic dynamic that develops between teacher and student, we define this kind of mutual and bidirectional competences as "*mirror competences*", by virtue of the fact that what we require from students, in terms of attitude and behavior, must be a *conditio sine qua non* in their teachers. Pedagogy has long recognized that the first and most powerful form of learning passes through imitation of related and plausible patterns.

Another significant aspect of those competences (shared with other types of competences) is their complex and articulated nature. Mirror competences are, in fact, multidimensional and multilevel:

- multidimensional, as they are made up of different dimensions: creative, emotional, ethical, aesthetic, physical, creative, sensory, cognitive, empathetic, etc.
- multilevel, as they reveal themselves at different levels: explicit, implicit, rational, unconscious, verbal, non-verbal, symbolic, pre-symbolic, etc.

They are also characterized by a double dimension, which is intrapersonal and interpersonal, and can be mobilized only within a social interaction.

Indeed, as highlighted in literature and school legislation, an innovative and inclusive teaching cannot be achieved alone; schools and teachers, families and students need to work together, create a network, synergies, ask for help and support, exchange materials and practices. We often speak of learning communities and communities of practice, of strategic

actions and organizations based on interpersonal, good and positive relationships, and on bonds of trust, but we have already highlighted the fact that these aspects cannot be taken for granted, and are not sufficiently safeguarded at the level of school structures and practices. Above all, no institutional assessment is currently able to certify teachers with *extensive and inclusive relational minds*.

The "good" inclusive and orientation didactics is focused on the educational relationship in which the central role of the teacher (of his mind), as a mediator of development and learning processes, is affirmed unanimously in psychopedagogical and neuroscientific literature. Therefore, the recognition of the need for mirror competences (or at least some of them, although it is not easy to define their internal hierarchy) by all teachers seems an unavoidable conceptual and operational shift, if we want to make the educational success of all students possible.

We are well aware that unfortunately, too often, students' effective successful school and training paths depend on the fact -almost fortuitous- that they find "good and sensitive" teachers, according to the parameters of the relational-communicative-emotional competences that, after all, are more impactful and significant than cultural and disciplinary competences, which are more visible, selectable and assessable. Multi-qualified teachers, "fonts of knowledge" in their subjects but unable to establish positive relationships with students, often causes failures and suffering in both them.

In line with what we have affirmed so far, and in relation to the different levels and types of competences necessary for teachers and their interconnections, it seems useful to identify a new concept for completing the professional profile: *Integrated Competences*.

The adoption of an idea of integrated competence makes all the dimensions more visible, available and thinkable, even the deep and implicit ones typical of the extended and inclusive relational mind, necessary to achieve required personal and professional competences.

It's about following a backwards path, by shifting the focus from teachers' core, community, social and inclusive competences, those identified in school institutional documents (which we define of level I - superficial), to basic fundamental and instrumental competences: affective, empathetic, bodily abilities; in other words, embodied abilities (which we define of level II - deep).

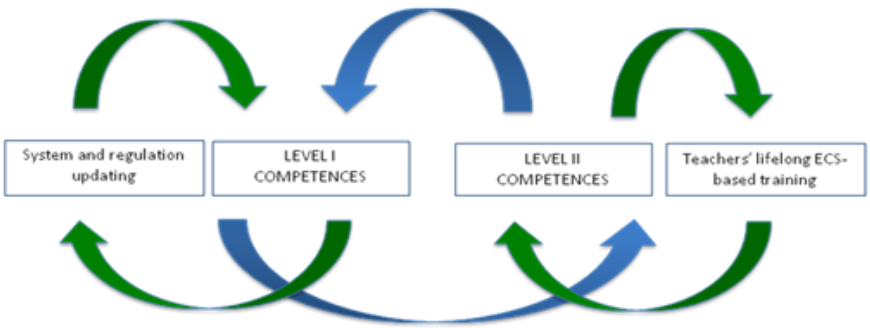
Level I competences are required and expected from teachers (as well as from students); they relate to institutional documents and professional profiles, and must be subject to professional training and external assessment.

Level II competences are fundamental, "basic" and essential, and have a deep neurobiological affective-relational (also unconscious) nature, they are often not recognized by professionals and reference frameworks, and are taken for granted. They belong to scientific literature and can/must be subject to professional training and reflection, self-assessment or internal assessment, within innovative school scenarios and training settings.

Both competence levels are necessary, interconnected, difficult to separate and mutually enhancing: they are, in fact, "integrated competences." There is a basic circularity between them that, in relation to the mutual feedbacks determining each other, uses training as a driving force. It's interesting to think how necessary this circularity is: the continuous update of science, in our opinion, should aim at making level II competences support the basic level I ones. The latter, in fact, are enhanced by the constant changes and self-regulate their application over time. Unfortunately, training (or even better, information) often aims at upgrading level I competences, which, although necessary, find it difficult to be applied. The

necessary energy, in fact, lies in the evolution of level II competences. Being them more difficult to be "discovered," less simple to be built, very intense in their explanation and very difficult to be measured, in a more relevant way, they are those qualities that belong to the Personal Factors (from an ICF standpoint) of teachers who need a cultural and scientific orientation that goes beyond their role.

The following picture sums up the energy flow that enhances and enriches professional teachers' integrated competences. It is clear how training enhances level II competences, which, in turn, enhance level I ones, in order to make them significantly employable.



Therefore, our study goal and research focus on trying to support and improve students and teachers' level I competences, thanks to the development and strengthening of teachers' level II competences, by planning and implementing appropriate training paths. Paths that take into account the mistakes already highlighted by the analyses in the previous paragraphs, but which are mainly based on scientifically valid approaches and that employ coherent strategies.

WHICH APPROACHES? WHICH TRAINING STRATEGIES?

Relational mind must be necessarily developed in trainers, so that they can promote and support it in trainees too. EC helps us identify some possible approaches to work in that direction.

We have already stated, in the first paragraph, that prevalent training, focused on abstract theoretical contents, reserved particularly for higher grades school teachers, is identified as one of the structural problems of the current training systems.

The lack of practical traineeship and knowledge contextualization is an element of pedagogical-didactic weakness, because it does allow hinging on knowledge in action, on the practical rationality of training professionals (Damiano, 2005: La Neve, 2005; 2014).

This may be considered a double problem. Also from the standpoint of neurosciences and EC (and before them, from that of psychoanalysis) this kind of training is inadequate, since it's not based on emotional, relational, bodily and experiential dimensions, typical of authentic learning and development processes. Ultimately, traditional training paths would not allow for the development and safeguard of the "extended and inclusive" relational mind as a necessary precondition for ensuring the possession of the required professional competences.

In fact, teachers' training pattern largely follows that of students in schools, but both are going through a rethinking and updating phase, with almost satisfactory outcomes, in different ways and speeds. Teaching is the art of conveying experience" (Irigaray 2005, p. 58). Based on this short but meaningful quotation, it should be recognized that much of Western education is significantly "disembodied" with students. The body/mind distinction is clearly expressed in what we expect from schools and universities which, by appealing to mind, often (always?) ignore body. The 'embodied experiences of being and doing' (Matthews, 1998, p.327) are so far still a quite under-researched area in educational research. The field of teaching and learning seems to be dominated by cognitive theories that ignore, or at least neglect, the bodily experiences of teaching and learning, while learning is activated more successfully through experience. Merleau-Ponty (2002) is known for arguing that we can conceptualize through our bodies; learning is a much more holistic experience encompassing the senses as much as the brain (Jarvis, 2006; Jarvis and Parker, 2007). Some authors have suggested that the body itself can be a source of learning and insight (Beaudoin, 1999; Matthews, 1998) but, basically, Maria Montessori had already acknowledged that. In theatre studies, material arts as well as yoga are recommended to overcome the body/mind dualism (Zarrilli, 2008). However, even if we wanted to recognize a high degree of awareness of these principles by teachers, it's not possible to deny that the application level is reduced to almost zero.

As for the professionalization of teachers, the Italian system "... instead of growing as an autopoietic system, able to fully impose the rules of its own functioning by itself, depends on external decisions, often in strong disagreement with the real needs of a school system and a teachers' training system closely interconnected and functionally cooperating with it" (Sorzio, 2011, p. 101). In fact, it seems we can affirm that the lab is the modality which is mostly hindered at university. First of all, it's because the Cartesian dualism is still prevalent, thanks to its rootedness in our classical culture. At university, even when a training lab is foreseen, monologue and passive listening prevail. A student/teacher active and comparison relationship is rarely observed. How to solve a problem like this if university culture orients students towards disembodied training? It is really what a future school teacher needs?

A teacher sensitive to the bodily aspects of the relationship is certainly a more careful observer of how bodies are situated and move in the space, their "dances" (rhythms), the different relational configurations that bodies (including their own body, of course) create. "It will no longer isolate individual behaviors, with the inevitable resulting judging action and, consequently, it will know how to use such awareness as operational resources. [...] A pedagogy of gestures and movements offers itself as a pedagogy of listening and presence, an attitude which legitimates a different attitude and a different positioning in relation to the other, which allows to transform regular patterns and propose learning distributions" (Gamelli, 2012, p. 21).

By laying aside judgment, the rash intervention, encouraging ourselves to listen to our body, we open ourselves up to many meanings of our body and gestures. "To know what I'm feeling through my body does not allow me only to understand what the other is feeling, but especially to generate naturally an effective coordination, highlight and attach a name to emotions and feelings informing the relationship with that particular child, adolescent or adult" (Gamelli, 2012, p. 22).

School is not only the space where we learn, but it's also the environment in which there are the emotions and experiences of each person taking part in the educational process.

School context is the place where, thanks to the constant presence of teachers and students, situations stimulating reflection are provided, in which the subject learns to adopt positions, compare himself with others, express opinions and critical judgments.

EC-BASED APPROACH IN TEACHERS' TRAINING

The fact that professionals acquire the awareness of a need for lifelong education, often also referred to by school legislation, in order to implement a process of trans-formation, genuine and deep change of their personhood, is not enough. In fact, to develop awareness of one's own lack, and thus of a resulting need for training, does not guarantee the acquisition of the dimensions characterizing the deep and personal professional competences (Level II competences and integrated competences) related to the knowledge of how to be, mainly expressed in terms of behaviors and aptitudes. Perceiving a need can easily make a person start seeking knowledge and acquire techniques and skills (know-how), but only the desire (willingness to be) will allow to activate learning, deep and radical change processes (knowledge of how to be), functional to the didactic and EC-based school model that we have proposed.

The interconnected dimensions of well-being, emotions and body, described by Damasio (1994) as "somatic markers," affect cognition, thought, choices, motivations, study and school (Oliverio, 2009); a school that takes account of these aspects and enhances them, by integrating them in an ordinary school curriculum, is an *EC-based school*, founded on principles in line with EC that requires "*ECS-oriented teachers.*"

It is therefore necessary to identify educational approaches in line with this view of school and teachers: these are "EC-based" initial and in-service training approaches.

One of the main methods, tested and validated in the field of care and health (in their broader contexts), is narration; the ability to self-narrate, develop and tell stories - starting from the self-story (autobiography) - activates awareness, cognition and metacognition paths, which are the basis of the possibility of feeling good, as well as of learning and participating. A strategy applied and validated in the field of health deserves to be enhanced in a training and inclusive field too. In fact, courses focusing on narration and reflection strategies are already being tested in the field of education and training (Smorti, 1994; 1997; Demetrio, 2012). Narrative approaches already employed in the training of professionals and teachers, are based on reflection to allow for a learning experience or learning from experience (Damiano, 2014; Mortari, 2014). As emphasized by Mortari, narration is the privileged heuristic mechanism for researches on understanding the meaning of the lived experience. In fact, to narrate is an essential cognitive action in the knowledge process; human beings think in terms of stories (Bateson, 1972; 1979) and narration has the function of organizing experiences and providing a structure for the meanings of the experience (Bruner, 1992; Mortari, 2014 p. 26).

However, as already noted, the relationship with the body and the experience through the body must necessarily become part of these paths, in order to achieve an authentic, comprehensive and embodied experiential learning. Its absence could in part explain the high number of failures in the change processes of trainees and school in general (with respect to

the data acquired at the beginning of this chapter: there are many types of teachers' training, the results of which are not as satisfactory).

Our contribution aims to provide ideas for boosting these approaches, and trying to strengthen them in the light of the contributions of neurosciences and the EC paradigm. It needs to think of experiential paths and strategies, based on narration and reflection, able to make the most of the pre-verbal, non-verbal and pre-symbolic dimension too (pieces of experience that have not found a conventional formulation yet), integrating them by taking advantage of physiological ability of the brain to form connections.

In this way, we find it possible to try to work for the development and improvement of the deep personal competences - defined as level II competences - an essential part of those competences required to all teachers, which we have called integrated competences, through "ordinary" and systematic, non-clinical, non-voluntary, exceptional and spontaneous professional training paths, just like they have been so far.

EC-BASED PRINCIPLES AND STRATEGIES FOR THE DEVELOPMENT OF TEACHERS' INTEGRATED COMPETENCES

The training of an extensive and inclusive mind is achieved through the deep experience of the relationship with oneself and with others. As confirmed by recent neuroscientific research, this relationship mainly develops through the body and the emotions at implicit, pre-verbal and pre-symbolic level.

Our research goal is to identify approaches and strategies for trying to work with teachers in this direction, within "ordinary," not psychological or therapeutic training paths: an *EC-based training* for the strengthening of the teacher's relational, extensive and inclusive mind.

We have already found out that some approaches and methodologies are in line with our goal. The psychoanalytic perspective, updated and re-evaluated today, has long highlighted strategies that can be re-interpreted from an EC-Based training perspective. In addition to the therapeutic role of verbalization and the recovery of experiences through narration (the Talking-cure), the healing and transformative value of communicative and emotional-relational exchanges through the interaction and joint action, the "doing together," has been recently recognized. The increasing dialogue between neurosciences and psychoanalysis has contributed to highlight the evolutionary and therapeutic role of reflection in the mirroring in the interaction, through a continuous "validation" (understood as the recognition of the other, his being and his value) by the caregiver, which occurs through sensory-perceptual (smells, sounds, touch, movement) and implicit relational affective (feeling of well-being /malaise) experiences. Even the psychoanalytic therapeutic intervention is orienting over the verbal and rational dimensions, through the re-evaluation of the non-verbal (Imbasciati, 2010). In this sense, to think of an embodied education, for an embodied, deep and integrated change (body-emotions-cognition; implicit and explicit), means to focus on learning from the relational experience with the trainer, and on the value of the trainees' agency. The carrying out of joint actions, meaningful to both partners, within a setting that can safeguard and enhance everything that goes beyond the verbal and the explicit, would therefore seem to be an appropriate strategy. It's about thinking and organizing training courses that focus on learning from global interpersonal (embodied) experience, and on the learning occurring

through joint action; the "acting together," the "doing together," the "moving together," the "experiencing together," in addition to the speaking and listening, typical of the traditional classroom setting. In reality, these are educational principles already known to pedagogical literature - just think of the experiential learning theories, from those developed by Dewey - which we think they may be updated and enriched in the light of neuroscientific and psychoanalytic research and, above all, in relation to the EC-based approach that aims to contemplate and integrate them.

Although recognizing that there is no single and unitary method, just as the scientific contributions we have highlighted must not be assumed in an uncritical and uncontextualized way, we propose some ideas to think of training approaches, allowing putting together and taking account of emerged elements. The professionalism of trainers, the needs and resources of the contexts and trainees will always represent the main players and variables able to select, articulate and contextualize the ideas proposed by the reference frameworks into concrete operational training paths.

Therefore, we will only point out some strategic principles and guidelines, able to guide the establishment of learning experiences in line with the EC paradigm.

Founding Principles and Guidelines

Relatedness

A "good" relational experience in education is built starting from the activation of bonds of trust. The strategic - healing and educational - value of trust and encouragement has been investigated extensively by authors such as Adler, and more recently in Italy by Franta and Colasanti (1991); to recognize and give trust is part of the relational dynamic of giving - taking (Boszormenyi Nagy, 1987), which deals with the embodied need for recognizing others and one's own being and value. The dynamic of recognition originates from deep motivations, which are both endogenous-personal, and exogenous-cultural (Honneth, 2008). In order to build and maintain interpersonal relationships based on trust and recognition, it needs to have adequate abilities to observe and listen to, and negative abilities to tolerate confusions and uncertainties (Blandino, 1996, 2010). These abilities are recognized by literature as essential for living (personal and professional) relationships collaboratively, rather than competitively and conflictually: to collaborate, in fact, is a word that preserves the term "labor" deriving from the Latin ("labor-oris"), an etymology that involves suffering and effort (Blandino, 2010). Collaboration requires commitment and spirit of sacrifice.

Reflexivity

The choice of this guiding principle orientation has been already argued in part: reflexivity is a method being employed in health and supervision / training paths, able to give start to change processes through the reflection on the experience. Also in the educational field, the different methods currently being employed in empirical research in education support two training movements: the link between the observable dimension of the behaviors and that of the ideas and representations (social, individual and cultural), and the active involvement of the protagonists-subject of the research, through the exercise of reflexivity (to think and re-think about one's own educational experience and attributions of meaning) through questions, stimuli, curiosities, attitudes and instruments (narrative or visual) of

researchers (Bove, 2006). Educating in the professions includes a deep understanding and the implementation of reflection practices; these are gradually being integrated within formal and informal, individual and collaborative learning contexts. Similarly, researchers who deal with education, according to a circularity, feed their interest thanks to and together with professional associations (Mc Kee & Eraut, 2012).

Agency

Agency. Starting from the contributions on the complex social meanings of actions (Vygotsij, 1978; Leont 'ev, 1978) and the reflections on their cognitive and personal dimensions (Suchman, 1987), neurosciences have helped understand the complex and relational nature in the person-action-object dynamics, highlighting the central role of intersubjectivity. As pointed out by Gallese (2006), thoughts and actions are closely linked interconnected; the discovery of the "mirror" systems has radically changed our view of the human brain, bringing intersubjectivity to the fore.

Action is a mental process that connects us with others and with the world; in this sense, perception and action are closely interrelated. Perception is not a representation: it's an action that is simulated and projected on the world. Perception does not result in a static representation, but it is an internal simulation of the action; it is judgment, choice, anticipation of the consequences of the action. To perceive an object means to imagine the actions implied by its use, select particular traits and ignore others (Berthoz, 1998). We do not just see by means of the visual part of our brain, but we also use our motor system (Gallese, Keysers, Rizzolatti, 2004; Rizzolatti e Craighero, 2004).

From a more purely methodological point of view, in the field of training, to act means to live a process, and not think abstractly of a goal. The acting trainee teacher acquires the awareness of the pleasure of doing it, and the professional effect it entails, transferring the principle more easily into the classroom for inclusive and learning purposes (Gomez Paloma, 2013).

Methodological Approaches and Strategies

Narration

It's the transversal founding strategic dimension that must characterize and pervade every activity; to build stories allows to connect/relate elements, develops metacognitive competence and awareness, supports empathetic capacity and the development of a theory of mind, that is, the experience of putting ourselves in the shoes of others (Mortari, 2014). Narrating our personal and professional stories promotes the development and strengthening of transversal competences needed in the world of work, through the enhancement of multidimensional "pieces of experience and existence" (feelings, emotions, perceptions).

Sharing (Cobb, 1976) and Social Support

The concept of social support is connected to physical and social well-being. These are virtuous patterns of relationship that also become technique and lifelong training working method, for the professional and for the person. "The intensity of emotions and the dissatisfaction with their received support are two key variables in determining emotional

exhaustion, the starting point of the teachers' burnout (Albanese et al., 2013, p. 15)." Strategies of social support (experiences exchange), co-teaching, peer teaching, modeling and videomodeling stimulate sharing, comparison and mutual help among professionals, through structured and systematic ways.

Self-Assessment

The involvement of the person triggers a circuit of exposure/judgment that often limits didactic fantasy and creativity, reducing tasks to mere performances. A teacher who is aware of the courage needed to take the lead and expose himself, avoids assessing technically the student and invites him to analyze his strengths and weaknesses. The culture of the subjectivity of the experience is the basis of the EC-based training.

Key Principles of the Contents

Social Learning: Relationships, Emotions and thought

Assuming once again that learning and development can be achieved only through a relational experience, it needs to enhance and focus on the emotional-cognitive dimension, which is attained in the relationship with teachers and peers. The social nature of learning is already clear on a biological level (Rivoltella, 2012; 2014). Emotions – experienced in the relationship with others - are evolutionary and educational forces that activate knowledge processes and develop competences. Therefore, it needs to promote the reflective experience on one's own emotions, and the narration of one's own emotions and those of others. In training, working with others acts on neuroplasticity: there is a shaping that is mainly neurophysiological, well before being cultural and reflective. It needs to promote the building of appropriate settings: spaces – times to be and learn together, which are both real and virtual, systematic and structured.

Art and Corporeality: Body in Art and the Art of Body

In training paths, it needs to support the enhancement of ethical and aesthetic dimensions, through the body language in art (videos, slides, pictures, sounds and music ...) and through the body, posture and movement as art and experience. The building of stories on and with the body (Gamelli, 2012), which employ multiple codes, stimulates connective, thought and cognitive processes in general and can foster a sense of "good" by educating in the "beauty" understood as harmony, proportion, rhythm, pleasantness.

Pre-Verbal, Non-Verbal and Unconscious Dimension. Environmental, Global and Holistic Approaches

To narrate experiences, stories and emotions with the body, with images, with the non-verbal or the pre-verbal (unformulated experiences). To retrieve the use of co-verbal gesture to enhance the understanding of concepts and the memorization of terms. To plan "curricular" spaces and times for spontaneous and guided bodily expression, and other forms of expression.

Problem Solving, the Ability to Imagine and the Art of Making Predictions

The proposed contents and activities should be centered on these essential educational and evolutionary processes, which have their roots in neurobiology. In this context, it's very useful to adopt again prediction as the primary objective of a training which tries "to develop a strategic attitude for problem solving, through the use of educational mediators: a task, an artifact or instrument through which the teacher replaces the direct experience of reality, making it teachable" (Rivoltella, 2014). Indeed, prediction is represented as a mechanism that works on the basis of simplification, categorization, correlation and substitution, each element may be associated with a specific type of didactics.

Body Relaxation for Maximizing Cognitive Functions and Mindfulness

Conscious breathing and forms of mind-body relaxation, as we all know, promote concentration and feeling of psychophysical well-being. It needs to stimulate the person's global self-awareness, in his interdependence with the world. Recent studies have shown that well-being is promoted by relationships of secure attachment, and enhanced by an awareness that Siegel defines as "mindful" (Siegel, 2007). The functions activated thanks to this property are: 1) body regulation; 2) attuned communication; 3) emotional balance; 4) response flexibility; 5) empathy; 6) insight; 7) fear extinction; 8) intuition; 9) morality.

CONCLUSION

We believe that the scientific and cultural framework, made up of key principles and methods, can orient trainers towards the adoption of an EC-based approach.

First of all, it's about recognizing that body and movement are no longer a person's biomechanical extension, but they are entities which cognitively belong to it. Movement, in fact, is the closest instrument to a sixth sense. Indeed, in the brain, lies the ability to anticipate what is about to happen in the space surrounding us. "...Perception is not just an interpretation of sensory messages: it is influenced by the action: it is an internal simulation of the action; it's judgment, anticipation of the consequences of the action" (Berthoz, 1998). Before moving and performing an action, the brain calculates the position of the body, performs operations in relation with the space around it and measures itself up with the circumstances, proving to be much more like a simulator than a calculator which uses the movements of a body in space to develop a stable model of reality, balanced between senses and thoughts, i.e., that software we use to explain sensations.

What we define and perceive as movement is, in fact, only the result of a complex series of operations that our brain performs on a more or less unconscious level. If we recognize these principles of EC as a substrate on which to build our proposals, we can attach to training (as trainers and trainees) the noble value it deserves, with the right spirit and greater chances of success.

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Conclusions

EDUCATIONAL AND INCLUSIVE PROCESSES: TOWARDS THE EMBODIED COGNITION METHOD OF TEACHING/LEARNING AND TRAINING

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We can affirm that an EC-based approach to training processes is integrated and integrating by definition; it is based on the building of relationships: between body and mind, between mind and minds, between cultural objects and subjects, between individuals, between individuals and contexts. A teaching based on the EC approach is a specialized, enhanced, enhancing and inclusive "enriched" didactics because, since it's based on the brain ways of functioning, it creates connections and facilitates the processes of co-participation, co-teaching and co-learning through the re-understanding of the body and the emotions and the enhancement of observation, imitation, imagination, reflection and relationship processes in the learning experience.

Some research topics are moving in this direction, but their applications in the school context are still very limited. Here are some synthetic cues in this direction, hoping that they can undergo didactic experimentation and be the subject of research– training paths for teachers.

A growing field of study concerns the relationship between neurocognitive functioning and the learning-teaching of disciplines. Studies and research are investigating the deep dynamics of learning processes of individual disciplines, in the light of the paradigm of neurosciences, and in particular of EC. The most explored areas involve mathematics and languages; in particular, research on the way the brain learns mathematical concepts are now essential to rethink the new effective and inclusive didactics.

We are referring to these studies also because mathematics is thought of to be the cause of failures and early school leaving for many students; moreover, math skills are considered as fundamental in the frameworks of competences at supranational level (Key competence; OECD, etc.).

Neuro-cognitive studies that are conducted with a focus on mathematical reasoning include different aspects of mathematical processing. Some studies examined brain regions

related to mathematical processing and found, for example, that the parietal and frontal lobes were involved in the processing of number sense and arithmetic, algebraic equation-solving, in the processing related to different representations of functions, in calculus and geometry proof generation, and in solving simple mathematical word problems (e.g., Arsalidou and Taylor 2011; Anderson, Betts, Ferris and Fincham 2011; Lee, Yeong,Ng, Venkatraman, Graham and Chee 2010). Additionally, some fMRI and ERP studies examined brain activity associated with the solving of such complex problems as insight problems (for review see Dietrich and Kanso 2010). In this context, note also that the right hemisphere has been found to play a special role in insight-based problem solving (e.g., Shen et al. 2013) with increased activation of the right anterior superior temporal gyrus (reflected in increased power at PO8 electrode) when performing insight-based solving as compared to non-insight solving (Jung-Beeman et al. 2004). All these studies, however, did not address the differences in brain activation of students with different levels of mathematical performance as reflected in school achievements, or the differences in students with varying levels of general giftedness, as our study does.

According to Lakoff and Nunez (2005), recent research in the fields of neurosciences and cognitive sciences and the history of mathematics are moving towards an "embodied mathematics". In the embodied mathematics theory, the only possibility for accessing any form of mathematics is through the concepts that are in people's minds, which are shaped by their bodies and brains, and implemented physically in their neural systems; in other words, the only mathematics that all beings are able to know is that mediated by their bodies and brains. This reflection can be extended to any other (non-mathematical) transcendent form. The basic elements are not axioms and demonstrations, but image schemes, aspectual concepts, basic level concepts, semantic frames, conceptual mixtures and metaphors etc.

Nuñez and collaborators (1999) have stressed the idea that, as all the cultural and social products, mathematics should not be considered as completely abstract; rather, it seems the case that since basic mathematical ideas showed a surprising stability over thousand years, a common set of neural and bodily structures with which to connect mathematical concepts to everyday experiences are required. The authors identify those structures in the embodied conceptual structures provided by the experiences of the surrounding environment. Concepts like motion, spatial relations, space and time should account for mathematical concepts like the continuity of a function (for a recent review, see Winter, Marghetis & Matlock, 2015). According to the authors, the mathematical definitions of continuity given in textbooks are misleading, because they lack of the experiential part of the definition; consistently, they claim that mathematics should be conceived as a product of adaptive human activity, made meaningful through language, but ultimately based on our biological and bodily background. The crucial point, in the perspective of the authors, is to consider how the human creation of mathematics is not arbitrary, but is rather bodily grounded.

The revolutionary scope of this approach is still underestimated in daily teaching practice; in fact, as evidenced by theorists, because mathematics does not study the mind nor its products by its very nature, in order to achieve a correct approach to mathematical knowledge, methods and apparatus of embodied cognitive science are necessary (Lakoff, Nunez, 2005, p. 347). This theory is based on the idea that human mathematics does not reflect a mathematics that exists externally to human beings, nor is it transcendent or part of the physical universe. Mathematics is a mental creation which developed to study the objects of reality and, since the objects of reality have their characteristics and properties,

mathematics takes them on, proving to be universal, precise, coherent and stable. According to the authors, most of the key aspects of arithmetic and mathematics would be innate (like for example, the perception of small numbers of objects or subitizing); other simple and complex concepts, instead, are created and learned (the concepts of zero and infinity; square roots; logarithms, etc.). However, precisely because mathematical concepts are created and learned, it means that there is a biological explanation of the mechanisms through which they are generated, taught and learned, hence represented and used. Lakoff and Nunez justify this approach in relation to two types of requirements: weak and strong. "When someone presents you with an idea, the appropriate brain mechanism must be in place for you to understand it and learn it. Language and the meanings conveyed by language do not come out of thin air. Every bit of the meaning of language must also be accounted for by neural and cognitive mechanisms. These are the weak requirements imposed on the cognitive science of mathematics by what we know about the embodiment of mind."(op. Cit, p. 347). The strong requirements, instead, relate to the possibility to explain how abstract reason is possible and how it is possible to have abstract concepts and to understand them, since they cannot be perceived by the senses. The challenge for cognitive science is to explain, in terms of body and brain, the understanding of abstract mathematical and non-mathematical concepts, which cannot be listened to, touched, smelled or seen.

According to the theory of embodied mathematics, the explanation of how to actually understand complex concepts cannot be provided in terms of axioms and theorems, as it would only shift the problem onto another question (how to understand axioms and theorems?). The answer to questions about mathematical cognition is given in terms of cognitive and neural mechanisms found in the automatic, unconscious, human conceptual system. The discovery of the embodied nature of human concepts must also explain mathematical concepts; the hypothesis held by the authors is that in mathematical knowledge there are supposedly the same mechanisms working in the rest of human knowledge: there are no special mechanisms for mathematics; knowledge processes, from basic arithmetic, employ cognitive mechanisms of the general conceptual system (image schemas, frames, metaphors, conceptual blends, etc.). "What we know about the embodiment mind imposes strong constraints on any theory of the embodied mathematics".

In the field of Mathematics Education, another branch of neuro-cognitive research focuses on the relationship between intelligence and the extent of induced brain activity during cognitive task performance (Jaušovec and Jaušovec 2000). These studies have led to the formulation of the neural efficiency hypothesis of intelligence, which states that "brighter individuals display lower (more efficient) brain activation while performing cognitive tasks" (Neubauer and Fink 2009, p. 1004). The neural efficiency phenomenon was also shown to be related to individuals ' expertise in a given field (in our case excellence in mathematics) (e.g., Grabner, Neubauer and Stern 2006). It should be noted that there is an inconsistency in findings concerning the extent of brain activity in relation to expertise: some of the studies report increased brain activation with practice while others claim the opposite effect (Kelly and Garavan 2005). This inconsistency can be seen in the relationship to the difficulty of the task; while neural efficiency is shown when solving easy to moderate tasks, more intelligent individuals exhibit higher brain activity when performing difficult and challenging tasks (eg, Neubauer and Fink 2009). In parallel, ERP studies found several components that seem to be associated with insight-based mental processing (Leikin R., Waisman I. Leikin M. and Shaul S., 2013). Ansari and Lyons suggest that this research will increase the connection between

cognitive neuroscience and mathematics education, and reaffirms that there is a need to move beyond the use of traditional paradigms that are derived from experimental psychology towards more ecologically valid research paradigms. Moreover, much work remains to be done in connecting the behavioral and neural levels of explanation, and to develop models for which they can truly combine to yield a better understanding of issues specifically relevant to mathematics education.

A fruitful interdisciplinary research area based on using neuroimaging techniques is highlighted too; particularly from the study of developmental difficulties in acquiring literacy skills (i.e., Developmental Dyslexia) have suggested That neuroimaging measures are not only responsive to intervention but can also be sensitive tools for the prognosis of long-term developmental outcomes (eg, Hoeft et al. 2007, 2011). "Importantly, in some cases, neuroimaging measures explain more variability in future outcomes than concurrently acquired behavioral measures. This suggests that neuroimaging methods can represent a significant 'added value' when it comes to screening children who might be at risk of developing long term learning difficulties. In the domain of mathematics, there also exists an emerging body of research demonstrating the prognostic utility of neuroimaging for long-term individual differences in mathematical abilities as well as in responses to intervention (Supekar et al. 2013; Evans et al. 2015). Future studies should further examine the value offered by neuroimaging as a screening measure. Here, it would be particularly useful to examine the use of lower-cost neuroimaging methods such as EEG and Near Infrared Spectroscopy (NIRS) as predictors of long-term outcomes. We think that, for what concerns the use of techniques for early screening and the assessment of children's outcomes, of great importance is the correlation with pedagogy and other human sciences, also for a reflection on the ethics of research and intervention.

Recent research has tried to apply an EGC approach to learning of complex matters, as physics and numerical cognition: for example, Kontra et al. (2012) attempted to use specific motor training to simplify the learning of a physics item, the angular momentum and torque. Undergraduates were pre-tested on a torque judgment task to evaluate their starting knowledge about angular momentum. Researchers created two groups of students, and gave a motor and experiential training to the first group (together with a verbal description) during which students had to manipulate a pair of bicycle wheels on an axle under various conditions. Students in the second group were only given the verbal description, and they observed another student manipulating the wheels. Both groups then completed a post-test to verify what they had learned during the training session. Results showed that students in the "action" group improved significantly inaccuracy at post-test, while students in the "observation" group did not. It seems that motor simulation offered support in understanding a non experiential concept like angular momentum.

About the development of language, Iverson (2010) says that it should be viewed in the context of the body in which the developing language system is embedded. In infancy, there are significant changes in the ways in which the body moves in and interacts with the environment; and these may in turn impact the development of skills and experiences that play a role in the emergence of communication and language. The emergence and continued development of new motor abilities during the first eighteen months has far-reaching consequences that extend to other developing systems, including language. The developing motor system provides opportunities for practicing and refining skills that are crucial for language and for increasingly complex learning about speech sounds and meaning making.

Studying the ways in which motor achievements contribute to the development of language may not only yield a more comprehensive picture of the emerging language system; it may also provide fundamental insights into the processes underlying this emergence (Iverson, 2010).

Borghi et al. (2013) affirm the idea of "Words As social Tools", by proposing integration between the perspective of extended mind view and the embodied-grounded view of cognition and language, typically considered as rather independent perspectives. Words are not only grounded, Words are not simply pointers to their referents: they are tools, allowing us to interact with the physical and social environment Language provides us with a sophisticated means that guides our actions. We have shown that the challenge to account for abstract concepts, critical for EGC theories, can be solved thinking that not only sensorimotor information, but linguistic and social experience matter too. Which implications has this view for educational sciences and practice? The implications are many and pivotal. As we have seen, since our infancy, our action capabilities, constrained by our peculiar kind of body, influence the development of cognition. Sophisticated cognitive abilities, such as those involved in abstraction, are grounded in our bodily, social and linguistic experiences. The time has arrived, that educational practice takes into account this simple but crucial fact. In general, language cannot be reduced to associations between words, and words cannot be simply intended as pointers to their referents. Instead, in our view words influence the formation of concepts (Lupyan, 2012), in particular of abstract ones, since they help keeping together the various and diverse sensorimotor and emotional experiences abstract concepts refer to. In a nutshell, according to the WAT (Words as social tools) view we propose that both sensorimotor and linguistic experience play a role, but that the second is more crucial for abstract concepts representation, while the first for concrete concepts one (see Borghi & Binkofski, 2014, for a thorough overview, and for description of supporting evidence).

Most crucially, the acquisition of the ability to comprehend and use abstract words has been recently related to the development of social abilities, as those necessary to engage in joint action (Bergelson & Swingley, 2013). Embodied effects can also appear in early reading understanding and recall: specifically, 6- and 7 year-olds' accuracy in understanding and recall of stories is enhanced when they are allowed to interact with physical objects and characters of the story compared to when they simply have to rehearse the story (Glenberg et al. 2013). This higher accuracy in story recall is present also when children are required to interact with objects on a computer screen. We have tried to show that language is grounded in perception, action and emotional systems, and that, in line with theories of reuse, language reuses structures and mechanisms of the motor system. However, we have shown that this is not the whole story.

Further research in this direction include the interconnections between mathematics and sport, highlighting significant interesting elements for curricular planning: the parallelism between learning- teaching of sports and of mathematics and physics and the importance of the implicit attention as underlying condition required for both. Outside mathematics, other authors have helped unravel the deep mechanisms of cultural and disciplinary learning. Dehaene (2014), in dealing with the development and nature of the abilities to read, understand and calculate, calls into question the discovery that consciousness can no longer be considered as "the glue that binds our distinct sensory modalities into a coherent whole ", highlighting the fact that there is no need to be conscious to merge auditory and visual signals from environmental and didactic stimulation. "Sensory information can be bound together

unconsciously, while we become aware only of the result ... Many complex sensory operations unfold sub rosa to assemble the scene that eventually plays out seamlessly in our mind's eye, as if coming straight from our sensory organs "(2014, pp. 93-94). The author states that maybe it would be more appropriate to distinguish between two types of bindings: routine links coded by specific neurons committed to specific combinations of sensory inputs, and nonroutine bindings, requiring the de novo creation of unforeseen combinations, and must be mediated by a more conscious state of brain synchrony. What is reaffirmed, and that may have significant implications for didactics, is the discovery of mechanisms of information processing and attribution of meanings unconsciously. In fact, there's a continuous "learning without knowing to learn", like the author as showed in relation to chess. As already pointed out, the possibility of full understanding of communications and relationships, at a superficial and a deep level, is central to cognitive responses, in the strict sense, and to the subject' socio-relational behavioral responses.

In the light of the above, we believe that the curriculum can be rethought according to inclusive "enhanced and integrated" didactic and training models, and most importantly, we believe that such rethinking should involve both the didactic paths for students, and the training paths for teachers, according to a virtuous reciprocity and synergy based on the awareness of the mirroring and modeling mechanisms. Anyone concerned with training is well aware that teachers tend to repeat, in their profession, the styles and attitudes of their teachers, at least implicitly and "automatically". University courses of initial teachers' training, focused on experiential learning, self-training and the model of reflective practitioner (Schon et al., 1983), try to work on the development of the awareness to deconstruct implied beliefs and theories on teaching (Damiano, 2010; La Neve, 2014). But they're not always successful. In the following paragraphs, we will deal with the specific problem of teachers' training.

As for the possibility to improve curricular planning starting from the reflections and research we have briefly mentioned, we propose an expansion of the inclusive EC-based didactics through the conscious and deliberate contemplation of the role of the "embodied" dimension, which can be operationalized in the interconnection between teaching-learning of disciplines (mathematics, literature, art, grammar) and experience of corporeality, emotions, unconscious and social learning environments. The general idea is that children are embodied learners, and that they use sensorimotor information to gain knowledge about the world. The role of the body for the growing of cognitive and social abilities is crucial since the first years of life. The goal is to revitalize didactics and make knowledge meaningful, by adopting approaches that take advantage of the natural mechanisms of human functioning. Having knowledge is a global, existential action and not only a formal and abstract action; of course, with the progress of studies, the object of knowledge must also become formal and specific, but before this can happen, it must involve all the dimensions of human experience and the multiple symbols (verbal, non-verbal multisensory, etc. ...) in itself, in order to make it accessible, more understandable, appealing and meaningful to all, hence "easier" to learn in its theoretical and abstract aspects too.

Finally, it should be noted that the influence of motor experience does not end after infancy: embodied effects on cognition can be also seen in adulthood, and a wide range of studies has recently investigated the relation between motor processes and educational sciences. It has been demonstrated how gestures can influence thought and subsequent

learning, and how motor experience can facilitate the understanding of complex concepts such as physical or mathematical ones.

We believe that the scientific and cultural framework, made up of key principles and methods, can orient trainers towards the adoption of an ECS-based approach.

First of all, it's about recognizing that body and movement are no longer the biomechanical extension of a person, but they are entities which cognitively belong to it. Movement, in fact, is the closest instrument to a sixth sense. Indeed, in the brain, there's the ability to anticipate what is about to happen in the space surrounding us. "... Perception is not just an interpretation of sensory messages: it is influenced by the action: it is an internal simulation of the action; it's judgment, anticipation of the consequences of the action" (Berthoz A. and Thirioux, B., 2010, p. 38). Before moving and performing an action, the brain calculates the position of the body, performs operations of relation with space around it and checks the circumstances, proving to be much more like a simulator than a calculator that uses the movements of a body in space to develop a stable model of reality, balanced between senses and thoughts i.e., those software that we use to explain sensations.

What we define and perceive as movement is, in fact, only the result of a complex series of operations that our brain performs on a more or less unconscious level. If we recognize these principles of ECS as a substrate on which to build our proposals, we can attach to training (as trainers and trainees) the noble value it deserves, with the right spirit and greater chances of success.

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INDEX

A

B

C

D

E

F

G

H

I

J

K

L

M

N

O

P

Q

R

S

T

U

V

W

Y