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Controversies on hypercomplexity and on education in the hypertechnological era

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The objectives of this paper are threefold: firstly, to reconstruct the controversies and the scientific debate on the subject of complexity and on the factors determining its passage to hypercomplexity; secondly, to underline that an interdisciplinary and systemic approach which envisions *objects as systems* rather than considering systems as objects (as sets of divisible parts) is of the utmost urgency, calling for a radical makeover of our concepts of educative, formative and skill-related processes, overstepping the *"false dichotomies"* common to education and training, which reinforce the new asymmetries and inequalities emerging today; and finally, to recognize and understand the *"great mistake"* we are currently making in our attitude to technology in general and digital technology in particular.

Keywords: controversies, hypercomplexity, non-linearity, rethinking education, objects as systems, false dichotomies, great mistake, anthropological transformation, systemic approach, hypertechnological era

A short history of complexity

In the past, along the evolutionary and cognitive footpaths of the natural and exact sciences, there was a deep-rooted conviction that it would somehow be possible to get to the bottom of virtually all phenomena, controlling and managing their complexity. The earliest systemic models of complexity were defined by the biological sciences in the first decades of the last century, attempting to explain the behavior of complex organisms, going beyond reductionist terms or mathematical formulas of the more classical, or so to say, the traditional sciences. As the instruments of observation, analysis and measurement were improved and refined, little by little the *anomalies* began emerging more and more clearly (Kuhn, 1962), as well as the substantial inadequacy of the observations and descriptions made by

the traditional sciences. At the same time, an unavoidable and irrepressible necessity began once more to emerge: that of attempting to unify the disciplines and fields of knowledge, setting off firmly and without hesitation on the pathways of interdisciplinarity and multidisciplinarity. Subsequently, certain eminent scientists even began speaking of a "new science" capable of going beyond classical sciences. A complex and multi-branched project that in the last decades has gained new force and momentum within scientific communities as well as in public debate. Complexity and interdisciplinarity was and is also a circular project that brings our attention back to the urgency of finding and constructing a common language for the various fields of knowledge and disciplines. It was, above all, the research undertaken in the fields of biology and physics that reinforced definitively the conviction and the (although far from widespread) vision that systems and complex phenomena cannot be traced back either to relatively simple mathematical formulas or to systems of elementary rules, which in the past had at any rate proved capable of providing convincing representations of the complexity of reality. We are not merely considering a crisis in the traditional linear models and the reductionist approaches that have characterized the hard sciences themselves. Topics and issues that are revealing themselves to be even more urgent and ineludible in this moment, in the light of the *paradigm shift* (Morin, 1973; Morin, 1990; Morin, 1999; Morin, 2015; Prigogine, 1996; Dominici, 1996; Dominici, 2005; Dominici 2011) and the ongoing process of *anthropological transformation* (Dominici, 1996). The traditional models of critical thinking themselves had to reckon with phenomena, systems, organisms, organizations, reality. All of this radically eluded any idea or vision whatsoever of equilibrium and stasis. And in no way could these be framed any more in outdated concepts or functional definitions, which at this point were no longer capable of discerning or describing the incessantly unstable dynamics of reality.

Following the footsteps of biology and physics, the social sciences, cybernetics, and later, philosophy, semiotics and linguistics began to develop systemic hypotheses, or in any case approaches that seemed to have caught a glimpse of possible evolutions towards complexity and towards a systemic approach to complexity itself. Considering that the capacity to cope with rising complexity, the capacity to differentiate and self-organize systems, was long overdue already at that time, it can by no means be put off today.

From the very beginning, the concept of systems has revealed itself to be a powerful explanatory and cognitive "device", capable of recognizing and bringing out the best aspects of the (by now) highly probabilistic and statistical character of knowledge, giving up on the idea of (proven) truths and the absolute value of knowledge. A concept, with all of its relative implications, capable of drawing together the natural and artificial elements found in all phenomena and objects of

study. From this point of view, a systemic approach to complexity seems capable of overstepping the traditional logics of separation that have been set up between the fields of knowledge and the disciplines. The complexity of living beings provides those cognitive elements that can put us in the condition of going beyond any deterministic or linear perspectives.

The complexity of living beings (not to speak of that of social beings) is never completely comprehensible or intelligible. Our awareness of this fact is still very dim. The problem (as always) is not merely to define or distinguish order from chaos: the problem is becoming capable of recognizing this complexity with which order and chaos coexist and cohabit, in which they are both present and retroactive. The problem is knowing how to recognize this complexity without falling into these typical errors: (1) reductionist and deterministic interpretations; (2) dialogical reasoning that inevitably brings out apparently irreconcilable and incurable dichotomies and polarities; (3) linear and causal models. Life and its social, human, relational aspects have always been complex and have always constituted a problem of complexity – complexity is a fact of life and not an option – that we unfortunately continue to approach, even within areas of scientific research, with too little awareness of the uncertainty and the unpredictability that govern complex relations and interactions. A discourse that also regards the very close correlation between democratic praxis and complexity. Democratic regimes enter into crisis precisely when they begin to follow rationales and objectives leading to excessive simplification of their complex problems.

Complicated, Complex and Hypercomplex: Difference between a (closed) complicated/mechanical system and an (open) complex system

Fundamentally, the mere act of embracing the concept of 'system' implicates the awareness that the whole of the system will not coincide with the sum of the parts that make up the system itself. On the one hand, a complicated system is manageable and its evolutions are predictable: we can break down/divide its parts to observe them, study them, understand their behavior. Furthermore, should we decide to put the parts back together, we will see that the total quantity of parts will be equal to the whole. Complicated objects can be dissected, categorized and construed according to linear models (cause – effect, stimulus – response), whereas complex systems cannot. And predictability means control, the possibility of managing the temporary absences of balance. If, on the other hand, we want to understand the functions of a complex system, we must observe and study it in its totality, focusing our attention, not on its parts, but on the connections and levels of interconnection among them. Even so, we are dealing with a system, due

also to the characteristics of the parts that constitute it (cells, animals, human beings, etc.), that can never be completely controlled or simplified. What should be clarified, however, is that the opposite of complexity is not simplification but rather reductionism. In the analysis or management of a complex system, it is truly difficult to try to speak about predictability or control. The quality and the quantity of the connections always make the difference; and the system does not limit itself to swinging back and forth between order and disorder, order and chaos, equilibrium and dynamics/entropy.

Complexity, therefore, which is a naturally inborn structural feature common to collectivities: to groups of humans, to their relations, to social systems (Coleman, 1990; Luhmann, 1968, 1984, 1991) to the world of all living beings and even, with some variations, to objects, is neither predictable nor reproducible; it is observable and comprehensible solely by examining the manifold planes of connection between the parts (the objects) themselves and by taking a systemic view of the processes, the phenomena and the dynamics: a systemic perspective that requires a totally novel manner of observing "objects", and not only by looking at the union of the various parts that compose it, or even at its global 'entirety'. In fact, it should be kept in mind that when we are talking about complexity, in contrast with complicated systems, the whole is always *greater, richer and more varied/diverse/different* than the sum of the parts.

As I have pointed out before, there is also another element that characterizes complexity: "the fact that we are talking about adaptable complex systems capable of modifying themselves to satisfy new conditions or requisites. In these systems the parts are not 'inanimate', passive or neutral, nor do they react only to certain stimuli in a predictable manner; they are individuals, entities and relations that are constantly contributing to change and to co-create the conditions of the interactions, of the framework of reference, of the ecosystem which they are part of. If we observe social organization or simply a group of people or even a random set of people seen together, not only will the totality be superior to the total number of people, not only will we be unable to understand the dynamics of the group by isolating individuals or narrowing our fields of observation, but we will be forced to realize that these same people (individuals, entities) are constantly modifying, co-creating, co-constructing the social environment in which they are immersed." (Dominici, 2018, p. 2–3).

A further feature of complexity is that the very existence of an observer, the simple act of observing will itself affect the conditions, the planes and the intensities of interaction, exchange and sharing. Truly observing and comprehending relationships and dynamics in constant evolution means learning to see the holistic bonds, the connections, the systemic relations, instead of dividing objects into sectors and classifying them. Speaking of classification, we might ask ourselves:

what is left to talk about under the third term of our heading? Exactly what do we mean by *hyper*complexity? Doesn't complexity say it all?

Apparently not: complexity as we understand it is fast becoming *hypercomplexity*. Keeping in mind that societies, social systems and organizations, from their beginnings, have always been complex, in the ongoing phase of global change (McLuhan-Powers, 1989; Sennett, 1998; Bauman, 1998, 1999; Beck, 1986, 2007; Touraine, 2004; Habermas, 2013) we are experiencing, the transition from complexity to hypercomplexity is being induced by multiple factors, including greater numbers of intervening variables and concauses and of the parameters to be accounted for. Among these, two main determining factors stand out, involving velocity and communication. The former regards technological innovation, whose *digital 'revolution'* has introduced a 'new speed' to the latest stages of the industrial revolution, triggering a phase of hyper-acceleration in those social, economic and cultural processes marking the current mutations. The second factor is none other than communication, increasingly strategic, viral and vital, not only to the crucial sectors of education and socialization, but also to the functions of representation and perception. These two factors are the most significant drivers that we must consider as we observe – and traverse – the breakneck passage from complexity to hypercomplexity.

As I have written before, both in recent and not so recent times, "nowadays, as never before, technology has begun to take part in the synthesis of new values and of new evaluation criteria, bringing out, even more clearly, the centrality and the strategic function of cultural evolution, which is unrolling alongside biological evolution, deeply conditioning it and determining dynamics and retroactive processes (such as, for instance, the technological progress linked to artificial intelligence, robotics, IT, nanotechnologies, genomics, etc.)" (Dominici, 2018, p. 3; see also earlier works). Technological innovation enables the social actors to perform further – and irreversible – improvements, reaching higher and higher levels of quality. This amounts to, as said before, an *anthropological transformation*, as we find ourselves "hurled into hypercomplexity" (Dominici, 2005, 2017a, 2017b, 2017c, 2018): a hypercomplexity that is cognitive, social, subjective and ethical. The individual and collective perception of the difficulty of managing this hypercomplexity is further augmented by our incompleteness and by the substantial inadequacy of our education and training.

A hypercomplexity that is a distinctive feature of the social systems and the "lifeworlds" (Habermas, 1981), based on diverse scientific theories, philosophical thought and public debate,[1] which can be understood in many ways:

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1. *See:* Wiener, 1948, 1950; Arendt, 1958; Ashby, 1956; Simon, 1962; von Bertalanffy, 1968; Bateson, 1972; Morin, 1973, 1993, 1994; Holland, 1975; Capra, 1975, 1996; Musgrave & Lakatos,

–   as reciprocity of totalities and multiplicities;
–   as a new formative and educational paradigm;
–   as an epistemology of interdependency for the *Hypercomplex* and *Hyperconnected Society;*
–   as a reflection on complexity itself;
–   as an approach → organization of experiences and fields of knowledge;
–   as disorder and chaos;
–   as pluralism of principles, values e visions;
–   as enhancement of heterogeneity;
–   as the urgency of an interdisciplinary and multidisciplinary approach.

A hypercomplexity that also has an obvious impact on representations and narratives that have already been hegemonic for some time now. The real concern is that our educational processes have never taught us to recognize this hypercomplexity, or at any rate, not by using our own heads. (Dominici, 1998 and further works). This inadequacy, I always say, "has become even more apparent in this society of interdependency and of global interconnections: a "new ecosystem" in which everything is (or at least, appears to be) linked and connected, within non-linear processes and dynamics, with many variables and concauses that must be considered." (Dominici, 1996 and 2018, p. 3).

In particular, we are facing a social (and organizational) complexity that eludes the traditional systems of control and surveillance (Foucault, 1975, 1988). In order to reduce that complexity, or at any rate to define the conditions of behavioral predictability within and without these organizations and systems, what is needed is a total *'rethinking':* a reformulation of thought and a redefinition of the *fields of knowledge.*

As I have said so many times in the past, "social and organizational complexity, even in its particular characteristics, is always an issue of *knowledge and knowledge management* (Dominici, 2003, 2011), from which cognitive possibilities can effectively be selected, carried out and transformed into choices and decisions; here it is impossible not to recall the Weberian finite section *of the meaningless infinity of events in the world.* A kind of complexity, as we understand it, which has been expanding, and contrary to what one might believe (the so-called interconnected society is based on the idea that more information and data = more rational choices and decisions), becoming even more unpredictable… notwithstanding the exponential *augmentation of the dimensions of technological control*, owing

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1970; von Foerster, 1981; Bocchi & Cerruti, 1985; Maturana & Varela, 1980; Ceruti, 1986, 1995; Gleick, 1987; Gallino, 1992; Kauffman, 1993; Gell-Mann, 1994; Prigogine, 1997; Diamond, 1997, 2005; Emery, 2001; Morin, 2001–2008; Barabási, 2002; Israel, 2005; Dominici, 2008–2014; Braidotti, 2013; Taleb, 2012; Longo, 2014; De Toni & De Zan, 2015.

precisely to the enormous amount of data and information. Not only do these data and information pile up without ever 'speaking for themselves', but they also determine a *permanent state of limited rationality* (Simon, 1947, 1959, 1997) on all levels, from social to organizational" (Dominici, 2018, p. 4).

From this point of view, one has the impression of a great comeback of the persistent idea of "capturing" the facts of life through "rigorous" analysis and interpretation of data (big data, open data, algorithms, AI) (Hammersley, 2013), more and more often delegated to software, apps and technology, under the conviction that data are (=) facts of life, whereas the very interpretation of this data carries implications of value – and at time ideological – judgments (Dominici, 1996–2018). With serious repercussions, as well, on the choices related to education and training and on the definitions of new professional profiles.

Without borders: The urgency of rethinking education

One of the aspects of our era that I have always described as essential is that: "the 'traditional' borders between studies in the scientific fields and in the humanities have been completely done away with, owing to the extraordinary scientific discoveries and the continual accelerations brought about by technological innovation, which renders even more unavoidable the urgency of an education/training that teaches complexity and critical thinking (logic). However, a deep-rooted resistance to such a radical change of perspective (models, procedures, routines and instruments) hails above all from the very "sites" where knowledge is produced and processed, and is linked to motivations of various kinds: dominating logics, feudal social models, cultural issues, the primacy of politics in every dimension, amoral familism, organizational culture, climates of opinion, and so forth. Essentially because, in every field of individual and collective praxis, innovation means questioning consolidated fields of knowledge and methods [(Weber, 1922; Feyerabend, 1975)], upsetting individual and collective imagination, unbalancing equilibriums, *breaking the chains of tradition* [(Dominici, 1998)], abandoning *certainty* to move towards *uncertainty,* with considerably greater risks (opportunities), real and perceived. In other words, rendering systems and their spaces for communication and relationships more vulnerable, at least temporarily. A strategic and crucial question for the complex process of the social and cultural construction of the "Person" and the citizen, and thus of the public domain, which takes on a fundamentally important role, in consideration of the constant and rapid transformation of the local and global contexts of reference." (Dominici, 2005, 2017a, 2017b, 2017c and 2018, p. 4).

As I have written before, our best hope of reaching such complex goals is to spark off a grandiose revival of humanistic backgrounds and studies, as well as the more creative disciplines (such as the visual and performing arts) in schools, universities, and all fields of research, through long-term policies, hopefully managing to at last shake off – although this is far from simple – what I have called the "false dichotomies": nature vs. culture; natural vs. artificial; human vs. technological; culture vs. technology; art vs. science; humanistic studies vs. scientific studies; complexity vs. specialization; interdisciplinarity vs. specialization; creativity vs. rationality; theory vs. practice/research; knowledge vs. competences; soft skills vs. hard skills; so much would fall into place naturally if these aims were pursued.

As a community, in fact, (meant generally and not limited to a scientific or discipline-based community) the price we are paying for persisting with and consolidating these "false dichotomies" (Dominici, 1998, 2017a, 2017b, 2017c, 2018) allowing them to form the neural networks of our educational institutions (schools and universities) and to structure our research and didactics, is still very high. I would like to underline that the abovementioned false – and misleading – dichotomies "between *complexity* and *specialization*, [between interdisciplinary/]multidisciplinary and specialized areas, are in no way antithetical, and by no means constitute/represent dichotomies. It is necessary to start over from the need for the fusion of theory and practice/research, knowledge and skills (not solely technical), human and technological, without falling into the (not merely didactic) trap of "useful" and "useless" fields of knowledge (on the question of the usefulness and uselessness of knowledge there would be much to say: this being the 'concept' on which we are building our schools and universities", as we have mentioned before (Dominici, 2018, p. 7). These are fundamental strategic errors, even more determining/significant, as reality itself is hypercomplex and in rapid evolution.

Digital education and/or training for the "new media" (a term that is no longer valid) is still being seen, in many cases, as a question simply concerning skills, to be delineated above all in terms of know-how: knowing "how to do" and "how to use". This concept is further stretched and spread out every time it is expressed, in order to demonstrate, particularly in public discourse, that one's personal/own vision is the most original, regardless of the fact that evidence from experience and praxis show us that it is not just a matter of knowing "how to do" or "how to use", nor of the idea of providing solutions as rapidly as possible. From another standpoint, digital education is perceived and presented as an instrument to guarantee/protect future generations from the risks and dangers brought about by the digital revolution, and specifically by the advent of the "new" *technologies of connection* (Dominici, 1996–2014). Yet in this case as well, the viewpoint is limited and limiting: the issue cannot and must not be dealt with solely in terms of protection and safeguards, otherwise we once more risk taking an exclusively

reductionist and deterministic approach, built upon fear and lack of knowledge (correlated variables), and confined to means and instruments (including social tools and networks). Whereas once again, the focus should be on the People, on the systems of relations, on the educational and cultural context, on the lifeworlds (!) in a perspective – I will forever insist on this – that can only be systemic, multidisciplinary and interdisciplinary.

The fundamental objectives of digital and, more in general, technological education are, in my opinion, diversified, and regard multiple levels of analysis and intervention that I will attempt to recall and summarize into the following points: (1) so-called *digital education* must (should), at the very least, enhance our awareness of the many variables involved (on this first point I have recently noted a certain amount of consent); (2) digital education must (should) help to define and set up the conditions of a *genuinely critical and systemic approach* to the ongoing transformations: there is a great need to work on this aspect, given that certain concepts are still being essentially used as mere slogans; (3) digital education should empower us, as citizens but above all as People, the younger generations as well as the adults, to cope with and manage the emerging dynamics and processes brought on by technological innovation and from numerous other social, economic, political and cultural features of the new ecosystem. It should show us how to defend ourselves from the digital "dark side", to inhabit the new environment and to utilize its instruments, but also and above all, to exploit the advantages and the enormous potential of information and knowledge-sharing and of constructing/ strengthening/ intensifying the relational networks (distinguishing communication from connection; inclusivity from exclusivity; liberty from security; liberty from surveillance) (Toffler, 1980; Beniger, 1986; Dominici, 1998, 2017a, 2017b, 2017c; Lévy, 1992, 1994, 1997; Lyon, 1994, 2001; Thompson, 1995; Ferrarotti, 1997; Rifkin, 2000; Himanen, 2001; Castells, 2009; Kelly, 2010; Bauman & Lyon, 2013; Boccia Artieri, 2012; Bostrom, 2014; Lovink, 2016). So much more should be said, expanding and illustrating these brief considerations – regarding the necessity of thoroughly reformulating digital education, and indeed, education itself, both by rethinking their foundations and by redefining their principal purposes. Let me repeat this once more: "[i]n the interconnected/hyperconnected society, precisely because we are living in the 'new ecosystem' (Dominici, 1996) and the so-called *'age of access'* (Rifkin, 2000), in which the new inequalities (standing out more and more conspicuously) and the new asymmetries closely regard the access to immaterial resources, the ability to process and share knowledge and to organize it systematically and functionally. Precisely in this complicated evolutionary phase, then, digital education is in fact cut out to be – cut out to become – the base on which to build a new citizenship, both socially and culturally, a new *cohabitation*, rethinking the spaces for communication and relations, and attempting to redefine

the 'social contract'" (Dominici, 1998–2010 and 2018, p. 7). To put it another way, we absolutely cannot afford to be satisfied with merely becoming more aware of the multitude of variables at stake (important as this may be). Digital education must be thoroughly reformulated on the basis of a re-definition of its fundamental objectives. This implicates the passage, far from simple or certain, from a *limited* outlook on digital education – and, let it be clear, on education in general – taken as an instrument (a set of instruments) and as a set of skills designed to endow our young people, (along with teachers, directors, the "Person" and so forth) with know-how and *technical* capacities, towards the visualization/conception of education as a *culture of complexity* and responsibility (Jonas, 1979; Dewey, 1916; Dominici, 2005–2018), both crafted within an *epistemology of uncertainty* (Morin, 2001–2008; Morin, 1993–2016). This concept or vision must, in the meantime, become conscious of its new role as a set of complex tools designed for honing the effectiveness of essential rights and duties, without which no modern democracy can hope to survive. Democracies, whose crisis is apparent, whose politics have become, to say the least, greatly overshadowed by the economic and technological spheres, democracies, which are suffering from a loss of credibility/trust in their institutions, rooted in increasingly unequal and asymmetrical social systems, with increasingly more obvious chasms between the rich and the poor, as to access to quality education and training. Seen from this viewpoint, it becomes even more evident how strongly correlated education is with citizenship and inclusion (Dewey, 1992; Dominici, 1996, 2008, 2014, 2017). Because no technological or digital factor has ever – or will ever – be able to determine citizenship or inclusion, nor will it produce Montaigne's famous "*well-made heads*". At the risk of repeating myself, I wish to emphasize that, in my opinion, among the risks we are running is that of committing the all but unlikely error, when we speak of digital education or digital culture(s), of believing and behaving as though we were dealing merely with technical questions, based exclusively on technical preparation and on skills specific to the (new) technologies of connection and to the new communicative ecosystems/ environments**.**

Teaching responsibility, complexity and empathy: Why digital education does not suffice

Teaching complexity, therefore, is the best way to foster its recognition and management (?), proving fundamental, decisive and strategic for organizations and democracies alike; both, for that matter, in the throes of a deep crisis. And yet in the hypercomplex society (Dominici, 1996, 2005), this can no longer suffice: it is more and more crucially important to know how to communicate this hypercomplexity

as well, and this, evidently brings us back to the question of knowledge and skills, other than to the urgency of overcoming, once and for all, the "false dichotomies" (Dominici 1998 and further works). As I always say: We are dealing with knowledge and skills which by now are required in all those professions that comprise highly cognitive contents, increasingly common to the "knowledge society" and the sharing economy.

Complicated systems (closed)	Complex systems (open)	Factors & variables of transformation	HyperComplex systems*
		➔	
Typical of artificial and mechanical systems	Typical of natural, biological, human and social systems **capable of self-organization**	**More intervening variables and concauses (from simplicity to complexity - as quantity and quality)**	*A hypercomplexity that is cognitive, linguistic, social, subjective, communicative and ethical*
Hierarchical know-how / knowledge/ structures	**Shared knowledge, networked structures and processes;** perception of surroundings		*Cultural evolution* is determining *biological evolution**
Categorical	Inter/multidisciplinary		
Structured; stable	Chaotic; flowing		
Closed pathways	**Open, intersecting pathways and trajectories, at times discontinuous**	**Technological (and digital) innovation "New Speed":**	The quantum leap in acceleration and technologies of connection has determined an irreversible *anthropological transformation**
Linear	Non-linear	*Acceleration of dynamics and processes*	
Reducible/ divisible / dismountable into separate parts and/or stages; The function of each part or process is definable	**Multiple levels of connection between processes and parts capable of self-modification;** The function of the parts are interdependent and inseparable; their union forms a new organism/system		*Doubt and uncertainty, chaos and disorder* are intrinsic elements of the *life-worlds*
Predictable and reproducible : steady and regular **INPUT ➔ OUTPUT predictable and predicted**	**Unpredictable and irreproducible** : variable and dynamic balance **INPUT ➔ OUTPUT Unpredictable and unforeseen No center of control**	**Communication** *Playing an ever more strategic role*	*Mathematical formulas* and *scientific methods* applied to systems for predicting actions/outcomes or describing scenarios can no longer produce satisfactory results
Sum of parts = whole	**Sum of parts < whole**	• in processes of education and socialization	
Cause and effect, stimulus and reaction are linear and chronological	Impossibility of reducing or interpreting through linear models (cause-effect, stimulus-reaction) – behavior emerges from interaction	• in the **representation and perception of dynamics and of processes of systemic evolution**	*- In (complex) biological systems this already holds true, but its effects have been amplified and accelerated by the latest evolutions in human communication and technology*
Reductionist	Exponential	• *New virality* of communication	
Deterministic	Interconnected and retro-active contexts and processes		****Dominici 1998-2018*
Can be observed by an external observer	The observer has an impact on what is observed. **The observer is observed**		
The dynamics of the system can be analyzed by **isolating the single elements and/or by narrowing the fields of observation**	**Adaptive systems**: the various elements within the system modify, co-create and co-construct their own interactions and the system itself and adapt to new requirements or conditions	**Increase of the parameters to be considered**	
Systems perceived as objects	**Objects perceived as systems**		

Figure 1. Complicated, complex and hypercomplex systems

That is why it is just not possible to avoid insisting on the strategic centrality of schools and universities, of the didactic-formative pathways they are proposing, and of the related objectives.

And I do realize, in doing so – which does not worry me in the least – that I run the risk of seeming repetitious but, as I have been insisting for over twenty years, this is the "mother" of all questions. If we do not intervene in a deep-cutting and systematic manner upon these dimensions, we will find ourselves, year by year, caught up in a distressingly "retrograde" cultural condition with respect to the complexity, multidimensionality and ambivalence of the processes of innovation and change. Coming back to the *complex* question of (hyper)complexity, to conclude these reflections, we cannot fail to point out that, all of a sudden, complexity is the talk of the town. While, in one respect, this is undoubtedly positive (it's one of the ways that cultural climates can change), the slogan "everything is complexity" (or likewise "everything is flexibility") could be used, analogous to the other famous slogan "everything is communication", *which, by the way, has been useful for every purpose barring that of clarifying its complex and ambiguous nature, other than its strategic relevance* (Watzlawick, Helmick Beavin & Jackson, 1967; Dominici, 1998, 2005, 2015). In fact, the risk being run is precisely that of trivializing, of creating a public discourse to shape the agendas of public opinion according to the usual driving logics of polarization, leaving little or no space for in-depth analyses or critical evaluation of the positions being taken. However, in facing complexity, the subject, (the approach), and the implications we must be conscious of its "nature"; (Edgar Morin himself speaks of "the nature of knowledge" and of "knowledge of knowledge") (Morin, 1977–2004). This encompasses what we mean by (hyper)complexity, as it is, in itself, complex and ambivalent, as has been observed. For some time now (long before it first came into vogue), we have been calling attention to "the risks of a technological innovation bereft of culture, and of a decline which, as in all of the more "advanced" countries, derives in part from our schools and universities themselves, who have been (at least partially) deprived of those very functions which are vital for a complete democracy" (Dominici, 2018, p. 7). A democracy founded on citizens and not on subjects, founded on genuine, effective participation, rather than "simulated participation" (Dominici, 2005, 2008, 2014a, 2014b, 2017a).

Complexity (open systems, non-linearity, adaptation) has always characterized the "world" and "reality", and as we have seen, the same can be said today for hypercomplexity, and yet, notwithstanding the currently trendy use of these themes and questions, utilized in public discourse whenever it is convenient to do so, behind the catchy slogans we are still keeping the "two cultures separate" (Snow) we are still teaching linear interpretative models; we are still relying on definitions and explanations that stem from determinism and reductionism. We

must, therefore, go beyond the repetition of slogans and key words, striving to achieve a more complete and mature awareness that the only "true" innovation, by which we mean one that is capable of bringing on a *social and cultural* future, is the one that will succeed *in healing the fracture between the human and the technological* (Dominici, 1998, 2005, 2017a, 2017b, 2017c, 2018). The innovators – *the healers* – will be those who will succeed in reformulating, redefining, and revitalizing our thinking with respect to the complex relationships between the natural and the artificial, in putting an end to the separation between knowledge and skills, in uniting the hitherto separated scientific and humanistic cultures in education, training and in the outlining of professional profiles, capacities and competences; (regarding competences: I will never tire of repeating that it is necessary to have both hard and soft skills… while instead, we continue to classify everything according to ranks and ratings, even on these topics).

In conclusion, I would like to underline a concept (that unfolds into an approach) on which I have been working for many years and which – you will no doubt have gathered – I withhold is essential: "The very definition of *digital education* – as I have already remarked – needs to be revised, amplified and extended to other approaches, skills and fields of knowledge, and of the two, education should be firmly placed in the center, owing precisely to the fact that we must not solely educate and train individuals who are aware of digital complexity (although it would be a step in the right direction), and are technically well-prepared, we must train and educate people (first of all) and citizens (later) capable of reflection, thinking, debating, organizing in a logical, critical, correct and efficient manner, capable of imagining, or better yet, recognizing complexity and the levels of connection and rapports amongst people, amongst systems, amongst people and systems. Approaches, methods, knowledge and competences that must remain constant, as an element of continuity in the didactic-formative pathways in our schools and in our universities."

"Only when we have come to be fully aware, and we have clearly recognized our "great mistake" (Dominici, 1998, 2017a, 2017b, 2017c), which marks the (withheld) dialogue between knowledge and skills, and is also profoundly marking public life and democracy, will we succeed in redirecting our present course of navigation, which leads us to adapt to change but not to understand how to manage and modify it. Beyond the many paradoxes of the mutations currently underway, the "great mistake" of and in hypertechnological and hypercomplex civilizations is to keep thinking of education and of educational processes (which also refer to training) as a question of a purely technical nature, solely a problem of "skills" and "know-how" and nothing more; a problem – a series of problems – which must be dealt with by staking everything on speed and simulations. Hence continuing to reproduce, not to correct, the dramatic separation between studies

in the humanities and in scientific fields; (time and time again, we will keep on claiming that first one, then the other, is more important), dooming ourselves to gradually losing sight of the whole, the complex, the global, to losing sight of the OTHER FROM OURSELVES." To put it in other terms: we need to rethink and revise the concept of "digital education" so that it will actually come more and more to represent – as we had imagined and defined it – a complex instrument for shaping the structural conditions of "non-simulated" participation, and of a well-rounded, fully effective and fully participatory citizenship (de La Boétie, 1549-1576; Bobbio, 1984; Balibar, 2012; Bellamy, 2008; Marshall, 2002; Nussbaum, 2010; Norris, 2011; Byung-Chul, 2012, 2015; in lieu of one that is – as I often repeat – "hetero-directed". Again, from this perspective, if we don't rethink *education* – I'll go even further and say: if we don't rethink *thinking about education*, changing the direction of our choices and strategies regarding both didactics and training (continual and systemic, with a modular and flexible component), touching all of the subjects involved at different levels, including decisional levels, we will not get very far in our endeavors to stay astride of the transformations, using only the same old short-term logics.

Digital education must be imagined and defined, in any and every case, with the socio-cultural aim of forming citizens, but only after having culturally and socially formed *the Person* in the first place.

As I have written in the past: in dealing with the above issues, one must take care not to give in to the temptations of simplistic solutions, of deterministic explanations or of easy reductionism. We have an urgent need of explanations and analyses based on data and research, but we also have a tremendous need for a critical theoretical approach to complexity, which will allow us to save ourselves from the *quicksand of mono-causal determinism*, (Dominici, 1996, 2010, 2016, 2017c) and also (on a less worrisome level), from a prosaic acritical neophilia that has led us to convince ourselves, in recent years, that all that is new is fantastic.

I strongly emphasize this once again: "schools and universities, teaching, training and continuous education must (should) be solidly (!) placed at the core of every innovative project and process (systemic view), and when dealing with the challenges of citizenship (Marshall, 1950; Bobbio, 1984; Veca, 1990; Dahl, 1998; Bauman, 1998, 1999; Bellamy, 2008; Norris, 2011; Balibar, 2012) and of "inclusive innovation", which coincide with the challenges of hypercomplexity but also of responsibility. In doing so, however, with regard to topics concerning school and university, society must heed the warning that has so far fallen on deaf ears: "to resist the continuous temptations, the short-cuts, the easy solutions, the reassuringly well-beaten paths that often conceal mere vested interests in power or in economic factors, the ideological views, which incessant promotion and event marketing have done so much to render visible, acceptable and approvable.

The definition I have always used is the following: *'Innovating means destabilizing'* (Dominici, 2013, 2014b, 2017b,c, 2018, p. 8). First of all, however, it is necessary to teach analytical and critical thinking to people, enabling them to use their own heads (and to question themselves and others around them), instead of simply accepting the standard answers / solutions, and to see "objects" as "systems", rather than vice-versa" (Dominici, 2008, Dominici, 2017a, Dominici, 2017b, Dominici, 2017c and 2018, p. 8).

For some time now, we have been losing our ability to look at/observe the set, the system, the whole, the global totality and the system of relations and/or inter-actions that these feature; in other words, we have difficulty recognizing bonds, correlations, causal nexus: precisely because we have been taught and trained (in the best of cases) to describe and record regularities, to see the "hows" and not the "whys"; we have been educated to look for (?) and be satisfied with simple or pre-coded answers (in any case, obtained in a brief amount of time), to look for – as I am always saying – simple solutions to (hyper)complex problems. This perspective, aside from being nearsighted and misleading, reveals itself to be even more paradoxical exactly because what we live in (= what we know) is the era of global interconnection, in which all processes are interdependent and linked to one another (and will become increasingly so): we must cope with dimensions and levels of interaction and retroaction – on subjective, relational, systemic, organiza-tional, social levels – that highlight, as if more evidence were needed – the urgency of rethinking our paradigms from/in/on a systemic, (hyper)complex perspective. All the more so today, now that even the scientific method, based on the replica-bility and the empirical verification and falsifiability (Popper, 1934, 1994) of the original hypotheses, cannot always find full confirmation within hypercomplexity, where the very concepts of cause and effect are no longer sufficient/adequate to describe/comprehend the systemic relations and connections. The same problem closely regards the language of mathematics, which has always been considered the universal code (an exact code) of science – of all of the empirical sciences (Lafforgue, 2017).

Once again, I strongly insist: we must completely reboot our educational sys-tem, correcting its flimsy structural inadequacies, without that narrow-minded and nearsighted perspective that has long characterized schools and universities, which are the only "true" institutions/"places" in charge of defining and construct-ing the conditions of social emancipation. (To do this, of course, we will have to deal with the age-old question of teaching the teachers). What must be promoted is the kind of education that is capable of analytically addressing complexity and en-dowing students with a sense of responsibility (beginning from the very first years of school), but also and above all, what must be encouraged, not just proclaimed in institutional documents, are critical thinking, complexity, and *interdisciplinarity*

and *transdisciplinarity* on a level of scientific research and not only. The benefits would, furthermore, significantly influence the didactic pathways themselves, and thus, evidently, the (continuous) teaching of our future teachers. In the meantime, we need to take full and accepting cognizance of the fact that these vital strategic choices have, by definition, exclusively long-term outcomes that will only be "seen" many years into the future.

Admittedly, it has become difficult – at times well-nigh impossible – to distinguish clearly between the *complexity, hypercomplexity and (hyper)complexity* facing us. It can only become possible by adopting a systemic approach, which requires educational methods focused on healing the artificial fracture that has split knowledge into false dichotomies between the human and the technological. The way to achieve this is to foster critical and independent thinking by encompassing doubt and uncertainty into our learning systems. This must be undertaken from the first years of school on, to provide us with the tools for studying and understanding interconnections, intersections and interactions, in other words for perceiving *objects as systems*, as well as for establishing the equal starting conditions essential for authentic knowledge sharing and for rendering *innovation* genuinely *inclusive and participative*.

Objects as systems, not systems as objects! Life is found precisely in what is non objectifiable.

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