REVIEW ARTICLE

Holonic thinking and systemic creativity in sport education: A new paradigm for collective tactical training

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ABSTRACT

The holonic approach in sports education offers a new paradigm for collective tactical training, moving beyond rigid and hierarchical models. This study explores how systemic creativity enhances team performance by integrating individual autonomy with collective adaptability. Players function as holons, self-organizing units that dynamically interact within a structured system, fostering emergent tactical patterns. The research highlights how team coordination and decision-making improve when tactical structures are designed to be flexible and responsive rather than rigid. By shifting from fixed positional roles to adaptive interactions, players develop a deeper situational awareness, enhancing strategic cohesion. This study emphasizes the practical applications of holonic thinking in sports, demonstrating how it can optimize team dynamics, creativity, and performance. The findings suggest that holonic structures in training and gameplay lead to greater tactical intelligence, reinforcing the importance of self-organization and adaptive strategies in modern sports education.
Keywords: Physical education, Holonic theory, Systemic creativity, Tactical training, Self-organization, Adaptability, Team dynamics, Sports education, Decision-making.

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INTRODUCTION

The intellectual legacy of Arthur Koestler (1905-1983) trespasses his times and still offer today a modern perspective for studying, interpreting and manage complex systems, the sport education included.

Koestler was one of the most widely read and appreciated journalist, writer and essayist of his time, and an original scholar of the "*human condition*" (Watson, 1999). In 1967 he wrote "*The Ghost in the Machine*", where he first used the term "*holon*", a concept that was further developed in 1970 in his article "*Beyond Atomism and Holism-the concept of the holon*".

The conceptualization of the term "*holon*" found its grounds in the attempt to overcome the dichotomy between holism and reductionism and to take into account both the individualistic and integrative tendencies of whatever agent interacting within whatever complex system. This concept implies the non-existence in nature of autonomous units indivisible and separate as well as the oxymoron nature of the term "*individual*".

Koestler (1970) notes that "*whenever there is life, it must be hierarchically organized*", but the term "*hierarchy*", as Koestler notes, is a non-appropriate as it is full of military reminiscences and generates the idea of a rigidly authoritarian structure. Koestler's hierarchy has quite another meaning: it is a structure with many levels, branched and stratified. A system that branches into subsystems, a structure that encapsulates substructures, of a process that activates sub-processes. For this reason holons start from the hierarchy and move over the hierarchy. Their organization is in the same time hierarchical (pyramidal) and heterarchic (horizontal), for which Koestler coined the term Olarchy (hierarchy + heterarchy).

From the analysis of biological systems to that of human systems, the step is short. The "*holonic*" theory is also a candidate for the study of models of human social systems, because it is able to analyse both the micro-level of individuality and the macro-level of the community.

The next and inevitable step is the recognition that organisms and societies have the same holarchical structure. Koestler attempted to re-establish a sociological thought, encompassing the current epistemological fracture that separate, in a sort of new Cartesian view of society, structure and agent as different poles of the sociological reasoning. Such a fracture, generating "*dichotomies*", still has some appeal in sociology as it should allow to mediate between "*two strong and opposite positions*" as, according to Jenks (1988) "…*we reason in the form of dichotomies here because they enable us to establish arguments from two strong and opposite positions and because they will you also to engage with debates from both sides and to see the strengths of the arguments on both sides*." Koestler, instead, imagined a study of human social structure based on an original approach in which the single concepts of "*holon*", as well as the equivalent structure and agent, could be merged and then be overcome. Koestler's ambition was to find a new epistemology in which to leave behind forever the fruitless dichotomies.

The concept of "*holon*" designates an entity that is, at the same time, something defined in itself and a part of a larger whole. An atom is defined in itself, but it is also part of something more complex when it participates in the structure of a molecule. When the molecule participates in the cellular structure it is a holon, inserted in a more complex system. An organ is a part in itself and, at the same time, a part of an organism.

Up to this point, everything seems to be a consolidated discourse, and therefore not original, about the emergent properties of the higher levels of organization that cannot be predicted starting from levels of lower complexity (von Bertalanffy, 1952). Instead, it is about the identification of a hierarchical model that considers the hierarchy of relationships in an innovative way. In this regard, as explicitly quoted by Koestler (1970), this concept was derived from the general system theory of Ludwig von Bertalanffy and from what the same von Bertalanffy underlined in his book "*Problems of life; an evaluation of modern biological thought*"(1968): "*Hierarchical organization on the one hand, and the characteristics of open systems on the other, are fundamental principles of living nature"* [quoted by Koestler (1970)].

Reality can be seen as an infinite series of holonic relationships. Holons have action, individuality, autonomy, commonality, mutuality and collective relationships. They have the ability to transform into larger full-scale agents and to emerge creatively and indefinitely. Koestler (1970) notes that parts and wholes have no absolute value in nature, what matters is the way in which parts and wholes are holarchically related. Koestler uses the concept of "*holon*" for an interpretation of nature that ranges from the examination of the structure of the brain to the "*holonic*" interpretation of ontogenesis.

The holonic theory was widely used, in recent years, in a broad range of sectors, spanning from manufacturing systems (Babiceanu and Chen, 2006; Valckenaers et al., 1998) to urban planning (Boudjemaa and Ridda Laouar, 2006), from multi-agent systems (Beheshti et al., 2016) to climate change communication (Briggs, 2007) and industrial ecology (Kay, 2003).

The holonic theory does not seems to appeal sport education, even though it appears to have a great potentiality in this field, as demonstrated, for instance, by the interest this theory raised in the educational field at large. Recently, Galifa (2019), reasoning about the popularity of the teaching process based on "*thinking skills*" (Wegerif, 2002) - much appreciated in our informatics era -, expressed the idea that a shift of paradigm towards a more complex systems of thought is needed. Thinking skill, by the way, seems an elusive concept. Wegerif (2202) define it as "*a desire to teach processes of thinking and learning that can be applied in a wide range of real-life contexts […] information-processing, reasoning, enquiry, creative thinking and evaluation*". Ennis (1985) in his seminal article "*A logical basis for measuring critical thinking skills", defined thinking skills as […] reflective and reasonable thinking that is focused on deciding what to believe or do*", whereas Paul and Elder (2006) definition is "*the art of analysing and evaluating thinking with a view to improve it*". We believe is hard to construct an epistemology on so elusory arguments. Galifa (2018; 2019), instead, preconizes a sort of merging the General System Theory (von Bertalanffy's, 1968; Boulding, 1956) with the Koestler's holonic theory. We will afford this topic in the next section of this work, whereas the potential use of the holonic approach in sport education will be the section concluding our essay.

The rational of this approach is that the application of Koestler's holonic theory (1970) to the world of sports and sports education offers an innovative perspective for understanding team dynamics and tactical training. While traditional approaches to tactical preparation have focused on rigid and hierarchical models, the concept of systemic creativity opens up new possibilities for developing more adaptable and fluid collective strategies. This paradigm perfectly aligns with Koestler's holarchy theory (1967), in which each player is viewed as a holon—an autonomous yet interdependent unit, capable of dynamically interacting within the team, considered as a system. In team sports, creativity is often perceived as a chaotic element that may interfere with a team's strategic organization. However, Memmert (2015) demonstrated that tactical creativity is not synonymous with anarchy, but rather a refined balance between individual improvisation and collective coherence. McGarry et al. (2002) argue that the most effective teams are not those that rigidly follow a set pattern, but rather those that can generate emergent responses based on the interactions between players. This principle is consistent with the concept of holarchy, in which the game is viewed as a continuously evolving ecosystem rather than a linear sequence of predefined actions. Self-organization, defined by Kelso (1995) as the ability of a system to structure itself without a centralized command, is a key concept in systemic creativity applied to sports. The coach cannot predict every possible tactical scenario but can create an environment that fosters real-time creative and effective decision-making. Passos et al. (2008) highlighted how training based on situational creativity leads to an improvement in decision-making ability and the effectiveness of team strategies. This approach finds practical application in models such as the Tactical Games Approach (Hastie et al., 2025), which emphasizes tactical understanding and strategic thinking over mere technical execution. A practical example of the application of systemic creativity is Tiki-Taka, the football philosophy developed by Guardiola's Barcelona (Lago-Peñas et al., 2010). In this system, each player acts as a holon, making independent decisions while remaining aligned with the collective team dynamics. Tactical flexibility is maximized through:

- Function redundancy (multiple players capable of performing the same role).
- Interconnection strength (instant understanding between teammates).

This holonic and adaptive approach allows teams to be more fluid, responsive, and strategically intelligent, creating emergent tactical patterns that enhance collective performance.

THE SPORT EDUCATION TODAY

Sport education, in accordance with the theoretical aspects pertaining to all educational fields, deals with the subjective and personal nature of both teaching and learning experience (Sequeira, 2017). Motor education is aimed at individuals experiencing a peculiar education conveyed both through mind and body. In this context, the body assumes an extremely relevant importance as the bodily perception of the learning subject interacts unceasingly with an ever changing surrounding environment. This continuous transformation is able to generates new knowledge and skills making the sport teaching a particularly challenging experience for both teacher and pupil (Ceciliani, 2018).

Today, constructivist and situated learning perspectives are considered as leading conceptualizations to the teaching and learning in physical education (Dyson et al., 2004). In this frame of reference, three student-cantered models to learning (namely Sport Education, Tactical Games, and Cooperative Learning) seem to have the potential to embody situated learning within a social constructivist theoretical coordinate system.

According to Dyson et al. (2004) Sport Education is "*a functional model which links the sport taught in physical education to the wider sporting culture. system of tasks and learning activities are planned that will result in students not only becoming more skilled, but understanding the histories, traditions, and nuances of the sport, as well as becoming willing participants within the wider sport culture*." This line of thought is very much consistent to the Structural Functionalism defined as "*a framework for building theory that sees society as a complex system whose parts work together to promote solidarity and stability*" (Macioni and Gerber, 2011). The filiation from the general system theory is glaringly evident.

The Sport Education approach is a pedagogical endeavour aimed at involving students not only in learning the fundamental practical and theoretical basis of a specific sport discipline, but also to learn how to leader a team, in the broadest meaning of the term, and take responsibilities for the management of a team. The roles students are called to take on different roles other than those of player (coach, referee, captains, etc.).

Lave and Wenger's, in their seminal book of 1991, introduced the concept of "*situated learning*" by placing the didactical emphasis on the whole person, viewed as constitutive agent operating and interacting within a complex system. These authors overcome, that way, the approach to learning procedures seen as somewhat passive transmission of factual concepts and information, unravelling, in the meantime, the profound social character of education. The Sport Education approach fully falls back into this line of thought as it interprets the learning process as a way to participate in communities of practice.

Dyson et al. (2004) put the emphasis on a second sport learning strategy, other than Sport Education: the Tactical Games. This is a didactical method aimed at reducing the hindrance of the technical aspects of the game, appropriately tuning some rules of the game, thus allowing participants to understand and develop, step by step, both technical and tactical characteristics of the game.

The Tactical Game approach allows student to discover the underpinning similarities pertaining to different games in a sort of "*holistic*" view of games. Having specific array of games similar tactical problems, the understanding of them assists in transferring performance from one game to another as they are framed in a similar technical and tactical structure.

A third learning model envisaged by Dyson et al. (2004) is the Cooperative Learning. The theoretical basis of such an instructional model were defined by Johnson and Johnson (1999) in a seminal article that exerted wide influence on pedagogy. It can be defined as instructional strategy enabling small groups of students to work together on a common assignment. Each student becomes a meaningful participant in learning and can be individually responsible for their part or role in the assignment. Cooperative Learning (CL) also has social outcomes such as positive inter-group relations, the ability to work collaboratively with others. This teaching method is also able to develop social skills, as the group members gain awareness of the importance of interpersonal, social, and collaborative skills. It is easy to see in filigree both the foundations of holonic theory and those of general systems theory.

FROM GENERAL SYSTEM THEORY TO INTEGRAL THINKING AND INTEGRAL EDUCATION

Richardson (2004), in this preface to the reprint of Boulding's "*General systems theory: The skeleton of science*" quoted the following Boulding's sentence "… *such a theory would be almost without content, for we always pay for generality by sacrificing content, and all we can say about practically everything is almost nothing*." The Boulding's caveat refers to one of the most common criticisms moved to the General System Theory, sometime perceived as a "*theory of everything*".

Contrary to such a criticism, the basic and more typical feature of the theory is the attempt to identify universal principles applying to system in general, irrespective of the nature of the system itself (von Bertalanffy, 1968). Such a need was recognised as imperative by von Bertalaffy (1969) because the expanding fragmentation in disciplines, as well as and the ever increasing progress in scientific and technological research, are sharpening the antithesis between mechanism and vitalism. Such an antithesis is perceived by von Bertalanffy (1952) as the most important antipodal confrontation of biological thought in need to be reconciled through an "*organismic conception*", that take shape in a mathematical formulated general theory of systems (Gregg, 1953).

Considering the works of Boulding (1956) and von Bertalanffy (1969), as well as the excellent review of Laszlo and Kripnner (1998) on the origins and foundations of the system theory, we try to conceptualize the very essence of the system in the following paragraphs.

To contextualize the idea of "*system*" into the framework of the education at large, and sport education in particular, it is necessary to carry out some considerations about its definition. The "*system*" concept can be formalized, in its broadest picture, as a not defined number of components (characteristic that enable its "*reduction to components*") interacting together (characteristic enabling its "*reduction to dynamics*") and operating within boundaries that ensure the maintenance of both entity and process.

The identification of boundaries, an essential prerequisite in the general system theory, can be difficult to achieve in some fields of human sciences, as sociology and psychology, where number of interactions incessantly shape the behaviours of number of systems components exposed to forces and events outside any possible definition of boundaries. The difficulties arising from that criticism will be dealt with later on.

In the field of biological sciences the general system theory enriches the "*reduction to components*" strategy with the "*reduction to dynamics*" strategy. The "*reduction to component*" applies to the basic question of whether "*the properties, concepts, explanations, or methods from one scientific domain (typically at higher levels of organization) can be deduced from or explained by the properties, concepts, explanations, or methods from another domain of science (typically at lower levels of organization)*" (in Brigandt and Love, 2008). The "*ontological reduction*" (Rosemberg, 2006) supports the idea that each particular biological system is only constituted by molecules and the interactions among molecules. The "*whole*" is, then, mostly the sum of its constituent parts. In the same line of thought, the "*methodological reduction*" supports the idea that the very essence of biological systems lies in its lowest and smallest possible levels, and that experimental studies should be aimed at exploring the underpinning molecular and biochemical structures of any system (Andersen 2017).

Both the heuristic approaches "*reduction to components*" and "*reduction to dynamics*" are aimed at simplifying the too complex set of phenomena characterising all systems of our perceptible and non-perceptible world. Such a simplification is necessary to "*make order out of chaos*", for chaos is often perceived as the leitmotiv of nature. Worster (1990) goes so far as to declare: "*What is there to love or preserve in a universe of chaos? How are people supposed to behave in such a universe?*" Then, the "*reduction to component*" is seen as the only way to re-orient chaos into order, through the inventory and study of the smallest component of any system. In this regard, the Latour's (1983) claim is paradigmatic: "*Give me a laboratory and I will raise the world*".

The heurist approach, alternative to the "*reduction to components*" is then the "*reduction to dynamics*". The study of the smallest component of a system cannot take into account both the behaviours of each component, when subjected to the influence of external factors, and the emerging properties, that come to light when proceeding from a lowest to the highest level of organisation. In this regard, Laszlo and Kripnner (1998) say: "*Structurally, a system is a divisible whole, but functionally it is an indivisible unity with emergent properties. An emergent property is marked by the appearance of novel characteristics exhibited on the level of the whole ensemble, but not by the components in isolation. There are two important aspects of emergent properties: first, they are lost when the system breaks down to its components — the property of life, for example, does not inhere in organs once they are removed from the body. Second, when a component is removed from the whole, that component itself will lose its emergent properties — a hand, severed from the body, cannot write, nor can a severed eye see. The notion of emergent properties leads to the concept of synergy, suggesting that, as we say in everyday language, the system is more than the sum of its parts.*"

This concept became particularly clear in case, for instance, of team sports. A single player, severed out from his team, cannot display the same properties showed by this same player when he is playing as part of the whole represented by his team.

For the primary purposes of our approach, according to Mesarovic and Takahara (1975), we could try to summarize the main goal of the General System Theory as an attempt to explain phenomena in terms of relationships and transformation of components of a system, regardless the specific nature of the system itself. The nature of the mechanism involved (physical, biological, social, etc.) is, then, less explicative than the "*formal relationships between observed features or attributes*" (Mesarovic and Takahara, 1975).

The systems theory offers a trans-disciplinary framework for the study of several aspects of social and education sciences seen as "*relationships between observed features or attributes"*. The studies on cognitive development - defined as the process by which human beings acquire, organize, and learn to use knowledge – and human perception – defined as the way the information conveyed by our sensory organs is organized, interpreted, and filtered through consciousness -, are relying more and more on the systems approach.

von Bertalanffy (1968) anticipated the general tendency leading to the integration of natural and social sciences through the general theory of systems, as well as the possible, and much-needed, integration in scientific education. All this opens the door to an integration between this theory and educational sciences at large.

Without any doubt, the Integral Thinking and the Integral Education concepts derived the foundation of their respective line of thought from the General System Theory, even though not always correctly understood. Galifa (2019), quoting Wilber (2006), preconizes an advanced modality of thinking being independent from any religious or philosophical tradition, maintaining, in the meantime, the possibility of being recognisable by any cultural tradition of the world. In this context, it is not matter of founding a new "*Esperanto*" in terms of thinking system and thinking theory, as the plurality of approaches to the interpretation of our world, in the widest meaning of the term, is the real wealth of the humanity.

The General System Theory is not a way to reduce all thinking to a single interpretative scheme. It is, on the contrary, a way to overcome the dichotomy "*mechanism versus vitalism*" (von Bertalanffy, 1952) or "*holism versus reductionism*" (Koestler, 1970). Whatever way we wish to define such a dichotomy, it is undoubtedly daughter of the Cartesian approach to scientific thought, then it is contextualized inside the western scientific thought.

According to Weckowicz (2000), one of the most important legacies of the General System Theory is the rejection of reductionism and vitalism and the stress on creativity and organized complexity of human behaviours. The human culture makes human unique and different from animals, despite the many essential biological features we share with them. Man is the only living organism able to live in a world of symbols, or rather in worlds of symbols, interposing symbols between himself and the physical objects populating the perceptible world. The most appropriate designation of man is then "*homo symbolicus*".

Taking all this into account, it is clear that the General System Theory, apart from the original and specific biological field for what it has been conceived, and according to the theorists who codified such an approach (Boulding, 1956; von Bertalanffy, 1952; Koestler, 1970), can be useful in number of applications, education strategies included.

Floyd (2008) observed that, since the pioneering works of von Bertalanffy during the 1960s, the so called systems thinking was mature enough to explore disparate domains of inquiry, outside the highly specialised fields from which it emerged and was theorized. The same author is keen to differentiate system thinking from system theory, highlighting those systems thinking is, above all, an epistemology, while the system theory is a representational tool established on 'four basic ideas: emergence, hierarchy, communication, and control' (Chichester, 1981 quoted in Floyd, 2008). In our opinion, a correct schematization of the system theory should not omit a fifth basic idea: the boundaries, a fundamental element without which a system simply cannot exist.

It is somewhat surprising that some theorists of the Integral Education did not mention in their works the founders of the "*integral way of thinking*", just mentioned above. Murray (2009), admitting that "*integral education*" means more than the sum of various theories (concept derived from von Bertalanffy's work), defines as "*integral*" the meeting point of four perspectives: model, methodology, community and capacities. According to this author, model can be defined as "*system of concepts for interpreting the world*". In this case, one of the most peculiar characteristics of the model, as conceptualized in the General System Theory is lost. We are referring to the definition of the "*system boundaries*", an assumption of paramount importance in the analysis of the system dynamics.

Even the concept of holism, as interpreted by Murray (2009), seems to have lost its richness of potentiality to explore the space of human thinking, for this author defines it as:

Holism: An acknowledgement and appreciation of the "*whole person*" or "*whole child*" – mind, body, heart, spirit, and community are all interconnected and important. Artistic expression, bodily movement and health, spontaneity and fun, interaction with the natural world, and service are as important to creating good citizens and realizing students' full potential, as is the learning of "*content*." The physical arrangement of the classroom, what a student had for breakfast, and whether he has caring parents seeing him out the door, all affect his learning and engagement.

This definition reduces the space of interaction to those related to individual, shadowing, in some way, the holonic nature of all that is interacting with him.

Nevertheless, as underlined by Floyd (2008), the transition from the general system dynamic theories to integral thinking and integral education has to solve a specific problem, for the formers explicitly expound the observer from the boundaries of the system observed. In other words, such theories have "*a strongly objectivist stance*" (Floyd, 2008), as "*they are not designed to take account of the relationship between those studying the system and the understanding that their study creates*" (Midgley, 2000). In the sociological/educational field, all this is an evident drawback. In addition, this peculiar field is hard to compare with biological systems as, according to the theorists of deconstructivism/postmodernism the "*meaning is context dependent and contexts are boundless*" (Floyd, 2008).

Accepting the boundless nature of contexts, the foundation of the integral thinking on the general system dynamics theories has to face a sort of epistemological problem: how to find the dynamic analysis of interacting objects within a system without defining the boundaries of the system? Such an impasse is probably more theoretical than practical, in the sense that some specific fields could escape from that bottleneck by focusing on bounded sub-systems of boundless systems. The sport education, operating in the specific context of sport discipline, could, in that sense, consider defining the boundaries of its applicative domain by taking into account the specific nature of sport team. A team, then, could be dealt with as a bounded system pertaining to a boundless social context. Even though such an approach could be considered as forcefully approximate, in reality represents an operational choice able to overcome an otherwise paralyzing cul-de-sac.

According to Murray (2009), the term "*integral*" coupled with education, or even more generally with pedagogy, points out four interrelated points:

- *model* (intended as a system of postulates, data, and inferences presented as a description of an entity or entities of the real world)
- *methodology* (intended as a body of methods, rules, and self-evident basis for reasoning employed by a discipline)
- *community* (intended as a group or groups of people to which integral models and methods is to be applied),
- *capacities* (intended as a developmental stage of thinking able to compromise past modern and post-modern cultural perspectives, and past formal operational modes of thinking).

All of these points, considering the peculiar field of sport education could benefit of the "*integral*" approach in the broadest meaning of the term. It is now mattered to shift from the widely shared constructivist and integral approaches to a paradigm able to merge different learning model into a general system, keeping, in the meantime, all the peculiarities of each model.

HOLONIC APPROACH IN SPORT EDUCATION

The term holon denominates entities displaying at the same time autonomous behaviours, cooperation and synergism. Uliero et al. (2001) points out the importance of balancing of the possible contradictory forces driving each of these properties on a behavioural level. As observed by Calabrese et al. (2011), in this kind of "*cooperation in autonomy*" is rooted the property of "*emergence*", as in complex systems we witness the emergence of characteristics that cannot be deduced from the lower levels of organization.

According to Wilber (2000), the holonic approach is much more than an interpretation of recurring patterns within a systemic dynamic, which is made possible thanks to the interaction among holons. This author states that: "*In all of these movements and more, we see the radiant hand of vision-logic announcing the endless networks of holonic interconnection that constitute the very fabric of the Kosmos itself."*

Taking apart the possible interpretation of the intimate cosmos structure, the holonic theory is a very useful tool for the analysis of the "…*fields within fields, patterns within patterns, contexts within contexts, endlessly*" (Wilber, 1996) that made the very fabric of nature, social fabric included.

Wilber (2000) describes the holonic nature of our world as follows: "*In other words, we live in a universe that consists neither of wholes nor of parts, but of whole/parts, or holons. Wholes do not exist by themselves, nor do parts exist by themselves. Every whole simultaneously exists as a part of some other whole, and as far as we can tell, this is indeed endless. Even the whole of the universe right now is simply a part of the next moment's whole. There are no wholes, and no parts, anywhere in the universe; there are only whole/parts*."

This is the ground on which the concept of holarchy has been founded. According to Koestler (1967), the concept of hierarch vs that of holarchy can be summed up in Table 1.

Holarchy implies recognizing that every agent in our world, irrespective to their level of organisation, are part of a whole co-evolving with the parts of which it is composed. This co-evolution process incessantly creates and reshapes meanings making. All this, translated in meaningful behavioural patterns, make us to relay on self-affirmation (as holons) and integration (again as holons) making our collective participation and support beneficial for the whole as well as for the individual.

This is particularly true in the team sport dynamics and perfectly apply to sport didactic. In Figure 2 (Bell et al. 1996) another graphic conceptualization of holarchy is reported, where holons and cluster of holons show bidirectional interactions, networking, contemporary multiple states of interaction in a de-centred structure.

Table 1. Hierarchy vs Holarchy

Hierarchy	**Holarchy**
Top-down control. Individuals at higher levels play the role of controllers of the behaviours of individuals at lower levels.	Bidirectional interactions. Lower holons influence higher holons and vice versa.
Linear chain of command. Individual at higher levels rule individual at lower levels in a sequential order.	Networking. Holons can organize in networks resulting in holarchic complex relationships.
Fixed Roles. Individuals in institutional hierarchies are defined by particular functions they fulfil in the organization.	Contemporary multiple states. Holarchies display different kinds of interactions among holons.
Centred structure. Structure or system orbiting around a stable centre. The evolution of such a structure implies the destruction of the gravitational centre and the emergence of a new one.	De-centred structure. Structures that are constantly being re-centred sequentially at a series of locations, like a football game. The focus of activity is ever shifting to something else that was not the focus (Derrida, 1967).

The graphical conceptualisation of hierarchy and holarchy is reported in Figure 1.

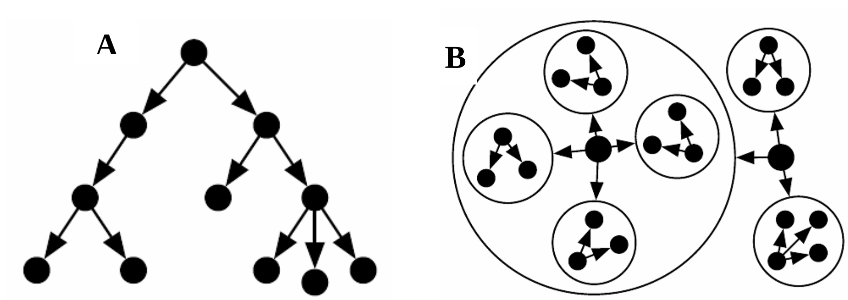

Figure 1. Hierarchical (A) vs holarchical (B) organization (Horling and Lesser, 2005).

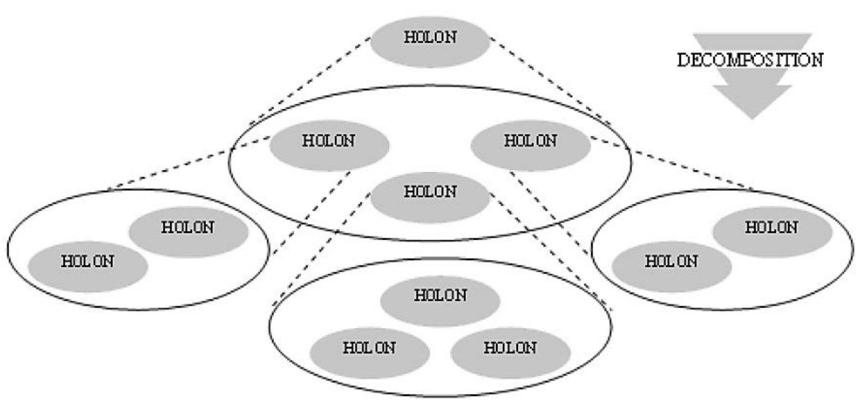

Figure 2. The Bell et al. (1996) graphic conceptualization of holarchy (Georges 2009).

Georges (2009), points out some emergent characteristics of a holarchy of auto-regulated holons:

- Working as autonomous wholes in supra-ordination of their parts;
- Working as dependent parts in subordination of upper control levels;
- Working in coordination with its local environment (other holons and external environment).

Taking into account a bounded system (for instance a sport team), one of its emerging characteristics could be represented by the number of interactions between elements in the evolution within such a system. On the other hand, a complex system, even though is displaying a high number of connections, is not necessarily efficient. A higher efficiency of the system is attained aggregating elements (holons) in clusters interacting each other. This concept is clearly sketched in Figure 3 (Georges, 2006). On the left side of this Figure we found a "*modular system*" where each module (holon) may be largely in control of its own operation and deciding when it communicates with other modules (holons). In this case, the relationship between the elements of the subsets is larger than the relationship between the subsets for all levels. On the right side of Figure 3 we found a model made by three clusters of two sub-clusters, each made of two holons. This configuration, as mathematically demonstrated by Toulouse and Bok (1978), decreases the degree of difficulty (i.e. the number of interactions among modules), stabilizes and makes more efficient the system.

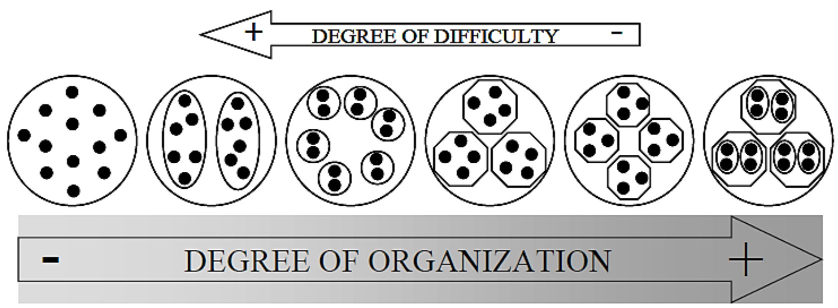

Figure 3. Model of different organizations of a system as function of the degree of clustering of their constituent modules (Georges, 2009).

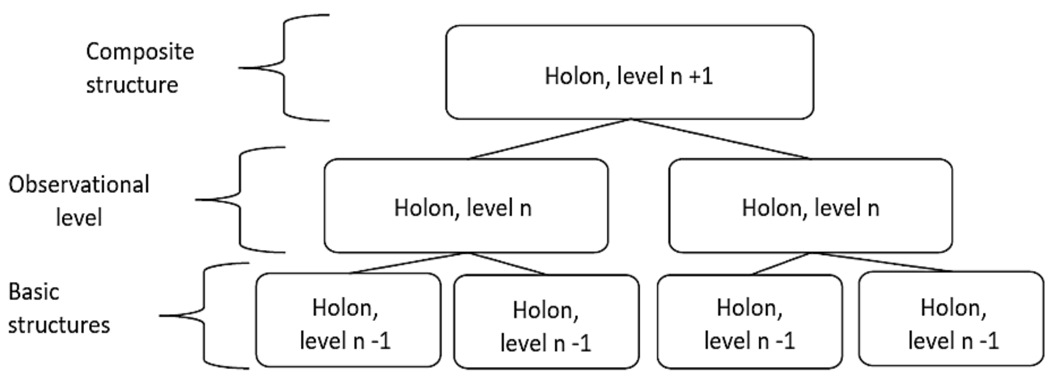

Figure 4. Holon as a centre of relationships with basic components (below ordered) and composite (above ordered) structures (from Mella, 2005).

Interestingly, each group of agent has attributes arising from other agents members of the group, but original and distinct from them. Reasoning from a lower level to a higher level of complexity, a group behave exactly as the single agent constituting it, as it contributes to the properties of one or more groups of which it interacts (Horling and Lesser, 2005). The structure of each of these groupings is a basic unit of organization that can be seen throughout the system as a whole.

Mesarovitch et al. () underline that holons of the same level elaborate elements or information coming from the lower level holons. The results are transferred to upper level holons for further processing. The processes going on at the *level n* holons originate from processes originated from the subordinate *level n - 1* holons and configure those of the super ordered holons at *n + 1 level*. A simple way in which holons participate in a making of a complex structure is outlined in Figure 4.

Horling and Lesser (2005), debating about enterprise holonic organisation, pinpoint the importance of choosing the appropriate agents to be embodied in the individual holons. Ulieru et al. (2001), quoting Zhang and Norries (1999), define three different kinds of holons:

- Static holons.
- Resource holons.
- Mediator holon.

In the context of sport science, static holons could be represented by the physical infrastructures (i.e. ball, lines defining the various segment of a playground, doors or baskets, etc.) corresponds to a group of physical objects, or information, in the environment. Resource holons could be the players and the mediator holons could be the referee and the trainer. In Figure 4 a graphical conceptualisation of this notion is reported.

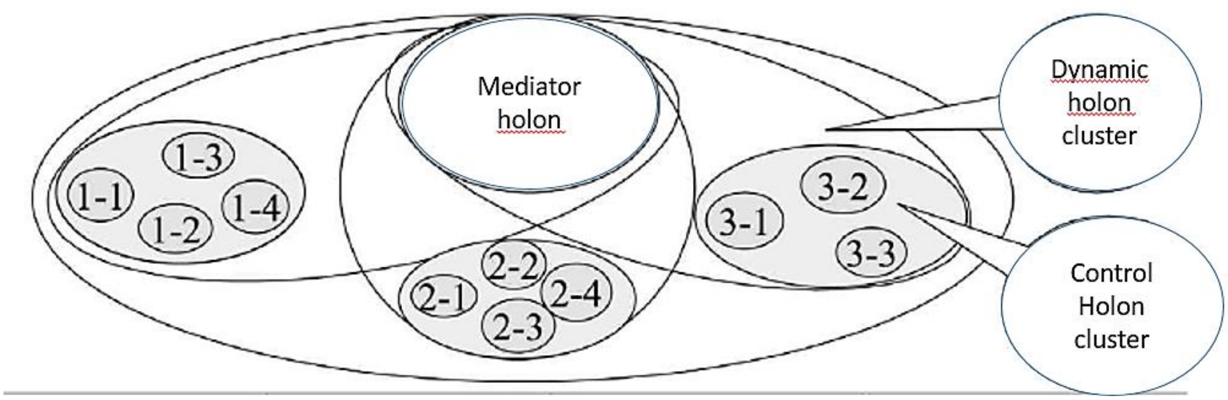

Figure 5. Interrelationships among different holons and holon clusters (modified from Ulieru et al., 2002).

A holonic educational system is, then, a holarchy of collaborative agents oriented towards a common goal. Such agents agglutinates in clusters interacting each other in the view of the optimization of the teaching process.

Holonic systems derive their architecture from the model of autonomous distributed system (Figure 6), since the control is conferred to single peripheral units cooperating through a coordination agent.

The scheme of Figure 6 shows the interplay between players of a hypothetical team sport and a "*coordinator*" (a coach, for instance). A common goal to achieve is essential for obtaining both coordination and cooperation within the system. Such a common goal leads the different elements of the system towards coordinated actions required to fulfil needs emerging from an ever changing environment. The supplementary parameters involved are a) the feeling of belonging to a team and b) the perception of equifinality of the system. The principle of equifinality, according to von Bertalanffy (1950), can be defined as the multiple ways trough which an equilibrium can be approached, even taking the move from different starting points.

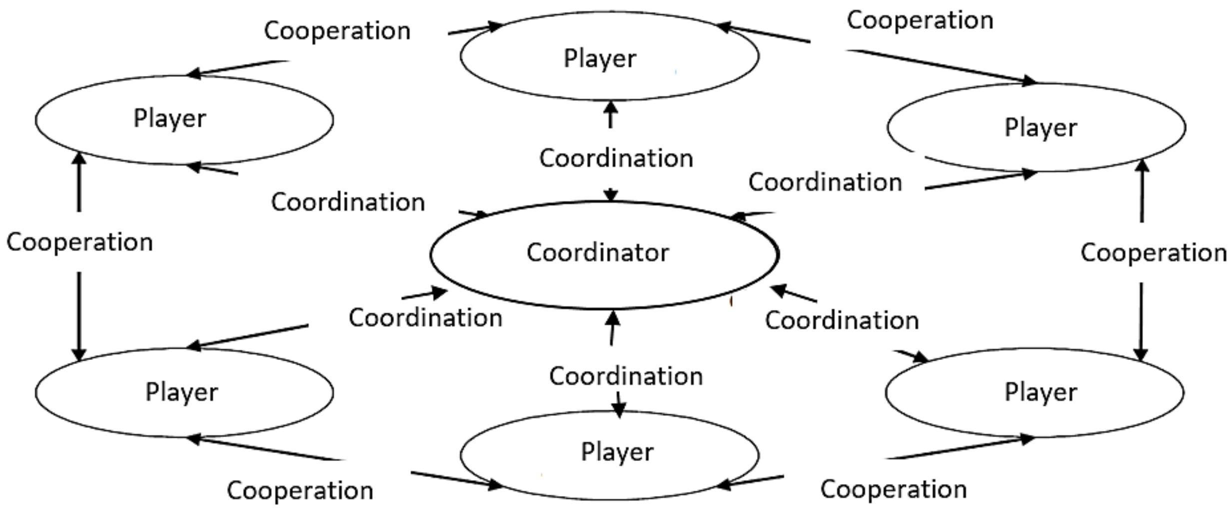

Figure 6. Architecture of a distributed autonomous system applied to a sport team (see text for details). (Modified from Dominici, 2008).

Such a scheme can be easily introduced to sport education, instilling in the pupils the concepts of "*equifinality*", "*common goal*" and the holonic structure of a sport team, leading to a coordinate action deriving from independent holons. The ultimate scope is, then, to integrate systemic creativity into tactical training, through the application of holonic thinking.

Modern team sports require great adaptability and tactical flexibility, characteristics that naturally emerge in self-organized and distributed systems (Cusano et al.,2019). Collective tactical intelligence manifests when players, while maintaining a degree of autonomous decision-making, dynamically cooperate to achieve a common goal. This type of organization is not purely hierarchical but holarchic, where information and tactical decisions emerge through distributed interactions among player-holons (McGarry et al., 2002). In this context:

- Teams with higher collective intelligence tend to dominate the game, as each player contributes to the team's dynamic organization.
- Tactical adaptability is essential to outmanoeuvre opponents, as it allows players to adjust strategies in response to in-game conditions without waiting for external instructions.

One of the most striking examples of emergent collective tactics is the "*tiki-taka*" model adopted by Barcelona and the Spanish national football team (Lago-Peñas et al., 2010). In this style of play, players do not follow rigid schemes but instead continuously adapt, constructing fluid actions through coordinated movements and a dense network of passes. Integrating systemic creativity into tactical training requires a different methodological approach, one that promotes situational learning and real-time decision-making. To this end, several innovative training models have proven effective:

- Tactical Games Approach (TGA) → A method that emphasizes decision-making and game understanding, reducing the emphasis on rigid schemes (Hastie et al., 2025).

- Small-Sided Games → Game simulations on reduced fields to increase player interactions and improve tactical perception (Travassos et al., 2013).
- Constraints-Led Approach → Introducing restrictions in play (e.g., a limited number of touches) to stimulate creativity and strategic adaptation (Renshaw et al., 2010).

All these approaches would greatly benefit from the integration with the holonic theory, which could result in enhancing team's adaptability and game fluidity, preventing the risk of tactical rigidity and distributing responsibilities, activities, and the overall understanding of the ever-changing scenario in which players are called to play. Another interesting issue is that the "*holonic players*," acting in the framework of a the holonic team, could move forward the ability of changing and controlling the playing scenario more rapidly than the opponent team can due.

CONCLUSIONS

The future of tactical training in team sports is moving toward an increasing integration of data analysis and artificial intelligence. Today, many professional clubs are adopting models based on pass network analysis to optimize ball circulation and improve tactical efficiency, such as expected goals statistics (Cusano et al.,2020).

With match analysis driven by AI algorithms, coaches can:

- Analyse recurring game patterns.
- Identify areas for improvement in player connectivity.
- Optimize tactical strategies based on real-time data collection.

These developments align perfectly with holonic theory, which views teams as adaptive complex systems, where learning and tactical evolution are not imposed rigidly from above but emerge through player interactions. The application of holonic thinking and systemic creativity in collective tactics opens new perspectives for sports training. The shift from hierarchical models to self-organized and interconnected structures enables teams to develop greater flexibility, creativity, and adaptability to the dynamic nature of the game. Integrating innovative methodologies such as the Tactical Games Approach, Small-Sided Games, and data analysis improves decision-making and game fluidity, making training more effective and aligned with the modern demands of professional sports. As Koestler (1970) suggested, the future of collective tactics does not rely solely on rigid, predefined schemes but on a dynamic and intelligent system, where each player is an autonomous unit capable of significantly contributing to the team's collective intelligence.

This article does not claim to build a holonic theory of the teaching of sport science through the complete definition of educational mechanisms, structures and processes. Our aim is to underline the undeniable potential of the holonic interpretation of sport teaching, through an examination of its theoretical assumptions and of the links that exist between this theory and other accredited educational paradigms in this field. A more complete operational definition, through the identification of specific educational strategies, which allows the complete implementation of the holonic theory applied to sport teaching is a fruitful field of research to be carried out.

AUTHOR CONTRIBUTIONS

Conceptualization: P.C. and S.D.; Methodology: P.C.; Formal Analysis: P.C. and M.A.J.; Resources: P.C. and M.A.J.; Data Curation: P.C. and S.D.; Writing–Original Draft Preparation: P.C.; Writing–Review & Editing:

P.C.; Visualization: P.C. and M.A.J.; Supervision: P.C. and S.D. All authors have read and agreed to the published version of the manuscript.

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