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Small-Sided Games as *Holons* in the Football: a hierarchical systems approach

Jogos Reduzidos como Hólons no Futebol: uma abordagem sistêmica hierárquica

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Abstract – Sports science has showed benefits in the use of small-sided games in the teaching-learning and training processes of football. We propose that such benefits occur because the small-sided games are *holons* of a hierarchically organized that maintain the same characteristics of game, regardless the reduced complexity. The hierarchical model of football considers the numerical relations of cooperation and opposition in specific spaces of play. It characterizes a nested hierarchy model because it deals with both the parts and the different processes of game. Such a hierarchical model contains five levels, in which the upper level is the football game and the elementary level a game situation, that is, a small-sided game. As any open system of hierarchical organization, the small-sided games present simultaneously invariant characteristics of whole and the specificities of the parts according the context and level of analysis. The adoption of such a hierarchical perspective allows setting goals as well as selecting the teaching-learning and training's contents at different analysis levels by considering the autonomy-dependency in each one.

Keywords: Physical Education and Training; Soccer; Systems analysis.

Resumo – *A ciência do esporte traz benefícios na utilização de jogos reduzidos nos processos de ensino-aprendizagem e treinamento do futebol. Nós propomos que tais benefícios ocorrem porque os jogos reduzidos são hólons de um sistema organizado hierarquicamente que mantém as características do jogo, apesar da complexidade reduzida. O modelo hierárquico do jogo de futebol considera as interações de cooperação e oposição entre os jogadores em um espaço específico de jogo. O modelo é caracterizado como uma hierarquia aninhada porque leva em consideração as diferentes partes e processos do jogo. O modelo possui cinco níveis hierárquicos, em que no nível superior se encontra o jogo de futebol como todo e no nível elementar se encontram situações de jogo, que caracterizam os jogos reduzidos enquanto intervenção. Como qualquer sistema aberto organizado hierarquicamente, os jogos reduzidos apresentam simultaneamente as características invariáveis do todo e as especificidades das partes de acordo com o contexto e nível de análise. A adoção dessa perspectiva hierárquica permite definir objetivos, bem como selecionar conteúdos no ensino-aprendizagem e treinamento do futebol em diferentes níveis de análise, mantendo a autonomia-dependência de cada um.*

Palavras-chave: *Educação Física e treinamento; Futebol; Análise de sistemas.*

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INTRODUCTION

Over the past few decades, studies about small-sided games have been increasingly developed in the sport pedagogy and physical education fields, including on the sport of football[1]. Overall, the literature seek to understanding the benefits of small-sided games on teaching-learning and training in football by considering they enable (i) proximity to real football actions and situations, (ii) player relate technical (how to do) and tactics (reason to do), (iii) learning rules, and (iv) learning transfer[2].

The small-sided games involves two important characteristics: complexity and difficulty. The latter refers to the level of proficiency demanded by players in the performance of the motor skills to solve the game problems[1], whereas complexity is related to the number of components and their mode of interaction[3].

In this paper, we propose that the foregoing benefits occur because the small-sided games are *holons* of a hierarchically organized open system. We explain this starting from its definition as a system: the small-sided, conditioned, or reduced games refer to a system of reduced complexity in relation to the formal game, but that maintains its nature[2]. This occurs by maintenance of cooperation and opposition interactions among players, which allow the emergence, persistence and change of team patterns[4].

THE SYSTEMIC NATURE OF FOOTBALL

In team sports, teams have been conceived as open complex systems[2,3]. This is because they are composed by several players who interact with each other in a cooperation way. The openness characteristic of the system is based on the fact the cooperation occurs in function to another type of interaction: opposition[5,6].

The fact the players cooperate to as a team oppose to another team in order to achieve the objective of the game also makes the football a dynamic system[4,5]. This is because teams exchange information with each other in order to increase certainty to teammates and uncertainties to opponents[2,3,5], similarly to systems functioning based on interplay of negative and positive feedback mechanisms[3].

Still, the functioning of a team in relation to other could be a process of increasing and decreasing of entropy. This is a measure of disorder and probability of distribution that, according to the second law of thermodynamics, tends to grow in closed systems until reaching a state of thermodynamic equilibrium[6,7]. Therefore, a football team would act to increase the entropy of the opposing team in order to bring it to a state of most likely distribution, maximum disorder, so as not to have free energy to functioning. On the other hand, the opposite team would act to diminish the entropy by using free energy to work[3].

Therefore, keep away from thermodynamic equilibrium appears to be an essential feature for the teams can reorganize (adapt) to achieve their goals. It has been proposed that to remain far from equilibrium, a system needs successive exchange between its components at an immediately lower level[7], which implies considering a hierarchical structure of open systems[8,9].

A MODEL OF HIERARCHICAL STRUCTURE OF FOOTBALL

A hierarchically organized system is composed of interrelated subsystems, with each subsystem having another hierarchical structure up to an elementary level. To modelling of a hierarchical system, Wu[9] suggests that seven main aspects need to be considered (Table 1). First is the definition of what are the hierarchical levels, layered structures that have one or more subsystems. The subsystems in any level of the hierarchy are named *holons* - open self-regulating systems that present both the autonomous properties of whole (system) and the dependent properties of its parts[10]. Therefore, there is a balance between autonomy and constraint at all levels of the hierarchy. The hierarchical levels are established in vertical (asymmetry between levels) and horizontal structures (symmetry between the subsystems characterizing the level variety), through a descending causation in which the whole restricts the parts, but does not control them[8,9].

The second aspect concerns the ordering of hierarchical levels. This is done based on the frequency and strength of the interactions between the elements of the system, in addition to the process rates on the space-time scale, are fundamental criteria. The ordering of hierarchical levels must consider that higher levels of the system operate more slowly, less frequently, restricting and generating contexts to the lowest levels.

Table 1. Seven main aspects to hierarchically model complex systems adapted from Wu[9].

1	Define hierarchical levels
2	Organize hierarchical levels
3	Establish vertical and horizontal structures
4	Apply near-decomposability
5	Structure the basic triad
6	Apply the hierarchy scale match
7	Understand the role of the phenomenon observer

The third aspect concerns the establishment of vertical and horizontal structures. Components with different process rates on the time scale must be grouped into different structures (vertical structure), while elements with similar contributions in the process are arranged at the same hierarchical level (horizontal structure). The vertical coupling of the levels establishes the separation between them, and from top to bottom there are constraining forces from one level to another, while from bottom to top the initiating forces of the system are established. The horizontal coupling determines the dynamic functioning of each *holon*.

After that, it is important to apply a quasi-decomposition process to attain the simplifying threshold necessary to understand and describe the complexity of the system. The term "quasi" is used in the sense of unpacking balance because the parts of the system cannot be completely decoupled from each other, but they cannot be tightly coupled either.

The fifth aspect is the structuring of the basic triad, in which at least three adjacent hierarchical levels need to be considered to describe the focal level. The upper level explains the operational dynamics of the focal level. The lower level explains the initial processes. This process is followed by applying the correspondence of the hierarchy scale (sixth), which is related to the discontinued changes in patterns and processes from one hierarchical level to the next, since systems are decomposed over space and time.

Finally, the seventh aspect is related to the understanding of the phenomenon observer's role in the hierarchical modeling of the system. A hierarchical system is the product of the interactions between reality and the perception of the phenomenon, but it depends on factors such as expertise, method and data used. Thus, the role of the observer is important, but it should not be emphasized due to subjectivity and arbitrariness.

Based on the above, we present a hierarchical model of football (Figure 1) considering the numerical relations of cooperation and opposition in specific spaces of play. It is a nested hierarchy model, because it deals with both the parts and the different processes of the football game[9], proposing small-sided games to the elementary level of the model.

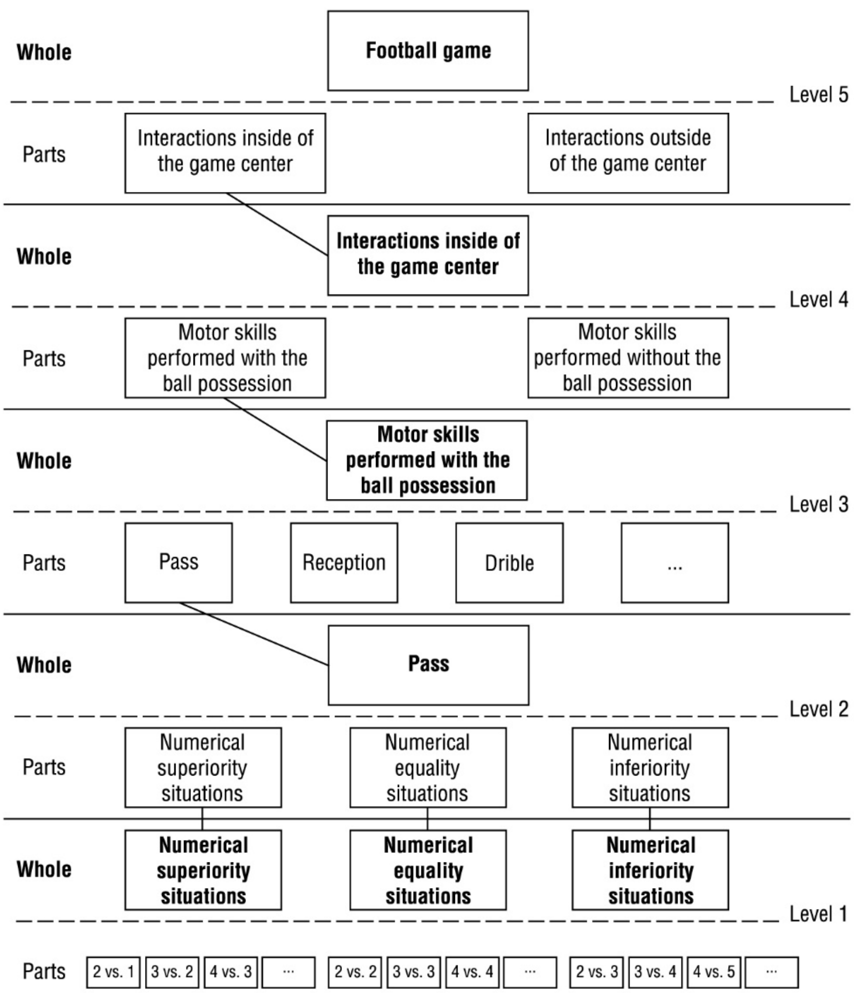

Figure 1. Hierarchical model of football game.

At level 5, football game is the whole and its parts are the interactions of cooperation and opposition inside and outside the "game center". This refers to a game space that has the ball as its epicenter[11], since it acts as an attractor in the football game by constraining the recovery and loss of the ball through phase transitions typical of dynamic systems[5,12]. Therefore, the game center is dynamic according ball localization. Costa et al.[11], proposed the game center refers to an imaginary circle with 9.15 meters in radius, but other positional measures can be used to identify the game center from the ball carrier[13].

At level 4, the inside of the game center becomes whole, while its parts are the motor skills performed with and without the ball possession. At level 3, motor skills with ball possession become whole and its parts are the specific motor skill (pass, reception, dribble, ball control, driving de ball and shot). At level 2, a motor skill becomes whole (e.g. pass), while situations of superiority, equality, and numerical inferiority in which the ball carrier is in the center of the game to perform the action become its parts.

Finally, at level 1, situations of superiority, equality and numerical inferiority become a whole formed by the different numerical interactions of cooperation and opposition as their parts. In situations of numerical superiority, passer would have the same number of passing lines in relation to the number of opponents within the game center (e.g. 2 vs. 1, 3 vs. 2 and 4 vs. 3); in the numerical equality situation passer would have one passing line less in relation to the number of opponents (e.g. 2 vs. 2, 3 vs. 3 and 4 vs. 4); and, in numerical inferiority situations passer would have at least two passing lines less than the number of opponents (e.g. 2 vs. 3, 3 vs. 4 and 4 vs. 5). Importantly, these situations have been extracted from the formal game and used in pedagogical contexts of teaching-learning and training of football, as well as in academic research[1,2].

In this way, the small-sided games may be considered as *holons* because they preserve the context of the football game (interactions of cooperation and opposition), that is, the invariant characteristics of the whole, however each small-sided game has its particularity, typical of the parts that compose the whole in a determined analysis level of system. For example, a small-sided game 2 vs. 1 request decision-making demand from attacking and defending players like those of the football game, but it is also a part with different characteristics regarding to the same level analysis[14].

RECOMMENDATIONS FOR FUTURE RESEARCH AND PRACTICE IMPLICATIONS

From this hierarchical model future research could be developed by considering the players' numerical relations. For example, level one involves three different configurations of numerical relations among players on the specific game space, superiority, equality and numerical inferiority near ball carrier, which could be considered as independent variables to investigate the effect of the different parts of each whole about a specific motor skill. In addition, understanding how discontinuous changes from one hierarchical level to another take place another possibility for scientific investigation is. For example, identifying how small-sided games in which players inside the game center need to pass the ball to teammate outside the game center affects the players' decision-making as well as tactical and technical behaviors.

Regarding the practical applications, an adoption of such a hierarchical model allows setting goals as well as selecting the teaching-learning and training's contents at different analysis levels by considering the autonomy-dependency in each one. Besides that, the football coaches/teaches may manipulate task complexity without to loss the coordination among parts of the system (football game). Obviously, as part of the scientific enterprise, our propositions need to be put to the test to guarantee the consistency necessary for generalization.

FINAL COMMENTS

Concluding remarks: the small-sided games as a holons

Open systems have long been considered based on a view of hierarchical organization[6]. However, it has only recently been considered in relation to sports phenomena[3,15]. Conceive football game as a system of hierarchical structure allows:

- understanding that, despite reduced complexity, small-sided games can maintain the same characteristics of the system (whole) because they are *holons*;
- identifying which are the small-sided games of football based on the identification of each *holon* in the hierarchical structure;
- knowing that, as *holons* the small-sided games present simultaneously the invariant characteristics of whole and the specificities of the parts according the context and level of analysis;
- maintaining the game's functionality at any hierarchical level due to the autonomy-dependency in each one.

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Ethical approval

This article did not use data collected from humans and represents a scientific opinion of literature. This study was written in accordance with the standards set by the Declaration of Helsinki.

Conflict of interest statement

The authors declare that they have no competing interests.

Author Contributions

Conception and design of the article: MAMR. Article Writing: MAMR and UCC. All authors read and approved the final version of the manuscript.

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