COMPLEX AND SYSTEM THINKING IN PHYSICAL EDUCATION AND PHYSICAL ACTIVITY PROMOTION

PENSAMIENTO COMPLEJO Y SISTÉMICO EN EDUCACIÓN FÍSICA Y PROMOCIÓN DE ACTIVIDAD FÍSICA

PENSAMENTO COMPLEXO E SISTÊMICO NA EDUCAÇÃO FÍSICA E NA PROMOÇÃO DA ATIVIDADE FÍSICA

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How to reference

ABSTRACT

Here we explore the advantages and limitations of adopting and implementing complex and system thinking in physical education and physical activity promotion. To this end, we have revisited contributions from the critical theory and complex and system thinking. From the intersection of these fields of knowledge, and understanding physical education and the promotion of physical activity as complex systems, we seek to adopt an integrative and relational stance to advance the disciplines of human body movement. We have also discussed the advantages and challenges of applying approach and suggest examples of systemic intervention. Finally, we analyze and describe the limitations and real-world barriers to its application.

KEYWORDS: Systems science; social ecology; human body movement.

RESUMEN

En este texto exploramos las ventajas y limitaciones de adoptar e implementar el pensamiento complejo y el pensamiento sistémico en educación física y promoción de actividad física. Para ello, revisamos contribuciones desde la teoría crítica y el pensamiento complejo y sistémico. A partir de la convergencia de estos campos de conocimiento, y entendiendo la educación física y la promoción de actividad física como sistemas complejos, buscamos que se adopte una postura integradora y relacional para avanzar en las disciplinas del movimiento corporal humano. Analizamos también las ventajas y desafíos de implementar este abordaje y sugerimos ejemplos de intervención sistémica. Finalmente, planteamos y describimos las limitaciones y barreras del mundo real para su implementación.

PALABRAS CLAVE: ciencias de sistemas; ecología social; movimiento corporal humano.

RESUMO

Neste estudo exploramos as vantagens e limitações de adotar e implementar pensamento complexo e pensamento sistêmico na educação física e na promoção da atividade física. Para isso, revisamos as contribuições da teoria crítica e do pensamento complexo e sistêmico. Da convergência dessas áreas do conhecimento, e entendendo a educação física e a promoção da atividade física como sistemas complexos, procuramos adotar uma postura integradora e relacional para fazer avançar as disciplinas do movimento

do corpo humano. Também discutimos as vantagens e os desafios da aplicação desta abordagem e sugerimos exemplos de intervenção sistêmica. Por fim, analisamos e descrevemos as limitações e barreiras do mundo real para sua aplicação.

PALAVRAS-CHAVE: ciência de sistemas; ecologia social; movimento do corpo humano.

INTRODUCTION

The challenges faced by physical education and physical activity, as areas of professional practice, are cutting-edge issues emerging from the current sociohistorical context. From a broad perspective, these challenges can be framed as issues originating either exogenously or from endogenous dynamics of physical education and physical activity. Exogenous challenges could be grouped into problems of inequities by gender, inclusion, diversity, health, and body culture, which in Kirk's words (2019), represent the range of precariousness of current physical education. This precariousness exacerbates the risks of physical activity promotion losing relevance in general health promotion efforts (Abu-Omar et al., 2019). On the other hand, endogenous challenges revolve around temporality and time allocation, curricular elements such as forms of teaching and learning objectives (life skills and social and personal values), status of the profession, availability of resources, and connections among physical educators (teacher networks) and between physical educators and the community (Hardman, 2011).

These challenges demand to empower people to participate in the physical culture of societies, since these environments can be framed by oppressive tendencies, social problems, and injustices produced by dynamics exogenous to physical education. Likewise, these challenges demand counteracting the predominant reductionist worldview and the adoption of a broader, holistic and ecological perspective, a new vision of real-world leverage points, and a transformation of the way of thinking, perceiving and valuing (Martínez Miguélez, 2014).

Therefore, since it is relevant to the current social role and future projection of physical education and physical activity how these challenges are addressed, we will examine the advantages and limitations of system and complex thinking in dealing with them. For Peters (2014), system thinking is used to understand

"how things are connected to each other within some notion of a whole entity" (p. 1). Furthermore, as an extension of the system approach, complex and system thinking are useful for analyzing system behavior, which emerges from the complex interconnectedness between agents or components of the system (Hopper, 2013).

Historically, various epistemological currents have influenced the study of human body movement (Fernández-Balboa, 1997b) with their respective ontological, axiological and methodological postulates. In some moments and geographic regions, some currents have been more influential than others, and these influences have been analyzed from different academic perspectives. The analysis of its repercussions has had a marked interest in the field of the critical theory of human movement (Fernández-Balboa, 1997a), as well as in the currents of system and complex thinking (Ovens et al., 2013), becoming a great challenge for physical education and physical activity in the 21ST century.

Critical theory and complex and system thinking are relevant to this discussion. Critical theory is a benchmark for questioning and deconstructing what is taken for granted (Fernández-Balboa & Muros, 2006). Complex and system thinking allow us to better understand how physical education and physical activity phenomena develop and operate from a systemic perspective (Ovens et al., 2013).

Critical theory has proposed the perspective of socio-critical physical education, characterizing it as an element of social transformation, which invites action and empowerment, to guide thinking and teaching practice from an emancipatory interest, and overcome the injustice and inequality of the environment (Devís-Devís, 2012; Fernández-Balboa, 1997c, 2000; Fraile, 2004). To do this, it is necessary to reconcile the hegemony of technological rationality and the emancipatory reason (Fahlberg & Fahlberg, 1997).

Technological rationality is the rational disposition adopted to identify the most effective way to achieve a particular purpose with a technological interest. For instance, when evaluating the effectiveness of physical educators based on restricted criteria imposed by the technical requirements of the instrument used to measure such effectiveness. On the contrary, *emancipatory reason* is the rational disposition to achieve emancipation by critically questioning unrevised and restrictive assumptions, and to provokie self-reflection to influence unconscious positions and processes. For instance, exploring with the community the meaning of health and physical activity prior to a community intervention (Fahlberg & Fahlberg, 1997).

The hegemony of technological rationality in Western culture has caused human-body movement to be analyzed predominantly for hygienic-preventive and sports performance reasons (Brustad, 1997). As a result of this emphasis, today there is a restricted view of human-body movement. For example, some educational systems structure their plans based on foreign theories and decontextualized orientations. Similarly, in some public health systems, physical activity is promoted as a healthy behavior through strategies generally prescribed by academic communities outside the context in which they are applied.

Here, the implicit concepts of *health*, *education* or *physical activity* are rarely questioned. Under the scrutiny of emancipatory reason, these concepts are assumed to be immaterial entities and, therefore, any conception must be mediated by context. The absence of this scrutiny leads to questioning the applicability of these strategies and may in fact explain the limited results of their effectiveness in different contexts.

In turn, complex thinking posits that physical education phenomena are inherently complex (Ovens et al., 2013). Hence its close relationship with the perspective of the systemic approach, in which it is assumed that reality is complex, constructed in a particular context, and, therefore, derived from the dynamics of

complex systems. Advances from this perspective have suggested the need to formulate an integrative frame of reference that fosters knowledge for action (Best et al., 2009). Reflections in this sense point to the need to target research towards problem solving, without abandoning the interest in generating knowledge. This need is based on the excessive proportion of Mode I research over Mode II research (Denis et al., 2004).

Mode I research is characterized by being researcher-driven to "fill gaps" in knowledge, thus motivated by discovery and designed to contribute to a generalizable body of knowledge (Best et al., 2009). In Mode I research, it is assumed that researchers produce knowledge that is transmitted to users to be introduced into professional practices or exercises.

On the other hand, *Mode II* research is problem-based, thus solution-oriented and intended for the dissemination and implementation of knowledge (Best et al., 2009). The findings of Mode II research are mediated by contextual factors and a marked interest in external validity, without sacrificing internal validity (Best et al., 2009), given that external validity is especially important for the transfer of knowledge from research to practice (Green & Glasgow, 2006).

Both modes of research are complementary, although they may seem opposed, and both produce necessary knowledge. In the search for a complement, De Sousa (2009) argues that "for that, another form of knowledge is necessary, a comprehensive and intimate knowledge that does not separate us and rather unites us personally to what we study" (p. 53).

Currently, however, in physical education and physical activity, there are not enough scientific findings from Mode II research to complement the efforts and knowledge of Mode I research. For example, several systematic reviews in the field of physical activity have found that studies frequently fail to report the elements of external validity or legitimacy, which compromises and limits generalizability and dissemination of the findings

of each study (Klesges et al., 2008; McMahon & Fleury, 2012), and the translation and implementation of science (Brownson et al., 2012).

Now, from the perspective of complex thinking, Morín (2015) notes that "it is what wants to overcome confusion, annoyance and difficulty in thinking with the help of an organizing thought: that separates and that unites" (p. 87). Precisely, it is indicated that the confusion lies in the fact that it has not yet been possible to efficiently integrate the aforementioned divergences of rationality and modes of investigation.

For this reason, complex thinking (from its dialogic, recursive, hologrammatic and systemic principles) makes researchers and the community aware of the need to work collectively using research as a tool for the effective detection of problems, interventions and knowledge production. It is worth noting that complex thinking does not seek to prescribe a final solution, but to facilitate the emergence of new possibilities (Ovens et al., 2013).

Convergence between critical theory and complex and system thinking

Considerations coming from these fields of knowledge converge at a certain point. While critical theory highlights the importance of the context, of *where* the study takes place (Brustad, 1997) and emphasizes the need to reconcile technological rationality and emancipatory reason, the currents of complex thinking and system thinking highlight the importance of the external validity of the investigations and suggest the need to integrate Mode I and Mode II research, promoting problem-based research and the translation and implementation of research.

In this sense, it is necessary to resort to the systemic paradigm to address the complexity of realities to promote dialogue between methods, sciences and disciplines (Martínez Migúelez,

2014). It is precisely here where the relevance of complexity theory is manifested, given that, according to its principles, reality is an open system that is related to everything, its application causes changes, sometimes autonomous, sometimes dependent, and admits the uncertainty of the world and of life.

## Physical education and physical activity as complex systems

By its nature, the understanding of complex systems is based on the use of complex thinking and system thinking, closely related to theories of system dynamics and other theories of ecological systems, and, likewise, its intention is to achieve knowledge relevant to the context: the global, the multidimensional and the complex (Morín, 1999). Complex systems are made up of a diversity of heterogeneous components that interact with each other, unleashing different collective effects different from those generated individually by each component, resisting the passage of time and adapting to changes in the environment (Mitchell, 2009).

From an ecological and complexity thinking perspective, physical education is characterized by a set of relational dynamics between individuals, the environment, and key tasks (Jess et al., 2016a). In this sense, different scholarly reflections have suggested complex thinking frameworks for physical education. For instance, current practical problems in physical education can be understood as the complex nature of interactions between three broad topics: pedagogy, teacher learning, and educational environment (Jess et al., 2016b). Also, according to the ecological paradigm of physical education, the classroom environment is shaped by the interaction of components of three broad systems: The classroom organizational system, the teaching system, and the social system of the students (Hastie & Siedentop, 1999).

As shown in Figure 1, each system affects and is affected by the other two. For instance, any decision made by the teacher

to indicate the motor task affects the student's behavior and, at the same time, the student's response (positive or negative) stimulates further actions by the teacher to correct or reinforce the response. Similarly, socialization among students during class depends on the teaching style, i.e., some teaching styles stimulate socialization, while others restrict it. Any change in one of these systems affects the other two individually and the class as a whole. These changes may express some predictable patterns and, simultaneously, display unpredictable and irregular effects, characteristic of complex systems (Morrison, 2008).

Figure 1. The ecological paradigm of physical education
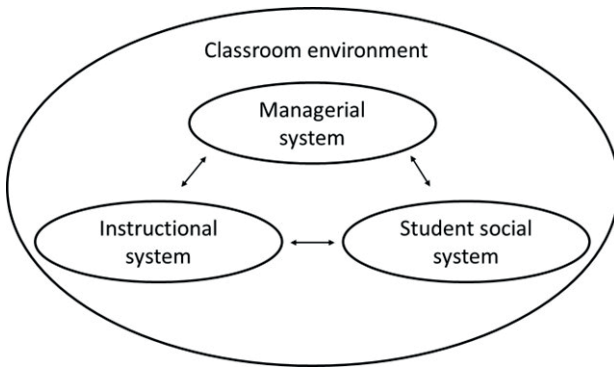
Source: own elaboration.

Similarly, the ecological model of behavior is the tool for understanding in physical activity as human behavior (Sallis et al., 2006). This model indicates that individual behavior suffers from the dynamic interactions of four major levels of influence: personal, social environment, physical environment, and politics. For this reason, it is suggested that interventions aimed at physical activity should take into account multilevel relationships and be approached from multiple disciplines (Sallis et al., 2006).

Both physical education and physical activity can be understood as complex systemic phenomena composed of biological, individual, environmental, social, community and political elements. Hence the relevance of relying on complex thinking and system thinking, since both approaches understand reality by recognizing the interconnectivity and interactions of the components of a system as a whole. Here the whole is much more than the sum of its parts, that is, its understanding goes beyond the analysis of the individual behavior of its components.

The behavior of complex systems is emergent and reflects the dynamics of interactions between its components and, consequently, its study requires that the system be analyzed as a whole and discourages decomposing it and analyzing to avoid reductionism (Luke & Stamatakis, 2012) and discard a predictable linear progression (Biesta, 2010). Thus, through the exclusive use of reductionist approaches, contextual factors and the historical perspective of a phenomenon are lost sight of (Verschuren, 2001); also, linear analyzes do not allow for an adequate understanding of the behavior of a system, due to the non-linear nature of the interconnections between the system's components (Atencio et al., 2014). Consequently, traditional research methods based exclusively on reductionism and statistical techniques of linear models are not suitable for the analysis of complex systems.

In recent decades, research on complex systems in the field of physical education and physical activity has attracted a great deal of interest. In physical education, for example, complex systems have been applied for a diversity of purposes, including the implementation of school curricula based on the complexity of the interactions between school, teacher and students (Ennis, 2013), teacher training (Hopper, 2013), and motor skills teaching (Corrêa et al., 2016), among others.

In the broader field of public health, initiatives have been implemented to model and simulate the behavior of complex systems in which physical activity is taken as an outcome varia-

ble or as an antecedent variable for other outcomes of public health interest (Macmillan & Woodcock, 2017; Meisel et al., 2018; Morshed et al., 2019). Importantly, these simulations and modeling are an approach to understanding complex systems. Although these models are significant research efforts, they reflect a temporary and provisional understanding and, consequently, should not be taken as pure and perfect representations of reality (Osberg et al., 2008). That is, modeled complex systems are description of our understanding of that model, a rough description of reality.

Advantages and challenges of implementing complex and system thinking

As has been said, the problems of physical education and physical activity are complex. Hence, the appropriate response to face them is to design and study complex solutions. In the field of body movement, the advantages of the complex system are manifested both in the actors and in the field of knowledge itself. Complex and system thinking allows the development of meaning, knowledge and understanding (Biesta & Osberg, 2010) of body movement that transcends the physical and biological aspects, and integrates social, environmental and political components. That is, it fuels the impulse to establish interdisciplinary dialogues for a more appropriate understanding of the phenomenon, without losing sight of the incompleteness and uncertainty of our understanding (Morín, 2011).

In school settings, the complex perspective assumes a logic in which students, teachers, school managers and non-teaching staff are linked to classes and schools in the context of a dynamic and multifaceted complex system, which invites to characterize educational institutions as collective subjects (Jess et al., 2017). In the field of public health, complex and system thinking descri-

bes the relevance and need to integrate scientific, social, cultural, economic, and political domains in collective actions aimed at promoting physical activity (Rutter et al., 2019).

These conceptual descriptions are useful for identifying "leverage points", i.e., those places within the system that, once intervened, can produce meaningful changes in the entire system (Meadows, 1999). Table 1 shows some examples of how to intervene the system, from different levels, in physical education and physical activity promotion. These levels are based on the intervention-level framework proposed by Finegood (cited in Johnston et al., 2014; Malhi et al., 2009), in which the content of the system intervention is described in five levels: 1) paradigm (system core beliefs), 2) goals (targets embedded in the system paradigm), 3) system structure (connection between system components), 4) feedback and delays (flow of information about the effects of actions), 5) structural elements (subsystems, components, system actors).

Table 1. System intervention level for physical education and physical activity promotion

Level	Physical education	Physical activity promotion
Paradigm	Physical education should be recognized as an essential area for cognitive and social development, in addition to its primary educational function for motor development.	Physical activity promotion should be understood, from an ecological perspective, as a complex behavior.
Goals	Educational policies that foster the development of physically educated individuals.	Public health policies that promote physical activity from a political, environmental, social, and personal point of view.
System structure	Curricular discussion integrating all educational actors (principals, teachers, students, parents).	Culturally adapted and socially inclusive physical activity promotion practices.

Level	Physical education	Physical activity promotion
Feedback and delays	Evaluation of physical education to inform educational decision-making.	Investigate the connections between physical activity promotion and physical activity at community level.
Structural elements	Stimulate students' critical thinking and reflection on human-body movement to foster autonomy and the value of body movement.	Improve facilities and social support for physical activity.

Source: own elaboration adapted from Meadows (1999).

Implementing this approach in educational contexts could stimulate an organizational structure conductive to physical-education practices, framed in a complex curriculum, characterized by emergent responses, uncertain outcomes, self-organized, process-driven, non-linear, diverse, adaptive, creative, and flexible (Jess et al., 2017). It would be an open pedagogical exercise contextualized to the realities of educational communities.

This could trigger a diversity of teaching methods, creating new learning possibilities (Light, 2008), and would contribute to overcoming the marginalization of physical education caused by the discourses of power (Corson, 1996) and the hierarchy of knowledge (Goodson, 1993) that have been hegemonically implanted in schools, where knowledge is fragmented and cognitive learning is prioritized over practical learning.

Thinking physical education and physical activity from the perspective of complexity is to conceive education for life, which should stimulate autonomy and freedom, and also teach to face uncertainties and risks (Morín, 2011). In terms of student learning, complex and system thinking relates to cognitive structures that stimulate the development of higher-order thinking skills, such as critical thinking (Lodewyk, 2009; Pill & SueSee, 2017). This approach provokes the student to engage in conversations

with teachers, peers and parents to reflect on the execution and understanding of their movements and the orientation that can be given to their learning (Jess et al., 2017). As a result, the physically educated person will have skills to realize their autonomy in ways of being, doing and valuing human-body movement.

Implementing theoretical formulations and scientific knowledge is in itself a challenging task. And in this case, their implementation in the field of physical education and physical activity faces many challenges. We must turn to the knowledge to action movement, which puts forward different theoretical models framed in system thinking and is useful for the translation of scientific knowledge into practical actions (Holmes et al., 2017).

According to Best and Holmes (2010), the intervention of complex systems involves three major challenges. First, actors must carefully examine the meaning and type of evidence for the context in which it is intended to be introduced. This implies questioning the convenience of using standardized curricula in physical education or physical activity promotion strategies that have not been contextualized in the community in which implementation is planned. Next, leadership demands must be identified to guide the change in the system. In the face of this challenge, Kirk (2019) exposes the lack of preparation of physical educators to provide inclusive, fair and equitable forms of physical education that help empower young people to overcome the negative effects of precariousness. He argues that now more than ever physical educators must be aware of the serious social and economic challenges that shape young people's health, happiness and life. Finally, it is necessary to trace the multiple connections between the actors of the system, with need to assume an ecological and systemic perspective that allows us to identify the level of influence and the dense network of interactions that manifest themselves between the actors in the system, whether in school settings for the physical educator or in community settings for the physical activity promoter.

Limitations and real-world barriers

Now, although we have said that complex thinking and system thinking offer attractive principles to understand reality, overcoming the imposed and implicit limitations of other perspectives, it is worth mentioning some limitations to their application.

The complex and system thinking approach demands creativity and innovation. This represents a serious challenge for school settings characterized by the rigidity of traditional educational models, high staff turnover, and unfavorable organizational environment and culture. Relevant here is the collective engagement of key stakeholders in physical education to provoke a shifting agenda that embraces the complex thinking perspective (Jess et al., 2016b).

It is also important to recognize that the application of complex and system thinking makes great cognitive demands (Dorner, 1980). In fact, it has been suggested that complex systems are by their nature incomprehensible (Cilliers, 1998). This assertion is based on the premise of complex systems understanding that everything is connected to everything and that, to understand the system, one must take into account the dense network of interactions between the components of the system. That is, any analytical strategy for understanding a complex system must establish the limits of the system, clearly identify its components, and make possible a full tracking of the interactions among them. But in establishing the system's boundaries, inevitably components or actors will always be excluded and some of its elements will be lost (Richardson et al., 2001). This creates a paradox, since the interpretation of the system must faithfully project the system of interest and, by leaving out elements of the whole, one has a partial interpretation of the system. Hence, some authors suggest that the appropriate term for this type of analysis is "partial complex-systems science" (Richardson et al., 2001).

CONCLUSIONS

We have discussed the relevance of adopting a transformative vision of thinking, capable of relating knowledge to each other, the parts to the whole and the whole to the parts, a thinking that can materialize the will to think globally, but acting locally. Understanding complexity as a key backdrop for improving physical education and the promotion of physical activity means understanding these fields of action as complex systems.

The approach of the complex paradigm in aspects such as emergence, uncertainty and science as a whole, leads to different views, showing that the way of thinking and acting in the pedagogical, didactic and investigative endeavors in physical education and physical activity must be changed, that behavior and linear behaviorist practices must be changed by flexible aspects, in which the contextual reality is understood as something complex and full of uncertainties, in absence of certainties and unique paths, a reality in which problems should not be approached and understood under a single vision. On the contrary, they must be seen in all their complexity due to the multiplicity of the factors involved.

Socio-cultural changes, inequalities, different ways of conceiving body movement and health have been changing with time and contextual realities. For these reasons, the construction of knowledge in this field of study also has to rethink training strategies for life and problem solving.

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