


Ecological dynamics approach in physical education to promote cognitive skills development: A review

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ABSTRACT

The aim of this paper is to carry out a theoretical transposition of the principles of the ecological dynamic approach in the field of physical and sports education, aimed at defining educational approaches capable of promoting an effective acquisition of cognitive skills, through the practice of physical activity and sport. Physical education, according to an ecological dynamics perspective, considers the performer a complex adaptive system, which interacts with the environments in a functionally integrated way, underlining the interrelationship between motor processes, cognitive and perceptive functions. The cognitive area of Life Skills (Cognitive Life Skills, CLS), divided by the WHO, into decision making, problem solving, creative thinking and critical thinking processes, can be framed as an intrinsic part of goal-directed behaviour influenced by functional constraints determined by individual-environment interaction. Therefore, physical and sport activity practiced according to the principles of the ecological dynamic approach can be configured as an elective tool to promote the development of cognitive skills. In this article, the relevant theories of ecological dynamics are discussed and recent empirical data on the perceptual-cognitive processes which are activated through the practice of physical education and sport are described to underline the potential of such practices for the development of cognitive skills. The development of this specific theoretical transposition represents a starting point for the definition and experimentation of ecological dynamic interventions designed with the aim of investigating the effects of physical and sporting activity on the development of cognitive skills for life.

Keywords: Physical education, Non-linear pedagogy, Cognitive skills, Ecological approach, Inclusion.

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INTRODUCTION

The World Health Organization (WHO) to contrast health risk behaviours and to promote a life-style wellbeing oriented also within the educational field, has developed different documents, starting from the first “*Life Skills Education for Children and Adolescents in Schools*” (1993), up to the last “*Life skills education school handbook*” of 2020. In these documents, life skills, which transversally involve all domains of a person’s life, from the cognitive to the personal to the interpersonal/social domains, are described as indispensable tools for the promotion of well-being, personality development and social inclusion, for the younger generation (WHO, 1993). In particular, the cognitive dimension refers to problem solving, decision making, critical thinking and creative thinking skills. The scientific literature has long described cognitive functions as rooted in the sensorimotor system and, therefore, strongly linked to the processes of perception/action that the subject experiences in interaction with others and the environment (Wilson, 2002; Barsalou, 2008; Glenberg et al., 2013; Caruana & Borghi, 2016). Thus, motor/sports activities, i.e. activities that quintessentially involve the individual in all dimensions of being, represent an elective learning context able to promote the personal, emotional, and cognitive development of the individual (Minghelli et al., 2023).

In the scientific literature there are several studies that have investigated the effectiveness of educational interventions in the motor and sports fields for the development of Life Skills (WHO, 1993); the results show that physical and sport activity are configured as elements capable of promoting the development of these skills (Coppola et al., 2014; Bean et al., 2018; Coppola & Vastola, 2019; Kendellen & Camire, 2019; Matsankos et al., 2020; Holt et al., 2020), due to some specific characteristics and consonant elements between motor skills and life skills, including which the essential presence of the experiential activity for the development of both and the peculiarity related to the transferability of the skills acquired through physical activity in other domains of life (Goudas et al., 2006; Goudas, 2010; Ballester et al., 2019). In continuity with the principles of non-linear pedagogy (Chow, 2013) and in continuing reflections on the concept of the transfer of learning, from the motor domain to life contexts, it is essential to emphasize the importance of the choice of the level of representativeness of the teaching or training proposal. In both the educational and sporting domains, this principle refers to the concept of the transfer of skills learned in terms of performance (problem solving, decision making, initiative, communicating, collaborating, etc.) and in everyday life contexts (life skills) (Minghelli et al., 2023). Thus, interaction with an effectively representative environment would seem to expand the possibilities for interaction and meaningful experiences, offering the subject the opportunity to directly experience problem solving, decision making, creative and critical thinking skills. Physical education in the ecological dynamics perspective, considers the performer as a complex adaptive system (Kugler et al., 1982; Newel, 1986; Thelen & Smith, 1994), interacting with environments in a functionally integrated way, emphasizing the inter-relation between motor processes, cognitive and perceptual functions (Davids et al., 2012; Rudd et al., 2020; Romano et al., 2022; 2023; Renshaw et al., 2022).

According to these considerations, the dynamic ecological approach is configured as a potential educational model to favour the development of transversal skills, in particular skills of a cognitive nature (Araújo et al., 2020).

In the context of the ecological dynamics approach, the activity is not made explicit through the repetition of a solution to a given task, but through the processing of stimuli and affordances present in the environment which guide self-regulated motor investment and performance (Chow et al., 2020), activating the cognitive and perceptive functions in order to experiment, through the principle of variability, the different motor solutions (Davids et al., 2003; Silva et al., 2013; Pesce et al., 2019; Chow et al., 2019; Coppola et al., 2021).

In the ecological perspective, a crucial role is played by affordances, which are essential tools of individualization and personalization that, unlike a traditional approach, are effective in order to favour all subjects a flexible active participation consistent with the prerequisites of each one and consequently in promoting the development of new competences, transferable to life contexts. In this perspective, didactic action implies the mobilization of resources and cognitive functions aimed at the emergence of spontaneous (heuristic) solutions to contingent motor problems (Hepler et al., 2012; Furley et al., 2013), stimulating and enhancing executive variability, through a complex and non-linear processes of searching for motor solutions which is expressed through the constant presence of variability (Preatoni et al., 2010; 2013; Seifert & Davids, 2012; Silva et al., 2016). *“This type of planning can include the prediction of which affordances learners may select and their potential movement solutions and elaborating on how these may be developed to potentiate further performance behaviours”* (Correia et al, 2019, p. 119).

There are several studies in the scientific literature that have investigated the potential in the use of the ecological dynamic approach in sports for the development of different cognitive abilities; most have focused attention on aspects related to the development of decision-making skills (Araújo et al., 2019; Renshaw et al., 2019).

The Ecological Dynamic Approach, in line with the theories of enactivism (Varela et al., 1991) contributes to the thesis that the cognitive structures of the mind emerge from the recurrent sensory-motor dynamics between the incarnate agent (embodied) and inserted in a natural environment (embedded), which allow the action to be guided perceptively (Adolph & Hock, 2019). According to the theses of enactivism, conscious experiences are constitutively connected to sensory-motor interactions between subject and external environment (Shapiro, 2010; Mahon, 2015; Varela et al., 2017; Shapiro & Stolz 2019; Meloni & Reynolds, 2021). In the field of motor and sports activities, in the constant interaction with the environment (physical and social) and in function of the morpho-functional characteristics of the body, motor behaviour assumes characteristics of adaptability and flexibility in the choice and execution of functional movements in significant environments. Behavioural flexibility will consist of *“the ability to select and modify actions to meet changes in body, environment and task”* (Bernstein, 1996, in Adolph & Hock, 2019, p. 143).

Consistent with what has been described so far, Physical Education in the school environment allows for immersive teaching that engages students in realistic or authentic tasks, motivating them to use their acquired knowledge and skills in an organized manner in problem-solving, decision-making, constructing and creating of ideas.

In this theoretical framework, sport, and more generally physical activities, offer the possibility of stimulating and promoting in an extremely effective manner the acquisition of personal, cognitive, and social skills, which can be generalized and transferred to other social and life contexts, favouring the pursuit of bio-psycho-social well-being. The ecological dynamics approach can fully fit into the educational model of Life Skills (WHO, 2020) as a potential approach to build, through the experience of physical activity, transversal cognitive skills for life.

The aim of this contribution is to carry out an overview of the scientific literature, in order to frame the topic of physical and sport activities within the perspective promoted by the ecological dynamics approach, to better understand what has been argued and experimented on this specific topic, both in sporting contexts and in the educational/scholastic field, in order to be able to orient future research perspectives and plan possible implementations of practices.

METHODS AND MATERIALS

To achieve this aim, relevant theoretical principles from ecological psychology are discussed, focusing on ecological dynamics, as a potential elective area for the development of Cognitive Life Skills. To support the argumentation, recent empirical data on perceptual-cognitive process training inherent in the practice of physical education and sport are described. These studies delineate and emphasize the potential of this educational paradigm to build, through the experience of physical activity, transversal cognitive skills.

Selection of the literature

During January 2024, a comprehensive search of databases of literature (PubMed, EBSCO, Web of Science, Scopus and SpringerLink) from 2013 through February 2024 was undertaken.

The principal terms were as follows: (1) “*Ecological Dynamics Approach*”; (2) “*Physical activities*” (3) “*Sport*” (4) “*Cognitive skills*”.

Inclusion criteria

A predetermined set of inclusion criteria was used to select papers. Each study had to meet the following criteria: (1) been published between 2013 and February 2024; (2) the focus had to be the Ecological Dynamics Approach, Physical Activities, Sport, and Cognitive Skills.

Data extraction and reliability

A standard data extraction template was developed to extract the main details for every eligible study in terms of author, title, year of publication, objective, methodology and skills investigated.

RESULTS

Research findings in the scientific literature have led to several studies that have investigated the potential in the use of the dynamic ecological approach in the motor and sports fields for the cognitive skills. Most of the studies conducted have focused attention on aspects related to the development of cognitive skills of decision-making, attention, memory, thinking, brain plasticity, spatial ability, through the dynamic ecological approach in sports.

Table 1. Part of the literature review within Sport, Physical Education and Ecological Dynamics approach to promote cognitive skills development.

Year	Title	Authors	Objective	Study design	Skills investigated
2023	Team decision-making behaviour: An ecological dynamics approach.	Araújo, D., Brito, H., & Carrilho, D. (2023).	Summarizing the key principles of ecological dynamics, the contribution describes decision-making and, more generally, behaviour as arising from processes of self-organization from which functional synergies develop. The article suggests that the dynamic ecological approach represents a theoretical framework that is particularly well adapted to explore the topic of individual and group cognition, with possible important applications to practice.	Argumentative paper	Cognitive skill (Decision-making)

2023	An applied model for using variability in practice.	Czyż, S. H., & Coker, C. A. (2023).	The contribution frames the problem of the variability of practice within the processes of motor learning from an applied perspective. In particular, within the implications of the application of variability in practice, are described the positive effects on decision making processes, within a dynamic ecological perspective.	Argumentative paper	Cognitive skill (Decision-making)
2020	Cognition, emotion and action in sport: an ecological dynamics perspective	Araújo, D., Davids, K., & Renshaw, I. (2020).	This study summarizes advances in ecological dynamics and discusses their implications for cognition, perception, and action in sport performance.	Argumentative paper	Cognitive and emotional skills
2019	Evaluating weaknesses of “perceptual-cognitive training” and “brain training” methods in sport: An ecological dynamics critique.	Renshaw, I., Davids, K., Araújo, D., Lucas, A., Roberts, W. M., Newcombe, D. J., & Franks, B. (2019).	This study proposes how an ecological dynamics approach, aligned with an embodied framework of cognition, can be considered together as part of a process training approach proposing enhanced cognitive and perceptual skills and brain capacity to support performance in everyday life activities.	Argumentative paper	Cognitive processes (attention, memory, thinking)
2017	Ecological cognition: expert decision-making behaviour in sport.	Araújo, D., Hristovski, R., Seifert, L., Carvalho, J., & Davids, K. (2017).	Through a critical review of the literature, this study supported the thesis according to which expert decision-making can be directly assessed, if sport action is understood as an expression of embedded and embodied cognition.	Argumentative paper	Cognitive skill (decision-making)
2016	Variability of practice as an interface between motor and cognitive development	Pesce, C., Croce, R., Ben-Soussan, T. D., Vazou, S., McCullick, B., Tomporowski, P. D., & Horvat, M. (2016).	This study adopts a joint sport science and neuroscience approach to identify the characteristics of the construct of variability, as it is conceived in the ecological approaches to motor skill learning, that can impact brain plasticity and cognitive development.	Argumentative paper	Cognitive development (Brain plasticity)
2013	An Ecological Dynamics Approach to Skill Acquisition: Implications for Development of Talent in Sport	Davids, K., Araújo, D., Vilar, L., Renshaw, I., & Pinder, R. (2013).	This paper proposes how ecological dynamics provides a basis for understanding skill acquisition in sport. Learners are conceptualized as complex, neurobiological systems in which inherent self-organization tendencies support the emergence of adaptive behaviours under a range of interacting tasks and environmental constraints.	Argumentative paper	Cognitive skill (decision-making, creativity)

The research highlights a prevalent absence in the literature of experimental studies dealing with the subject of declination of the dynamic ecological approach for the development of Life Skills in the cognitive area in the teaching of physical activity.

DISCUSSIONS

On the one hand, from the scientific literature emerges a conspicuous presence of studies, both of a descriptive and experimental nature, which have identified the effectiveness of physical activity and sports interventions aimed at the development of transversal skills and, in particular, at the development of Life Skills (WHO) (Papacharisis et al., 2005; Pierce et al., 2017; Holt et al., 2017; Hermens et al., 2017; Super et al., 2018).; on the other hand, studies that have investigated the effectiveness in the use of the ecological dynamics approach in the teaching of physical activities and sports for the development of Life Skills are almost completely absent.

However, probably also considering the relatively recent establishment of the ecological-dynamic perspective, studies that have investigated the effectiveness in the use of the latter in the teaching of physical activities and sports for the development of Life Skills are still lacking or almost completely absent.

In general, the literature review highlights a substantial lack of experimental studies useful for building evidence-based design models. In this sense, it is crucial to highlight how the ecological dynamics approach, considering its founding principles, refers to the need to move away from prescriptive elements in the implementation of practices.

However, in relation to the numerous advantages highlighted in the literature, deriving from the theoretical and application principles of the dynamic ecological perspective, it is desirable to promote an increase in practices consciously oriented towards these principles. In addition, it is possible to hypothesize that this 'application gap' can be traced back to educational motivations, in respect of which it is appropriate to rethink training for pre-service and in-service teachers, in order to provide them with suggestions useful for a redesign of practices (Davids & Rudd, 2021); secondly, it is also conceivable that principles can be applied unconsciously, especially within educational practices, on which it is intended to shed light to understand if and how educational interventions declined in the motor field already take into account some common elements between ecological design and the inclusive, promoted in a bio-psycho-social.

CONCLUSIONS

The results present in the literature, even if partially consistent with the four cognitive skills of the model developed by the WHO, are theoretically very grounded and experimentally very promising.

Although there are no studies in the literature that have investigated the potential in the implementation of the dynamic ecological approach for the development of the four skills of CLS, there are, instead, numerous studies that demonstrate that physical activity and sport represent a particularly effective disciplinary field for development of Life Skills. On the basis of this scientific evidence, this work attempts to shape the implementation of the dynamic ecological approach for the development of the cognitive skills of the Life Skills model in the educational practices in school contexts. Further studies are necessary to understand the real effectiveness of the transposition of this model in the teaching of physical activity for the development of cognitive skills for life.

It is also conceivable that there already exists within educational practices, an unaware application of ecological-dynamic principles. On this particular aspect it would be appropriate to shed light to record the state of the art and to identify elements of effectiveness and repeatability, which can encourage the

progressive structuring of an approach that, by its founding principles, is constituted “*in fieri*” along with the experiences.

Moreover, among the future prospects of research, there is the desire to understand if and how educational interventions declined in the motor field, especially in an inclusive perspective of customization, already take into account the effective epistemological overlap of theoretical constructs underlying the design of practices in both ecological and inclusive (Minghelli & Coppola, 2023), which in the perspective of bio-biopsychosocial, in turn attributes to the context an equally decisive role in outlining the possibilities of participation in significant movement experiences and in encouraging for all the acquisition of skills for life.

AUTHOR CONTRIBUTIONS

SC and VM designed the study, wrote the initial draft, and made revisions, formulated methods, conducted the search of the scientific literature and processed the results, managed data, created visualizations, supervised, and managed the project. CD participated in data curation, formal analysis, visualization, and manuscript revision. RV conducted formal analysis, supervision, validation and revision. All authors have contributed to the manuscript, approved the final version for submission, and consent to its publication in JHSE. and consent to its publication in JHSE.

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No potential conflict of interest were reported by the authors.

REFERENCES

- Adolph, K. E., & Hoch, J. E. (2019). Motor development: Embodied, embedded, enculturated, and enabling. *Annual review of psychology*, 70, 141-164. <https://doi.org/10.1146/annurev-psych-010418-102836>
- Araújo, D., Brito, H., & Carrilho, D. (2023). Team decision-making behavior: An ecological dynamics approach. *Asian Journal of Sport and Exercise Psychology*, 3(1), 24-29. <https://doi.org/10.1016/j.ajsep.2022.09.005>
- Araújo, D., Hristovski, R., Seifert, L., Carvalho, J., & Davids, K. (2019). Ecological cognition: expert decision-making behaviour in sport. *International Review of Sport and Exercise Psychology*, 12(1), 1-25. <https://doi.org/10.1080/1750984X.2017.1349826>
- Araújo, D., Davids, K., & Renshaw, I. (2020). Cognition, emotion and action in sport: an ecological dynamics perspective. *Handbook of sport psychology*, 535-555. <https://doi.org/10.1002/9781119568124.ch25>
- Bernstein NA. 1996. On dexterity and its development. In *Dexterity and Its Development*, ed. ML Latash, MT Turvey, pp. 3-244. Mahwah, NJ: Lawrence Erlbaum Assoc.
- Barsalou, L. W. (2008). Grounded cognition. *Annual Review of Psychology*, 59, 617-645. <https://doi.org/10.1146/annurev.psych.59.103006.093639>
- Ballester, R., Huertas, F., Pablos-Abella, C., Llorens, F., & Pesce, C. (2019). Chronic participation in externally paced, but not self-paced sports is associated with the modulation of domain-general

- cognition. *European journal of sport science*, 19(8), 1110-1119. <https://doi.org/10.1080/17461391.2019.1580318>
- Bean, C., Kramers, S., Forneris, T., & Camiré, M. (2018). The implicit/explicit continuum of life skills development and transfer. *Quest*, 70(4), 456-470. <https://doi.org/10.1080/00336297.2018.1451348>
- Caruana, F., & Borghi, A. M. (2013). Embodied Cognition: una nuova psicologia. *Giornale italiano di psicologia*, 40(1), 23-48.
- Chow, J. (2013). Nonlinear Learning Underpinning Pedagogy: Evidence, Challenges, and Implications. In *Quest*, 65, pp. 469- 484. <https://doi.org/10.1080/00336297.2013.807746>
- Chow, J. Y., Shuttleworth, R., Davids, K., & Araújo, D. (2019). Ecological dynamics and transfer from practice to performance in sport. *Skill acquisition in sport*, 330-344. <https://doi.org/10.4324/9781351189750-18>
- Chow, J.Y., Davids, K., Renshaw, I., Rudd, J. (2020). Nonlinear Pedagogy. In: Peters, M., Heraud, R. (eds) *Encyclopedia of Educational Innovation*. Springer, Singapore. https://doi.org/10.1007/978-981-13-2262-4_92-1
- Coppola, S., Vastola, R., Scatigna, M., & Fabiani, L. (2014). Training and health in gymnastics. *Journal of Human Sport and Exercise*, 10(1proc), 391-398. <https://doi.org/10.14198/jhse.2015.10.Proc1.30>
- Coppola, S., & Vastola, R. (2019). Health Pedagogy and Sport: Attitudes and Practices of Gymnastics Coaches. *Journal of Sports Science*, 7, 115-122. <https://doi.org/10.17265/2332-7839/2019.04.003>
- Coppola, S., Romano, B., Albano, D., & Vastola, R. (2021). Training in young athletes: Ecological dynamics approach. *Journal of Human Sport & Exercise*, 16(49), 1563-1577. <https://doi.org/10.14198/jhse.2021.16.Proc4.02>
- Correia, V., Carvalho, J., Araújo, D., Pereira, E., & Davids, K. (2019). Principles of nonlinear pedagogy in sport practice. *Physical education and sport pedagogy*, 24(2), 117-132. <https://doi.org/10.1080/17408989.2018.1552673>
- Czyż, S. H., & Coker, C. A. (2023). An applied model for using variability in practice. *International Journal of Sports Science & Coaching*, 17479541231159473. <https://doi.org/10.1177/17479541231159473>
- Davids, K., & Rudd, J. (2021). Time for a Rethink: Why a New Approach to Physical Literacy Is Needed. In *Nonlinear Pedagogy and the Athletic Skills Model* (pp. 5-19). Routledge. <https://doi.org/10.4324/9781003025375-1>
- Davids, K., Glazier, P., Araújo, D., & Bartlett, R. (2003). Movement systems as dynamical systems: the functional role of variability and its implications for sports medicine. *Sports medicine*, 33, 245-260. <https://doi.org/10.2165/00007256-200333040-00001>
- Davids, K., Araújo, D., Hristovski, R., Passos, P., & Chow, J. Y. (2012). Ecological dynamics and motor learning design in sport. *Skill acquisition in sport: Research, theory and practice*, 112-130.
- Davids, K., Araújo, D., Vilar, L., Renshaw, I., & Pinder, R. (2013). An ecological dynamics approach to skill acquisition: Implications for development of talent in sport. *Talent Development and Excellence*, 5(1), 21-34.
- Forte, P., Pugliese, E., Ambretti, A., & D'Anna, C. (2023). Physical Education and Embodied Learning: A Review. *Sport Mont*, 21(3). <https://doi.org/10.26773/smj.231020>
- Furley, P., Memmert, D., & Schmid, S. (2013). Perceptual load in sport and the heuristic value of the perceptual load paradigm in examining expertise-related perceptual-cognitive adaptations. *Cognitive processing*, 14, 31-42. <https://doi.org/10.1007/s10339-012-0529-x>
- Glenberg, A. M., Witt, J. K., & Metcalfe, J. (2013). From the revolution to embodiment: 25 years of cognitive psychology. *Perspectives on psychological science*, 8(5), 573-585. <https://doi.org/10.1177/1745691613498098>
- Goudas, M. (2010). Prologue: A review of life skills teaching in sport and physical education. *Hellenic Journal of Psychology*, 7(3), 241-258.

- Goudas M., Dermitzaki E., Leondari A. & Danish S. (2006). The effectiveness of teaching a life skills program in a physical education context. *European Journal of Psychology of Education*, 21, 429-438. <https://doi.org/10.1007/BF03173512>
- Hepler, T. J., & Feltz, D. L. (2012). Take the first heuristic, self-efficacy, and decision-making in sport. *Journal of Experimental Psychology: Applied*, 18(2), 154. <https://doi.org/10.1037/a0027807>
- Hermens, N., Super, S., Verkooijen, K. T., & Koelen, M. A. (2017). A systematic review of life skill development through sports programs serving socially vulnerable youth. *Research quarterly for exercise and sport*, 88(4), 408-424. <https://doi.org/10.1080/02701367.2017.1355527>
- Holt, N. L., Neely, K. C., Slater, L. G., Camiré, M., Côté, J., Fraser-Thomas, J., ... & Tamminen, K. A. (2017). A grounded theory of positive youth development through sport based on results from a qualitative meta-study. *International review of sport and exercise psychology*, 10(1), 1-49. <https://doi.org/10.1080/1750984X.2016.1180704>
- Holt, N. L., Deal, C. J., & Pankow, K. (2020). Positive youth development through sport. *Handbook of sport psychology*, 429-446. <https://doi.org/10.1002/9781119568124.ch20>
- Kendellen, K., & Camire, M. (2019). Applying in life the skills learned in sport: A grounded theory. *Psychology of Sport and Exercise*, 40, 23-32. <https://doi.org/10.1016/j.psychsport.2018.09.002>
- Kugler, A.N., Kelso, J.A. & Turvey, M.T. (1982). On the control and coordination of naturally developing systems. In J. A. S. Kelso & J. E. Clark (Eds.). *The development of movement control and coordination*, 5-78. New York: Wiley.
- Mahon, B. Z. (2015). What is embodied about cognition?. *Language, cognition and neuroscience*, 30(4), 420-429. <https://doi.org/10.1080/23273798.2014.987791>
- Matsankos, N., Gargalianos, D., Coppola, S., Vastola, R., & Petromilli, A. (2020). Investigation of skills acquired by athletes during their sporting career. *Journal of Human Sport and Exercise*, 15(3): 489-501. <https://doi.org/10.14198/jhse.2020.153.02>
- Meloni, M., & Reynolds, J. (2021). Thinking embodiment with genetics: epigenetics and postgenomic biology in embodied cognition and enactivism. *Synthese*, 198(11), 10685-10708. <https://doi.org/10.1007/s11229-020-02748-3>
- Minghelli V., Coppola S., (2023) from observation to educational design: the video modeling in the training of physical education teachers, *Giornale Italiano di Educazione alla Salute, Sport e Didattica Inclusiva - Italian Journal of Health Education, Sports and Inclusive Didactics*. Anno 7, V 1. Edizioni Universitarie Roman
- Minghelli, V., D'anna, C., & Vastola, R. (2023). A biopsychosocial approach to plan inclusive learning environments in physical education. *Journal of Physical Education and Sport*, 23(9), 2492-2502.
- Newell, KM. (1986). Constraints on the development of coordination. In: MG Wade and HTA Whiting (eds) *Motor development in children: aspects of coordination and control*. Dordrecht: Martinus Nijhoff, pp.341-360. https://doi.org/10.1007/978-94-009-4460-2_19
- Pesce, C., Croce, R., Ben-Soussan, T. D., Vazou, S., McCullick, B., Tomporowski, P. D., & Horvat, M. (2019). Variability of practice as an interface between motor and cognitive development. *International Journal of Sport and Exercise Psychology*, 17(2), 133-152. <https://doi.org/10.1080/1612197X.2016.1223421>
- Papacharisis, V., Goudas, M., Danish, S. J., & Theodorakis, Y. (2005). The effectiveness of teaching a life skills program in a sport context. *Journal of applied sport psychology*, 17(3), 247-254. <https://doi.org/10.1080/10413200591010139>
- Pierce, S., Gould, D., & Camiré, M. (2017). Definition and model of life skills transfer. *International review of sport and exercise psychology*, 10(1), 186-211. <https://doi.org/10.1080/1750984X.2016.1199727>

- Preatoni, E., Ferrario, M., Donà, G., Hamill, J., & Rodano, R. (2010). Motor variability in sports: a non-linear analysis of race walking. *Journal of sports sciences*, 28(12), 1327-1336. <https://doi.org/10.1080/02640414.2010.507250>
- Preatoni, E., Hamill, J., Harrison, A. J., Hayes, K., Van Emmerik, R. E., Wilson, C., & Rodano, R. (2013). Movement variability and skills monitoring in sports. *Sports biomechanics*, 12(2), 69-92. <https://doi.org/10.1080/14763141.2012.738700>
- Renshaw, I., Davids, K., Araújo, D., Lucas, A., Roberts, W. M., Newcombe, D. J., & Franks, B. (2019). Evaluating weaknesses of "perceptual-cognitive training" and "brain training" methods in sport: An ecological dynamics critique. *Frontiers in psychology*, 9, 2468. <https://doi.org/10.3389/fpsyg.2018.02468>
- Renshaw, I., Davids, K., O'Sullivan, M., Maloney, M. A., Crowther, R., & McCosker, C. (2022). An ecological dynamics approach to motor learning in practice: Reframing the learning and performing relationship in high performance sport. *Asian Journal of Sport and Exercise Psychology*, 2(1), 18-26. <https://doi.org/10.1016/j.ajsep.2022.04.003>
- Romano, B., Albano, D., & Coppola, S. (2022). The manipulation of constraints to train the complexity of soccer: the small sided conditioned games. *Giornale Italiano di Educazione alla Salute, Sport e Didattica Inclusiva*, 6(1).
- Romano, B., Coppola, S., & Vastola, R. (2023). The Declination Of The Dynamic Ecological Approach In The Teaching And Evaluation Of Motor And Sports Education Interventions In The Developmental Age. *Giornale Italiano di Educazione alla Salute, Sport e Didattica Inclusiva*, 7(2).
- Rudd J.R., Pesce C., Strafford B.W. & Davids K. (2020). Physical Literacy - A Journey of Individual Enrichment: An Ecological Dynamics Rationale for Enhancing Performance and Physical Activity in All. *Front. Psychol.* 11:1904. <https://doi.org/10.3389/fpsyg.2020.01904>
- Seifert, L., & Davids, K. (2012). Intentions, perceptions and actions constrain functional intra-and inter-individual variability in the acquisition of expertise in individual sports. *The Open Sports Sciences Journal*, 5(1). <https://doi.org/10.2174/1875399X01205010068>
- Shapiro, L. (2010). *Embodied cognition*. New York: Routledge. <https://doi.org/10.4324/9780203850664>
- Shapiro, L., & Stolz, S. A. (2019). Embodied cognition and its significance for education. *Theory and Research in Education*, 17(1), 19-39. <https://doi.org/10.1177/1477878518822149>
- Silva, P., Garganta, J., Araújo, D., Davids, K., & Aguiar, P. (2013). Shared knowledge or shared affordances? Insights from an ecological dynamics approach to team coordination in sports. *Sports medicine*, 43, 765-772. <https://doi.org/10.1007/s40279-013-0070-9>
- Silva, P., Duarte, R., Esteves, P., Travassos, B., & Vilar, L. (2016). Application of entropy measures to analysis of performance in team sports. *International Journal of Performance Analysis in Sport*, 16(2), 753-768. <https://doi.org/10.1080/24748668.2016.11868921>
- Super, S., Verkooijen, K., & Koelen, M. (2018). The role of community sports coaches in creating optimal social conditions for life skill development and transferability-a salutogenic perspective. *Sport, education and society*, 23(2), 173-185. <https://doi.org/10.1080/13573322.2016.1145109>
- Thelen, E. & Smith, LB. (1994) *A dynamic systems approach to the development of cognition and action*. Cambridge, MA, USA: MIT Press.
- Varela, F.J., Thompson, E., Rosch, E. (1991) *The Embodied Mind: Cognitive Science and Human Experience*. Cambridge MIT Press. <https://doi.org/10.7551/mitpress/6730.001.0001>
- Varela, F. J., Thompson, E., & Rosch, E. (2017). *The embodied mind, revised edition: Cognitive science and human experience*. MIT press. <https://doi.org/10.7551/mitpress/9780262529365.001.0001>
- Wilson, M. (2002). Six views of embodied cognition. *Psychonomic Bulletin & Review*, 9, 625-636. <https://doi.org/10.3758/BF03196322>

World Health Organization, Division of Mental Health, and Prevention of Substance Abuse. 1993. Life Skills Education for Children and Adolescents in Schools. Geneva: WHO Division of Mental Health.
World Health Organization. 2020. Life Skills Education School Handbook: Prevention of Noncommunicable Diseases. Geneva: World Health Organization.



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