

Criticisms and perspectives of heuristic learning in physical education

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Abstract

Background and Study Aim The ecological-dynamic approach promotes motor learning through task variability, modification of environmental constraints and appropriate use of feedback, original and creative motor solutions. This study wants to open a critical perspective on the didactics of physical activity selecting a methodological perspective adherent to ecological-dynamic approach. The aim is to highlight the significant aspects and the uniqueness and unrepeatability of heuristic learning, starting from theoretical lines.

Material and Methods For this purpose, an accurate survey of the scientific literature has been analyzed, highlighting the points of contact and contrast of cognitive and ecological-dynamic approach.

Results In the context of physical education, the most used pedagogical approach is the linear one. Teaching is influenced by spatial and temporal constraints, spaces and equipment, with reproduction styles and with predefined tasks and motor responses. This modality promotes awareness of motor skills and not transferability to other subject areas, as indicated by ministerial documents. Non-linear pedagogy, while promoting motor learning as a consequence of the interaction between the subject and the context, shows some limits. The first concerns the learning of transversal skills and, the second concerns the use of prescriptive teaching, absent in the ecological-dynamic approach, through heuristic learning.

It is necessary to overcome the areas of prescriptiveness that still resist in the paradigm most recognized by the scientific community, the Constraints Led Approach, closely related to nonlinear pedagogy. They do not favor completely a heuristic learning as the anthropometric constraints suffer from the limitation of biomechanics. Also, goal constraints are prescriptively determined by the physical education teacher, which is not compatible with heuristic learning.

Conclusions Conclusions. This analysis highlights the need, usefulness and usability of heuristic learning in different professional fields. The study aims to offer a new perspective on physical education objectives in the National Indications, projecting them towards a social and transversal purpose.

Keywords: ecological-dynamic approach, teaching method, soft skills, life skills, didactics exercise.

Introduction

The teaching-learning process, adopted by physical education teachers in Italian high schools, has been developed traditionally on models and practices signed by dualistic relationships. An example is the relationship between theory and practice, object and subject, mind and body, quantity and quality, which influence teaching styles and consequent approaches to the learning process [1]. The learning process has been suffering from causal and linear visions and prescriptive methodological-didactic frameworks. They, despite the consolidated practices and theoretical foundations supporting them, cannot comprehensively understand the complexity of the mechanisms that are established in the realization of human movement. Specifically, it concerns the complex interaction between the individual and the environment and the circular relationship between perception and action. They are understood through an ecological-dynamic

approach [2]. A valid educational process, including a variety of methodological approaches and teaching styles, [2] could take into consideration the physical, psychological characteristics and needs of students to determine different ways of elaborating information. Consequently, a valid educational process would facilitate original and creative motor responses in the students [3]. Each motor learning experience should be planned, monitored, inclusive and as significant as possible. It should be developed in the curriculum from pre-school education and constitute a continuous commitment of the student in sport and physical activities. Physical education lessons should respect the individuality of each student by facilitating their interaction and collaboration to make them acquiring knowledge, skills, motor skills and transversal skills (soft and life skills). The aim is to subsequently be able to better deal with daily problems and have a better quality of life [4]. A pedagogical-didactic process requires knowledge of content and organizational methods, but also knowledge and mastery of teaching approaches

and teaching styles to foster the development of significant motor learning. This requires a didactical-methodological approach which triggers interactions between psychological, emotional, perceptual, coordinative, motivational factors [5, 6], taking into consideration the contextual variables. If the organizational modalities and motor tasks have their functional valence, also teaching styles have their didactic valence. They provide communication and educational relationship between teachers and students [7]. We know that there is not a teaching style better than another, but the most appropriate can be identified to develop skills and motor competences to stimulate the development of soft skills [8]. A particular teaching style should combine the need to implement disciplinary content with the characteristics and educational needs of the student. So, the teacher has the task of creating an appropriate and stimulating learning context for the optimal development of the skills and competences of the student [9]. Regarding motor learning, it emerges the need to develop theories and teaching models referable both to the cognitive and ecological-dynamic approach. We need to emphasize teacher-student relationship, human and material resources available and the environmental context of learning, where students acquire useful information to perform motor experiences [10]. It is clear that the type of approach used by the teacher has a relevant value [11] because it significantly influences how students improve their knowledge, skills and motor competencies.

Hypothesis. Highlighting the educational-formative valence and the influence of different didactic approaches on motor learning, we want to open a critical scenario on the current didactics of motor activities. We also want to tend a theoretical framework of reference of the ecological-dynamic approach, according to a dualistic scheme (prescriptive versus heuristic).

Purpose. The purpose is to highlight, starting from the theoretical lines, the methodological applications of the ecological-dynamic paradigm, highlighting the points of contact and contrast of cognitive and ecological-dynamic approach.

Material and Methods

Data sources and search strategy

An in-depth investigation of the scientific literature was conducted highlighting the main points of contact and contrast of the cognitive and ecological-dynamic approach, with the theoretical and argumentative elaboration of operational proposals. For the purpose of searching the available literature, following data bases were used: Scopus, Scholar and Web of Science. Searching was performed using following terms (individually or in combination): heuristic learning,

cognitive approach, CLA, teaching method, physical education. All the papers and abstracts were evaluated for selection of potential papers to be included in the systematic overview. Relevant studies were considered after detailed search if they met the criteria.

Type of study and analysis

Inclusion criteria. Theoretical and practical studies about motor learning approaches and limitation of CLA and non-linear pedagogy were included in the analysis.

Results

Only 29 articles met the inclusion criteria and were included in two paragraphs: one on motor learning approaches and one on the limitation of CLA and non-linear pedagogy; then concluding with a comparison between the two approaches, cognitive and ecological-dynamic, through methodological proposals.

1. Motor learning approaches: conceptual and empirical definitions and comparative results

In the last years, didactic research has focused on the teaching-learning process, that is, on the transition from how the teacher teaches to how the student learns [12, 13, 14, 15]. The choice of methodological-didactical approach implies how the teacher should teach, how the pupil learns, imposing observation and evaluation of different motor tasks and response modes in qualitative and quantitative terms [16]. The approach may be cognitive and ecological-dynamic and, differently for each student, it may have different effects on learning, psycho-social development and the enhancement of individual differences [17]. The cognitive approach determines the following learning methods: by imitation and by conditioning. These are learning based on the repetition of the task with predefined and inflexible organizational and environmental methods which, due to their predictability and repetitiveness, when skills are acquired, perfected and automated. They also produce an inversely proportional effect in terms of cognitive commitment, e.g. the reduction of attention and motivation levels [18]. In this approach, the teacher determines the motor task, intensity, duration, constraints, etc. This methodological-didactical approach is the one most used at school in physical education, in which teaching is influenced by spatial and temporal constraints, spaces and equipment, with styles of reproduction and with predefined tasks and motor responses. In this sense, this modality only promotes the awareness of how motor skills are acquired and not the transferability of these motor acquisitions to other disciplinary and extra-disciplinary areas. The constraints represent a series of factors that influence learning and motor-sports performance all time, based on the

relationship established with the environment [19]. The aforementioned interacting constraints are dynamic and in continuous evolution so as to alter or facilitate the activity of the student, making his behavioral adaptability stronger [20]. The scientific literature promotes an interaction between the constraints during physical-sports activity. This reciprocal influence is constant. Therefore, a student must be able to self-regulate the various constraints in order to generate effective and efficient movement solutions [21]. Otherwise, in pedagogy non-linear acquisition of knowledge, skills and motor skills occur because of the interaction between the subject and the environmental context. And the tasks become significant by promoting the appropriate links with previous learning, preparing the student for the following ones [22]. However, having some limitations regarding the learning of transversal skills (soft and life skills) and rushing to prescriptive teaching in some stages of learning, something that the ecological-dynamic approach, through heuristic learning, does not provide at all.

The ecological-dynamic approach is phenomenological, it describes laws and principles on which the motor control system is based on [23] and has self-organizing properties. By practicing on a specific task with this approach does not mean always repeating the same solution, but repeating several times the process of solving the task itself [24]. Teaching in the heuristic-dynamic approach is aimed to stimulate the emergence of spontaneous solutions to motor problems, that is, to implement a process of finding motor solutions through the continuous variation of motor actions [25]. In heuristic learning, the teacher assists the student in the autonomous research of motor solutions, but if the learning task is too complex, the student should not be prescriptively instructed on how to simplify motor execution, and the constraints of the environment should be modified [26]. Moreover, self-regulation has a main function [27] that is, to permit the free expression of movement in interaction with others and with the limits of the context. The ecological-dynamic approach promotes, with contributions of different methodological approach rather than the cognitive one, motor learning in a heuristic form, through didactic experiences based on variability of tasks, modification of environmental constraints and appropriate use of feedback (intrinsic and extrinsic). So, students can develop original and creative self-generative and self-determined motor solutions. In this process, the teacher assumes a different role according to the approach adopted. In the presence of a cognitive approach the teacher will play his role with a function of instructor predetermining with different degrees of prescription the activities to be performed and the goals to be achieved. In the case of ecological-dynamic approach, the teacher assumes the role of observer and supporting the students in

their activities of exploration and discovery [28]. Executive variability is not seen as a limiting factor, but as an index of the non-linear interaction of the system with the constraints imposed by the organism, the task and the environment in the process of finding new motor solutions [29]. The teacher proposes content and organizes the educational setting. He chooses the teaching style (of reproduction and production, guided discovery and problem solving), proposing motor tasks not always predefined [30], in which the student can experiment with the executive variants of motor skills (e.g. playing 3vs3 in mini-basketball or mini-volleyball). Through productive styles, guided discovery, and problem-solving, the pedagogical-didactic focus is placed on the learner and operational proposals will need to consider the complex interactions that occur between students, the task, and environmental constraints [31]. On the other hand, through reproductive styles, the focus is placed on the teacher, promoting prescriptive teaching.

2. *Limitations of CLA and non-linear pedagogy*

Considering the scientific evidence from different areas, in particular the theories of the ecological-dynamic paradigm and neuroscience [32, 10], it is necessary to surpass those areas of prescriptiveness that still resist, such as for anthropometric constraints, goal constraints and in the practice of sports games. For example, the use of the Constraints Led Approach (CLA), strictly related to non-linear pedagogy [33], does not completely promote heuristic learning. This is because anthropometric and goal constraints are prescriptively determined by the physical education teacher, poorly reconciled with heuristic learning, especially in educational terms. In ecological-dynamic approach, 3 different types of constraints that modify and shape the behaviors of a complex dynamical system can be identified: organic, environmental, and activity constraints. In contrast, the ecological-dynamic approach studies the activity of the complex dynamical system by leaving it to evolve independently under specific manipulations of the constraints [34]. The ecological-dynamic approach, in fact, determines specific ways of learning by discovery, by problem solving, as well as having a strong impact on intrinsic motivation and in providing fun to do this type of motor experiences. These motor experiences are determined, in the school context, also through cooperative strategies, such as circle time, cooperative learning, role playing, peer tutoring, etc. The goal is to facilitate the priority acquisition of soft and life skills, as described in the Ministerial Indications for the part related to physical education. In addition, these practices make it possible to work together to try to overcome the gap between excellent and not-excellent students in motor skills, for example,

through peer tutoring, that is, a cooperative strategy that increases learning capacity, self-esteem and motivation of both the student-tutor and the student-tutee, overcoming the motor skills gap between the two groups. Prescriptive teaching, on the other hand, increases the gap, because those who are able to perform the exercises imposed by the teacher, pass to the next level, while those who need more time will continue to be unable to perform that particular motor task. It is therefore of considerable educational and social impact to be able to provide for the possibility of personalizing teaching-learning. This also provides students with Special Educational Needs to participate and learn with others [35]. Some of them may express the need for longer time to learn and to solve motor problems. It will be possible to valorize individual differences and therefore personalize the motor and sport experience only if the educational path has not been predefined by the teacher. Not surprisingly, reasonable accommodation is also mentioned in Art.2 of the UN Convention on the Rights of Persons with Disabilities, 2006 (ratified in Italy by Law 18 of March 3, 2009), that is, to be able to apply modifications and adaptations necessary to ensure that all people with disabilities enjoy all human rights and fundamental freedoms. These indications transferred to the didactics of physical education means by recognizing and designing different didactic programs to promote the learning of motor and sports skills, but especially transversal skills [36]. The foundations of this type of teaching can be traced, as previously highlighted, to the paradigm of the ecological-dynamic approach, in which an important value is attributed to the variability of the environment and the stimuli generated by it [37], to the teaching style, in which the teacher has a role as a facilitator, while the student has a role of active research and experimentation in processing data and producing answers for the resolution of motor problems. An observational study on the indirect teaching style showed that this style has a high influence on students' social development, self-perception, cooperative activities, and that it succeeds in promoting intrinsic motivation, awareness of the meanings and values of physical education [38]. Other research also moves in this direction, in which the positive impact of the play is highlighted:

- It involves all students, independently of their motor skills,
- It promotes and facilitates cooperative learning and socialization processes [39, 40].

Finally, it is hoped that physical education, starting from pre-school through the area of experience "the body and movement", in continuity with the Primary School and the Secondary School of the first degree, will be developed through didactic-motor programs that stimulate heuristic learning

by promoting not only the motor development of students, but also and especially the cognitive, affective and social-relational ones (soft and life skills).

3. Methodological proposals of the two approaches compared

Table 1 shows some examples of activities to propose, underlining the difference between heuristic learning and prescriptive teaching. Regarding heuristic learning, the general scheme consists of:

- Choice of theme, also previously anticipated by the teacher.
- Brainstorming activities, a modality of teamwork used to encourage creative thinking and the production of multiple ideas, where each student expresses what they know about the chosen topic.
- Vision of a video-tutorial or scheme, prepared by the teacher, on the activity to be performed with a defined objective.
- Autonomous division of children into cooperative groups to practice. The activity can be modified through the rules and the environment. Some alterations of the environment and the rules of the game, especially for older children, could consist of reducing the height volleyball net reducing the size of the court with the aid of lighter balls in basketball and volleyball for more control, more touches, more time, more passes, more freedom.
- The teacher assesses through grids and can only help kids find the solution through clues or by asking questions. He cannot demonstrate or give the answer.
- At the end, the practice of circle time will be performed to deal with relational and emotional topics regarding the activity performed.

Regarding prescriptive teaching, the general scheme consists of:

- Choice of theme and objective to be reached by the teacher.
- Explanation and demonstration of the activity to be performed.
- Execution of the activity by the students, using partial exercises (simplified, segmented), varied, randomized, error correction.

To sum up, prescriptive teaching with the use of didactic exercises enhances physical performance and skill refinement, little autonomy, much external independence, high specialization, low flexibility, preordained and repetitive patterns, and maximum development of conditional skills, but limited applicability in competition. Heuristic learning, on the other hand, with the use of instructional delivery promotes self-programming, self-determination, self-regulation, autonomy, high flexibility/low specialization, problem solving and creativity,

Table 1. Practical examples of some activities divided by each thematic core for prescriptive teaching and heuristic learning.

Thematic core	Activity	Heuristic learning	Prescriptive teaching
The body and the relationship with space and time	Path, circuit	Brainstorming on motor schemes and watching a video, with subsequent discussion. The teacher prepares a circuit based on the discussion that emerged, but does not explain how to perform it: he/she leaves the students free to explore. He/she can intervene through questions or by applying the degrees of freedom. Circle time.	The teacher explains and demonstrates how to perform the paths or circuits. Children imitate the teacher's actions.
Body language as a communicative-expressive modality	Nature imitation	After watching and discussing a video on nature, the students will have to assume the various positions of characters/objects of nature in free interpretation, chosen by their classmates in turn. Circle time.	Perform the positions of the teacher demonstrating various positions of characters/objects of nature.
The game, sport, rules and fair play	Fair play and rules in sport	Brainstorming on what the students mean by fair play, dividing them into groups. Watching a video on some examples. Discussion about what has been seen and application of the rules through a sport. Circle time.	Teacher explains what fair play means, explaining a sport game with its rules.
Health wellness prevention and safety	Path at various levels of difficulty.	Brainstorming on risk prevention and perception and watching a video on this focus, with discussion. Have the students construct a route with various options, placed side by side, so that everyone can choose which one based on their perceptions of their own difficulties and potential. Circle time.	The teacher prepares a course at various levels of difficulty, explaining how to perform it.

minimal development of conditional skills, but high applicability in competition. In this view, remembering that physical education must be of quality and quantity, able to influence all four domains of the person, such as physical efficiency, motor coordination, executive functions and life and soft skills, we can summarize by stating that the teaching-learning method that best lends itself to the achievement of these objectives is the heuristic one.

Discussion

Physical Education is a discipline that can make a specific contribution to the development of different domains of human functioning, thanks to the constant activation and mediation of the body and movement by promoting within the school curriculum:

The development of motor potential, starting with basic motor patterns, and then evolving into specific skills, including technical, sporting and expressive skills);

The development of social-relational skills through recreational-sport activities, rules and fair play;

The development of active and healthy lifestyles for the maintenance of an adequate level of psycho-physical well-being (as a fundamental element of health and prevention).

Physical education is characterized, therefore, as a discipline of "hinge" between the scientific field (knowledge of the body, how it works, movement), expressive communication, relationship and citizenship [41]. These aspects are punctually considered in the 2012 Directions. The study wants to open a new scenario on the use of the ecological-dynamic approach in teaching practices through the method of heuristic learning, which has a peculiar feature by developing a unique and unrepeatable way for each individual with executive particularities that take into account the structural anthropometric characteristics and different cognitive functions. Moreover, by not receiving any indication during the motor-sport experience from external subjects (e.g., teacher or coach), it is the self-regulation the main function and allows the free expression of movements in interaction with others and with the limits of the context. The teacher has the task of facilitating activities, stimulating spontaneous solutions to respond to problems that arise, ensuring safety and developing the maximum motor potential for

everyone. The need to move towards the structuring of dynamic ecological teaching methodologies has emerged, such as laboratories that, through heuristic learning, promote the construction of learning by the student, which corresponds to a non-directive teaching where the student takes on different functions of the teacher, differentiating into teaching and tutoring among peers, small group and cooperative learning, and self-learning; such outcome is what does not happen in the cognitive approach and what, on the contrary, happens only partially in the ecological-dynamic one.

Conclusions

The study wants to offer a new perspective on the objectives of physical education in the National Indications, which already present a heuristic profile because they are not performance objectives, but project learning towards transversal and socialization objectives. In the light of what has been analyzed and exposed, the articulation of disciplinary purposes should be divided into intrinsic, extrinsic and the whole teaching-learning process needs intentionality and systematicity

in the different didactic phases. Ascertained that the different methodological approaches produce different effects on the ways of learning and that an approach with reproductive styles is not the optimal solution for the quality of learning to respect individuality, enhance the capabilities of individuals and include all students. Therefore, it is necessary to ensure and propose motor experiences through production styles capable of bringing out original and multivariate motor skills, and furthermore, these skills would have a higher frequency of being transferred to other areas. It is necessary to remember that the process of meaningful learning [42] and the proximal development of it [43] and the production of learners' motor skills are continuously influenced by the constraints due to the interaction between individual-activity-environment. This interaction, alongside the active role of the learner and the facilitating role of the coach (teaching style/ learning by discovery), produces significant changes in the learning processes and in the motor and sport responses of the learners by assigning a primary role to heuristic learning in the pedagogical-didactic domain.

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