PHYSICAL LITERACY AND NON-LINEAR PEDAGOGY. HOW CAN TECHNOLOGIES ENHANCE MOTOR LEARNING?

ALFABETIZZAZIONE MOTORIA E PEDAGOGIA NON LINEANRE. COME LE TECNOLOGIE POSSONO MIGLIORARE L'APPRENDIMENTO MOTORIO?

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ABSTRACT
The present paper aims to develop a theoretical model that brings together the opportunities of new technologies and the principles of non-linear pedagogy.
This research study allows to identify fundamental principles of "non-linear-technology-based model" and potential outcomes on motor learning, physical literacy and health promotion. Great importance is given to teacher training for evidence-based didactic to provide strong foundation for a critical integration of technology in physical education.

Il presente contributo intende proporre un modello teorico che integri le opportunità offerte dalle nuove tecnologie e i principi della pedagogia non lineare, al fine di sviluppare un "modello basato sulla tecnologia non lineare" e i potenziali risultati sull'apprendimento motorio, l'alfabetizzazione motoria e la promozione della salute. Particolare rilievo è attribuito alla formazione degli insegnanti per la didattica basata sull'evidenza per fornire solide basi per un'integrazione critica della tecnologia in educazione fisica.

KEYWORDS
Non-linear pedagogy, technology in PE, physical literacy.
Pedagogia non lineare, tecnologie in educazione fisica, alfabetizzazione motoria.

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Introduction

The Covid-19 pandemic represented a global health emergency that has radically changed (and continues to change) the lifestyles of millions of people around the world. The pandemic emergency has required the joint intervention of governments, health and public institutions, scientists and researchers, profoundly impacting the lives of citizens and entire communities with measures of isolation, quarantine, social distancing and partial or total closures (Ghozy et al. 2021).

Despite the measures and restrictions put in place to contain and limit the spread of the pandemic, it is not possible to ignore the undesirable effects deriving from the modification of lifestyles, including the decrease in levels of physical activity, the increase in the incidence of discomfort psychological, anxiety, depression and negative mental health effects of children and adolescents (Ghosh et al. 2020; Singh et al., 2020; Bonati et al. 2020), especially in overweight and obese populations (Chen et al. 2021).

Furthermore, the Covid 19 pandemic has further accelerated the process - already in place for several decades - of technological innovation in all areas and sectors.

The increasing use of digital technologies in educational contexts is at the center of an important international debate: while technologies can promote new and stimulating ways to practice physical activity, on the other hand represent one of the main factors that favor the onset of sedentary habits and increased screen time, especially in youngest (Carpena Lucas et al., 2022). In fact, the increase in time spent in front of the PC, tablet, TV is associated with reduction in physical activity levels and weight gain, behavioral changes, acquiring irregular sleep-wake habits and incorrect eating habits, but, at the same times, technologies represent an useful tool to stay physically active (Goldschmidt, 2020).

Although studies on the negative effects of technologies on the mental health, cognitive development and psycho-physical well-being of children and adolescents still present conflicting results (Straker et al. 2018), activities such as online coaching, online personal training, but also physical education lessons, introduction to sport, dance, etc. have taken advantage of the benefits and advantages offered by technological devices (notebooks, smartphones and tablets).

In some ways, in the field of physical and motor activity, the COVID-19 pandemic has only accelerated the process of technological integration which has its roots in the beginning of the 21st century.

In the light of these evidence, the present paper aims to develop a theoretical model that brings together the opportunities of new technologies and the principles of non-linear pedagogy.

1. Epistemological determinants of "Play"

The study of the communicative modalities and the teacher's behavior in relation to the learning contents has acquired in recent years a considerable importance to highlight the effects of the proposed activities on students' cognitive, emotional and social development (Kyriakides, Anthimou, & Panayiotou, 2020; Wang et al., 2020). In the school context, the educational proposals, organized in different ways and environments (class, laboratory, gym, outdoor environment, etc.) and aimed at promoting the learning outcomes require an effective communication between the teacher and the group-class to promote the didactic mediation (Zhang, Bowers, & Mao, 2020). In this field, several studies have confirmed that the relations between children's cognitive, emotional, motor, and social area are determined by the mediating effects generated by teacher-student(s)-student(s)-environment interactions (Vandenbroucke et al., 2017; Endedijk et al., 2021; Brian & Taunton, 2018). Moreover, research in educational setting have been widely demonstrated that it is not only the relation teacher-student(s) dyad, but also it is the learning environment that plays a fundamental role in children's development (Saiz-González, Iglesias & Fernandez-Rio, 2024).

Gibson' Ecological Theory, in fact, considers the human development as the result from the interaction between environmental stimuli and child's perception with great importance to affordances as learning objects and space in which children can climb, walk, run, jump, etc. (Lobo et al., 2018; Costall, 1984).

Moreover, according to the Socio Ecological Model of Health personal wellbeing, human development, behavior, attitudes and learning outcomes are affected by the external environment (Hu et al., 2021). This model provides a comprehensive and global approach to health promotion involving the individual (i.e., personal physical activity program, food education, etc.), interpersonal relations (i.e., walking/running groups), community (i.e., promote the correct choose of fruits and vegetables, define walking/running trails in the city/rural area, etc.), and society (i.e., cultural values, norms, and policies).

These are just some of the approaches developed between the 20th and 21th century, that have contributed to build a strong interest in the field of physical activity (PA) on the analysis of settings and contexts in which motor activities took place, and virtual or hybrid learning Virtual learning environments fall among these. The better understanding of the effects of environment underpinning adherence to PA and healthy habits have become an important research area over the past years (Rhodes, McEwan & Rebar, 2019; Pietsch, Linder & Jansen, 2022).

Through motor activities the child perceives his own body and relates to the external environment through gestures, postures and actions; psychobiological

maturation processes interact with learnings promoting the balanced development of the person (Bruner et al., 1981; Malina, 2004). The benefits of the game are numerous and well documented and include improvements in executive functions, language, early mathematical skills and motor development (Yogman et al., 2018). The game is essential for learning the skills of the 21st century, such as problem-solving, collaboration, and creativity, which require the executive operating skills that are critical to success in adulthood (Yogman et al., 2018).

Motor play, especially during childhood, is an inevitable field of experience that favors the interdependent relationships between the cognitive, organic, and socio-affective functions of the person. Motor activities, in fact, constitute the dynamic component of the personality, in which the individual functions integrate and influence each other: the evolution or delay in the development of each functios is interdependent and decisive for the growth of the individual in its entirety (Bruner et al.,1981; Côté & Hancock, 2016). The motor experiences lived through the game mobilize and coordinate the different functions favoring the development of each one.

In fact, neuroscientific studies highlight that in preschool age and during the developmental age, the bodily experiences through sensory-motor activities promote deep mind-body interconnections, different ways of learning, favoring the physical self-perception, the discovery of the object and the environment, the relationship with others (Berthoze, 2003).

It should not relate the child play only with the concepts of motricity, freedom, fun, spontaneity, joy, emphasizing exclusively the unconscious aspects of the game; it also mobilizes cognitive processes as the child, repeating movements and skills, increases its ability to analyze events and to establish relationships, analogies, differences, connections of randomness.

The motor activities realized through different games and other organizational modalities (individual, in pairs, in group, paths) and, subsequently, the orientation to the various sports disciplines, are essential precursors for the cognitive development, organic-motor, emotional, social of children.

Children's motivation to play is today limited by technological evolution, urbanization, the disappearance of spaces for child play and screen time, influenced as it is by family life patterns and the often negative peer group (Ginsburg et al., 2007; Gray, 2015; Digennaro, 2019).

Increasing the time devoted to the game during physical education classes, is essential to promote physical literacy and the transition to the sport (Murphy & Nì Chronin, 2013).

2. Promoting Physical Literacy through Technologies in Physical Education: Current Evidence

According to M. Whitehead (2013) Physical Literacy (PL) is a process that develops throughout life and involves different and complementary, cognitive, emotional, social and physical factors of the person. Physical literacy is the acquisition of a motor repertoire that promotes, in different ages, the development of psychological and social factors related. Promoting PL in children through the different organizational modes of the game (in pairs, in groups, in teams) is a crucial educational purpose for health promotion because it allows the learning of skills, knowledge, and responsible behavior for the acquisition and continuation of physically active lifestyles in adulthood (Hulteen et al., 2018; Cairney et al., 2019). Through the game children structure the foundations on which to build their mobility, to acquire numerous and different motor experiences through opportunities, quantitative and qualitative, to learn more motor skills and develop motor abilities through a circular report (Gallahue & Cleland, 2003; Hulteen et al.,2018).

Children today, compared to previous decades, have reduced opportunities to experiment-learn-develop executive variants of fundamental movement skills (for example, running forward-back, right-left, fast-slow, inside-out, before-after, in whole/part of the field/platform/lane, in pairs, in a row, etc), through unstructured motor activities.

Recently Faigenbaum, Rebullido and Mcdonald (2018) proposed a reference theoretical model to highlight the causes of this global phenomenon: physical inactivity, pediatric dynapenia and motor illiteracy. The interaction of these factors, defined as the Triad of Physical Inactivity, gives rise to a non-virtuous circular process, which effectively limits the practice of physical and/or sporting activity.

A sedentary child (physical inactivity) is defined as not very active, unlikely to follow international guidelines which recommend practicing at least 60 minutes a day of moderate to vigorous physical activity (Bull et al. 2020), with a greater tendency, therefore, to overweight and obesity. Furthermore, a sedentary child will be characterized by poor levels of strength (pediatric dynapenia) which constitutes a fundamental prerequisite for carrying out any type of activity: assuming and maintaining static positions, running, jumping, climbing, crawling, throwing, grabbing, etc. Physical inactivity and pediatric dynapenia represent the basis for motor illiteracy, defined as a reduced individual repertoire of motor skills, with consequent absence or lack of intrinsic motivation for movement, self-efficacy and enjoyment.

Therefore, the increase in sedentary habits represents a complex multifactorial phenomenon that includes cognitive, affective, social and organic-metabolic variables, which require operational proposals and intervention protocols aimed at improving not only the quantity of MVPA, but also and above all the quality of the motor experiences experienced by the child.

New insights into the technological development, together with the reduction of both quantitative and qualitative opportunities for children to be physically active, required modifying and integrating tasks, strategies and teaching methodologies in a new and creative way, also through the re-enhancement of traditional environment.

Riva et al. (2020) defined the possible role of "Positive Technology" as a critical and scientific approach applied to the use of technologies to improve, increase, and enhance the quality of people's personal experiences and psychological well-being. The authors highlighted three different dimensions of Positive Technology: the hedonic dimension, linked to positive experiences (positive emotions, awareness, resilience), the eudemonic dimension, linked to motivational and self-realization aspects (involvement, self-efficacy and fun), and the social dimension, promoting social integration and inclusion, the development of communication and connection networks between people.

In this field, international literature highlighted interest in the possible areas of study and application of wearable technologies (Riffenburg & Spartano 2018) and digital tools for the promotion of physical activity: the so-called "Exergames" (Exgs) and "Active Videogames" (Avgs) can be considered an evolution of traditional video games: they are technological tools which, using videogame platforms, offer games and activities that require total or partial movement of the body (Benzing & Schmidt, 2018).

A recent systematic review of the literature (Santos et al. 2021) highlighted how it is possible for children and adolescents to improve physical efficiency, increase self-esteem and manage body weight (by increasing energy expenditure both during activity and at rest, thus reducing the BMI) by practicing activities with AVGs in a home environment, 1-3 times a week and for 10-90 minutes.

Vernadakis et al. 2015 evaluated the effects of two different experimental interventions (practice with Exgs via Xbox Kinect® and traditional practice) on the learning of object control skills in a sample of 60 primary school children. The sample was divided into 3 groups: control group (without any specific intervention to improve object control skills), experimental group with traditional teaching and experimental group with Exgs. The protocol involved 8 weeks of experimental intervention, with 2 interventions per week lasting 30 minutes each

(approximately). In addition to the object control skills assessed with the TGMD-2 (Ulrich, 2000), the authors also assessed the pleasure during the practice of physical activity through the PACES (Physical Activity Enjoyment Scale; Moore et al. 2009). The results highlighted a significant improvement in object control skills in both experimental groups (traditional activity and activity with Exgs), while the approach based on Exgs highlighted greater pleasure during the activity compared to the group that carried out the traditional activity.

In Australia, a national online survey of 1188 adults and 963 adolescents assessed the relationship between adherence to health and physical activity promotion guidelines and the use of digital platforms (Youtube, Facebook, Instagram, apps for smartphones/tablets, zoom classes, Xbox Kinect, etc.) (Parker et al. 2021). The findings report that (a) 39.5% of adults and 26.5% of adolescents regularly used digital devices to maintain physically active lifestyles and (b) higher levels of MVPA activity among people who used these digital platforms, compared to those who carried out "traditional" physical activity (without using digital tools, devices or platforms). The study by Siani & Marley (2021) instead underlined the growing diffusion and tendency to use Virtual Reality (VR) for the practice of physical activity, which, it would seem, increases perceived intensity during the activity, compared to online platforms.

3. Technologies and Physical Literacy: Towards a Pedagogical Model

Despite the proposals and initiatives for the promotion of physical activity in different sectors and contexts, some questions emerge regarding the feasibility and effectiveness of interventions for promoting physical literacy through technologies. The debate on the current state and future directions of technological tools should guide the reflections on the methods and strategies through which to re-orient the teaching of physical education, which, by its very constitutive nature and epistemological, it is based on processes that involve interpersonal relationships (teachers-students and students-students).

The use of technologies could provide a contribution to physical education teachers, parents and operators who work in the field of health promotion, to reduce, at least partially, the negative effects of the historical period we are living in, providing a means of connection between students and teachers (Bentlage et al. 2020; Sheikhhoseini et al. 2020).

These activities with the Exergames provided an interesting alternative to traditional gaming and "sedentary" video games, making them a useful complement to promoting active lifestyles (Graf et al., 2009). Among the peculiar

elements characterizing the use of such methods emerges the relationship between individual (player) - motor activity - game console or associated technological device (Giblin et al., 2014).
According to Beck and Wade (2004) the interest in this type of activity is due to the following factors:

- ease of use;
- possibility to receive rewards based on the scores obtained;
- highly challenging entertainment experience that allows players not to get bored.

We need a careful methodological approach, however, when using technology in any school-curricular environment and in school motor activities in particular: the Exergames and technologies in general, should contribute to increasing the effectiveness of the educational project, and not simply be gaming activities for their own sake.
After having analyzed how the integration of technologies in educational contexts and their possible interpretation in a pedagogical and methodological key have slowly led teachers to broaden and extend the contents, spaces, and organizational and conduction methods of the "traditional" lesson" of physical education, through the creation of hybrid learning environments, the question remains: what can the physical education teacher practically do? What does this knowledge translate into in practice?
Beard & Konukman (2020) proposed seven examples of good practices and organizational methodologies to improve the effectiveness of interventions based on physical education carried out online:

a) Improve the relationship between students and the relevant educational institutions, through the definition of specific educational objectives, the proposal of tasks and activities that involve the use of video links, digital resources, multimedia contents, linked together in an interdisciplinary and multidisciplinary way;
b) Improve cooperation among students, through the application of innovative teaching methodologies (e.g. "brainstorming", "flipped classroom", "cooperative learning", "role play", etc.) in virtual contexts (e.g. creating virtual laboratory classrooms in which students can discuss issues relating to the promotion of health, physical activity and nutritional education, but also develop and share programs and tasks for physical activity, etc.);

c) Structuring active and dynamic learning contexts, through recreational activities, e.g. treasure hunts and orienteering, creation and sharing of personalized training programs oriented towards physical fitness;
d) Provide timely, real-time feedback, through software that allows the teacher to develop and propose structured knowledge tests that give an immediate answer (right/wrong, total score obtained, true/false, etc.), or through the use of smartphones, tablets, applications and wearable technologies that allow you to monitor quantitative parameters such as heart rate and energy expenditure, number of steps, distance travelled, etc. in real time;
e) Increase the time dedicated to the learning process, through the use of online platforms and databases useful for sharing material in electronic and digital format to improve the students' learning experience;
f) Generate and promote a competence-oriented motivational climate: make students aware and participate in what they are about to study and learn, including through online columns and blogs, maximize students' time and effort;
g) Value individual differences, through the proposal of different and diversified teaching-learning strategies, adapted to the individual and/or class group, respecting the educational needs of each individual.

From this perspective (Figure 1), technologies should be considered as a tool to enrich and enhance the motor experiences experienced by the child, expanding the educational setting and the contents of motor activities, in order to convey learning that materializes with the body and through the body. The technological evolution in the field of teaching motor activities during the Covid-19 pandemic has pushed teachers to structure virtual educational environments to allow children to continue learning and playing, developing online teaching interventions capable of (a) encouraging the process of motor literacy in children and adolescents and (b) ensure compliance with WHO guidelines and recommendations on active lifestyles and correct eating habits (Filiz & Konukman, 2020).

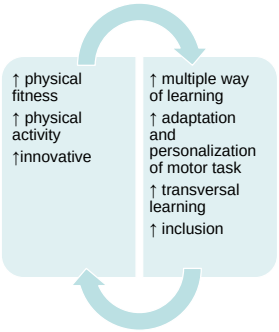

Figure 1. Relation between Technology in PE and Non-Linear Didactic Approach

All these elements contribute to making the application of technologies in physical education innovative, functional and attractive, which lends itself and adapts well to the logical-functional constructs of non-linear pedagogy and non-linear learning of motor skills (Chow, 2013), in which the learning process is strictly correlated, contextualized and dependent on the variability of environmental stimuli, as a consequence of the interactions between the activities carried out by the teacher (motor activities and/or knowledge), the students and the environment (both natural and virtual ones).

Such an approach is expressed in the research, by the child, of dynamic and variable learning contexts, able to enhance the body-stimulus/ external-environment relationship in order to orient the decision-making processes (what to do) and problem solving (How to do?) towards the definition of a certain movement, leaving the possibility for the child to experiment, try, make mistakes and try out a series of tasks and activities that are not predefined, but open, suitable and customized to the individual skills (Rudd et al., 2021; Woods et al., 2020). From the point of view of the teacher, this type of approach implies the choice and the prevailing use of production teaching styles, in which children are required to provide unconventional answers, not stereotyped and not predefined through discovery and research a considerable number of executive variants (how you can perform a certain task) (Mosston & Ashworth 2002; Colella 2019).

The linear didactic-methodological approach, on the other hand, involves the organization and preparation, by the teacher, of a specific teaching setting, in which the tasks and activities are predefined and organized a priori. The choice of teaching methods will be mainly oriented towards reproduction styles, through exercises and sequences of tasks that only include the executive variants identified by the teacher. The result is a limited variability of practice and learning, as well as the

proposal of motor tasks that proceed, in a linear and sequential way, from the simplest to the most complex, from the easy to the difficult, from the best known to the least known, etc (Colella, 2019).

In order to be able to speak of non-linear teaching experiences, therefore, it is necessary to guarantee: (a) the personalization of the motor task (different learning times, duration, executive difficulty, intensity, etc.), (b) a relative autonomy in the choice of executive variants and motor responses to be produced, leaving room for originality and motor creativity, (c) the creation of a conceptual network, in which the learnings and factors related to the motor development of the child and adolescent (motor skills, motor skills, theoretical knowledge, etc.) are interconnected and interdependent, and (d) the inclusion and promotion of didactic obliquity, that is to propose motor tasks and learning experiences adapted and focused on the potential and levels of learning-development of each. From this perspective, the learning process (Figure 2) takes on a more global and inclusive connotation, closely linked to the opportunities and constraints that the environment offers, and resulting from the reciprocal interactions between motor activity (e.g. motor task), child and environment (Chow. 2013).

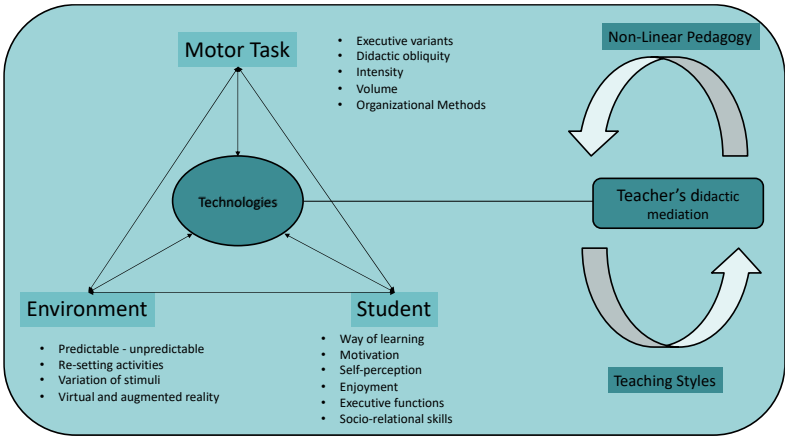

Figure 2. Proposed Model for Integrating Technology in PE

O'Brian et al. (2020), analyzing the strategies and methodologies used regarding physical education teaching in five European countries (England, Finland, Greece, Ireland, Portugal), referred to the role played by technologies (e.g. online physical education), supporting, however, the inescapability of the in-person experience, and hence the affirmation of the need to develop innovative online teaching methodologies to increase the level of involvement and motivation of students.

Rüth & Kaspar (2021) have, however, analyzed the possible implications of practicing exergames in a home environment. The benefits concern (a) the improvement of physical efficiency, (b) the increase in levels of physical activity, adequate caloric and energy expenditure, (c) the increase in levels of structured physical activity, (d) the increase in intrinsic motivation and pleasure during activities, and (e) the possibility of modulating the parameters of the motor load (e.g. intensity, executive difficulty, density, duration and volume of activity performed). The authors also highlighted benefits that affect the socio-emotional and affective sphere, including participation in competitive and/or cooperative play activities between participants, high cognitive and emotional commitment, engaging in gaming experiences that are always innovative and attractive. The educational value which, in some cases, characterizes these activities, represents, if adequately supported and guided, an important opportunity to share personal and group experiences, encourage and make communication, critical discussion, acquisition and sharing more effective. of digital skills and personal behaviors.

Conclusions

Technologies represent an interesting opportunity to enrich the content, spaces and traditional organizational methods of physical and sporting activities which, in a domestic and family context, can contribute to creating a personal "home gym". However, this type of activity should always be supervised by the teacher or parents, oriented and guided by teaching-learning methodologies aimed at creating a positive motivational climate through the teacher's mediation in the relationship between motor activities-students-environment. The teaching-learning process both online and in person should, therefore, be conducted and oriented towards the development of socialization, sharing of experiences and knowledge, interaction and research into different modes of communication: physical education, processes of physical literacy, motor, cognitive, emotional and relational development are nourished by relationships.

However, teacher’s mediation is unavoidable to make environments and spaces significant for learning and stimulate cognitive, motor and social functions. The executive variants, in fact, intentionally proposed by the teacher through didactic activities based on the variability of the practice (Fish et al.,2019), enhance qualitative learning, allow you to gradually learn more difficult and more complex motor skills, solve motor problems in the game and in sport, through variable and transferable motor responses in different areas of physical activity.

Moreover, practicing motor activities has significant effects on learning processes as they promote in children the transferability of interdisciplinary and transversal skills and knowledge and contribute significantly to inclusion processes. In fact, in the educational field the role of context, environment and space are important factors in fostering participation and engagement during physical activity, as well as the intention to be physically active.

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