

IMPLEMENTING NONLINEAR PEDAGOGY IN PHYSICAL EDUCATION

Nonlinear Pedagogy

One of the four main aims of the National Curriculum for Physical Education in England is to “develop competence to excel in a broad range of physical activities” (DfE, 2013). This can be facilitated through the design and implementation of a knowledge-rich curriculum, which requires the structured and systematic teaching of important declarative and procedural knowledge. In our last article (Jafar, Walker and Beckey, 2022), we presented an ecologically informed argument that learning to move skilfully also requires a deep *knowledge of the environment*, which is the capability to seek out and pay attention to important sources of information which allow for the coupling of perception with action.

Taking badminton as an example, declarative knowledge would be knowing the key teaching points of an overhead clear and procedural knowledge would be the capability to reproduce the overhead clear technique. *Knowledge of the environment* would be reading the informational cues within a game of badminton (flight of shuttlecock, position of opponent, position of net etc.), recognising that the overhead clear is an appropriate action, whilst regulating emotional, cognitive or social factors in order to perform it successfully.

How can physical education (PE) teachers educate their pupils’ attention and plan to develop their *knowledge of the environment*? One evidence-informed way is through the implementation of Nonlinear Pedagogy (NP), which is a set of pedagogical principles that can guide how practice can be organised as well as how best to provide instruction (Chow *et al.*, 2021). (See Figure 1.)

Pedagogical principles underpinning Nonlinear Pedagogy

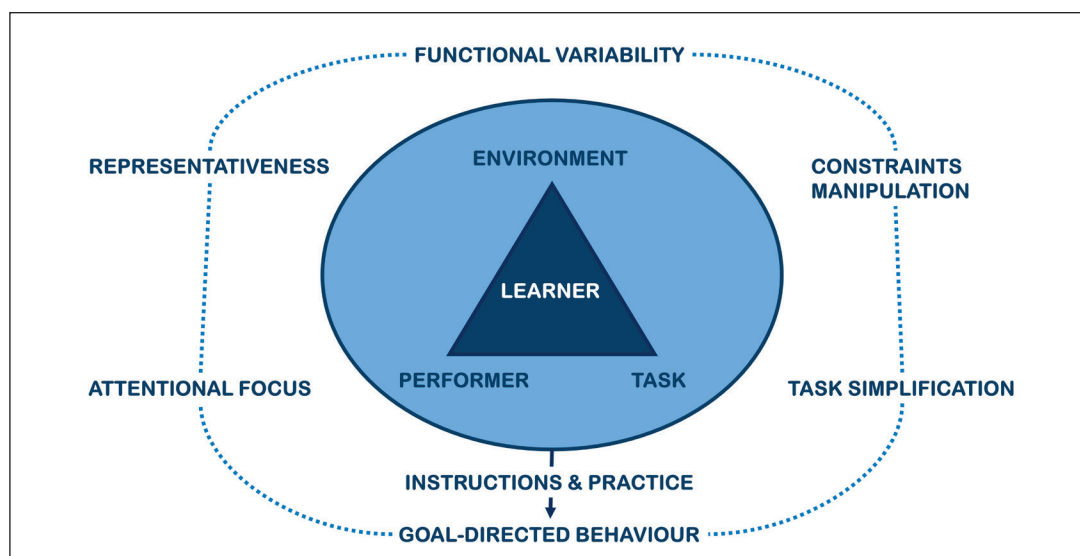
Representative learning environment

Learning activities and practices should be situated, where possible, in the performance context that captures the informational sources and dynamics where the skills need to be learnt and developed. This is not simply allowing the children to play a game, but the thoughtful facilitation of key interactions between the individual, task and environment (Newell, 1986). As humans, we get good at what we practise, therefore we want practice to be as specific as it can be whilst also being developmentally appropriate. As an example, shooting in basketball with a defender is a different task from without. A defender and



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Figure 1: Principles of Nonlinear Pedagogy.





their position provide the attacker with different informational cues, such as their positioning, height or orientation of feet. These influence how and when the shot is taken as action and perception are tightly coupled. Therefore, the careful consideration of including opponents is one way of maintaining the representativeness of practice tasks (Gorman & Maloney, 2016).

Constraints manipulation

As a PE teacher, you can and should manipulate constraints to enhance learning, such as the task constraints which include the instructions you give, the equipment that is being used or the goals of the task you wish the pupils to achieve. Constraints should not be used to force a specific action but to guide the participants' attention and exclude some potential opportunities for actions. By doing this, you can encourage exploration of certain movement solutions and develop behaviours that are functional. The manipulation of constraints rather than the transmission of declarative knowledge is an important aspect of NP and developing *knowledge of the environment*. This will be the focus of our final article in the series, when we cover a Constraints-led Approach to PE.

Attentional focus

The type of verbal instructions that you give to pupils can influence where and what they pay attention to, which, in turn, has an impact on their performance and learning. Attentional focus instructions can be categorised as either internal or external. Wulf (2007) describes an internal focus of attention when an individual's focus is on the action itself and an external focus of attention is when their focus is directed to the effect of their action. Using a volleyball serve as an example, a PE teacher might say, "arch your back, accelerate your shoulder, then upper arm, lower arm then hand to hit the ball" as an example of internal focus and "hit the ball as if using a whip" as an example of external focus (Winkelman, 2020). An NP

approach would prioritise the use of the external focus of attention to allow for less conscious control of a movement. However, it must be noted that novices would also benefit from using an internal focus of attention, especially in the early phases of learning a new skill, to help gauge a rough idea of the movement pattern (Chow *et al.*, 2021).

Task simplification

One of the key priorities of using NP to develop *knowledge of the environment* is to always ensure there is a strong coupling between perceptual information and action (Rudd *et al.*, 2021). This increases the likelihood of transfer from the practice environment to the performance environment. The way to do this is rather than decompose the task, wherein all environmental information is stripped away (usually through the isolated practise of movement patterns), simplify it. For example, hitting a cricket ball off a tee is different from hitting a cricket ball that is traversing through space in flight and would, therefore, be considered decomposed. Simplifying this task, in order to keep relevant sources of perceptual information, may require using a different size bat or ball or feeding the ball in a developmentally appropriate manner.

Functional variability

Usually in PE we are helping pupils to search for an ideal technique so variability in movement control is seen as undesirable and something to get rid of. However, if we are looking to educate pupils' attention so they can develop their *knowledge of the environment* then purposeful variability, through practice design, can help them to explore individual functional movement solutions and act as a desirable difficulty to enhance learning. For example, in a gymnastics lesson focusing on locomotion, movement variability could be created by asking pupils to carry different objects of different sizes and weights whilst navigating over, under and around different equipment.

The nonlinearity in learning

The use of the pedagogical principles of NP requires a certain perspective regarding the nature of skill acquisition and motor learning. A linear view of the process of skill acquisition would expect that pupils would develop and learn the same things at the same pace – the input of your teaching and their practice would result in a steady improvement for all of them, over time. A nonlinear view of the process of learning takes a different perspective. It argues that skill acquisition will involve progressions, abrupt transitions, plateaus and even unexpected regressions, and these will be individualised for each of your pupils (Chow *et al.*, 2022). This nonlinearity is even more pronounced with young people who are going through puberty and the growth, maturation and development which are associated with that time in their lives. A nonlinear view of the nature of learning requires a PE teacher to match a pupil's current capability and their development to certain task demands, which is where the pedagogical principles of NP can be of use.

There is a growing body of evidence which illustrates that successful implementation of NP by PE teachers can support the learning of skilful movement (Chow *et al.*, 2021). In the next two sections of this article, we will exemplify how NP can inform curriculum design (from a secondary PE perspective) then provide some specific examples of how NP can be implemented in a range of different PE contexts.

Knowledge of the environment in practice: a non-linear curriculum

To develop a rich educational experience for pupils in PE there is a need to have an alignment between three key factors: pedagogy, broad and aspirational learning outcomes or standards, and curriculum development (Metzler, 2011). In the previous section, we described the key principles of Nonlinear Pedagogy; the aim in this section is to present an example unit of work that aligns with this pedagogical approach.

Decisions made around curriculum planning in PE are heavily influenced by time, access to facilities and the knowledge and skills of PE teachers. However, there is a need to situate learners at the heart of any decisions to be made regarding the curriculum and teachers on the ground are best placed to do this (Taba, 1962). Ecological Dynamics has been described as a learner-centred framework (Chow, 2007) and a way we can begin to re-conceptualise curriculum work from an Ecological Dynamics perspective is to think about:

- Coordination patterns in goal-directed behaviour emerging as an interaction between pupil, environment and tasks constraints (embedded within a curriculum) (Newell, 1986). These constraints are dynamic in nature and thus ever-changing.
- The landscape of affordances (Rietveld & Kiverstein, 2014) that are available to pick up across activities and within the curriculum. Is the landscape narrowed towards optimal solutions? Do pupils have the opportunity to explore the boundaries of the landscape? Does the curriculum reduce the landscape for certain pupils?
- The representativeness of the curriculum. Are the information sources available to pick up in the curriculum representative of the information sources that pupils will need to attune to in order to lead a healthy active lifestyle outside of school?

Curriculum NetWork: connecting the dots...

One of the theories underpinning Ecological Dynamics is Dynamical Systems Theory. Learning from this perspective occurs when there is a disruption (a new challenge or new knowledge) to the stability of the system (knowledge already learned). The pupil is now tasked with going through the process of (re)organising and (re)stabilising and it is this imbalance that is perceived as an important part of the process to create a new way of knowing (Ennis, 1992).

The idea of a Curriculum *NetWork* has some key features that take into account this perspective and will be discussed using examples. However, the first point of call is to highlight the importance of the term *NetWork* as opposed to *Unit of Work*. This term is purposely used to denote the interconnectedness of each component and, much like the previous description of learning, the *NetWork* is viewed as an **emergent process**.

To bring this to life, a teacher could see that a group is successfully stabilising or becoming more attuned to the area of focus (e.g., maintaining possession) in the Invasion *NetWork* example (see Figure 2) and this might be an ideal point to 'disrupt' and present a new topic (e.g., making forward progression) or a new context (e.g., maintain possession with a numerical disadvantage). Alternatively, after observations and discussion with a colleague(s), the teacher might decide that the group has not stabilised but would benefit from exploring the game from a new perspective as the pupils are becoming demotivated, hence the same path can be taken for different reasons.

The shift or transition is shaped by the behaviour that emerges during lessons as opposed to moving on to a new topic due to it being the designated week to do so. Thus, the curriculum *NetWork* should be viewed as a live document. Consequently, there is a need to factor in longer time frames for activity and be pragmatic with regards to the logistics of groups working in different time frames. However, this should not deter from the overarching intentions to individualise the curriculum to the needs of the pupils within the class.

The completed *NetWork Map* for Class 9X may (and possibly should) look different to the *NetWork Map* for Class 9Y. Conversely, it may look very similar but the time spent on a certain topic may differ considerably depending on the needs of the group.

Principles are chosen as the topics to be learned as they encourage perception and action to stay coupled and avoid the intention to design drills that are de-contextualised in nature. In the example *Invasion NetWork*, learning how to pass has a function and can be taught under the umbrella of maintaining possession, creating goal scoring opportunities or making forward progression, hence game understanding coupled with technical proficiency and skilful movement is embedded throughout and this has been noted to facilitate prolonged engagement (Storey & Butler, 2013).

Using the broad category of invasion games is another deliberate step in the curriculum pre-planning phase as it allows **flexibility** in the activities taught whilst having **stability** in the intended learning outcomes. As an example, you could have a handball and a football activity under the

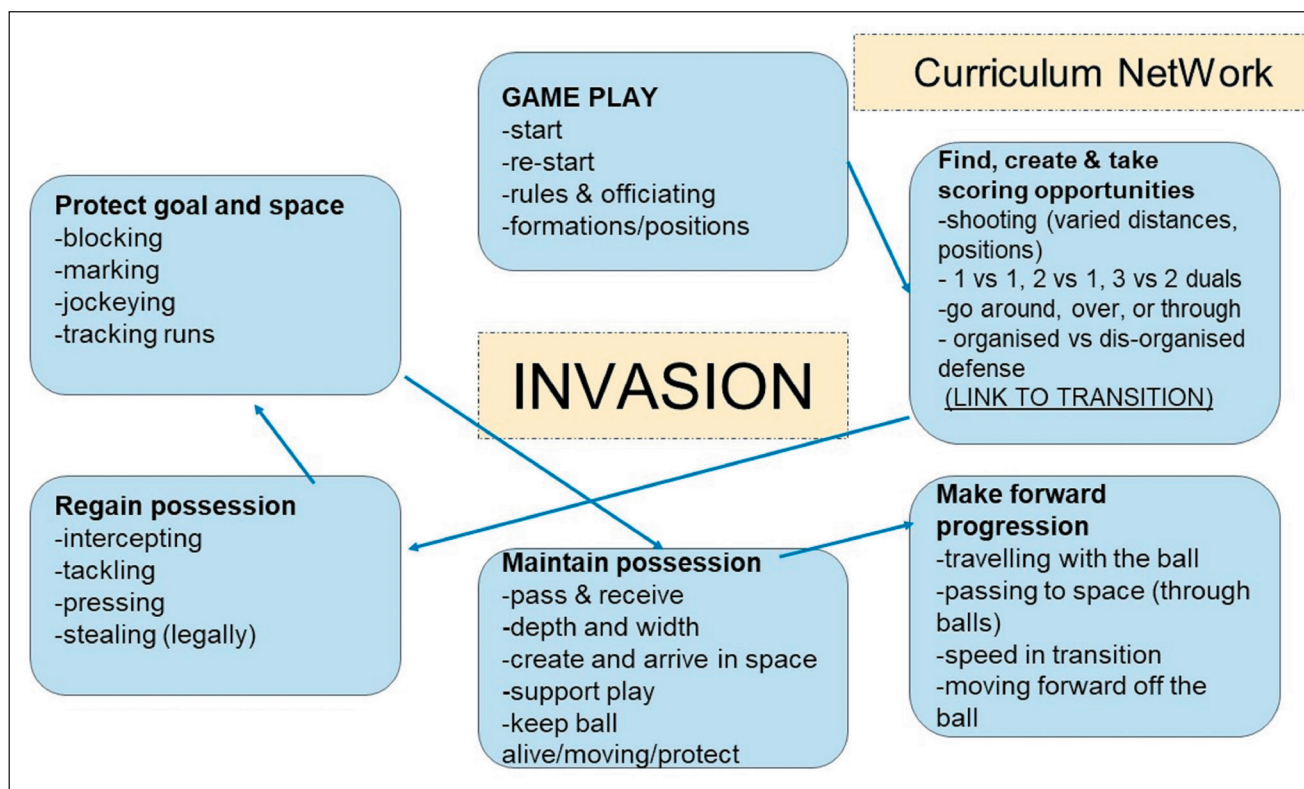


Figure 2: Invasion NetWork example.

umbrella of creating goal scoring opportunities all within the same lesson. This can be particularly useful for large groups with diverse abilities and motivations as it gives more options to **simplify tasks** and/or adapt lessons to the needs of all learners by **manipulating constraints** as well as providing **variability** in learning. Furthermore, the concept of skill adaptation is evident as pupils are afforded the opportunity to learn how to adapt their skills and develop an individualised functional relationship within different contexts (Araujo & Davids, 2011).

To maintain an alignment between the *Curriculum NetWork* and the broad learning intention denoted in the NCPE (2013) of *Developing a Healthy Active Lifestyle*, practitioners are also encouraged to take the *NetWork* outside of the school gates. This could be via community club links or simply educating the attention of pupils to local community spaces by having lessons situated in these spaces, hence PE is actively engaging in an educational experience that “leads out” (Rudd *et al.*, 2021). Of course, there are likely to be some logistical challenges with regards to leading out that need addressing and careful thought. However, if we espouse the value of the rewarding and enriching experiences pupils gain when we take them out for competitive fixtures or events, then we feel practitioners should strive to offer a similar experience to **all** pupils at some point in their school PE journey.




The example presented has a clear purpose to develop the knowledge and skills to engage in games within informal and/or organised settings. This is an important point as previous research (Sims *et al.*, 2022) has shown that the amount of informal physical activity decreases with age in both girls and boys, with an increase in organised sport mitigating this drop for boys but not for girls.

With the *NetWork* there is a path to take but this path is designed with flexibility to work with the nonlinearity of learning we have previously discussed. Effective teaching requires adaptation and “rather than fixing errors, teachers who believe that knowledge is complex and emergent might work to make sense of the web of associations that make up their learners’ interpretations and perceptions” (Butler *et al.*, 2014, p. 455). Going through the peaks and troughs of this suggested approach is a worthwhile form of professional development to develop one’s knowledge of PE in their context.

Nonlinear Pedagogy in practice: physical education

In this section, there is an opportunity to reflect on your current approaches to teaching PE across various contexts. For each context, the principles of Nonlinear Pedagogy have been considered and some potential actions explained. You may already be doing some of these without knowing that they are aligned to the principles of NP. The purpose of the table is to provide practical examples of the application of the principles and to act as a prompt to provoke thinking about your own practice. For each context, the shared strategies can be utilised to have an impact on the development of skilful performance and in building a greater *knowledge of the environment*. Lastly, it is important to note that practitioners do not need to use all of these principles at the same time, nor do they need to completely exclude typical pedagogical tools (e.g., demonstrating, feedback, instruction). On the contrary, the principles may give practitioners a clear purpose as to how, when and why these tools may be used to encourage the development of pupils’ *knowledge of the environment*. A useful analogy to think about is viewing the principles as a continuum to work back and forth from low to high depending on the needs of the interactions between the pupils and task in hand.

Nonlinear Pedagogy in practice: physical education

Activity / Sport	Representative Learning Environment	Attentional Focus	Functional Variability	Task Simplification
 <p>Tennis</p>	<p>Include ball flight information & information from the opponent.</p> <p>Is the ball being fed in the manner that is relevant to the task?</p> <p>Does the task allow the performer to be adaptable in shot selection/execution?</p> <p>Is the information from the opponent considered when making decisions?</p>	<p>Use external cues (analogies) when giving feedback.</p> <p>Tip of the racket pointing towards the sky (backswing).</p> <p>Hit the ball in the shape of a rainbow (ball flight over the net).</p> <p>Check the time on your watch (promoting a high finish on follow through).</p>	<p>Provide an opportunity for performers to explore different solutions, the use of variability can encourage this.</p> <p>This can be described as repetition without repetition – rather than repetition of a forehand topspin technique from a drop feed (static). Try an activity with opposition, where the aim is to hit the ball in a rainbow shape, aiming for the baseline.</p>	<p>Ensuring that all relevant information remains in place, you can scale and amend the equipment used. These can be changed independently or in combination.</p> <p>Short Handle Tennis Rackets</p> <p>Lower Compression Tennis Balls</p> <p>Smaller Sized Courts.</p>
 <p>Football</p>	<p>Reduce the use of blocked practice – coach-centred, technical drills, lines, and repetitive technique practice.</p> <p>How many times in a game will a player make an unopposed 10 yards pass? How many times will a player dribble around cones?</p> <p>Make it realistic – add opponents, add pressure, increase the opportunities for decision making.</p> <p>Using small sided games with task constraints is an approach that can support this.</p>	<p>Use external cues (analogies) when giving feedback.</p> <p>For example, you might describe a through-ball or pass between the lines as 'sliding the ball'. Which places a focus on the way the ball moves, rather than the technique.</p> <p>Or you might say; 'stand in a position where you can see both goals' for Centre Midfield positioning.</p> <p>Or using a mnemonic like BOTS when teaching scanning – where is the Ball, Opposition, Teammates, Space.</p>	<p>Introduce activities that do not force particular techniques or specific decisions to be made.</p> <p>Utilise tasks that provide problems for the performers to solve.</p> <p>This approach will encourage the performers to perceive information and provide their own solutions.</p> <p>For example, you might reward a team 2 goals if they regain possession in the opposition half. The performers will explore how and when to press. (rewarding a high press – without explicitly instructing them).</p>	<p>As previously mentioned, it is important to ensure that relevant information remains in place.</p> <p>However, it is possible to adapt and amend some aspects to simplify tasks.</p> <p>Pitch / Playing Area size.</p> <p>Number of players / density (space).</p> <p>Overloading teams.</p> <p>The size and number of goals.</p> <p>This information should be varied regularly and carefully managed in accordance with the intended outcomes.</p>
 <p>Orienteering</p>	<p>Remove the walls – in order to create an authentic experience with key information, orienteering experiences are incredibly rich when outdoors – playground, school field, town centre or the moors.</p> <p>Create fun and engaging activities that are relatable – perhaps through the use of gamification and trends – Pokemon Go, Hunger Games, Capture the Flag.</p> <p>There is some evidence that suggests confident orienteers will plan a route by focusing on attack points, rather than start points. So, you might consider the order that content is covered.</p>	<p>The perception of information is of vital importance in orienteering. How can information from the map and from the environment be used to inform decision making?</p> <p>Question participants about potential attack points, collecting features, aim off points and handrails. What do they look like on the map and within the environment?</p> <p>You may also encourage the students to pay attention to their bodies and their breathing when moving and to the environment supported by discussions about how their bodies and their breathing might impact decisions.</p>	<p>The problem-solving nature of orienteering lends itself nicely to functional variability. As individuals and as teams, there are vast strategies, skills and routes that could be utilised to be successful.</p> <p>You might explore a variety of surfaces to identify how this generates different running/scrambling styles.</p> <p>You might ask the teams/individuals questions such as; Is this the most efficient method? How might you do this differently? Are you utilising everyone's strengths?</p>	<p>As previously mentioned, it is important to ensure that relevant information remains in place.</p> <p>However, it is possible to adapt and amend some aspects to simplify tasks.</p> <p>Vary the support provided on team maps (additional information). Hints – key features highlighted.</p> <p>Increase/decrease the number of orienteers when using teams.</p> <p>Adapted routes.</p> <p>Additional drop in points.</p> <p>The use of technology and devices to support.</p> <p>Vary the visibility and accessibility of controls.</p>



Summary

The intention of this article is to introduce the principles of Nonlinear Pedagogy and provide examples of how some of the principles can inform curriculum design and lesson planning. The suggestions in this article have been created with real PE settings in mind and represent our attempt to translate theory to practice.

Previous research has found pupils developed higher levels of originality in their thinking as well as greater fluency and flexibility in their movement when principles of nonlinear pedagogy have been applied in learning activities (Richard *et al.*, 2018). However, NP is not a silver bullet and, as with anything in educational research, readers are encouraged to explore, expand and adapt these ideas to their own school context as there is no one way to teach PE effectively.

The idea that young people can develop their knowledge of movement through rich PE experiences is the key thread that runs throughout this and our previous article (see the summer 2022 edition of *Physical Education Matters*). Knowledge of movement emphasises a fit between a pupil and the environment and both

are ever-changing. NP has the potential to help young people to expand their *repertoire of movement competency* and thus become familiar with how their own physical literacy can be harnessed across different contexts (Chow *et al.*, 2021).

Our final article will focus on the manipulation of constraints. This principle of NP has gathered a lot of traction in sports coaching recently and we purposely left this out of the previous table to discuss in more detail and unpack how practitioners might use a constraints-led approach in physical education (Davids *et al.*, 2008; Renshaw *et al.*, 2019). ■

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