

## **Nonlinear Pedagogy and its implications for practice in the Singapore PE context**

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1 Abstract

2 Background

3 Nonlinear Pedagogy, underpinned by concepts in ecological dynamics, is a pedagogical  
4 framework that advocates an exploratory approach to acquisition of movement skills with an  
5 emphasis on individualised movement solutions. Its key principles have been successfully  
6 implemented in sports teaching and coaching and are currently being applied to learning  
7 designs in PE programmes.

8 Purposes

9 The purposes of the paper are to provide an overview of the theoretical underpinnings and  
10 practical implications of Nonlinear Pedagogy (NLP) for Physical Education (PE). We also  
11 seek to discuss how NLP is being implemented as a methodological framework for learning  
12 design in PE programmes of Singapore schools. Our analysis aims to focus on the ‘What’,  
13 ‘Why’ and ‘How’ of NLP to illustrate its application in Singapore PE programmes.

14 Discussion

15 Understanding the ‘What’ and ‘Why’ of NLP can provide a sound foundation to examine  
16 how this pedagogical framework can be applied in the school PE setting. While it is  
17 important for teachers to know what NLP is, the ‘Why’ of NLP, referencing its effectiveness  
18 as a pedagogical approach, can provide a rationale for its adoption to enhance teaching and  
19 learning. This paper seeks to exemplify the ‘How’ of NLP’s practical implementation in  
20 schools, which is of primary interest for teachers, managers and policy makers in education.

21 Conclusion

22 Key pedagogical principles from NLP can provide a platform for teachers to design effective  
23 lessons and practices to enhance learning in PE programmes. An important practical  
24 implication of the current paper is to provide educators with guidance for incorporating

1 pedagogical principles in NLP in lessons and learning programmes to enhance  
2 ‘nonlinearization’ of their current practices.  
3 Keywords: Nonlinear Pedagogy; Physical Education; Learning designs; Professional  
4 Development; Singapore education programmes.

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## 22 **Introduction**

23 Effective Physical Education (PE) programmes should encompass the development of  
24 an individual in the major domains of learning: psychomotor, cognitive and affective  
25 (Metzler, 2017). For example, in the Singapore PE context, one key goal pertains to how an  
26 individual should acquire a range of foundational movement skills that supports their  
27 functionality to participate in a variety of learning activities within the psychomotor domain  
28 (MOE, 2014). Unsurprisingly, skill acquisition has always been a topic of interest among

1 sports science support staff and practitioners like PE teachers and sports coaches as it  
2 provides the foundations on understanding how individuals move and engage with the  
3 surrounding environment on a daily basis. The benefits of developing effective approaches to  
4 enhancing skill acquisition and development of Physical Literacy goes beyond the realm of  
5 sports or physical activities in clubs and schools, playing an important role in helping  
6 individuals gain functionality in their movements. Importantly, there is a need for learners to  
7 use skills adaptively and transfer learning to different contexts across various activities,  
8 sports, games and outside of the school sports setting. For instance, Corlett and Mandigo  
9 (2013) described the principle of Physical Literacy as a construct that organizes our  
10 understanding of the experience of learning and performing of a wide range of activities and  
11 the whole person. The emphasis is more than just knowing how to perform basic movements  
12 but more importantly, to adapt and use these movement capabilities in authentic and more  
13 complex contexts. These ideas on Physical Literacy have been aligned with the ideas of  
14 Araújo and Davids (2011) on skilled negotiation of dynamic performance environments in  
15 sport and physical activity. In an ecological dynamics framework, these authors highlighted  
16 how the process of learning movement skills is not just about acquiring them as mental  
17 representations, but rather could be better described as skilled functional adaptations (Araújo  
18 and Davids 2011; Woods, McKeown, Rothwell, Araújo, Robertson and Davids 2020). More  
19 recently, these ideas have been implemented in PE contexts, addressing how Physical  
20 Literacy can be harnessed in developing skilled adaptation and movement functionality  
21 throughout the lifespan (see Rudd, Pesce, Stratford and Davids 2020; O’Sullivan, Davids,  
22 Woods, Rothwell and Rudd 2020).

23         The emphasis on Physical Literacy in PE, has thus created an inherent challenge for  
24 applied scientists, educators and practitioners to consider approaches that would best engage  
25 students in PE lessons (Lundvall, 2015). Importantly, there is a critical need to understand

1 how learners can take on a more active role in developing their own Physical Literacy to  
2 underpin skilled adaptation to dynamic performance environments throughout the lifespan.  
3 These foundational skills and experiences are needed to support teachers and coaches to  
4 facilitate learning by designing relevant activities and methods to channel learners to search  
5 and explore functional movement solutions (Button, Seifert, Chow, Araújo and Davids 2020).  
6 The level of autonomy given to learners and students in such settings, which are student- and  
7 learner-centred, would undoubtedly be higher, compared to learning contexts where the  
8 teacher prescribes specific movement templates for students to reproduce and adhere to  
9 (Moy, Renshaw, Davids and Brymer 2016). Thus, over the last decade, there has been  
10 increased interest in understanding processes behind exploratory learning, regarding  
11 practitioners as designers of practice (Chow, Davids, Button and Renshaw 2016; Correia,  
12 Carvalho, Araújo, Pereira and Davids 2019, Orth, Van der Kamp and Button 2019; Pinder  
13 and Renshaw 2019; Roberts, Newcombe and Davids 2019).

14 Nonlinear Pedagogy (NLP) is a pedagogical methodology that accounts for  
15 nonlinearities in individual learners, providing principles that govern effectiveness and  
16 efficacy in the learning process (Chow et al. 2016; Chow, Davids, Renshaw and Rudd 2020).  
17 Underpinned by concepts from Ecological Dynamics, NLP takes into account the critical  
18 learner-environment mutuality and advocates key pedagogical design principles that can  
19 address the inherent nonlinearity that is ever present in interactions of a complex system  
20 formed by each learner and a performance environment. Implementing these pedagogical  
21 design principles can help learners to adapt their goal-directed behaviours as conditions in a  
22 learning environment change, typically encountered in PE contexts. A rich understanding of  
23 this conceptual framework can provide practitioners with innovative learning design  
24 principles that can enhance learning for students engaged in PE (Chow and Atencio 2014). In  
25 recent years, interest in NLP has grown tremendously and significant attempts to understand

1 application of pedagogical principles of NLP in PE contexts have been published (e.g., Chow  
2 et al. 2016; Lee, Chow, Komar, Tan and Button 2014; Komar, Potdevin, Chollet and Seifert  
3 2019; Lee, Chow, Button and Tan 2017; Orth et al. 2019; Roberts et al. 2019).

4         The aim of this paper is to provide an overview of the theoretical underpinnings and  
5 practical implications of NLP for PE, exemplifying how it is being implemented as a  
6 methodological framework for physical educators to implement in learning designs in  
7 Singapore schools. Specifically, the paper focuses on the ‘What’, ‘Why’ and ‘How’ of NLP  
8 to present a coherent description of its application in the Singapore context. The ‘What’  
9 section outlines the design principles of a NLP. The ‘Why’ elaborates on the evidence that  
10 supports the potential effectiveness of NLP. Last, but not least, the ‘How’ presents a  
11 discourse on the ongoing educational initiatives to promote NLP to the PE community in the  
12 Singapore PE context. An attempt is also made to examine important practical implications to  
13 support teachers in incorporating pedagogical principles in NLP in their existing lessons to  
14 enhance ‘nonlinearization’ of their current practices. In the rest of this paper, we seek to  
15 provide a platform for applied scientists, educators, academics and practitioners to consider  
16 the relevance of NLP in making teaching and learning in PE more meaningful for the  
17 students in schools.

18

### 19 **What exactly is NLP?**

20         NLP is a pedagogical approach underpinned by concepts of Ecological Dynamics,  
21 adopting a Constraints-led Approach (CLA) as the methodological framework to help  
22 learners develop, explore and exploit a functional relationship with a performance  
23 environment (see Renshaw and Chow 2019). Key pedagogical design principles have been  
24 proposed to support how NLP could be enacted in teaching and learning contexts (Chow et  
25 al., 2016). At the centre of the approach lies the individual learner/student (see Figure 1). The

1 learner should be an active participant in the learning process and is empowered with the  
2 autonomy to search, explore and exploit individualised movement solutions (Button et al.  
3 2020; Chow 2013). It has been argued that enhancing Physical Literacy through PE is an  
4 important foundation of this empowerment process in learning, whether the learner is  
5 engaged in recreational or elite development programmes (Rudd et al. 2020; O’Sullivan et al.  
6 2020).

7  
8 \*\*\*Insert Figure 1 about here\*\*\*  
9

10 Learners in PE and sport have been conceptualised as nonlinear dynamical systems  
11 (Chow et al., 2016), demonstrating a myriad of behaviours in different learning  
12 environments. Chow, Davids, Hristovski, Araújo and Passos (2011) described some of these  
13 features of nonlinearity, relating how practitioners in sport may: i) observe non-proportionate  
14 changes in behavioural outcomes (e.g., practising for a long time does not necessarily lead to  
15 a pre-defined quantum of improvement; sometimes rapid jumps in learning can emerge from  
16 small periods of practice and small improvements may emerge from long periods of play and  
17 practice), ii) help learners develop multiple ways to accomplish a task goal, predicated on an  
18 individualised foundation of movement competencies (Hulteen Morgan, Barnett, Stodden and  
19 Lubans 2018) (e.g., one can throw a ball in different ways as long as an intended outcome is  
20 achieved: e.g., the learner hits an assigned target); iii) scale task constraints leading to the  
21 emergence of preferred (intended) behaviours (e.g., scaling the size of the ball can lead to  
22 different ways of catching it in a throw and catch game to encourage better understanding and  
23 experience of success); and iv), vary learning task designs to encourage learners to explore  
24 innovative movement behaviours that could be more functional. These characteristics of NLP  
25 demonstrate how properties of nonlinearity in learners may support the emergence of learning



1 in a PE setting. These inherent learning behaviours may form the basis of pedagogical  
2 methods that practitioners could design in lessons, games and activities to exploit inherent  
3 nonlinearity (Chow and Atencio 2014; Ovens, Hopper and Butler 2013).

4 It has been proposed that a rich understanding of key concepts of ecological dynamics  
5 can provide a solid conceptual framework for practitioners to develop innovative learning  
6 design principles that can enhance skill in individuals (Chow et al. 2016). What are these key  
7 concepts and how can they be translated into design principles for physical educators?

8 One of the key features of NLP is the focus on designing representative learning  
9 contexts with a purpose in mind (framing learner intentionality) (Chow, Davids, Renshaw  
10 and Rudd 2020). The design of **Representative learning environments** for learners requires  
11 a deep understanding of the information that constrains actions so that affordances available  
12 in a performance environment (defined as invitations for actions by Withagen, De Poel,  
13 Araújo and Pepping 2012) may be utilised to help individual learners to achieve intended task  
14 goals (for a more detailed explanation see Chow et al. 2020). Representative learning design  
15 (Button et al., 2020) is based on long-standing specificity of learning principles (see Henry,  
16 1958). The critical thinking behind creating representative learning environment is to  
17 replicate and include relevant information and invitations for actions in specific play and  
18 learning activities in PE classes (Chow et al., 2020). Taking the example of a territorial game  
19 in the Singapore PE context (MOE, 2014), if a lesson objective in football (or soccer) is to  
20 maintain ball possession where the learning outcome is to send the ball to a teammate in a  
21 supporting position (and for off-the ball attacker to move and be ready to receive), the ability  
22 to pass and receive would be key learning. A passing drill where students are stationary,  
23 conducted in the absence of any pressure from opponents, can merely allow for success in  
24 replication and reproduction of a passing technique. However, practice and performance in  
25 this more static learning environment would not be representative of whether students could

1 perform the task in an actual game context. The passing drill without an opponent could be  
2 representative if that was the intended outcome (i.e., if the performance goal was merely to  
3 reproduce and complete passing actions between isolated teammates without the presence of  
4 field markings and defenders). But the pass is a component within a game, which contains  
5 information in the form of the location of active defenders, restrictive field markings and  
6 intended outcomes, such as to advance upfield and score goals. At least some of these task  
7 constraints need to be present in practice designs rather quickly for learners. Perhaps a 3v1 or  
8 5v2 possession game may be designed to encourage passing and receiving between learners  
9 in the team with the ball. This type of representative design would present relevant  
10 information and thus affordances for the learners to perceive and use while trying to keep ball  
11 possession under defensive pressure (maintaining a focus on transfer of passing and receiving  
12 actions to a competitive game). From a NLP approach, the emphasis is on supporting learners  
13 to become familiar (or attune) to the nature of the information supporting interactions  
14 between themselves and the practice environment (see Renshaw, Araújo, Button, Chow,  
15 Davids and Moy 2016). The more representative a learning task is, the more specific is the  
16 replication of information between the learning task and the performance environment. In PE  
17 classes, teachers need to explore different learning tasks, varying in representative design  
18 (e.g., manipulating key constraints such as playing area dimensions, numbers of learners  
19 involved and task goals), depending on the skills, capacities and experience levels of the  
20 learners. Establishing *representativeness* in the learning context is the ultimate learning  
21 objective that the teacher would like to achieve with the learners, to enhance their  
22 functionality.

23         A major challenge for PE teachers is to understand how to help learners explore  
24 available affordances (opportunities or invitations for actions) that can be used to achieve  
25 their intended learning goals, such as maintaining ball possession by completing accurate

1 passes between team members. This is a fundamental aspect of skill acquisition from a NLP  
2 perspective (Chow et al. 2016). How can PE teachers design relevant affordances into a  
3 learning activity to help learners perceive and use them to functionally adapt their actions?  
4 Chow, Davids, Shuttleworth and Araújo (2020) discussed how the micro-structure of practice  
5 (i.e., the critical features of learning tasks that are shaped in every lesson, each day and each  
6 week by PE teachers) theoretically contains a rich landscape of affordances, capturing  
7 available opportunities for action for a learner. The teacher has the knowledge, skills and  
8 experience in PE to design learning practices where affordances can range from narrow and  
9 limited in variability at one end (constrained by prescription and instructional constraints of a  
10 coach or teacher) to extensively (e.g., randomly) varied at the other end (as captured in  
11 unstructured practice environments or when tasks are designed to facilitate exploratory  
12 behaviours and discovery learning) (see Chow, Davids, Shuttleworth et al. 2020). The design  
13 choices of the teacher, in terms of where to situate the practice in this continuum, has an  
14 impact on the kind of behaviours that the learners may eventually explore, discover and  
15 exploit in learning. The teacher has to decide on what affordances could be adapted and  
16 acquired by the learner and, therefore, what representative learning contexts should be  
17 designed.

18         The second key pedagogical principle of NLP relates to **constraints manipulation**  
19 which basically underlies and supports many of the other design principles. Manipulating  
20 interacting constraints related to the learner, task and environment is the key methodological  
21 tool underpinning the CLA which can be used to support learning by PE teachers and sports  
22 coaches. For example, creating a representative learning environment requires the carefully-  
23 considered manipulation of task constraints such as equipment, space, rules and task goals.  
24 The manipulation of equipment could be used by PE teachers to reduce the spatial and  
25 temporal challenges faced by learners. Scaled manipulation of constraints also allows self-

1 adjusted behaviours to emerge (i.e., exploiting inherent self-organisation tendencies in the  
2 learner). In NLP, teachers and coaches are considered learning designers (Button et al. 2020;  
3 Woods et al. 2020; Rudd et al., 2020; O’Sullivan et al., 2020). Scaling the parameters of task  
4 constraints from one level to the next, helps to engage learners to search and exploit  
5 innovative, exploratory movement behaviours in the absence of prescriptive top-down  
6 instructions by the teacher. For example, when the playing dimension of a 3v1 possession  
7 game of football is progressively scaled from a larger to smaller area, the passing and  
8 receiving behaviours of learners could progress from one where the players just have to shift  
9 minimally to keep possession (i.e., maintaining channels of passes) to the challenge of  
10 making quick scanning movements to look for space and play fast/short/accurate passes to  
11 keep the ball away from an immediate defender. Scaling of ball sizes from small to big or  
12 vice versa could also encourage different throw and catch behaviours in learners using single  
13 and two limbs. Similarly, scaling the length of a bat can afford different swinging movement  
14 solutions in striking games. Critically, PE teachers could be made more cognizant through the  
15 understanding of the key principle of constraints manipulation to design practices that support  
16 exploratory learning.

17       **Task simplification** rather than task decomposition is another key design principle of  
18 NLP since the way that a teacher organises a learning task can influence skill acquisition in  
19 learners. Ecological dynamics advocates that learners need to develop and maintain strong  
20 functional couplings of information and actions, gradually strengthened during learning. In a  
21 representative learning context, information is directly perceivable to be picked-up by  
22 individual learners to constrain their actions (Chow et al. 2016; Button et al., 2020). It has  
23 been argued that perception is, therefore, a process of searching for ‘specifying’ information  
24 that can be used to regulate actions and guide the generation of functional movement  
25 solutions (Chow, Davids, Shuttleworth et al. 2020). Task simplification is a principle that

1 helps learners seek, explore and maintain information and action relationships in task designs.  
2 It has relevance to the principle of constraints manipulation as the scaling of constraints by a  
3 teacher can allow for greater simplification of a produced movement (exemplified by the  
4 scaling of playing area dimensions or tennis racket and ball compression properties in mini-  
5 tennis games for children: see Fitzpatrick, Davids and Stone 2018). Importantly, task  
6 simplification supports learners in moving flexibility to explore the environment and generate  
7 more information that can be subsequently used for regulating performance but without  
8 compromising on the relevance of the intended learning objective in PE (i.e., it cannot be so  
9 simplified to the point where it is not meaningful for the learner) (Tan, Chow and Davids  
10 2012).

11 Another key pedagogical principle relates to **informational constraints** where  
12 attentional focus on augmented information such as feedback and instructions could either  
13 emphasise the movement form or movement effect (Chow 2013). When the augmented  
14 information provided by a teacher is focused on a certain expected movement form, there is  
15 greater likelihood of an overly conscious control of movement solutions to movement  
16 problems in a learning context (Chow, Davids, Shuttleworth et al. 2020). Providing specific  
17 verbal instructions on an optimal movement form can be counter-productive because it solves  
18 the movement problem for the learner and it typically fails to account for differences in  
19 individual constraints. In contrast, instructions that do not solve specific problems for learners  
20 but instead focus on movement outcomes (e.g., trajectory of ball flight, finding the biggest  
21 space in an area) can encourage learners to explore new and different solutions to solve a  
22 movement problem, achieving the same movement outcome in different ways. Critically,  
23 learners can become attuned to the impact that such key informational constraints can have  
24 on movement outcomes, supporting the exploration of movement problems in the specific  
25 learning context.

1           Given this emphasis on the nature of augmented information from teachers that help  
2 learners discover and explore different movement solutions, the inclusion of **variability in**  
3 **practice** provides a functional role in supporting the emergence of adaptive exploratory  
4 behaviours. From an Ecological Dynamics perspective, variability is not seen as something  
5 that is undesirable in motor learning and performance. Rather, variability is critical to allow a  
6 system to explore transitions to new behavioural patterns (Davids, Bennett and Newell 2006).  
7 With reference to human movement systems, variability is an important feature to support  
8 skill adaptation to occur (Button et al. 2020; Hacques, Komar, Dicks and Seifert 2020).  
9 Opportunities to explore movement variability in practice can be facilitated by effective task  
10 constraints manipulation to allow for students in PE classes to experience different conditions  
11 under which a skill can be learned. This aim could be achieved by requiring the learner to  
12 explore objects differing in material composition, mass, dimensions, and shapes, during play  
13 activities for moving them from one area to another. The use of small-sided games in PE  
14 (e.g., 2v2 or 5v5) will incorporate inherent levels of variability in the practice as game  
15 situations are dynamic in nature and possess higher levels of uncertainty due to the need to  
16 consider the actions of others (teammates and opponents). There is no need for high levels of  
17 variability in practice all the time, especially when a learner is seeking to stabilise the  
18 coupling of information and action. The amount of variability designed into a play activity or  
19 learning game by a teacher needs to be considered with regards to possible movement  
20 solutions that could be functional for learners to achieve an intended task goal. Search and  
21 exploratory behaviours should typically be guided by teachers in PE lessons and skilful  
22 design of task constraints manipulation will be essential to help learners engage in  
23 meaningful exploratory behaviours. Such behaviours are important and can support the  
24 learners to become better attuned to information that matches the environmental properties  
25 and the learner's own action capabilities (Hacques et al. 2020). This in turn could facilitate

1 transfer of skills to different performance situations and this is indeed aligned to one of the  
2 key objectives of PE: to be able to transfer the use of a range of movement skills to more  
3 diverse contexts. A key challenge for educators is to consider how to manipulate the amount  
4 of variability (in individual, task or environmental constraints) within and between learning  
5 sessions to challenge individual learners and enhance their self-regulatory capacities, rather  
6 than over-rely on the coach or teacher (Chow, Teo-Koh, Tan, Tan, Button, Kapur and Choo  
7 2019).

8         These fundamental pedagogical principles of NLP provide a framework for  
9 practitioners to consider when designing effective PE lessons to account for nonlinearity in  
10 the trajectory of learners. In recent years, there has been some empirical work on NLP  
11 conducted in school settings, although it is important for more to be done in the future.  
12 Notably, Lee et al. (2014) conducted a study involving 24, Primary level 4 children (10 year  
13 olds) and presented learning activities that were either NLP or a pedagogical approach  
14 focused on drills to develop consistency to an expected movement form (termed as Linear  
15 Pedagogy in the study). The skill that was taught to the children was the tennis forehand  
16 groundstroke and the children were placed in either the Nonlinear or Linear pedagogy group  
17 with the intervention period lasting 4 weeks in the school context. It was found that the NLP  
18 group performed just as well as the Linear pedagogy group despite the absence of specific  
19 instructions on expected optimal technique for the tennis stroke. More interestingly, the NLP  
20 group displayed a greater number of movement behaviours to achieve the same performance  
21 outcome. That is, a greater variety of movement solutions emerged in the NLP group and  
22 they did not necessarily match those seen to be ‘optimal, accepted’ movement forms for a  
23 tennis forehand groundstroke. Findings from Lee et al. (2014) challenged the notion that  
24 there is only one ideal movement solution for a task, suggesting that the design principles of

1 NLP have value in engaging learners differently to harness their individual performer  
2 constraints in relation to the task and environment constraints.

3 Moving forward in terms of empirical work, there is an impetus to undertake more  
4 work situated within the school PE context to examine how teaching and learning occurs with  
5 NLP.

6

### 7 **The ‘Why’ of NLP**

8 In a recent study examining the impact of NLP on the adaptation of fundamental  
9 movement skills by children (n=187, 8 years old) in two Singapore schools, it was found that  
10 the learning of students who were presented with an NLP intervention (lasting 8 weeks  
11 during the PE lessons) was at least as good as that in the Linear Pedagogy condition or better  
12 (Chow et al., 2019) based on data from TGMD-2 results. Specifically, the students in the  
13 NLP condition achieved higher scores for running and stationary dribbling at a post-test  
14 session, as well as elevation of scores for the overhand throw between post to pre-test  
15 sessions. Referencing the Validated Developmental Sequences (Gallahue and Ozmun 2012),  
16 it was also determined that there was a greater transition in terms of percentage of students  
17 from Elementary Stage to Mature Stage for the skills of sliding and stationary dribble from  
18 pre to post test for the NLP group, compared to the Linear Pedagogy group. Further interview  
19 data of both students and teachers also found perceptions that the learning processes differed  
20 qualitatively between the Nonlinear and Linear Pedagogy conditions. Students presented with  
21 the NLP intervention demonstrated behaviours that showed greater exploration in their  
22 learning (i.e., trying different movement solutions in representative learning tasks that are not  
23 overly prescriptive). Nevertheless, some of the teachers involved in the study responded that,  
24 while NLP seemed to encourage more active learning on the part of the students, some form



1 of inclusion of Linear Pedagogy type instructions may still be relevant (i.e., consider a  
2 Nonlinear-Linear Pedagogy hybrid approach).

3 In another study that examined the impact of an intervention programme based on  
4 Nonlinear Pedagogical principles on enhancing movement creativity among 140 fourth-grade  
5 students, it was found that children in the creative programme demonstrated higher  
6 originality in thinking and improved fluency as well as flexibility in their movement  
7 (Richard, Lebeau, Becker, Boiangin and Tenenbaum 2018). Specifically, the students were  
8 involved in a 3-month intervention programme where NLP design principles such as relating  
9 to enhancing variability in practice, providing problem-solving possibilities, using  
10 imagination and creating opportunities to challenge the students to try different movement  
11 solutions underpinned the creative intervention condition. This school-based empirical study  
12 provided valuable evidence on the relevance of meaningful manipulation of constraints and  
13 improvisation as key pillars to develop creativity among children. In brief, findings from  
14 Chow et al. (2019) and Richard et al. (2018) are recent examples of the promise that NLP  
15 holds and more of such empirical research needs to be conducted in schools.

16 The above findings create questions whether NLP has relevance for learning designs  
17 in movement skills that are not related to ball games such as tennis, basketball and football.  
18 Komar et al. (2014), in a pedagogical setting, showed that in early learning, merely practising  
19 breaststroke, through guided discovery learning, without any continuous pedagogical support,  
20 led to an improvement in performance after two months. Moreover, this improvement in  
21 swimming performance was not different to outcomes of other groups who received  
22 prescriptive instructions from a teacher about how to swim more efficiently or NLP  
23 intervention groups who received some augmented information through analogy and specific  
24 focus of attention during their practice, applying principles of NLP without any prescription  
25 of an ideal technique to imitate. On one hand, the performance improvement in the control

1 group was due to an optimization of the initial behaviour instead of the adoption of a more  
2 efficient one. For instance, the control group swimmers may have increased their force  
3 impulse during arm or leg propulsion in order to counteract the higher water resistances due  
4 to their inefficient movements. On the other hand, the effectiveness of NLP appeared through  
5 the adoption of an efficient movement behaviour by the students, which seems to be critical  
6 for acquiring deeper expertise and then reaching the highest stages of learning with later  
7 practice (Newell 1986). With reference to learning in a PE setting, these findings bode well  
8 for considering the need to guide the discovery of students to explore a diverse array of  
9 movement solutions. Rather than focusing too much on specific performance outcomes being  
10 reproduced, it could be more relevant to observe how students can be guided to use the  
11 movements that they have acquired for other physical activity contexts.

12         A recent study based in a school environment provided some insights on the value of  
13 the exploratory learning process. In a wall-climbing context, the amount of visible holds was  
14 modified during the ascent to help beginners rely on information that contributed to  
15 perception of affordances (Komar, Ding and Iodice 2020). With the use of an electronic  
16 climbing wall, the holds available in the route only appeared one step at a time during the  
17 climb. The number of holds that were visible by the climber for each ascent changed from  
18 one visible hold during the ascent to six visible holds. For instance in the first ascent, the  
19 climber was able to see only the next hold he can use, and once he touched this hold, the next  
20 one appeared, and so on until he reached the top of the wall. Preliminary results showed that  
21 compared to more experienced climbers, novices were impacted by the reduction in visible  
22 holds only when the visibility was reduced to one and two holds. For the more experienced  
23 climbers, performance was already impacted when the visibility was reduced to four holds or  
24 less (Komar et al 2020). This result highlighted that experienced climbers utilised more holds  
25 as useful information to perceive their action capabilities or affordances. Learning is not

1 about accumulating information across trials but rather generating and exploiting useful  
2 information for action. Interventions must lead performers to learn to explore rather than  
3 learning a predetermined model of skill based on an expert ideation (Hacques et al. 2020).  
4 Such exploratory behaviours are very pertinent to more effectively support learning on the  
5 part of the students. Exploration is messy and may result in the emergence of some irrelevant  
6 behaviours with reference to the expected task goal. However, it is through such exploration  
7 that the learner is able to search and experience what would work and what may not work.  
8 But importantly, this is actually when learning is taking place (i.e., the learning objective) and  
9 this will assist the learner to discover relevant information that underpins effective  
10 performance eventually. Again, the implication here for PE is about encouraging our students  
11 to become familiar with how their own Physical Literacy can be harnessed across different  
12 contexts. Designing learning activities in PE where there is meaningful representativeness to  
13 help students be attuned to the information and their corresponding actions would broaden  
14 their repertoire of movement competency that is more transferable to other movement  
15 contexts. This broadening ‘competency’ could also extend beyond movement as one can  
16 imagine how students may have the opportunity to reflect on and appreciate the value of  
17 moving and perhaps not constrained to move in a predetermined manner. This would possibly  
18 be appreciated by students who may inherently find the learning of movement skills more  
19 challenging and the removal of the threat to replicate some expected movement form could  
20 provide that safe environment to explore their own individualised movement solutions.

21         Some researchers have presented exploratory learning as a continuum, namely as a  
22 balance between exploration and stabilization rather than merely an expression of increased  
23 variability between two different behaviors (see Pacheco and Newell 2015). There seems to  
24 be an existence of an optimal balance between exploring and stabilizing movement patterns  
25 during learning for better learning outcomes (Pacheco and Newell 2015). In learning to swim

1 in PE, Komar et al. (2019) quantified the ratio between exploration and exploitation and the  
2 effect of different informational constraints following NLP principles. The authors showed  
3 that both the level of exploration and the nature of this exploration (i.e., which behaviours are  
4 explored) were highly individualised. During a learning intervention that lasted two months,  
5 it was shown that learners can successively use and explore up to 11 different behaviours  
6 before settling on a final functional movement solution. Most importantly, although the final  
7 movement solutions appeared more efficient than the initial ones, there was not a single  
8 unique movement solution preferred by all the learners at the end of the learning period  
9 despite achieving the same performance level. The application of NLP principles increased  
10 the level of exploration during learning that eventually led to a certain conformity of  
11 movement solutions that are aligned to general biomechanical principles of efficiency but  
12 with some individualized features (Komar, Sanders, Chollet and Seifert 2014). Learners  
13 should be given the opportunity to safely explore individual movement solutions and to be  
14 guided toward more reliable and functional information for action (Hacques et al. 2020).  
15 Notably, learning interventions underpinned by NLP principles may promote the discovery of  
16 exploratory actions that enhance the transfer of perceptual-motor skills.

17         Undoubtedly, the interest is in how NLP principles could be enacted in the school  
18 setting. How can teachers learn about NLP and how can they be supported to deliver NLP  
19 approach in the schools? In the following section, we discuss on how NLP is shared with  
20 teachers in the Singapore PE context.

21

## 22 **The ‘How’ of NLP in the Singapore context: Working with teachers in the schools to** 23 **implement NLP in professional practice**

24         If NLP principles are to be understood and adopted in professional practice, there  
25 needs to be significant professional development programmes to prepare teachers and

1 coaches on how to use them effectively in organised PE and sports contexts respectively. In  
2 this section we seek to provide insights from an example of how NLP is being enacted in  
3 schools as a form of Professional Development and the initiatives put in place to encourage  
4 the implementation of NLP in Singapore. One of the key organisations within the PE  
5 professional community in the Ministry of Education (Singapore), is the PE and Sports  
6 Teacher Academy (PESTA). The academy is dedicated to the professional development of  
7 PE and Sports teachers in Singapore. It serves to enhance the professional development and  
8 practice of PE teachers and to strengthen their capacity to deliver quality PE lessons and  
9 sports coaching through its professional development programmes, mentoring opportunities  
10 and networks.

11           While PE teachers in Singapore are more familiar with the Teaching Games for  
12 Understanding and Games-Centered Approaches, PESTA recognizes NLP's relevance and  
13 application to meet the purpose of the Ministry of Education (MOE) PE Syllabus, that is, “to  
14 enable students to demonstrate individual and with others, the physical skills, practices and  
15 values to enjoy a lifetime of active, healthy living.” (MOE, 2014, p. 1). The principles of  
16 NLP have the potential to augment and enhance Singapore PE teachers' pedagogical  
17 knowledge and skills for student-centred approaches, for more effective delivery of the PE  
18 Syllabus and sports coaching. Undoubtedly, there is also a need for more studies to be  
19 undertaken with reference to understanding the relationship between learning, NLP and  
20 enjoyment (or other concepts related to emotion development and motivation regulation in  
21 PE). Notably, exploration may be the key factor in increasing enthusiasm among learners and  
22 where the learner-environment interaction is critical in supporting learning (see Säfvenbom &  
23 Stjernvang 2020).

1           With the PE community that is relatively new to NLP, PESTA harnessed its officers  
2 who have been involved in collaborative research projects with the PE and Sports Science  
3 Department at the National Institute of Education on NLP. PESTA looked to work with  
4 teachers on NLP through a variety of professional development programmes designed to  
5 introduce NLP, deepen their knowledge and hone their teaching skills, through workshops,  
6 school support, and also sharing at zonal, cluster levels, networks and conferences (e.g.,  
7 Professional Learning Zones, Teachers' Conference 2019, Coach Singapore Conference  
8 2019). In this section, we would briefly highlight two key programmes of PESTA for NLP  
9 work with teachers.

#### 10 ***Visiting Fellowship***

11           A key programme for NLP was the engagement of Professor Keith Davids, as  
12 Visiting Fellow in 2019, for a period of 3 weeks. The overall aim of the programme of  
13 interactive presentations was to interact with delegates and provide information on the  
14 principles of NLP as well as the theoretical and practical implications of NLP. Importantly,  
15 valuable insights were shared on how the approach can be adopted effectively to the teaching  
16 of games, sports and physical activities, in the delivery of the 2014 PE Syllabus, to teachers,  
17 coaches, educators, administrators and even staff and students of higher education institutions  
18 in Singapore. During the Visiting Fellowship, there was a good balance of time spent in  
19 workshops, presentations, meetings, one-to-one discussions and observations of PE teachers  
20 at school sites, and follow-ups, to provide context for the Visiting Fellow.

21           The Visiting Fellow's sharing of key principles of NLP was well-received by a range  
22 of professional practitioners. Feedback from masterclass participants indicated that they  
23 found the NLP masterclasses beneficial and that the 'new' pedagogy was thought-provoking,  
24 insightful and enlightening. Participants found NLP to be refreshing and viewed NLP as a

1 very useful pedagogy to drive learning that encourages problem-solving. Responses to what  
2 useful ideas that participants would like to apply and how they plan to implement them  
3 showed participants' intention to apply the key pedagogical principles in designing  
4 meaningful and engaging tasks to suit the different needs of students in PE and co-curricular  
5 activities; several professional practitioners indicated they would apply them for their lessons  
6 as well as to share with their colleagues. In general, participants could see the relevance of  
7 the key principles as a guide for their planning and teaching. The participants shared how it is  
8 important to give students autonomy than to be overly prescriptive in designing learning  
9 experiences.

10 Teachers involved in the school visits by the Visiting Fellow were appreciative of the  
11 opportunity to be involved in the rich dialogue which promoted reflections and useful  
12 takeaways for their PE lessons and/or coaching sessions. Teachers reflected how they viewed  
13 NLP as a powerful tool in capturing students' movement and designing effective PE lessons  
14 and how the sharing by the Visiting Fellow helped them to review their approaches in re-  
15 designing their lessons. Some teachers also shared how NLP gives them a framework which  
16 they can use to bridge that cognitive (tactical ideas) and physical (actions) gap through the  
17 thoughtful design of affordances.

### 18 ***PESTA workshops and school support***

19 NLP workshop was also planned for teachers as part of PESTA's Professional  
20 Development initiative prior to the Visiting Fellow programme. Initially presented as part of  
21 a 1-day workshop to introduce NLP, it was extended to a full day workshop to provide more  
22 practical/ hands-on application for better theory-practice link. The purpose of the workshop  
23 was to provide an introduction to NLP and application of its pedagogical principles in  
24 designing lead-up and modified activities/games. Similar to feedback provided in

1 masterclasses by Visiting Fellow, participants found the approach, which is grounded in  
2 theory, very useful to teaching.

3 Some participants indicated their willingness to apply the learning and shared how the  
4 design principles for NLP definitely gave them the drive of wanting to design and then try out  
5 in their lessons, to explore whether the design work in enabling students to achieve the  
6 learning outcomes. They reflected that there was more focus on the learning outcomes rather  
7 than on one size fits all type of repetitive drills that could limit students in exploring how to  
8 play as well as enjoy the game.

9 To enhance the important link between theory and practice in the application of NLP,  
10 school-based collaboration by PESTA officers has also been planned to provide support,  
11 advice and mentorship to encourage PE teachers who have been introduced to NLP to  
12 become more effective learning designers, based on the NLP pedagogical principles. Initial  
13 effort with school-based collaboration was with two teachers from two schools (one primary  
14 and one secondary) by a PESTA Master Teacher. These school collaborations, which were on  
15 a weekly basis over 3-5 weeks, were based on a co-building and co-learning process; the  
16 format involved pre-post lesson discussions, lesson observations, co-planning and co-  
17 teaching. Such an approach has been evidenced as effective in a study by Moy, Renshaw,  
18 Davids and Brymer (2016) on how receptive student teachers are to alternative pedagogical  
19 approaches like NLP. Their findings suggested that opportunities to experience and observe  
20 NLP in action facilitates the student teachers' perception of the effectiveness of NLP.

21 The feedback from the teachers involved was generally positive, supporting the useful  
22 application of NLP's principles in their learning design. The teachers shared how the  
23 mentorship and the adoption of a co-plan/teach arrangement by the Master Teacher helped  
24 them to be more critical in their task designs and to think deeper about its intent or



1 application in teaching contexts. For example, one teacher shared how her younger pupils in  
2 Primary 4 understood quickly the concept of moving into space for a clear line of pass when  
3 she demonstrated these necessary spatial relations between passer and receiver with a laser  
4 pointer and she would continue to use this idea in teaching this concept. This example based  
5 on the key idea of external attentional focus, supports the power of a visual tool; it led her to  
6 think of and use more analogies (e.g., Captain America shield) for her lessons to help her  
7 pupils grasp concepts better and faster.

8         The co-planning/teaching approach, as mentioned by the teacher, may have been a  
9 reason why both pairs of teachers involved in the collaborations at two schools, did not  
10 surface the key challenges highlighted by Chow (2013). Chow (2013) highlighted key  
11 challenges such as ‘level of expertise and competency of practitioner’ and ‘question of time’  
12 in implementing a NLP approach. It was noted that learning of movement skills situated  
13 within a game setting can create a huge pressure on the teacher as he/she needs to know how  
14 to manipulate appropriate task constraints to encourage the emergence of desirable movement  
15 behaviours that are individually functional and also to be able to identify teachable moments.  
16 The co-planning/teaching approach, may have provided support for the two pairs of teachers  
17 facing those challenges. One of the teachers shared how the whole process of their learning  
18 was always facilitated by a lot of questioning from the Master Teacher from the planning  
19 phase to the reflection phase. The process used by the Master Teacher in her facilitating the  
20 teachers’ learning with questions to enhance their reflective skills in applying the NLP  
21 pedagogical principles in learning designs seemed to have help model how the NLP approach  
22 can be applied effectively in planning and implementation of lessons to enhance student  
23 learning. This, together with mutual support in their planning and implementation of NLP,  
24 could have contributed towards more appropriate manipulation of task constraints where

1 exploratory learning can be properly channelled for functional movement solutions to  
2 emerge.

3 In brief, it can be seen that a multi-pronged approach could be a sensible way to  
4 encourage the use of new initiatives/ pedagogical practices. Inviting external international  
5 experts in NLP coupled with strong and sustained local support in the form of mentoring,  
6 school-based collaboration and co-planning/teaching of NLP lessons can build a strong  
7 foundation for NLP within the PE landscape. Through the close support and partnership  
8 between the Ministry and the schools, effective professional development can be enacted.  
9 Critically, the effective sharing of NLP concepts/framework has made it possible for PE and  
10 coaches to re-consider practical ways in which they can (re)design PE and Co-curricular  
11 Activities programmes. It can potentially positively impact student learning and development  
12 through teachers'/practitioners' purposeful lesson planning and preparation, content and  
13 pedagogy, using the NLP concepts/pedagogical principles. NLP can possibly enhance current  
14 professional development and 'nonlinearize' practice of PE teachers and to strengthen their  
15 capacity to deliver quality PE lessons and sports coaching.

## 16 **Conclusion**

17 Empirical work and publications relevant to ideas of NLP have increased significantly  
18 in the past decade. This re-emphasis is testament to the interest that it has garnered in helping  
19 applied scientists and educational practitioners to enhance teaching from a learning design  
20 perspective. This update has hopefully provided further knowledge to trigger more discussion  
21 and thinking about the relevance of NLP to enhance learning in PE contexts. On a broader  
22 scale, some of the features of NLP could also be relevant or associated with other approaches  
23 to teaching (e.g., TGfU or Games Concept Approach) even though there may still be  
24 fundamental differences across various pedagogical approaches. The ability to make

1 connections could be useful for academics and practitioners in enhancing teaching and  
2 learning in the longer term. However, it is still critical to be cognisant that the theoretical  
3 underpinnings for NLP would be quite different from another like TGfU although there may  
4 be some perceived similarities on the surface (see Renshaw et al. 2016).

5         Undoubtedly, there are inherent challenges in this area of work and specifically, there  
6 is a need for more empirical studies in representative environment (schools and sports  
7 contexts respectively) to further examine its potential impact on teaching and learning within  
8 a PE setting. Critically, while we have presented examples where NLP is relevant to a PE  
9 domain, there is acknowledgement that more studies could be undertaken to examine the  
10 value of NLP in eliciting meaningfulness or joy in being involved in movement activities. It  
11 is also possible that game sports tend to dominate in PE although fundamental movement  
12 skills are covered comprehensively at the lower grades at the Primary School level. The  
13 teaching and learning of fundamental movement skills could also move away from being  
14 overly prescriptive on an optimal movement form which may be the typical expectation.  
15 Clearly more work is required to examine the impact of NLP on explorative aesthetic  
16 activities such as dance or parkour and how NLP may actually provide the bandwidth for  
17 students to be involved in more exploratory search for individualised movement solutions.  
18 Key questions of transfer of learning also remain as we begin to explore how specificity of  
19 practice designs can lead to different types of transfer of learning in sport, play, and PE (see  
20 Chow, Davids, Shuttleworth et al. 2020).

21

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Figure Captions

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Figure 1. Nonlinear Pedagogy framework

1 **Response to reviewers**

2 Thank you for the affirmation that the revision undertaken previously have significantly  
3 improved the manuscript to be accepted for publication in PESP. Below, we highlight further  
4 minor revisions that have been recommended by both reviewers.

5

6 **Response to Reviewer 1**

7 Reviewer 1 has provided valuable comments to help enhance the manuscript and we  
8 appreciate the review. Particularly, Reviewer 1 has requested for greater clarity in terms of  
9 the structure and aims of the manuscript and importantly, to provide greater emphasis in  
10 relation to what this paper can contribute in helping teachers/students reflect on teaching and  
11 learning objectives in PE.

1) You introduce Physical Literacy in the introduction with capital letter P and L. For example on p. 5, line 5 you use small letter when you address physical literacy. Please be consistent throughout the paper	This has been revised throughout the manuscript.
2) In the introduction you use the abbreviation PE for Physical Education but for example on p. 5, line 2 and line 5 you write physical education (in the first case with small letters and in the second with capital letters). The same goes for your introduction of Nonlinear Pedagogy on p. 5, line 21. On p. 6 you write the whole word in some sentences and the abbreviation in some. Again, please be consistent throughout the paper	This has also been rectified throughout the manuscript.
3) P. 8, line 14: You suggest that an understanding concepts will lead to a love for physical activity and movement? Isn't that to promise a	The description has been toned down, See pp 8. lines 11 to 13.

<p>bit too much? See for example Quennerstedt et al 2020 in Sport Education and Society for a critical analysis of what models-based learning (in that case Physical Literacy) can promise and deliver. Suggest that you tone down the love part.</p>	<p>“It has been proposed that a rich understanding of key concepts of ecological dynamics can provide a solid conceptual framework for practitioners to develop innovative learning design principles that can enhance skill in individuals (Chow et al. 2016).”</p>
<p>4) A comment to think about in relation to the authors’ response to point 7 (reviewer 2’s comment): I acknowledge the authors’ will to focus on NLP and to avoid comparisons to other types of pedagogical models. I am not going to argue that the authors’ should meet my suggestion of making links to, for example TGfU. However, looking from a broader perspective, I think we need more research in the field that also acknowledge similarities between pedagogical models. If we only focus on the specifics of the models we will risk building silos instead of seeing the big picture. This is just a comment for the authors to think about, and nothing that necessarily needs to be addressed in this paper.</p>	<p>Thank you for the comment. It is indeed useful to have a discourse on other pedagogical models. We have indicated a brief point on pp 26, lines 6 to 13, to highlight the relevance of making connections (where meaningful) across different pedagogical models.</p> <p>“On a broader scale, some of the features of NLP could also be relevant or associated with other approaches to teaching (e.g., TGfU or Games Concept Approach) even though there may still be fundamental differences across various pedagogical approaches. The ability to make connections could be useful for academics and practitioners in enhancing teaching and learning in the longer term. However, it is still critical to be cognisant that the theoretical underpinnings for NLP would be quite different from another like TGfU although there may be some perceived similarities on the surface (see Renshaw et al. 2016)”</p>

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1 **Response to Reviewer 2**

2 Reviewer 2 has further provided positive and constructive comments to enhance the

3 manuscript.

<p>1) Suggestion of a short paragraph to indicate NLP to be relevant within the PE domain and importantly beyond movement and movement activities.</p>	<p>New information to indicate the importance of NLP within the PE domain and how NLP is also relevant for students with reference to enhancing meaningfulness or joy of being involved in movement activities. See pp. 26, lines 14 to 19.</p> <p>“Undoubtedly, there are inherent challenges in this area of work and specifically, there is a need for more empirical studies in representative environment (schools and sports contexts respectively) to further examine its potential impact on teaching and learning within a PE setting. Critically, while we have presented examples where NLP is relevant to a PE domain, there is acknowledgement that more studies could be undertaken to examine the value of NLP in eliciting meaningfulness or joy in being involved in movement activities.”</p>
<p>2) Some discussion on how NLP could be relevant for other explorative aesthetic activities such as parkour. Provide a short discussion on why some of these examples on these activities are not prominent and what this may mean.</p>	<p>More information have been included to indicate why non-games examples are less frequently cited and what could be done more in the future.</p> <p>See pp. 26, lines 19 to pp. 27 line 1.</p> <p>“It is also possible that game sports tend to dominate in PE although fundamental movement skills are covered comprehensively at the lower grades at the Primary School level. The teaching and learning of fundamental movement skills could also move away from being overly prescriptive on an optimal movement form which may be the typical expectation. Clearly more work is required to examine the impact of NLP on explorative aesthetic activities such as dance or parkour and how NLP may actually provide the bandwidth for students to be involved in more</p>

	<p>exploratory search for individualised movement solutions.”</p>
<p>3) Further elaboration on how exploration itself could be a learning objective.</p>	<p>More information have been included to explain exploration and its relevance to learning.</p> <p>See pp 18, lines 12 to 18.</p> <p>“Such exploratory behaviours are very pertinent to more effectively support learning on the part of the students. Exploration is messy and may result in the emergence of some irrelevant behaviours with reference to the expected task goal. However, it is through such exploration that the learner is able to search and experience what would work and what may not work. But importantly, this is actually when learning is taking place (i.e., the learning objective) and this will assist the learner to discover relevant information that underpins effective performance eventually.”</p>
<p>4) Point on broadening competency beyond movement skills. Reviewer pointed out that this broadening of competency may include students’ reflections and even appreciations with regard to movement.</p>	<p>More information have been added to suggest how NLP can potentially promote other aspects of competency beyond movement skills.</p> <p>See pp. 18, line 18 to pp. 19, line 3.</p> <p>“Again, the implication here for PE is about encouraging our students to become familiar with how their own Physical Literacy can be harnessed across different contexts. Designing learning activities in PE where there is meaningful representativeness to help students be attuned to the information and their corresponding actions would broaden their repertoire of movement competency that is more transferable to other movement contexts. This broadening ‘competency’ could also extend beyond movement as one can imagine how students may have the opportunity to reflect on and appreciate the value of moving and perhaps not constrained to move in a predetermined manner. This would possibly be appreciated by students who may inherently find the</p>

	learning of movement skills more challenging and the removal of the threat to replicate some expected movement form could provide that safe environment to explore their own individualised movement solutions.”
5) p.19 l.49 (“.....teachers and coaches on how to use them effectively in organised PE and sports context”) I suggest to add “respectively” at the end of this sentence - to emphasize that this can or should be done differently -depending on different learning outcomes.	Revision have been made. See pp. 20, line 10.
6) p. 20 l.30 (.....to demonstrate individual and with others, the physical skills, practices and values to enjoy a lifetime of active, healthy living.”). The concept of enjoyment in the Singapore curriculum cannot be ignored because enjoyment seems to be the core of the aim. This means that we need more studies on the relationship between learning, NLP and enjoyment (or other concepts emphasizing emotions or motivational regulation in PE) in physical activity and physical education. Prior studies have shown that exploration may be the key variable to increase enthusiasm among students (see Säfvenbom & Stjernvang,2019).	<p>Addition materials have been added. To indicate a need for more studies to understand the relationship between learning, NLP and enjoyment. Säfvenbom &amp; Stjernvang (2020) was cited to support the discussions.</p> <p>See pp. 21, line 3 to 8.  “Undoubtedly, there is also a need for more studies to be undertaken with reference to understanding the relationship between learning, NLP and enjoyment (or other concepts related to emotion development and motivation regulation in PE). Notably, exploration may be the key factor in increasing enthusiasm among learners and where the learner-environment interaction is critical in supporting learning (see Säfvenbom &amp; Stjernvang 2020).”</p>
7) p 25 l 40: (schools and sports contexts) I suggest that you add “respectively” : schools and sports contexts respectively)	This has been revised. See pp. 26, line 16.

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