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EDUCATION RESEARCH FUNDING PROGRAMME

PROJECT CLOSURE REPORT

Nonlinear Pedagogy and its relevance for the new PE curriculum

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EXECUTIVE SUMMARY

INTRODUCTION/BACKGROUND

Increasingly, school teachers see the need to recognize the complex and dynamic interactions that occur between the individual, task and environmental constraints during learning. Nonlinear Pedagogy (NP), underpinned by Ecological Dynamics, provides a suitable pedagogical approach to encourage exploratory learning amongst children that is learner-centred and exploratory in nature. This approach is in contrast to a more traditional form of Linear Pedagogy (LP) that is teacher-centred and emphasises repetition in practices to promote movement form consistency in enhancing the acquisition of movement skills. Primarily, NP involves teachers identifying and manipulating constraints on learning to facilitate the emergence of goal-directed behaviours in children (Chow et al., 2016; Davids et al., 2008). Other key pedagogical principles relating to representativeness, awareness of focus of attention instructions, task simplification and the functional role of noise can help learners to develop 21st century competencies (Chow et al., 2016). Given growing concerns that physical inactivity could represent the biggest threat to global health in the 21st century, it is vital that children receive a high quality of education to develop their health and wellbeing.

STATEMENT OF PROBLEMS

A child's physical education should ideally provide them with transferable motor skills (physical and mental) to develop and utilise throughout their lives. With the launch of the revised PE syllabus in Singapore (2014), it is timely to ensure that teachers can facilitate the transfer of motor skills to determine the efficacy of NP in relation to the revised PE syllabus. While the structure of the revised syllabus is clear, there seems to be a lack of information on the pedagogical approaches that could underpin the delivery of content and teaching [e.g., teaching of Fundamental Movement Skills (FMS) and games skills]. NP, with its strength in encouraging exploratory learning that is student-centred and facilitative rather than teacher-centred (i.e., focus on prescriptive instructions with expectations of specific movement solutions), is an evidence-based framework to support teaching and learning of game skills and FMS from the PE curriculum. It will be pertinent to properly determine how students may be able to transfer learning across games of the same category in view of the restricted number of games to be taught and the relevance of using pedagogical principles for the teaching of FMS. The use of the revised Singapore PE curriculum as a case of investigation for this research programme will be novel and timely to enhance teaching and deeper learning processes in PE and sports.

PURPOSE OF STUDY

The aim was to examine how Nonlinear Pedagogy can provide insights on existing teaching practice with a strong interventionist focus to support the learning of game skills and FMS for the revised Singapore PE curriculum in schools.

The objectives of the research project are to (a) determine the impact of NP on teaching and learning of other categories of games (e.g., invasion games) in the PE context as an extension to the previous investigation on NP (OER 15/09 CJY); (b) the transferability of game skills to other games in the same game category requires further examination; (c) there is a need to examine how NP can be potentially effective for the teaching of FMS, which is a key component of the revised PE curriculum.

Research Questions:

1) How will key pedagogical principles underpinning NP impact the teaching of invasions games in the school context? (Secondary level)
2) What is the extent of the effectiveness of key pedagogical principles underpinning NP in the transfer of game skills across games of the same category? (Secondary level)
3) How will key pedagogical principles underpinning NP impact the teaching of FMS in the school context? (Primary level)

PARTICIPANTS

Phase 1
Participants

Eight classes of Secondary One level students (n=224) at 2 schools were recruited for this phase of the project. Classes and teachers recruited for this phase of study was randomly assigned to a Nonlinear Pedagogy (NP) condition and a Linear Pedagogy (LP) condition. The same teachers, with at least 3 years of teaching experience (n=4), taught both the NP and LP condition classes to ensure that there is control in terms of eliminating the potential impact of the teacher on the effectiveness of the two conditions.

Phase 2
Participants

Eight classes of Primary Two level students (n=187) at 2 schools were recruited for this phase of the project. Similar to Phase 1, classes and their respective teaches, with at least 3 years of teaching experience (n=4), were randomly assigned to a NP condition and a LP condition.

METHODOLOGY / DESIGN

Phase 1
Task

Students learnt game skills from an invasion game (soccer) within a PE context. All students underwent a pre-test, intervention (10 weeks), post-test, retention and two transfer tests sessions at the class level. For the transfer test 1, students were tested on a novel context (larger playing field) in relation to the same game that they were taught. In transfer test 2, students were tested using another invasion game (floorball) to determine transferability of learning (from soccer to floorball).

In relation to the intervention, students in the NP condition were presented with lessons that were underpinned by nonlinear pedagogical design principles. Similarly, the same teachers taught lessons supported by pedagogical principles typically present in linear pedagogical lessons. For example, learning activities from the NP condition incorporated many representative designs (e.g., small-sided games that provides relevant perceptual information), use of exploratory cues (e.g., analogies to encourage exploration of different movement solutions), infusing variability in practices (e.g., using difference ball sizes and playing dimensions in terms of space), a focus on simplifying task (e.g., rules and activities to encourage success). In contrast, LP lessons focused on repetition of practices to acquire consistency in the expected movement solutions (e.g., kicking a ball based on prescriptive instructions on the form), using standard size equipment to ensure practice specificity of the expected movement solutions. Intervention sessions were taught by the school teachers who had undergone training with the research team to ensure that the lessons on invasion games were delivered according to the lesson plans set out for the respective pedagogical conditions. Performance outcome data (e.g., mean number of passes, mean number of consecutive passes, number of types of passes and possession time) and positional data (e.g., distance covered in direction of play, surface area covered by teams) of students in a 4v4 game were captured using Global Positioning System for all test sessions.

At the end of the retention test session, all participants completed a questionnaire that was adapted from the Intrinsic Motivation Inventory (IMI) questionnaire (Deci & Ryan, 1985) to measure intrinsic motivation experienced during the intervention lessons. Focus group discussions with randomly selected students (n=5) from each class were also conducted to assist in supporting the understanding of the participants' enjoyment, motivation and competency in relation to their involvement in the soccer intervention. In addition, interview sessions were conducted with the teachers to augment the understanding of the students and teachers' experiences with the NP and LP lessons.

Phase 2
Task

Students performed a series of fundamental locomotor and object control skills (e.g., throwing, catching, sliding and running) during three different test sessions (Pre, Post and Retention). Proficiency in FMS of the participants was assessed with the Test of Gross Motor Development (TGMD-2) and validated developmental sequences from Gallahue, Ozum and Goodway (2012). The Sharpened Romberg Balanced Test (with vision) was also conducted.

All students underwent a pre-test, an 8-week intervention, post-test, retention and transfer test sessions. A modified obstacle course was used as the transfer test as it provided a representative and engaging setting to analyze students' FMS development after the intervention. Kinematic data was also collected using 3-D motion capture cameras to attempt to provide further insights to coordination changes as function of NP and LP. However, because the sample size was too small (n=3), no further data analysis was undertaken since group comparison will not be possible.

Students in the NP condition were presented with lessons that were underpinned by nonlinear pedagogical design principles. For example, lessons incorporated aspects of modifying task constraints (e.g., changing size of objects to be thrown), infusing variability (e.g., throwing to different directions, height and angle), focus on attention on movement effects (e.g., focusing on the trajectory of the throw: 'like a rainbow') and ensuring representativeness in the activities (e.g., throwing in pairs or small-sided game settings). For the LP condition, students were presented with lessons that were typically structured, drill based, focused on movement form and featuring practices with an emphasis on consistency. Intervention sessions were delivered by the school teachers who went through training with the research team to ensure that the lessons taught followed the lesson plans set out for the respective pedagogical conditions. Throwing, catching, sliding, dribbling of a ball and running were the key FMS emphasized for the lessons.

Similar to Phase 1, all students completed a questionnaire adapted from the IMI questionnaire. Focus group discussions and interviews were also conducted with 5 randomly selected students from each class and all the teachers respectively.

A multilevel hierarchical model was used to analyse group data. Within group comparisons over sessions (repeated measures) was undertaken to determine changes over time within groups. Between groups comparison was also made to determine differences between pedagogical conditions.

FINDINGS / RESULTS

Below, we highlight the key findings.

Phase 1

1. Significant improvements in performance outcome in soccer (e.g., mean number of passes, mean number of consecutive passes, number of types of passes and possession time) was observed for the NP groups. Game play patterns (e.g., distance covered in direction and width of play, surface area covered by teams, higher turn-over counts) acquired by the NP group were also functional and improved after intervention.
2. Evidence for transfer of learning for NP was not as strong as anticipated although there was still some potential (significant change for mean number of passes and total possession time) for encouraging transfer of learning from soccer to floorball.
3. No differences in IMI scores for both NP and LP conditions.

Phase 2

4. With regards to FMS competency (TGMD-2), both NP and LP improved by post-test sessions for running, stationary dribbling and catching. However, only the NP group demonstrated significantly higher scores for overhand throw as compared to LP.
5. Improvements were found across all skills within both NP and LP conditions for the obstacle course (at transfer test).
6. Both NP and LP condition improved for the skill of running, overhand throw, catching, sliding and stationary dribbling. In addition, there was a greater transition in terms of percentage of students from Elementary Stage to Mature Stage for the skills of sliding and stationary dribble from pre to post test for NP group as compared to LP group. (validated developmental sequences from Gallahue et al., 2012).
7. No differences in IMI scores and balance test scores for both conditions.

For both phases of work, based on qualitative data (FGD and interviews), Nonlinear Pedagogy can create a learning environment that encourages innovation and creativity among the students. While it takes more time to plan and deliver NP lessons, teachers also felt that NP provides a more authentic experience for greater active learning for the students. Nevertheless, there was also the suggestion that a hybrid of NP and LP approaches may be worth further investigation. Overall, the study provides plenty of food for thought in terms of how Singapore's revised PE curriculum may be best delivered in order to optimise fundamental skills development and transfer of motor skills.

CONTRIBUTIONS

Findings from this research project has added new knowledge to the impact of NP on the teaching and learning of invasion games and FMS. Specifically, there is greater clarity in ascertaining that key pedagogical principles for NP can be potentially effective. The manifestations of functional movement behaviours (e.g., greater number of different types of passes) seen from NP groups for Phase 1 further affirmed that an exploratory pedagogical approach could be just as effective as a prescriptive pedagogical approach (LP) to teaching invasion games and FMS.

The key findings further challenge the “one-size-fits-all” philosophy held by many PE teachers. An important implication would mean considering alternate assessment rubrics rather than those to focus solely on a ‘correct’ movement form expected of all students. Instead, key 21st century competencies such as creativity, problem-solving and team-work should be assessed in the future. This suggestion in turn has further implication on Teacher Education and Professional Development programmes pertaining to PE. Pedagogical principles pertaining to NP to support pedagogical approaches can be relevant for the revised PE Curriculum. Importantly, there is potential to use NP to encourage teaching and learning to be student-centred and focusing on optimizing individual movement competencies. Importantly, qualitative data (FGD and interviews) did provide insights to how NP differed from LP in terms of the learning processes as expressed by students and teachers. Practitioners could incorporate key pedagogical principles of NP in the delivery of content and teaching within school based PE settings to help develop greater creativity, and involvement among students. With reference to research, more empirical work on NP can also be conducted in the school setting to determine how to implement hybrid NP and LP teaching at different age groups, skill levels and for different activities. Translation of the findings and implications on practice can also be examined in future research projects.

Conclusion

NP was as effective as LP or better in teaching invasion games with reference to enhancing performance outcomes and game play behaviours. Both NP and LP showed some evidence of transfer of skills across games in the same game category (i.e., from soccer to floorball). NP was also effective in teaching FMS in the Primary School context.

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Keywords

Nonlinear Pedagogy, Physical Education, Invasion Games, Fundamental Movement Skills, Singapore Schools

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Nonlinear Pedagogy and its relevance for the new PE curriculum

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INTRODUCTION/BACKGROUND

How teachers undertake pedagogical practices impacts upon how well individuals learn movement skills (Renshaw, Davids, & Savelsbergh, 2010). It is therefore not surprising that a large number of empirical investigations have been conducted to determine how best to deliver coaching or teaching to maximize skill acquisition in PE and sports. There is increasing acceptance that individual differences among learners need to be accounted for when practitioners plan teaching interventions in any learning contexts (Chow & Atencio, 2012). The focus is on the individual and pedagogical practices needed to cater to the dynamic and complex interactions that occur between learners, the task and the environmental constraints (Chow, Davids, Hristovski, Araújo, & Passos, 2011). Critically, there is adequate evidence to support that human learning is nonlinear in nature and therefore, teaching and coaching should be underpinned by such nonlinearity (see Button, Dutt-Mazumder, Lee, Tan, & Chow, 2012; Chow, Davids, Button & Renshaw, 2016; Tan, Chow, & Davids, 2012).

A Nonlinear Pedagogy approach, based on nonlinear and complexity phenomenon, has increasingly been advocated to provide practitioners with key pedagogical principles to support teaching. Pertinent strategies on how to assess performance, how to structure practices, and how best to deliver instructions and provide feedback are particularly relevant (see Chow, Renshaw, Button, Davids, & Tan, 2013; Ovens, Hopper, & Butler, 2013). Nonlinear pedagogy emphasizes the need to design representative learning environments for individual learners supported by principles in understanding the nonlinear features of human learning. Features of nonlinearity in learning includes non-proportional changes, multi-stability in learning systems, scaling of parameters to effect non-proportionate changes and the functional role that variability plays in learning systems (Chow, Davids, Button, Rein, Hristovski, & Koh, 2009). The focus of nonlinear pedagogy is on the individual learner and is therefore "student-centric" (see Figure 1 for a conceptual visualization of a Nonlinear Pedagogy approach).

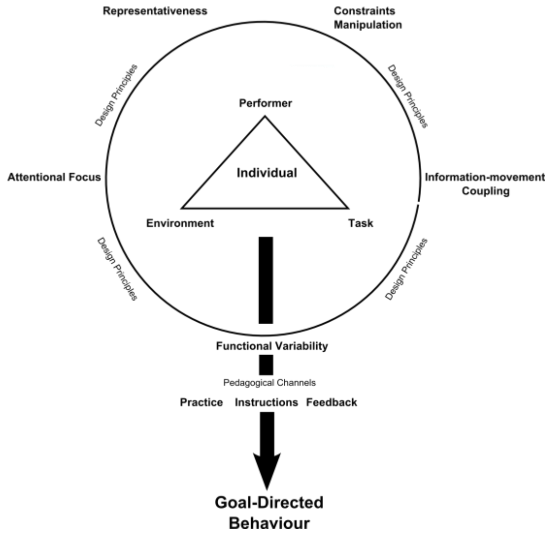

Figure 1: Conceptual Model of Nonlinear Pedagogy

The recognition is that learners should be given the opportunities to acquire individualized movement solutions based on the learning and performing context (Button, et al., 2012). The interaction of performer, environment and task constraints takes into account the dynamic influences that each has on the individual. Encapsulating these constraints, practitioners could develop design principles that incorporate representativeness, manipulation of constraints, attentional focus, functional variability and the maintenance of pertinent information-movement couplings through task simplification (Chow, 2013). Specifically, learning activities should be situated in game contexts that capture the dynamics where the skills to be learnt can be performed. The teacher should manipulate constraints (e.g., task constraints that include instructions, equipment and task goals) to encourage certain behaviours that are most preferred for the students. In addition, the teacher should consider focusing on the movement outcome rather than the movement form as an over-emphasis on the form can lead to overly conscious control of movements. Allow for practice variability so that the students can be challenged to explore different movement solutions that allow the close relationship between information and movement to be kept intact. These design principles can then be delivered through the key pedagogical channels of instructions, practices and feedback to allow functional goal-directed behaviours to emerge. Nonlinear pedagogy thus has the potential to provide the design principles and mechanisms that underpin learning activities that is situated in real performance context and suitably catered to the individual learner (Chow, 2013; Chow et al., 2016). Given growing concerns that physical inactivity could represent the biggest threat to global health in the 21st century, it is vital that children receive a high quality of education to develop their health and wellbeing.

Existing findings on the efficacy of Nonlinear Pedagogy

Most of the previous work that examined the efficacy of Nonlinear Pedagogy was based on recent findings from the motor control and learning literature that highlighted how the human movement system behaves like a nonlinear system and how learning as well as teaching processes captures these key traits of a nonlinear system (Chow, 2013). The previous investigation on Nonlinear Pedagogy from a project supported by OER, has provided key insights on how Nonlinear Pedagogy can be effective in teaching a modified net-barrier game in a Singapore school setting (see Lee, Chow, Komar, Tan, & Button, 2014; Lee, Chow, Button & Tan, 2017; OER 15/09 Final Report). To our knowledge, it was the first empirical investigation undertaken for nonlinear pedagogy. For that study, students from a Singapore primary school with no tennis background were selected for the research who underwent a learning intervention over several weeks comprising either the Nonlinear Pedagogy or Linear Pedagogy condition (i.e., a traditional pedagogical approach with an emphasis on drill and technique commonly present in PE context). Changes in performance were observed at three levels: 1) the individual; 2) in a game setting; 3) in a class setting (with the focus of discussion on the impact of Nonlinear Pedagogy and Linear Pedagogy in relation to the students). Findings showed that the students in the Nonlinear Pedagogy condition were just as effective as the Linear Pedagogy condition even though there were less explicit prescriptive instructions on movement form in the former condition. Students in the Nonlinear Pedagogy group were also generally able to hold longer rally lengths in the cooperative modified tennis games, which is undoubtedly more desirable in net-barrier games. These findings suggest that perhaps there is more than one best way to solve our movement challenges- Many ways of moving to achieve the same target – evidence of degenerate behaviours where there could be many movement pathways to achieve the same outcome (Seifert, Komar, Araújo, & Davids, 2016). These are insightful findings as the results suggest that students can engage in exploratory behaviours and acquire more individualized movement solutions to achieve success where the emphasis is on the students (i.e., student focused). Clearly, the implications to policy and to schools include how we should question the traditional one-size-fits-all, outcome-based philosophy that has dominated PE historically; rethink teacher education in PE; review professional development for in-service teachers.

Nevertheless, there is still much work that should be undertaken to examine the efficacy of a nonlinear pedagogical approach. Our previous project only investigated the impact of Nonlinear Pedagogy on the acquisition of modified tennis (net-barrier game) game play behaviours. More needs to be done to examine the efficacy of Nonlinear Pedagogy for other categories of games (e.g., invasion games) as well as the acquisition of fundamental movement skills which precedes the acquisition of game skills. In addition, it is important to determine how students transfer skills learning in one game to another game in the same category.

Relevance to the PE curriculum in Singapore

The Singapore PE curriculum has undergone some refinements and revisions over the last two decades. Most recently in 2014, the Ministry of Education (MOE) has launched the latest PE curriculum (with on-going review). Key features of the revised PE curriculum include the emphasis on teaching games as well as fundamental movement skills to students across the different levels (i.e., Primary to Secondary to Pre-University)

(Ministry of Education, 2014). In relation to teaching of games skills, the number of games to be taught to students is limited although schools have the independence to determine what games the students are to learn during their time in school. This potentially creates a challenge as the scope of games to be taught could be narrow. However, if the teaching approaches undertaken to teach these games can encourage and allow for transfer across games in the same category, it would significantly reduce the challenge of the perceived narrow range of games that would be learnt by the students in the revised PE syllabus. This is important as there is a focus on deeper learning, which can be indicated by good retention and transfer performance (see Pellegrino & Hilton, 2012)

One of the key emphases in the revised PE curriculum is the focus on teaching fundamental movement skills for the lower primary school levels. The issue of effectively teaching young children important fundamental movement skills is critical as physical literacy forms the basis for the acquisition of game skills seen in many of the more adult version of sports games in different game categories (Giblin, Collins, & Button, 2014). Importantly, can a nonlinear pedagogical approach be undertaken to effectively teach fundamental movement skills so that the acquisition of such important skills by our children is embedded in representative learning contexts? Are the design principles purported in nonlinear pedagogy relevant in enhancing the acquisition of fundamental movement skills as compared to a more typical drill based and prescriptive learning environment where direct instructions tend to dominate?

STATEMENT OF PROBLEMS

With the launch of the revised PE curriculum in Singapore (2014), it is indeed timely to ensure that practitioners can facilitate the transfer of knowledge and game to determine the efficacy of NP in relation to the revised PE syllabus. While the structure of the curriculum is clear, there seems to be a lack of information on the pedagogical approaches that could underpin the delivery of content and teaching for the revised curriculum (e.g., teaching of fundamental movement skills and games skills). NP, with its strength in encouraging exploratory learning that is student-centred and facilitative rather than teacher-centred (i.e., focus on prescriptive instructions with expectations of specific movement solutions), is an evidence-based framework to support teaching and learning of game skills and Fundamental Movement Skills (FMS) from the PE curriculum. It will be pertinent to properly determine how students may be able to transfer learning across games of the same category in view of the restricted number of games to be taught and the relevance of using pedagogical principles for the teaching of FMS. The use of the revised Singapore PE curriculum as a case of investigation for this proposed research programme will be novel and timely to enhance teaching and deepen learning processes in PE and sports.

PURPOSE OF STUDY

The aims of the research project is to examine how Nonlinear Pedagogy (NP) can change existing teaching practice with a strong interventionist focus to support the learning of game skills and FMS for the revised Singapore PE curriculum in schools.

The objectives of the research project are:

a) To determine the impact of NP on teaching and learning of other categories of games (e.g. invasion games) in the PE context as an extension to the previous investigation on NP (OER 15/09 CYJ)
b) To further examine the transferability of game skills and knowledge to other games in the same game category
c) To examine how NP can be potentially effective for the teaching of FMS.

Research questions are as follows:

1) How will key pedagogical principles underpinning NP impact the teaching of invasion games in the school context? (Secondary school level)
2) What is the extent of the effectiveness of key pedagogical principles underpinning NP in the transfer of game skills across games of the same category? (Secondary school level)
3) How will key pedagogical underpinning NP impact the teaching of FMS in the school context? (Primary school level)

PARTICIPANTS

Phase 1

Eight classes of Secondary One level students (n=224) at 2 schools were recruited for this phase of the project. Classes and teachers recruited for this phase of study was randomly assigned to a Nonlinear Pedagogy (NP) condition and a Linear Pedagogy (LP) condition. The same teachers, with at least 3 years of teaching experience (n=4), taught both the NP and LP condition classes to ensure that there is control in terms of eliminating the potential impact of the teacher on the effectiveness of the two conditions.

Phase 2

Eight classes of Primary Two level students (n=187) at 2 schools were recruited for this phase of the project. Similar to Phase 1, classes and their respective teaches, with at least 3 years of teaching experience (n=4), were randomly assigned to a NP condition and a LP condition.

METHODOLOGY/DESIGN

Phase 1

Task

Students learnt game skills from an invasion game (soccer) within a PE context. All students involved in the study underwent a pre-test, intervention (10 weeks), post-test, retention and two transfer tests sessions at the class level. For the transfer test 1, students were tested on a novel context (larger playing field) in relation to the same game that they were taught. In transfer test 2, students were tested using another invasion game (floorball) to determine transferability of learning (from soccer to floorball).

In relation to the intervention, students in the NP condition were presented with lessons that were underpinned by nonlinear pedagogical design principles. Similarly, the same teachers taught lessons supported by pedagogical principles typically present in linear pedagogical lessons. For example, learning activities from the NP condition incorporated many representative designs (e.g., small-sided games that provides relevant perceptual information), use of exploratory cues (e.g., analogies to encourage exploration of different movement solutions), infusing variability in practices (e.g., using difference ball sizes and playing dimensions in terms of space), a focus on simplifying task (e.g., rules and activities to encourage success). In contrast, LP lessons focused on repetition of practices to acquire consistency in the expected movement solutions (e.g., kicking a ball based on prescriptive instructions on the form), using standard size equipment to ensure practice specificity of the expected movement solutions. Intervention sessions were taught by the school teachers who had undergone training with the research team to ensure that the lessons on invasion games were delivered according to the lesson plans set out for the respective pedagogical conditions. Performance outcome data (e.g., mean number of passes, mean number of consecutive passes, number of types of passes and possession time) and positional data (e.g., distance covered in direction of play, surface area covered by teams) of students in a 4v4 game were captured using Global Positioning System (OptimEye S5, Catapult Innovations, Australia) for all test sessions.

At the end of the retention test session, all participants completed a questionnaire that was adapted from the Intrinsic Motivation Inventory (IMI) questionnaire (Deci & Ryan, 1985) to measure intrinsic motivation experienced during the intervention lessons. Focus group discussions with randomly selected students (n=5) from each class were also conducted to assist in supporting the understanding of the participants' enjoyment, motivation and competency in relation to their involvement in the soccer intervention. In addition, interview sessions were conducted with the teachers to augment the understanding of the students and teachers' experiences with the NP and LP lessons.

Phase 2

Task

Students performed a series of fundamental locomotor and object control skills (e.g., throwing, catching, sliding and running) during three different test sessions (Pre, Post and Retention). Proficiency in FMS of the participants was assessed with the Test of Gross Motor Development (TGMD-2) and validated developmental sequences from Gallahue, Ozum and Goodway (2012). The Sharpened Romberg Balanced Test (with vision) was also conducted.

All students (n=187) underwent a pre-test, an 8-week intervention, post-test, retention and transfer test sessions. A modified obstacle course was used as the transfer test as it provided a more representative setting to analyze students' FMS development after the intervention. Movement skills incorporated into the obstacle course include running, overhand throw, sliding, catching and dribbling. Kinematic data was also collected using 3-D motion capture cameras, during pre, post-test and retention test sessions to attempt to provide greater insights on changes to coordination as a function of the two pedagogical conditions. However, too little kinematic data was collected (only 3 students in the end) and the analysis of the data would not be adequately meaningful for group comparison at this point in time.

Students in the NP condition were presented with lessons that were underpinned by nonlinear pedagogical design principles. For example, lessons incorporated aspects of modifying task constraints (e.g., changing size of objects to be thrown), infusing variability (e.g., throwing to different directions, height and angle), focus on attention on movement effects (e.g., focusing on the trajectory of the throw: 'like a rainbow') and ensuring representativeness in the activities (e.g., throwing in pairs or small-sided game settings). For the LP condition, students were presented with lessons that were typically structured, drill based, focused on movement form and featuring practices with an emphasis on consistency. Intervention sessions were delivered by the school teachers who went through training with the research team to ensure that the lessons taught followed the lesson plans set out for the respective pedagogical conditions. Throwing, catching, sliding, dribbling of a ball and running were the key FMS emphasized for the lessons.

Similar to Phase 1, all students completed a questionnaire adapted from the IMI questionnaire. Focus group discussions and interviews were also conducted with 5 randomly selected students from each class and all the teachers respectively.

A multilevel hierarchical model was used to analyse group data for both phases of study. Within group comparisons over sessions (repeated measures) was undertaken to determine changes over time within groups. Between groups comparison was also made to determine differences between pedagogical conditions.

FINDINGS / RESULTS

Phase 1

Performance Outcome

Significant improvements in performance outcome in soccer (e.g., mean number of passes, mean number of consecutive passes, number of types of passes and possession time) was observed for the NP groups. Specifically, 4 out of the 5 performance outcome variables improved significantly for NP as compared to 2 out of 5 performance outcome variables for LP. See Table 1.

Table 1. *Performance outcome for game play (Phase 1)*

Performance Outcome	Nonlinear Pedagogy	Linear Pedagogy
Mean successful passes	More successful passes from post, retention, transfer test 1 to pre-test	No changes across sessions
Number of consecutive passes	More consecutive passes from retention to pre-test	No changes across sessions
Number of types of passes	More number of types of passes from post to pre-test. No difference between post and transfer test 1, retention test	No changes across sessions
Possession time	Higher possession time from post to pre-test. No difference between post and transfer test 1, retention test	Higher possession time from post to pre-test. No difference between post and transfer test 1, retention test
Number of goals scored	No changes across sessions	More goals scored from transfer test 1, retention test to pre-test

*Information on the reporting of statistics can be found in Appendix.

Game Play Behaviours

Game play behaviours (e.g., distance covered in direction of play, surface area covered by teams, higher turn-over counts) acquired by the NP group were also functional and improved after intervention. See Table 2.

Table 2. *Game play behaviours (Phase 1)*

Performance Outcome	Nonlinear Pedagogy	Linear Pedagogy
Distance covered in length of play	Greater distance at retention test	Greater distance at post-test
Distance covered in width of play	Greater distance at retention test	Greater distance at post-test
Surface are covered by teams (proxy for using available space)	Greater surface for attacking teams at retention test	Greater surface for defending teams at post-test
Turnover counts (proxy for complexity in game dynamics)	Higher counts from transfer test 1 to pre-test	No change across sessions

*Information on the reporting of statistics can be found in Appendix.

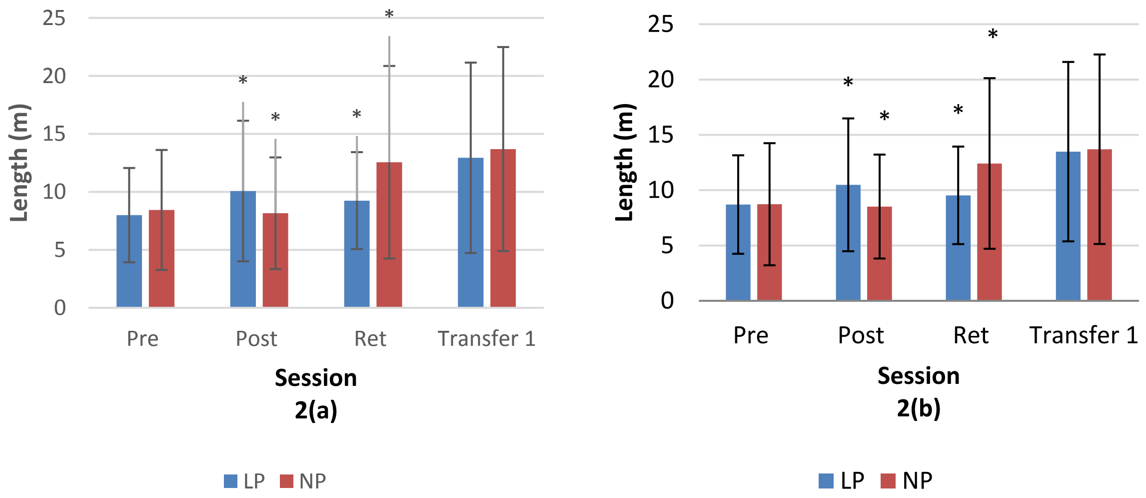

Figure 2(a): Average distance along the length of play for defending teams and *Figure 2(b)*: Average distance along the length of play for attacking teams. (*) indicates significant differences between groups ($p < 0.05$).

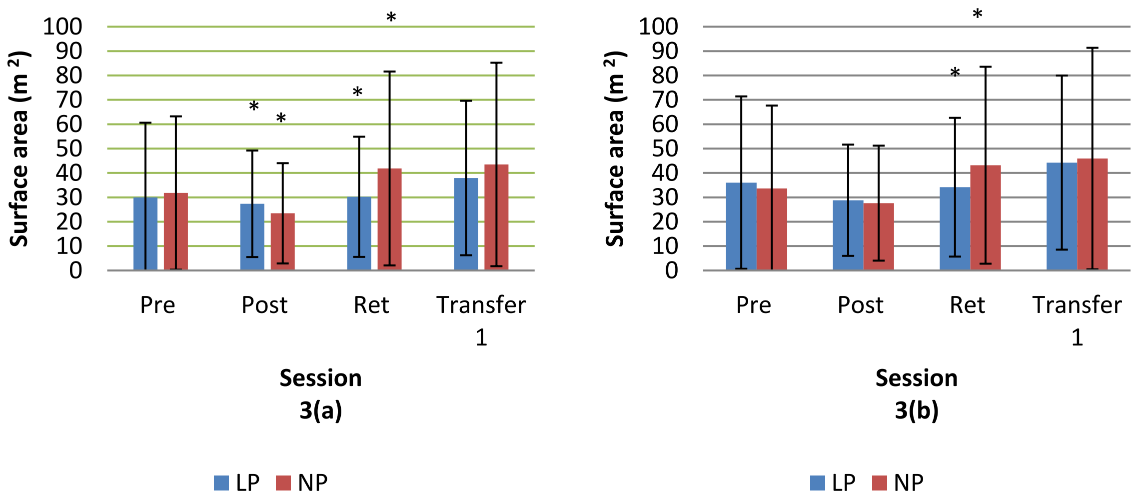

Figure 3(a): Surface area covered for defending teams and *Figure 3(b)*: Surface area covered for attacking teams. (*) indicates significant differences between groups ($p < 0.05$).

Transfer of Learning from Soccer to Floorball

Evidence for transfer of learning for NP was not as strong as anticipated although there was still some potential [significant change for mean number of passes (see Figure 4) and total possession time] for encouraging transfer of learning. See Table 3.

Table 3. *Transfer of learning (Phase 1)*

Performance Outcome	Nonlinear Pedagogy	Linear Pedagogy
Mean number of passes	Higher number of passes at transfer test 2	Higher number of passes at transfer test 2
Total number of goals	No change	Higher from transfer test 2 to pre-test
Total possession time	Longer possession time at transfer test 2	Longer possession time at transfer test 2

*Information on the reporting of statistics can be found in Appendix.

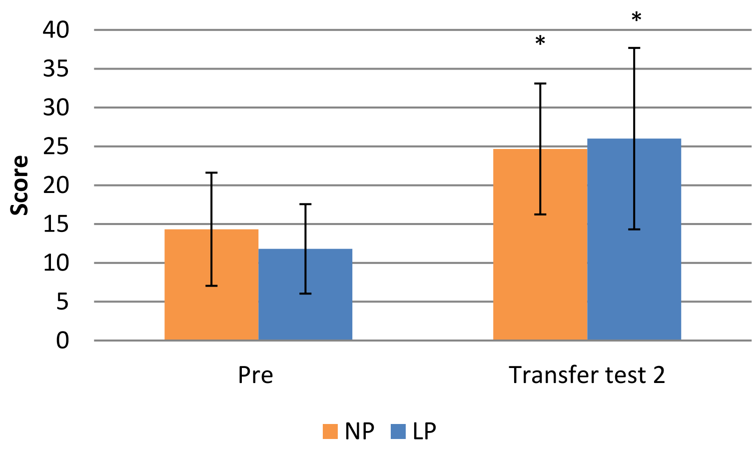

Figure 4: Mean number of passes for floorball between pre and transfer test 2 sessions. (*) indicates significant differences between Pre and Transfer test 2 ($p < 0.05$).

IMI Questionnaire

No differences in IMI scores for both conditions. Independent t-test showed that there were no significant differences ($p > 0.05$) for all subscales (enjoyment, perceived competence, effort/importance and value/usefulness) of the IMI questionnaire.

Phase 2

Performance Outcome (TGMD-2)

With regards to FMS competency, both NP and LP improved by post-test sessions for running, stationary dribbling and catching. However, only the NP group demonstrated significantly higher scores for overhand throw (Table 4 and Figure 5).

Table 4. *Performance outcome TGMD-2 (Phase 2)*

Performance Outcome	**Nonlinear Pedagogy**	**Linear Pedagogy**
Running	Higher score from post to pre-test. Higher than LP at post-test.	Higher score from post to pre-test. Lower than NP at post-test.
Stationary dribble	Higher score from post to pre-test. Higher than LP at post-test.	Higher score from post to pre-test. Lower than NP at post-test.
Catching	Higher score from post to pre-test. No different to LP	Higher score from post to pre-test. No different to NP
Sliding	Higher score from post to pre-test. No different to LP	Higher score from post to pre-test. No different to NP
Overhand throw	Higher score from post to pre-test.	No change

*Information on the reporting of statistics can be found in Appendix.

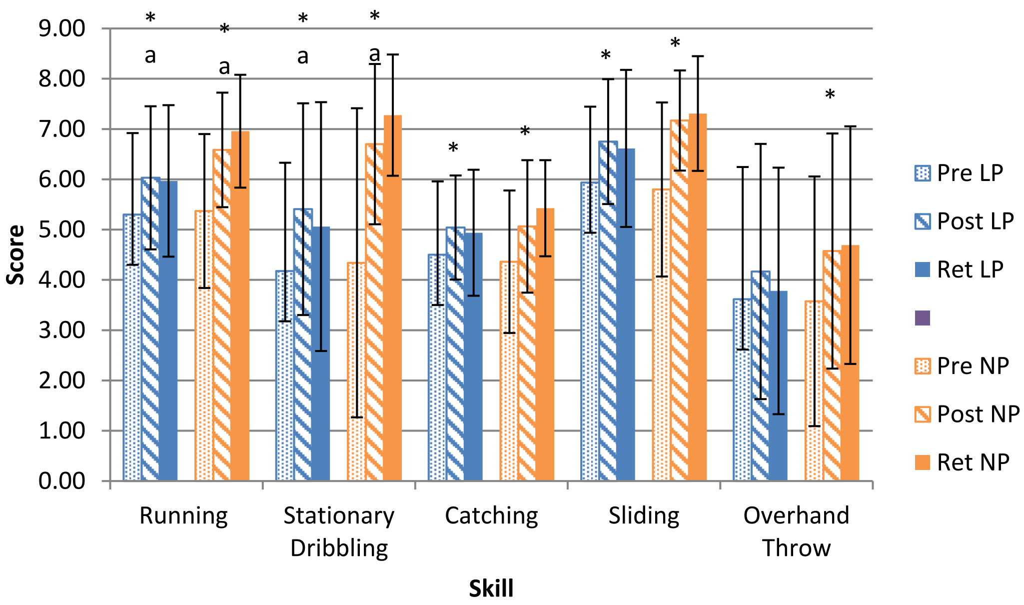

Figure 5: TGMD-2 Raw Scores for relevant FMS. (*) indicates significant differences from pre-test (p < 0.05) and (a) indicates significant differences between groups (p < 0.05).

Obstacle Course (Transfer Test)

Improvements were found across all relevant FMS for both conditions for the obstacle course (Transfer Test) (see Figure 6).

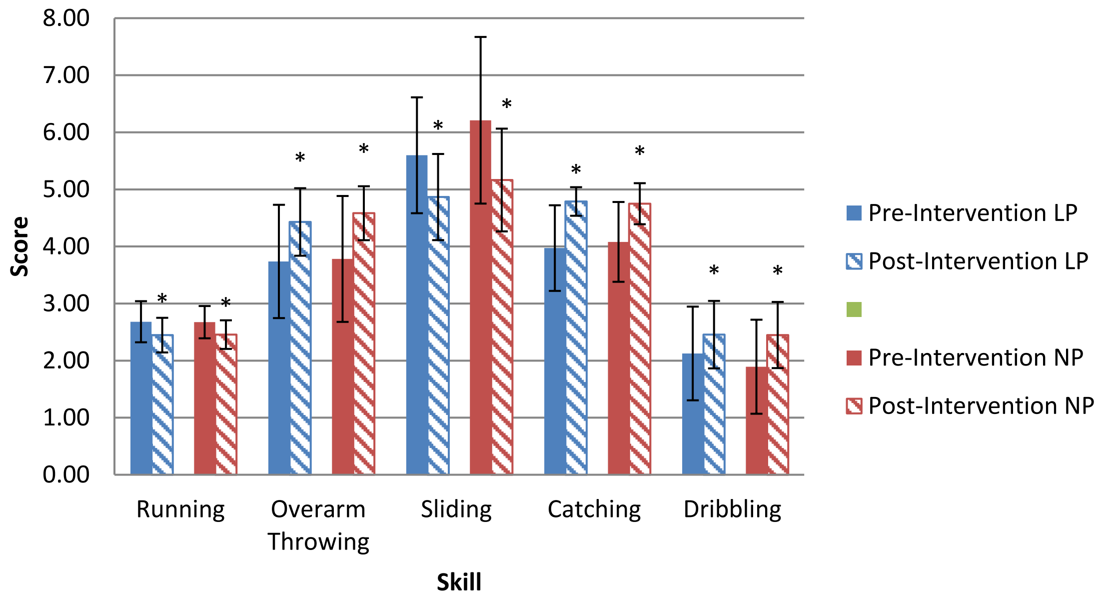

Figure 6: Performance outcome for relevant FMS for Obstacle Course (Transfer Test). (*) indicates significant differences from pre-test ($p < 0.05$).

Validated Developmental Sequences (Gallahue et al., 2012)

In terms of the validated developmental sequences, both NP and LP groups improved for running, overhand throw, catching, sliding and stationary dribbling. In addition there was a greater transition in terms of percentage of students from Elementary Stage to Mature Stage for the skills of sliding and stationary dribble from pre to post test for NP group as compared to LP group. See Table 5.

Table 5. *Validated Development Sequences (Phase 2)*

Performance Outcome	Nonlinear Pedagogy	Linear Pedagogy
Running	Higher score from post to pre-test.	Higher score from post to pre-test.
Overhand throw	Higher score from post to pre-test.	Higher score from post to pre-test.
Catching	Higher score from post to pre-test.	Higher score from post to pre-test.
Sliding	Higher score from post to pre-test. Higher increase in mature stage than LP at retention test	Higher score from post to pre-test. Lower increase in mature stage than NP at retention test
Stationary dribble	Higher score from post to pre-test. Higher increase in mature stage than LP at retention test	Higher score from post to pre-test. Lower increase in mature stage than NP at retention test

*Information on the reporting of statistics can be found in Appendix.

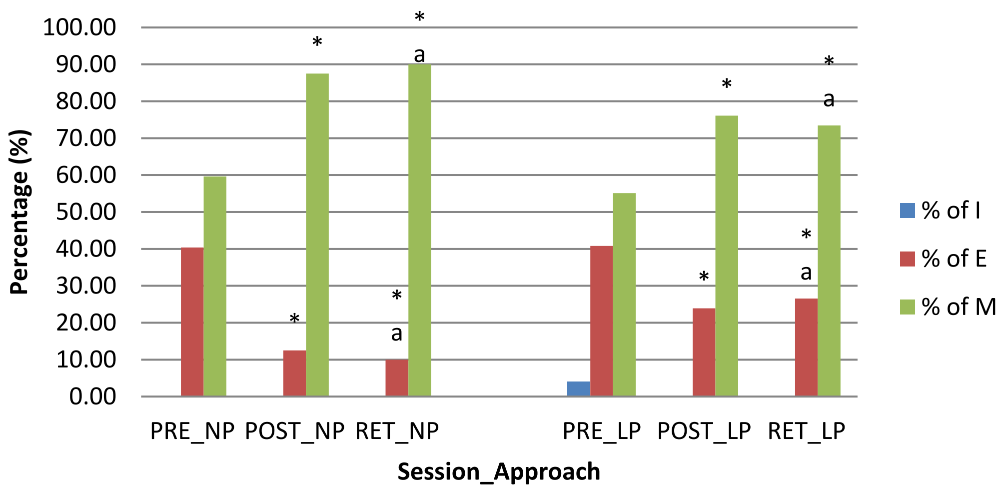

Figure 7: Percentage of students within initial (I), elementary (E) and mature (M) stage for sliding. (*) indicates significant differences from pre-test ($p < 0.05$) and (a) indicates significant differences between groups ($p < 0.05$).

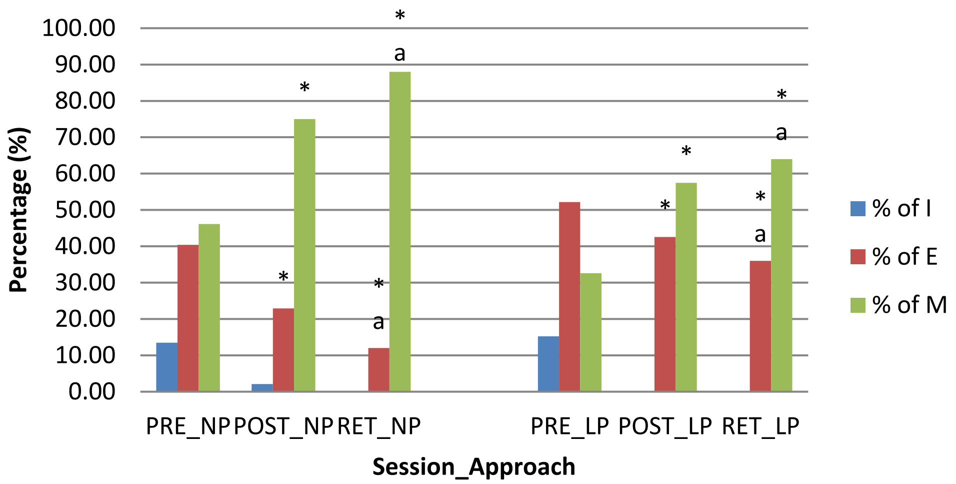

Figure 8: Percentage of students within initial (I), elementary (E) and mature (M) stage for stationary dribbling. (*) indicates significant differences from pre-test ($p < 0.05$) and (a) indicates significant differences between groups ($p < 0.05$).

IMI Questionnaire and Sharpened Romberg Balanced Test (with vision)

No differences in IMI scores and balance test scores for both conditions. Independent t-test showed that there were no significant differences ($p > 0.05$) for all subscales (enjoyment, perceived competence, effort/importance and value/usefulness) of the IMI questionnaire.

Qualitative Data (Focus Group Discussions and Interviews) (for both Phases)

Students Feedback

During the focus groups discussions, students from both groups were able to recall the respective cues and rationales for each move. LP group felt that the cues provided were clear and precise, thus making them easy to understand. NP group also expressed that the cues (analogies) used during the lessons were easy to grasp and interesting which helped them with their understanding. Below, we highlight some examples under the different themes of learning process, enjoyment, creativity and innovation.

Phase 1, Student: "Instead of shooting from far, you go nearer and shoot it. ***Create your own skill move****. Adapt it." (NP)*

Phase 2, Student: "Yes, ***very easy to understand****… I thought the dinosaur egg is like you bounce on the floor then the whole thing will crack out then the dinosaur die? Yeah, it's gently. If you beat too hard, the egg will crack." (NP)*

Phase 1, Student: "We had it ***etched it in our minds*** *what moves that can be used in that certain type of situation and what moves can be executed when an enemy is close by" (LP)*

In addition, both groups expressed some boredom but the causes were different. NP group mentioned that they wanted more variety to try different activities whereas LP students felt that they were losing motivation due to the repetitive drills.

Phase 1, Student: "I ***want more variety****… Like since we have quite a number lessons, we could have like 20 mins of free time to do any other soccer related things that we want like trying to perfect our shooting and all that" (NP)*

Phase 1, Student: "Sometimes it's ***very repetitive****… Yeah,* ***sometimes lose motivation****" (LP)*

Teachers' Feedback

Teachers expressed that NP approach encouraged exploratory learning as the cues did not restrict the students to only use a specific movement solution. Rather, it gave students the freedom to explore different movements, which resulted in the emergence of a variety of movement patterns. Furthermore the use of various equipment (constraints manipulation) throughout the intervention not only facilitated the exploration process but was also able to capture student's attention and seem to result in higher enjoyment levels.

Teachers also felt that NP provided a more authentic experience for greater active learning for the students and hence created a sense of satisfaction and ownership. This seems to reflect what the students felt where students from the NP approach mentioned that they adapted the skills taught to better suit their needs which was in contrast to LP students where students were memorizing the moves.

*Phase 1, Teacher: "I felt that the cues were meaningful. It gives a different perspective on how you can give the cues. The **cues don't restrict the student in a certain way** and I also like the idea behind it. The student is given time to adjust his movement to execute the desired outcome." (NP)*

*Phase 1, Teacher: "I prefer the NLP approach. It's more problem solving where you give students a problem and then they solve it, a **more authentic experience**. More active learning." (NP)*

*Phase 2, Teacher: "I find it allows creativity, that people find the **same solution** but in **different ways**" (NP)*

*Phase 1, Teacher: "Linear I think, if those who are of lower ability, I **teach them exactly what to do** and they do it, and it works right, I think they are **pretty happy with it already**." (LP)*

*Phase 1, Teacher: "The thing with an only linear approach is students **tend to only follow what's being taugh**t. Very few individuals will take the initiative to try something different unless they are prompted to." (LP)*

Nevertheless, there was also the suggestion that a hybrid of NP and LP could work for the students.

*Phase 1, Teacher:" I will **merge it together**. A hybrid one will **supplement** the other more, or rather compliment. To me, start the whole idea, the big picture, and then after that go down straight to how you are able to do it. (NP followed by LP)"*

Phase 2, Teacher: "sometimes I feel that sometimes we are being too technical nothing wrong… there is no one way or the other I find that there is possibility for us to explore a ***combination of both****"*

Contributions of study

Findings from this research project has added new knowledge to the impact of NP on the teaching and learning of invasion games and FMS. Specifically, there is greater clarity in ascertaining that key pedagogical principles for NP can be potentially effective. The manifestations of functional movement behaviours (e.g., greater number of different types of passes) seen from NP groups for Phase 1 further affirmed that an exploratory pedagogical approach could be just as effective as a prescriptive pedagogical approach (LP) to teaching invasion games and FMS.

Findings from Phase 1 with regards to performance outcome and game play behaviours were promising for a NP approach to teaching soccer. Nevertheless, the results on transfer across different games (from soccer to floorball) in the same game category did not emerge as strongly as anticipated. It is possible that perhaps the transfer test of floorball could be too different from the game of soccer in terms of game play dynamics and the effect of transfer did not manifest itself as significantly.

In relation to Phase 2 findings, TGMD-2 data and the Validated Developmental Sequences (Gallahue et al., 2012) data indicated that NP was effective in teaching FMS (at least as good as LP or better). Both NP and LP conditions also showed improvement for the relevant FMS for the obstacle course (Transfer Test). Importantly, qualitative data (FGD and interviews) did provide insights to how NP differed from LP in terms of the learning processes as expressed by students and teachers. Specifically, there seems to be support for how NP can encourage more creativity, exploration in the learning processes and opportunities for problem-solving. One key finding pertains to how teachers suggested that a hybrid of LP and NP could work. It is possible to undertake further observation of existing pedagogical approaches present in PE setting and offer suggestions to 'Nonlinearize' currently practices such that a hybrid of LP and NP could be present (with a significant proportion of NP but with elements of LP as LP could also be effective in achieving learning outcomes as seen in the current study although in different ways). Interestingly, there was no difference between NP and LP for IMI Questionnaire data and a possible explanation could relate to how students are already inherently motivated in a PE setting (opportunity to be active), regardless of whether it is LP or NP.

The key findings from this research project further challenges the "one-size fits all" philosophy held by many PE teachers. An important implication would mean considering alternate assessment rubrics rather than those focused solely on a 'correct' movement form expected of all students. Instead, key 21st century competencies such as creativity, problem-solving and team-work should be assessed in the future. This suggestion in turn has further implication on Teacher Education and Professional Development programmes pertaining to PE. Pedagogical principles pertaining to NP can be relevant for the revised PE Curriculum. Importantly, there is potential to use NP to encourage teaching and learning to be student-centred and focusing on optimizing individual movement competencies. Practitioners could incorporate key pedagogical principles of NP in the delivery of content and teaching within school-based PE settings to help develop greater creativity and involvement among students. With reference to research, more empirical work on NP can also be conducted in the school setting to determine how to implement hybrid NP and LP teaching at different age groups, skill levels and for different activities. Translation of the findings and implications on practice can also be examined in future research projects.

Conclusion

NP was as effective as LP or better in teaching invasion games with reference to enhancing performance outcomes and game play behaviours. Both NP and LP showed some evidence of transfer of skills across games in the same game category (i.e., from soccer to floorball). NP was also effective in teaching FMS in the Primary School context.

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NOTES

Information on sample lesson plans for NP and LP as well as representative collation of qualitative data (FGDs and Interviews) can be accessed via uploaded Appendix in the RC3 Research Form (ROMS)

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APPENDIX

Phase 1

Performance Outcome

Main effect for time was observed, F (3, 168) = 8.54, $p < .001$. $\eta_p^2 = 0.132$. Post hoc analysis showed that mean successful passes were significantly different ($p < .001$) for NP from pre (8.43 ± 4.65) to post test (13.60 ± 5.30), from pre to transfer test 1 (12.07 ± 5.99, $p = .030$) and from pre to retention test (13.17 ± 5.12, $p = .006$). No significant changes were experienced for LP across the test sessions ($p > 0.05$). A main effect of time was also observed for number of consecutive passes for NP, F (2.50, 129.75) = 5.83, $p = .019$, $\eta_p^2 = 0.101$. Post hoc analysis showed that number of consecutive passes were significantly different for NP ($p = .004$) from pre (2.43 ± 2.81) to retention test (4.50 ± 2.64). No significant changes were experienced for LP across the test sessions ($p > 0.05$). Both groups had significant improvements in possession time. A main effect of time was observed for mean possession time, F (2.73, 153.12) = 13.92, $p < .001$, $\eta_p^2 = 0.199$. Post hoc analysis showed that the mean possession time was significantly different $p < .001$ from pre (NP =01:01.44 ± 00:27.17; LP = 00:57.27 ±00:22.87) to post test (NP = 01:29.58 ±00:28.58; LP = 01:29.84 ± 00:30.89). This change was maintained for both groups as no significant difference was found between post to transfer test 1 and from post to retention test, $p > 0.05$. In terms of the number of goals scored, only LP experienced significant improvements. A main effect of time was also observed for mean number of goals for LP, F (3, 168) = 7.02, $p = .005$, $\eta_p^2 = 0.111$. Post hoc analysis showed that mean number of goals were significantly different ($p = .03$) for LP from pre (1.36 ± 1.79) to retention test (2.79 ± 2.57) and from pre to transfer test 1 (2.61 ± 2.03, $p = .061$). No significant changes were experienced for NP across the test sessions ($p > 0.05$).

Game Play Behaviours

In terms of distance covered in the direction of play (Figures 3a and 3b), during post-test, both defending (DEF) and attacking (ATT) teams within LP (DEF = 10.07 ± 6.06; ATT = 10.48 ± 6.00) was significantly higher than NP (DEF = 8.15 ± 4.82; ATT = 8.52 ± 4.70). However, at retention test, the length in the Y-axis for both DEF and ATT teams was significantly higher for NP (DEF = 12.55 ± 8.30; ATT = 12.41 ± 7.71) as compared to LP (DEF = 9.24 ± 4.18; ATT = 9.53 ± 4.41). This observation was similar when comparing with the width covered. For surface area covered by teams (which is a proxy for how a team uses space), the defending teams within LP (DEF = 4.84 ± 2.09) was significantly higher than NP (DEF = 4.20 ± 1.96) during post-test (Figure 4a). With reference to the surface area for the attacking teams, NP (43.17 ± 40.39) was significantly higher than LP (34.15 ± 28.46) during the retention test (Figure 4b). Turnover counts (i.e., change in possession between teams) were significantly higher during the transfer test 1 for NP (0.57 ± 0.50) as compared to LP (0.46 ± 0.50).

Transfer of Learning from Soccer to Floorball

A main effect of time was found for the mean number of passes (Figure 5), $F(1, 9) = 16.67$, $p = .003$, $\eta_p^2 = 0.649$. Post hoc analysis showed that the mean number of passes was significantly different for NP ($p = .031$) and LP ($p = .011$) from pre (NP = 14.33 ± 7.29; LP = 11.80 ± 5.76) to Transfer test 2 (NP = 24.67 ± 8.43; LP = 26.00 ± 11.68). With regards to the total number of goals, a main effect of time was found, $F(1, 9) = 15.07$, $p = .004$, $\eta_p^2 = 0.626$. Post hoc analysis showed that it was significantly different only for LP ($p = .002$) and from pre (1.20 ± 1.30) to Transfer test 2 (6.00 ± 2.55). No significant changes were found for NP across all test sessions ($p > 0.05$). A main effect of time was also found for total possession time, $F(1, 9) = 47.12$, $p < .001$, ηp2 = 0.840. Post hoc analysis showed that total possession time was significantly different for NP ($p = .030$) and LP ($p < .001$) from pre (NP

= 03:26.84 ± 00:40.40; LP = 2:12.94 ± 00:39.07) to Transfer test 2 (NP = 04:13.08 ± 00:15.49; LP = 04:30.26 ± 00:30.07).

Phase 2

Performance Outcome (TGMD-2)

A main effect of time was observed for running, F (1.71, 159.07) = 32.06, $p < .001$, $\eta_p^2 = 0.256$ and intervention, F (1, 93) = 5.55, $p = .021$, $\eta_p^2 = 0.056$, with a significant time x intervention interaction F (1.71, 159.07) = 4.54, $p = 0.016$, $\eta_p^2 = 0.047$. Post hoc analysis showed that it was significantly different for NP ($p < .001$) and LP ($p = .002$) from pre (NP = 5.37 ± 1.53; LP = 5.30 ± 1.62) to post test (NP = 6.59 ± 1.14; LP = 5.97 ± 1.49). At post-test NP scores were significantly different than LP scores ($p = .039$). Between post and retention test, there was no significant differences for both groups ($p > 0.05$). A main effect of time was observed for stationary dribble, F (1.70, 158.26) = 40.04, $p < .001$, $\eta_p^2 = 0.301$ and intervention F (1, 93) = 12.03, $p = .001$, $\eta_p^2 = 0.115$, with a significant time x intervention interaction, F (1.70, 158.26) = 9.20, $p = .001$, $\eta_p^2 = 0.90$. Post hoc analysis showed that it was significantly different for NP ($p < .001$) and LP ($p = .001$) from pre (NP = 4.34 ± 3.07; LP = 4.18 ± 2.15) to post test (NP = 6.70 ± 1.59; LP = 5.41 ± 2.11), with significantly higher scores for the NP group at post-test ($p = .001$). Between post and retention test, there was no significant differences for both groups ($p > 0.05$). For catching, a main effect of time observed, F (1.88, 174.89) = 16.68, $p < .001$, $\eta_p^2 = 0.152$. Post hoc analysis showed that it was significantly different for NP ($p = .003$) and LP ($p = .027$) from pre (NP = 4.36 ± 1.42; LP = 4.50 ± 1.46) to post test (NP = 5.06 ± 1.32; LP = 5.04 ± 1.04). There was no significant differences for both groups between post and retention test ($p > 0.05$). A main effect of time was observed for sliding, F (1.77, 1.60) = 26.80, $p < .001$, $\eta_p^2 = 0.224$. Post hoc analysis showed that it was significantly different for NP ($p < .001$) and LP ($p = .005$) from pre (NP = 5.80 ± 1.73; LP = 5.94 ± 1.51) to post test (NP = 7.17 ± 0.10; LP = 6.75 ± 1.24). There was no significant differences for both groups between post and retention test ($p > 0.05$). There was a main effect of time observed for overhand throw (Figure 6), $F(2, 186) = 7.05$, $p = .001$, $\eta_p^2 = 0.071$. Post hoc analysis showed that it was significantly different for NP ($p = .007$) from pre (NP = 3.58 ± 2.48) to post test (NP = 4.57 ± 2.34). There was no significant difference between post and retention test ($p > 0.05$). No significant differences were seen for LP across all test sessions ($p > 0.05$).

Obstacle Course (Transfer Test)

A main effect of time was observed for overhand throw, $F(1, 165) = 79.00$, $p < .001$, $\eta_p^2 = 0.324$. Post hoc analysis showed that it was significantly different ($p < .001$) from pre (NP = 3.78 ± 1.10; LP = 3.74 ± 0.99) to post test (NP = 4.58 ± 0.47; LP = 4.43 ± 0.59). For sliding, a main effect of time was observed, $F(1, 165) = 87.83$, $p < .001$, $\eta_p^2 = 0.347$. Post hoc analysis showed that it was significantly different ($p < .001$) from pre (NP = 6.21 ± 1.46; LP = 5.60 ± 1.02) to post test (NP = 5.16 ± 0.90; LP = 4.87 ± 0.75). A lower time would indicate a faster completion of the task. A main effect of time was also observed for stationary dribbling, $F(1, 165) = 59.58$, $p < .001$, $\eta_p^2 = 0.265$. Post hoc analysis showed that it was significantly different ($p < .001$) from pre (NP = 1.89 ± 0.82; LP = 2.13 ± 0.82) to post test (NP = 2.45 ± 0.58; LP = 2.45 ± 0.59). A main effect of time was observed for running, $F(1, 165) = 74.67$, $p < .001$, $\eta_p^2 = 0.312$. Post hoc analysis showed that it was significantly different ($p < .001$) from pre (NP = 2.67 ± 0.28; LP = 2.68 ± 0.36) to post test (NP = 2.46 ± 0.25; LP = 2.45 ± 0.30). A main effect of time was also observed for catching, $F(1, 165) = 151.11$, $p < .001$, $\eta_p^2 = 0.478$. Post hoc analysis showed that it was significantly different ($p < .001$) from pre (NP = 4.08 ± 0.70; LP = 3.97 ± 0.75) to post test (NP = 4.75 ± 0.36; LP = 4.79 ± 0.25).

Validated Developmental Sequences (Gallahue et al., 2012)

For running, there was a significant difference between sessions, $\chi^2(2) = 29.73$, $p = < .001$. Post hoc analysis showed that a significant change in scores between pre and post-test occurred for NP (*Z* = -3.36, *p* = .001) and LP (*Z* = -2.36, *p* = .018) and pre to retention test (NP: Z = -3.71, *p* < .001; LP: Z = -2.52, *p* = .012). Overhand throw also had statistically significant difference between sessions, $\chi^2(2) = 9.51$, *p* = .009. Post hoc analysis revealed that it was significantly different for NP (*Z* = -2.52, *p* = .012) and LP (*Z* = -2.00, *p* = .046) between pre and post-test. These changes were maintained from post to retention test (*p* > 0.05). In terms of catching, there was a statistically significant difference between sessions $\chi^2(2) = 3.52$, *p* = < .001. Post hoc analysis showed that a significant change in scores between pre and post-test occurred for NP (*Z* = -2.84, *p* = .005) and LP (*Z* = -3.00, *p* = .003), and pre to retention test (NP: Z = -3.37, *p* = .001; LP: Z = -1.58, *p* = .115). For sliding (see Figure 8), there was a significant change between sessions, $\chi^2(2) = 21.88$, *p* = < .001. Post hoc analysis showed that a significant change between pre and post-test occurred for NP (*Z* = -3.15, *p* = .002) and LP (*Z* = -2.56, *p* = .011), and between pre and retention test for NP (Z = -3.71, *p* = < .001) and LP (Z = -2.52, *p* = .012). At retention test, there was significant difference between groups (*p* = .034). For sliding, NP group students within the elementary group decreased from 40.38% to 12.50%, with an increase in mature stage from 59.62% to 87.50%. LP had a decrease of 40.82% to 23.91% for students within the elementary stage with an increase of 55.10% to 76.09% in the mature stage. With regards to stationary dribbling (see Figure 9), significant differences occurred between sessions, χ^2 (2) = 39.91, *p* = < .001. Post hoc analysis showed it was significantly different (p = .001) between pre and post-test for both NP (Z = -3.25) and LP (Z = -3.27), and significantly different (*p* < .001) between pre and retention test for NP (Z = -4.24) and LP (Z = -3.64). At retention test, there was significant difference between groups (*p* = .006). With regards to stationary dribbling, there was a decrease of students in the elementary stage from 40.38% to 22.92% and an increase of students in the mature stage from 46.15% to 75.00%. In comparison, the LP had a decrease from 52.17% to 42.55% for students in the elementary stage and an increase of 32.61% to 57.45% for mature stage.