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Nonlinear Pedagogy and its role in encouraging 21st Century Competencies through Physical Education: A Singapore Experience

Abstract

Nonlinear Pedagogy is an exploratory approach to teaching and learning Physical Education that can be potentially effective to help children acquire relevant 21st century competencies. Underpinned by Ecological Dynamics, the focus of Nonlinear Pedagogy is on the learner and includes the provision of less prescriptive instructions, and guided discovery which serve to develop greater autonomy, competency and relatedness in the learning process. This paper describes a study that examines the factors that contributed to motivation, enjoyment and the development of 21st century competencies in Primary School Children. 133 children were taught over 7-weeks to play a modified tennis game either with a Nonlinear Pedagogy or Linear Pedagogy (i.e., more teacher-centred) approach in a Singapore school. While findings from the IMI questionnaire showed that there was no difference for the subscales measured, student and teacher interviews indicated that the Nonlinear Pedagogy approach created a learning environment that facilitated perceived competence, autonomy and relatedness, thus potentially enhancing intrinsic motivation and enjoyment during practice. Nonlinear Pedagogy encourages teachers to create representative learning designs through the inclusion of a variety of modified games, the freedom to choose, an emphasis on exploration and problem-solving and can be relevant to develop 21st century competencies.

Key words: Nonlinear Pedagogy, Physical Education, 21st century competencies, Motivation, Enjoyment

Introduction

Central to the theme of this special issue is the importance of supporting our school children to acquire relevant 21st century competencies. Movement education in the form of Physical Education is an excellent platform to develop children's capacity to acquire valuable competencies that may not be so easily taught in a typical classroom setting. Being out in the field, courts and gym provides wonderful opportunities for student, and teacher-student interactions that are difficult to replicate in classrooms.

Advances in theory and practice within the domain of Physical Education over the last decade have provided strong support for pedagogical approaches that are more student-centric to help cater to individual needs (Author et al., 2016). Students tend to be more engaged when learning in representative environments that simulate the same challenges that are present in the performance context (Author et al., 2016). Opportunities for collaborative work and creative problem-solving are also presented when the key constraints (i.e., boundaries that shape behaviours) in the teaching process are identified and manipulated to encourage exploratory learning (Author et al., 2006). In the context of Physical Education, a renewed focus upon the student-environment relationship may allow learners to better acquire critical 21st century competencies (e.g., self-awareness, critical and inventive thinking) that can better prepare them for local and global challenges in the future.

One such novel pedagogical approach, Nonlinear Pedagogy, has theoretical grounding in Ecological Dynamics and provides scientists as well as practitioners with a suitable framework to understand how functional movement behaviours can be taught to learners. A Nonlinear Pedagogy approach, embraces the nonlinearity inherent to the learning process and it provides practitioners with key principles to underpin teaching of Physical Education (Author, 2014). Pertinent information on how to assess performance, how to structure practices, and how best to deliver instructions and provide feedback are particularly relevant

for effective teaching and learning (see Author, 2013; Ovens, Hopper, & Butler, 2013). Next, we will explain some of the design principles upon which Nonlinear Pedagogy is based and relate them to the 21st century competencies recently identified by the Ministry of Education (<https://www.moe.gov.sg/education/education-system/21st-century-competencies>) (although it can also be relevant to other contexts beyond Singapore). Particularly, there is relevance to the key competencies of, civic literacy, global awareness and cross-cultural skills (with an emphasis on working with peers from different cultural background, ideas and perspectives), critical and inventive thinking (with reference to the ability to think critically, assess options and make sound decisions), and communication, collaboration and information skills (ability to work together in a respectful manner, to share responsibilities and make decisions with one another towards a common goal) since Nonlinear Pedagogy is aimed at encouraging learners to explore their own individualised movement solutions in less prescriptive learning contexts and facilitate the interaction with others. Then, we further elucidate the relevance of Nonlinear Pedagogy with regards to motivation and enjoyment for children when learning new movement behaviours at school.

Design Principles in Nonlinear Pedagogy

Situated for representative learning design

For humans, the acquisition of motor skills is a lifelong, complex process, which arises as a consequence of individual differences and accumulated interactions between the learner and the environment (Author, 2010). From an educational standpoint, Davis and Sumara (2006) suggested that pupil learning should occur in a “bottom up” manner (i.e., emanating from the students themselves) reflecting higher levels of situated and authentic learning with the focus on students. Indeed, it is crucial for motor development to be embedded in a situated and embodied perspective (see Port & Van Gelder, 1995). This design

principle is well aligned with the Civic Literacy, Global Awareness and Cross-Cultural Skills relating to 21st century competencies. With appropriate guidance from teachers, the learner can develop awareness of how to anticipate and adapt to task and environment fluctuations. Hence, Nonlinear Pedagogy demands good citizenship from learners as they must work with others and self-navigate the bumpy and often challenging pathways to skill development.

Developing relevant information-movement couplings

The importance of developing relevant information-movement couplings cannot be trivialized and it is one of the key foundational pillars for Nonlinear Pedagogy as it has relevance to representativeness (Author et al., 2006; Author et al., 2007). From Ecological Psychology (see Gibson, 1979), the circular relationship between information and movement is fundamental to the understanding of the concept of affordances and the role it plays in the control of movement. Affordances are opportunities for action and are defined relative to the action capabilities of the individual (Fajen, Riley, & Turvey, 2009). The focus is on how opportunities for action are pegged to the *individual* as he or she operates within an *environment* (social or physical) (see Kulikowich & Young, 2001). Nonlinear Pedagogy builds on the importance of establishing functional affordances and such opportunities for action can be meaningfully created when the learners practice under representative learning contexts that capture the essence of real game situations. Hence, forging information-movement couplings serves to develop information literacy skills and the ability to identify and act upon opportunities when they present themselves. Individuals must continually search for and use relevant information sources that help to specify energetically efficient solutions to any given task problem.

Manipulation of constraints

The manipulation of constraints is another key pedagogical principle captured by Nonlinear Pedagogy (see Author, 2013; Davids, Button, & Bennett, 2008). Constraints such as playing area or equipment act as boundaries to define how learners can search for movement solutions afforded to the individual (Davids, et al., 2008). While there are three main classes of constraints (i.e., performer, environment & task), it is task constraints that practitioners have most direct control over in terms of how they can be manipulated. Indeed, task constraints like instructions, rules of the activity and equipment are customarily manipulated to help guide learners towards certain movement solutions (Author, 2014; Author, 2012). Learners must adopt core 21st century competencies of critical and inventive thinking to adapt to the confluence of constraints placed upon them. Rather than simply being told how to move by a teacher (a much more passive way to learn), the learner must instead devise for themselves the most appropriate solution for any given circumstance. Thus, the manipulation of constraints by the coach or teacher is a very powerful and important aspect of Nonlinear Pedagogy in encouraging transitions and acquisition of new preferred stable movement behaviours in a learning system (Author, 2013).

Attentional focus: Impact on modifying conscious control

The presentation of instructions (as a task constraint) with varied emphasis on external or internal focus of attention has important teaching and learning implications (Author, 2011). According to Wulf (2007), an external focus of attention is described as “*where the performer’s attention is directed to the effect of the action*”, while an internal focus of attention is defined as “*where attention is directed to the action itself*”. Practitioners can influence learning by guiding learners to focus attention on either the effects of a movement on the environment (i.e., the outcomes of an action) or on body movements (i.e., limb segments) involved in producing an action, respectively (see Peh et al., 2011).

Typically, internal focus of attention instructions that emphasize movement form tend to evoke a more conscious control of movement and thus may lead to less successful learning. In contrast, external focus of attention instructions can evoke a more sub-conscious control of movement and thus, encourage the use of self-organization process in movement control. In designing successful learning experiences from a nonlinear pedagogical perspective, self-organising processes should be exploited and the use of an outward focus on the environment and movement effects seems to encourage such processes (Author, 2013). Learning how to switch attentional focus and direct it appropriately is an important part of Nonlinear Pedagogy that serves to develop core 21st century competencies such as awareness and communication. Learners must understand how to focus attention effectively and communication skill is a vital tool in developing this capacity.

Ensuring functional variability

Another important aspect of Nonlinear Pedagogy is associated with the role of functional movement variability in enhancing acquisition of coordination since variability is an inherent feature of nonlinearity in human learning (Author, 2014; Author, 2011). From a traditional engineering science perspective, variability is seen as ‘noise’ and something that is undesired or should be avoided to improve system function. However, in Nonlinear Pedagogy, ‘noise’ amplifies the exploratory activity and helps the learner to discover individualized functional solutions to a specific task goal (Davids, et al., 2008; Newell & James, 2008; Schöllhorn, Mayer-Kress, Newell, & Michelbrink, 2009; Tan, Chow, & Davis, 2012). For example, a teacher may introduce variability in the practice of a ball sport by changing the characteristics of the ball (e.g., size, bounce, shape, colour) and thereby invite different solutions to emerge. By navigating variable practice conditions, learners must engage in exploratory behaviour and thus perform a wider and more thorough search of the

perceptual motor workspace. The teacher can focus on leveraging on the functional role of variability and alter practice conditions such that children learn to adapt their behaviour to different situations. This process develops core 21st century competences such as decision making and critical thinking.

Motivation and enjoyment in Nonlinear Pedagogy

Since sport and Physical Education research has provided empirical evidence that intrinsic motivation is related to positive learning outcomes (Ntoumanis & Biddle, 1999; Theeboom, De Knop, & Weiss, 1995; Treasure & Robert, 2001), creating a motivationally supportive learning environment in Physical Education classes is essential for learners. Self-Determination Theory (SDT), is underpinned by the concept of individual needs (Deci & Ryan, 1985; Ryan & Deci, 2000) and thus provides a suitable framework for understanding motivation in relation to Nonlinear Pedagogy. The three basic psychological needs of SDT are briefly explained as follows: Perceived competence indicates an individual's belief in one's ability to control outcomes; Autonomy refers to the desire to express choice rather than the feeling of being controlled or forced to do something; and Relatedness involves the need to feel connected, supported and for inter-personal relationship.

The design of learning in Nonlinear Pedagogy develops the basic psychological needs and thus intrinsic motivation and enjoyment in learners. Renshaw and colleagues (2012) suggest that employing a Nonlinear Pedagogy approach encourages an individual to explore their own functional movement solutions during practice. This has implications on how the learner's perceived competence and autonomy are not constantly threatened by being told what to do when instructed to perform the 'correct way'. Furthermore, perceptions of relatedness between the teacher and student are likely to be enhanced as the nature of

interactions is learner-centred (Renshaw et al, 2012). When the focus is on the learner, there is possibly greater connectedness and support that will be experienced by the students. A recent study provided empirical evidence that the Nonlinear Pedagogy approach led to higher motivation levels as compared to the traditional prescriptive and repetitive approach (referred to in the current study as Linear Pedagogy) for learning the hurdling skill (Moy, Renshaw, & Davids, 2016). Specifically, higher motivation subscale mean scores for competence, relatedness, autonomy, enjoyment and effort were experienced by Physical Education teacher education students after participating in lessons underpinned by pedagogical principles from Nonlinear Pedagogy.

The enhancement of motivation and enjoyment as a result of Nonlinear Pedagogy has relevance for developing 21st century competencies. For example, civic literacy, global awareness and cross-cultural skills as well as communication, collaboration and information skills is associated with relatedness and working with others, and critical and inventive thinking is linked to autonomy and problem solving. Enhanced perceived competence is also related to greater confidence, one of the desired outcomes of the 21st century competencies.

In this study, we aimed to investigate within a typical school setting, children's motivation and enjoyment for learning a unit of modified-tennis, when they were taught with either a Nonlinear Pedagogy (NP) approach, or a Linear Pedagogy (LP) approach (a typical teacher-led pedagogical approach with a focus on repetitive drills and prescriptive instructions). The two main research questions this paper aimed to address are as follows:

- 1) How does the NP (and LP) approach affect motivation and enjoyment and what are the factors involved?
- 2) What is the relevance of NP (and LP) for developing 21st Century Competencies?

Methods

Participants

Hundred and thirty-three students, aged 9 to 10 years, from four classes participated in the study. Two classes were assigned to the NP intervention (Class A: N = 28; Class B: N = 39) and the other two classes were assigned to the LP intervention (Class C: N = 28; Class D: N = 38). Eight students from each class (i.e., four pairs per class; 16 pairs in total) with little or no tennis background and other raquet sports were further selected to participate in three interview sessions. In addition, two experienced Physical Education teachers from the school taught the intervention to the four classes. The Physical Education teachers were teachers from the Ministry of Education (Singapore) and had at least nine years of teaching experience at the time of the data collection. Each teacher taught one class from each intervention type (i.e., Teacher 1 taught Class A and Class C; Teacher 2 taught Class B and Class D). Informed parental consent and participant assent was obtained from all students as well as the selected students involved in the interview sessions. Informed consent was also obtained from the two teachers that participated in the intervention and interviews sessions. Ethical approval was granted by the Institutional Review Board of the participating university and data collection in the school was approved by the Ministry of Education, Singapore.

Procedures

The experimental procedure consisted of a 7-week intervention, comprising 14 lessons incorporating either NP or LP intervention. Following the intervention period, all participants completed a questionnaire adapted from the intrinsic motivation inventory (IMI) questionnaire (Deci & Ryan, 1985). In addition, the eight selected students from each class participated in three focus-group interview sessions spread throughout the intervention period. The two teachers also participated in an interview session following the intervention. All students in each class participated in one of the teaching interventions (14 lessons) which were carried out by the respective teachers during the school's normal Physical Education

period. Each lesson in a week lasted for 0.5 hr and 1 hr respectively, with a total of 600 minutes of practice for both intervention groups.

Interviews (selected students)

Each focus-group interview consisted of four participants (the eight selected participants from each class were divided into two groups) and interviewed over three sessions immediately after assigned lessons (Group A: Lesson 4, 9 and 13; Group B: Lesson 6, 11 and 14). Each interview lasted approximately 15 minutes. The procedures of this interview were adopted from Gray and colleagues (2009). The main purpose of the interviews was to obtain qualitative data from the students about their learning experiences (Gray, Sproule, & Morgan, 2009). In the interview, questions were asked to find out about the learning processes and enjoyment experienced by the children.

The interview was conducted by a trained researcher following assigned intervention sessions. Prior to the actual interview sessions, the researcher practiced the interviewing techniques with children of similar age (9-10 years old). The interview questions followed a semi-structured style during which the interviewer had a specific number of major questions to explore but was free to probe beyond the respondent's immediate answers and develop additional questions to gain further insights within the context of the study (Merriam, 2014; Patton, 1990). All interviews were tape-recorded and subsequently transcribed verbatim.

Interviews (two teachers)

Following the intervention, the two teachers were interviewed separately, using a similar process to the student interviews. The main purpose of the teachers' interviews was to find out the teacher's perception of the children's learning processes and enjoyment during the lessons, as well as their perception of the applicability of the respective approaches to teaching and learning games in PE.

Intervention

All students in each class participated in seven weeks of practice (14 lessons). All lessons were taught twice a week by the respective teachers during the school's Physical Education period. Each lesson in a week lasted for 0.5 hr and 1 hr respectively, with a total of 600 minutes of practice for both intervention groups.

The main objective of both NP and LP intervention was to develop game skills to play a cooperative and competitive rally during a modified-tennis game. Both NP and LP followed a set of common objectives (Hopper, 2007; Hutslar, 1998) that was taught to the participants throughout the intervention, although the specific intervention activities for either NP or LP included key features of each respective instructional approach. The NP intervention involved the manipulation of task constraints including the manipulation of tennis balls, scaled racquets, net height, target area, court size and rules to achieve the task goal. The NP intervention also emphasised on instructions that focused on the outcome, variability during practice, task simplification as well as representativeness of the activities to allow for practice in the actual game context. On the other hand, LP intervention consisted of prescriptive teaching cues for various tennis strokes (e.g., forehand and backhand ground stroke, volley, and lob) and required participants to perform repetitive practice drills for each of these strokes (refer to Figure 1. below for examples of the equipment, set up and practice sessions for NP and LP intervention).

[Insert Figure 1 here]

The lessons for both conditions were taught by the two Physical Education teachers from the school. Prior to the start of the data collection, the teachers attended a training workshop conducted by the research team comprising two sessions. The first session was to explain the key characteristics of NP and LP during which examples were provided according

to each common objective throughout the intervention. The second session was a hands-on session during which each teacher taught activities from the NP intervention and the LP intervention. During the workshop, the teachers clarified their understandings about both instructional approaches. Throughout the intervention period, the research team met with the teachers weekly to run through the activities from both NP and LP lesson plans for the following week. This was to ensure that the teachers were clear about the planned activities prior to each lesson. During each lesson, the researcher was present to ensure that the teachers taught according to the lesson plans. In addition, the video recordings of three intervention sessions (two 30 min and one 60 min) were randomly chosen from each intervention and validated by an academic knowledgeable in this field of work, but external to this research.

Measurement and Data analysis

Intrinsic motivation questionnaire data was determined from all student participants. Student interviews were obtained from the 16 pairs of selected participants. Teacher interview data was obtained from the two participating teachers.

Interviews (students and teachers)

Qualitative data collected from the tape-recorded interviews was transcribed and a constant-comparative analysis was employed to identify the themes that emerged from the data (Merriam, 2014). Specifically, data analysis of the interviews involved three levels of data transformation (Novak & Gowin, 1984). The first level comprised the production of verbatim transcripts which refers to the full transcription of the interview. Transcription procedures and conventions were adapted from Kvale and Brinkmann (2009). The next level involved the coding of potential themes or categories of descriptive data based on excerpts from various interview data sources. During this process, key words or descriptive phrases

were allocated to parts of the transcript so that themes could be identified and further developed in relation to the research question. The third level involved the development of a framework to illustrate the relationship among themes. At this level, insights about the students' learning processes were reported. In order to ensure validity and reliability of the data, member checks were conducted by clarifying the transcripts and initial interpretations with the participants of the interview (Merriam, 2014).

Intrinsic Motivation Questionnaire

Following the intervention, all participants completed a 24-item questionnaire, adapted from the IMI questionnaire (Deci & Ryan, 1985), to measure intrinsic motivation experienced during the lessons. The questionnaire consisted of four subscales: enjoyment (7 items), perceived competence (6 items), effort/importance (4 items) and value/usefulness (7 items). Prior to this study, the items were verified with a group of children of similar age and characteristics to participants in this study, and certain words/ phrases were simplified according to their understanding. The revised questionnaire was given to the participants in a previous study to validate the questionnaire and a Cronbach alpha was established for each subscale. The Cronbach alpha for all four subscales (Cronbach alpha of enjoyment: 0.820; perceived competence: 0.897; effort/importance: 0.639; value/usefulness: 0.837) was within or near the acceptable range of 0.65 to 0.90.

Upon administering the questionnaire, the children were not required to write their names on the questionnaire to ensure that the responses were anonymous. The scores of each item on a subscale were averaged to obtain a subscale score. Independent t-test was used to examine differences between groups for each subscale and statistical difference was accepted at $p < 0.05$.

Results

Intrinsic Motivation Questionnaire

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.

Student interviews

Enjoyment and motivation

Enjoyment in NP group

When the children in the NP group were asked to describe some of the things that they enjoyed about the lesson, a main theme that emerged was that they enjoyed hitting continuously. For example, when asked about the cooperative rally, one child expressed that “It’s fun” because she enjoyed “Hitting back and forth, and back and forth, and back and forth, and back and forth, and continuously.” (Interview 2, Class B, Group B).

Another reason they enjoyed the lessons was that they looked forward to the novel experiences as the NP intervention often involved a variety of new activities. One child described her thoughts about attending the NP lessons:

I look forward to it because I’m always expecting some new things. (Interview 2, Class A, Group A).

The main reason that the emerged for feeling bored at times among the students in the NP group was the length of the intervention. One child shared her sentiments towards attending the NP lessons and explained that she felt bored at times because they were only learning tennis in class and no other sports.

Perceived competence in NP group

Some children in the NP group also shared that they found it challenging as sometimes they were unable to control the ball. A more common part of the lesson they

found challenging was the competitive game including performing the lob and volley. For example, one child shared:

Doing the lob is sometimes very difficult. It is limited, because like the lob, even though it goes over your opponent, but then it still goes out of court.” (Interview 3, Class B, Group A)

Even though the children found certain aspects of playing modified tennis challenging, they kept an optimistic attitude towards learning. For example, they shared that they had an I can do better attitude. In addition, the children felt that they improved because they now have a better understanding about tennis:

I improved a bit, not a lot, but it's still acceptable. ...I learnt more about tennis. ... I have gained a lot more knowledge. Last time, when we first started tennis, I had no idea what tennis was about. I only heard of the name. And then, I don't know how tennis operates. ... then it's like I learnt about guarding your space, the volley. (Interview 3, Class B, Group A)

This provides evidence of the emergence of perception of competence among the students from the NP group.

Another example demonstrative of a positive attitude towards learning was that they enjoyed the competitive game because it's a win-win (i.e., mutually beneficial) situation, even though they were not able to perform it well. One child explained about how she maintained a positive mindset even in challenging situations while playing a competitive game:

It benefits us and it also benefits them. ... If we can't play tennis we can hit anyhow ((meaning hit as they pleased)). But it benefits them ((the opponent)) to get a point. (Interview 2, Class B, Group A)

Enjoyment in LP group

A main theme that emerged in the LP group was that the children enjoyed playing games. In particular, they preferred playing games as compared to practice tasks, they also preferred playing cooperative games as compared to the competitive games, and enjoyed the

competitive game when it was successful. When asked about their feelings towards attending the LP lesson, one of the students shared that she found it “Fun ... But sometimes boring”.

She explained:

The fun is when I hit the ball, then she can hit back. The not fun is when she hits the ball, but the other person doesn't hit ((referring to the practice tasks where one person tosses the ball, and the other one hits)) ... Because she doesn't return me the ball.

Then it's like I have to wait there for her. (Interview 2, Class C, Group B)

The waiting time spent during the lesson is one of the reasons why the children did not enjoy the LP lesson, exemplified further in the next paragraph. Another reason they enjoyed the lessons was that they “get to learning new things” (Interview 2, Class D, Group B).

Many of the children in the LP group shared that they did not enjoy the boring repetitive drills but rather wished they had more time to play:

I think it was boring ... Because we keep on doing the same thing. ... It's like repetition. After we've done the first one, we must continue and continue and continue until the teacher told us to stop and gather there. (Interview 1, Class, Group A)

In a subsequent interview, the children clarified:

(We) Have to gather here, gather there. So boring the gathering. ... Playing is more fun. (Interview 2, Class C, Group A)

Furthermore, the boredom from the repetitive drills seemed to have affected the children's motivation to play as some of them shared that the boredom hindered their performance:

Because every week we always do the same type of skills, and then sometimes when we're not in the mood to play, we find it harder to play the competitive and cooperative game. (Interview 3, Class C, Group A)

Other topics that emerged during the interview, that were less common but worth noting, was that individual preferences were not taken into account just as one child shared she wished that there was a smaller and lighter racquet to use during the lesson as the racquet was too heavy.

Perceived competence in LP group

Similar to the NP group, some of the children in the LP group shared that they found it challenging as sometimes they were unable to control the ball. In particular, they claimed that the backhand and volley is difficult, and hence were not able to utilise it during the game. Some revealed that they tried to follow but failed to utilise the cues taught during the game:

I tried but I failed. ... I tried to just do like that. Then after a while, we just get bored.
(Interview 1, Class D, Group A)

Another common topic shared during the interviews was that their perceived competence was dependent on the ability of their partner. For example, one student commented:

It all matters if you choose your partner correctly ...you must choose your partner correctly so you can do it well. If you choose the wrong partner, then you won't do it well.(Interview 3, Class D, Group A)

Although it is possible that if a student has a relatively less competent partner, it can become challenging to get a rally going, this comment suggests that the LP group tend to place the responsibility of success or failure on others.

Teamwork and social skills

Teamwork and social skills in NP group

Questions about teamwork and social skills were not specifically asked but themes related to this topic also surfaced during the interviews. Specifically, the NP group expressed the ability to work cooperatively with others just as one child explained:

Sometimes you have arguments when your friend gets a point, who's out or something like that. So that time I think there was a misunderstanding, I hit and then P2 didn't manage to hit, (but) then she thought that she managed to hit back and I didn't manage to hit, that's why I was out, so for that time I gave in to her. (Interview 2, Class B, Group A)

Furthermore, the children in the NP group provided constructive feedback to their peers rather than criticising them. With reference to SDT, this presents the manifestation of relatedness for the students in the NP group.

Teamwork and social skills in LP group

Themes related to team work and social skills also emerged in the LP group during the interviews. The nature of the LP approach resulted in the children blaming others and getting into arguments. For example, when the children were asked what was going through their minds in order to play a cooperative game, they shared the following:

P1: I told her to like (hit) a bit slow, or do it properly. After that she said ok. But she hit until very high. Still no improvement. ... For myself, I hit hard, very hard for her. As a reminder for her, to ask her to slow down, I hit very high.

...

P2: My partner is also not cooperative, she won't retrieve the ball. She always asks me to retrieve the ball. Then she always likes to hit very hard, sometimes hit until the other side. (Interview 1, Class C, Group A)

Problem solving and creativity

Problem solving and creativity in NP group

The children from the NP group shared that they used strategies such as focusing on the outcome and analogies to keep a cooperative rally going and to win a competitive game. For example, one of the children shared that in order to win the opponent using the lob, she had to "hit over the 'monkey.'" (Interview 3, Class B, Group A).

Several children also illustrated a creative imagination as a method to keep the rally going or to win a point. For example, from the student interviews, it was found that students were able to creatively visualise the ball as a 'dynamite':

Just now when we were doing, we pretend that the ball is the dynamite, me and my partner keep tossing, never drop one time. (Interview 1, Class A, Group A)

Other examples of creative imagination included “saving the princess” (Interview 1, Class B, Group B) as a method to win during the castle game activity and imagining that the no-entry zone activity was a “poisonous pond” (Interview 1, Class B, Group B) which they had to hit over.

Problem solving and creativity in LP group

In contrast, students provided with the LP approach were fixated with only one correct way to overcome the movement challenge in the games and commonly followed without understanding. For example, one student described:

P: We learn about the forehand grip. And the racquet must always be horizontal to the ground ((she probably meant perpendicular)), so that we can clarify which is our top or the bottom, we (are) not allowed to face it at the floor, we supposed to place it there.

I: It has to be this way, is it?

P: Ya, so that when you hit the ball, then the ball will shoot back down.

(Interview 1, Class C, Group A)

Teacher interviews

Enjoyment and motivation

Enjoyment and motivation in NP group

Although both teachers had differing views on which group they felt performed better, both teachers shared that there was more fun manifested by the NP group. For example, one teacher described her observation of the students in the NP group:

If you see them playing the game, they look happier, and I’m happier, when I see them enjoying themselves.” (T2, line 55-59)

The reasons given were that the children appeared to enjoy the freedom to choose and they were enthusiastic about the variety of games. The reported autonomy experienced by the students from the NP group was evident from the teacher interviews:

They (NP group) like to explore, they don't really want you to tell them, you know, what racquet to use or what ball to use, they like to have the freedom to choose. (T2, line 27-29)

Enjoyment and motivation in LP group

While one of the teachers observed that the LP group enjoyed learning new things, both teachers felt that there was generally less fun manifested by them:

The LP definitely did not manifest as much fun compared to the NP group... the other group (LP) you see the way they behave, they are very on task, they "racquet ready position", then you know the feet will come ((step forward)), then "racquet back" that sort of thing. So, maybe it's a bit difficult to marry the so-called trying to follow all the instructions and still be having fun." (T1, line 225-240)

In particular, one of the teachers described the lessons as dull and military-like:

Personally, I find LP a bit dull and military...when it comes to perfecting the stroke, it really gets on my nerves, because, you know, some kids really can't follow you see. But I will prefer to see them enjoy the game rather than, you know, perfecting that skill. I'm not trying to train a professional tennis player, this is a PE lesson. (T2, line 476-480)

The teachers also shared that the children seemed to enjoy playing games more than drills and practices tasks and that both groups seemed to enjoy playing the cooperative game more than the competitive game as it gave them more.

Teamwork and social skills

Teamwork and social skills in NP group

The results suggest that NP approach facilitated the development of social skills and teamwork. In particular, the teachers commented that the children taught with the NP approach seemed to interact more with their team mates and provided constructive feedback. For example, when asked about the features in the NP approach that could have influenced the ability for the students to feed the ball to each other, one teacher responded:

I think probably (the) NP group they have to interact with their partner. For example, if I'm feeding to her the wrong way, she would tell me, 'Higher!' or you know, 'Can you feed a bit to my right?'"'. (T2, line 298-307)

They also displayed the ability to work cooperatively with others and exhibited less arguments (further example of relatedness).

Teamwork and social skills in LP group

On the other hand, the nature of the LP approach resulted in the children often waiting to be told what to do. The same teacher described:

... But for the LP group, because I'm giving them the direction, for the practice ... So there's no interaction between, maybe little interactions between the partners. Most of the time they are listening to my cues. ... So even if the friend is not feeding well, they're not telling the friend what to do ... They're waiting for me to tell them what to do, instead of, you know, the partner advising their friends like, 'You should give me the ball a bit higher'. (T2, line 298-317)

The teacher also shared that generally the LP approach resulted in the students blaming others and getting into arguments. These comments are consistent with the discussions shared during the student's interviews

Problem solving and creativity

Problem solving and creativity in NP group

Similar to the responses of the children in the NP group, information from the teachers' interviews provided insights to how the NP approach is viewed as encouraging learning through exploration with a focus on the outcome. In addition, the teachers shared about how the NP approach encouraged problem-solving as well as creativity and innovation. One teacher described how the lesson went for the NP approach:

For the NP, we give them the freedom to explore, and then you will see slowly their behaviours start to emerge. I prefer that kind of learning because you are inculcating the thinking skills that are involved in a game setting. (T2, line 7-18)

The other teacher elaborated on the ability for the children in the NP group to display creativity and innovation:

The teacher can also learn because students can also come up with very unconventional and sometimes unpredictable ways in the way they actually handle the task. (T1, line 59-64)

Problem solving and creativity in LP group

In response to questions about the LP approach, the teachers described it as a systematic approach with repetitive prescriptive drills that emphasised only one correct way of hitting. One of the teachers also observed that consequences of such a teaching method were that children in this group followed without understanding as they “don't seem to be really thinking about the game” (T2, line 370-379).

Discussion

The main purpose of this article was to introduce the NP approach and contrast how different teaching approaches (Nonlinear and Linear) potentially influenced motivation and enjoyment in a Physical Education setting. In particular, we undertook a research investigation to establish the factors that contributed to motivation and enjoyment, and its relevance for the development of 21st century competencies in teaching and learning a 7-

week modified-tennis intervention. While the IMI questionnaire did not show any significant differences between the NP and LP groups, the student and teacher interviews provided insight as to the possible reasons for the null-effect especially in terms of enjoyment and perceived competence. The interviews also provided a greater understanding of the underlying mechanisms that influenced enjoyment and motivation, and how the NP approach contributed towards development of the 21st century competencies.

Enjoyment and motivation (21st CC: Perception of competence => confident person, self-awareness, self-management; Autonomy => responsible decision making)

A common theme that emerged from both the NP and LP group was that the children enjoyed playing games during the lessons. In particular, both groups enjoyed the cooperative games as they liked being able to hit continuously and it gave them more success. The LP group also shared that they preferred playing games rather than the practice tasks and drills predominantly present in the LP intervention experience. Conversely, the NP groups were enthusiastic about the variety of games played during the lessons. Incorporating a representative learning design (which is an important feature in the NP approach), through the inclusion of modified games and the manipulation of constraints, has been proposed to enhance perceptions of competence (Author et al., 2016). Perceived competence (i.e., how an individual views their own competence) has been shown to be positively associated with intrinsic motivation, meaning that if learners perceived competence in Physical Education is high, they experience more enjoyment and invest more effort (Goudas, Biddle, & Fox, 1994; Gray, Sproule, & Wang, 2008).

While both groups felt that they improved in certain aspects and found other aspects of the lesson challenging, according to the interviews how both groups responded to these challenges and managed their perceived competency varied. The NP group seemed to express greater perceptions of competence and control over their learning as the students described

that they improved because they have a *better understanding about tennis* and that *they could do better* in certain areas of playing tennis. For example, one of the students from the NP group shared, “I feel that I’m quite good but I can still improve for backhand”. The NP group also seemed to portray a positive attitude towards learning. For example, some of the NP learners described how they *enjoyed the competitive game because it could be a win-win* situation even though the opponent gained the point. Furthermore, the teachers commented that learners in the NP group were given the *freedom to choose* their preferred equipment and playing courts. This potentially enhanced autonomy during the lessons. The data from the teachers’ interviews provided insights where the students from the NP group liked to explore the use of different equipment and prefer not to be told by the teachers on the requirement for equipment use. This is in accordance with Renshaw and colleagues’ (2012) explanation that a NP approach enhances perceived competence and autonomy as learners are allowed to explore their own functional movement solutions and are likely to be more in control of their learning process. Greater perceptions of competence builds a more confident person while increased autonomy in a learner enhances the ability to analyse situations and make responsible decisions in life. These potentially enhanced 21st century competencies for children who underwent the NP approach are not only applicable in playing a game in Physical Education but are likely to be transferable to general character building outside of sports.

On the other hand, the interviews with students from the LP group suggested that their perceptions of competence and autonomy were threatened by being told what to do in order to perform the ‘correct’ movement pattern. When the children in the LP group were provided with prescriptive instructions of the ‘ideal’ hitting techniques, some children revealed that they *tried to follow but failed*, while others claimed that their *perceived competence was dependent on the ability of their partner*, placing the responsibility of success or failure on

others. Although not specifically identified as a theme in the interviews, but categorised under the sub-theme '*only one correct way for a competitive game*', a 'fear of failure' seemed to be present in the LP group just as one child shared, "*I'm scared later I turn my leg ankle, it's not exactly the correct angle, then will hit wrongly and it will be out of court, and then the opponent will win one point*". A fear of failure could result in negative affect and a decline in overall motivation levels (Sagar & Stoeber, 2009).

The levels of perceived competence and autonomy expressed by each group are also reflected in the teachers' comments that *more fun was manifested* in the NP group. At the same time, some students from both groups expressed mixed feelings towards the lessons suggesting boredom, although the underlying causes of this negative emotion were quite different in the two groups. In the NP group, the *length of the intervention* seemed to be the main reason for feeling bored. This perhaps is a reflection of the children not being accustomed to participating in the same sport over a relatively long period during Physical Education lessons, rather than the instructional approach itself. The students from the LP group also expressed boredom although it was related to parts of the lessons. The reason that constantly emerged was that they did not enjoy the *boring repetitive drills* because they were *dull and military-like*, but rather that the children wished they had *more time to play*. As a result, the children revealed that this *boredom seemed to have hindered some of their performance*. The lack of enthusiasm expressed as a result of the repetitive drills is certainly an issue that needs to be addressed when designing the Physical Education curriculum.

An interesting point to note relates to the results from IMI questionnaire where there were no significant differences found for all subscales between the two intervention conditions. One possible reason that could have influenced the children's motivation was the novelty of participating in a research study during school hours itself, instead of attending the usual lessons. Another possible explanation could be that on the surface, the student

interviews seemed to indicate that some themes relating to ‘enjoyment’ and ‘perceived competence’ were consistent with the IMI findings. For example, the children enjoyed playing games but also found other aspects boring despite the pedagogy. Similarly, both groups shared that they improved in certain aspects and found other aspects challenging. However, in-depth analysis of the interviews revealed that the factors that influenced enjoyment and perceived competence were in fact quite different for each group. For example, how they responded to the challenges and managed their perceived competence differed in both groups. It is possible that the IMI scale may not be sensitive enough to reveal differences that one might expect given the qualitative data about enjoyment and perceived competency. Thus, access to both quantitative and qualitative data (a mixed methods approach) is especially valuable in this study.

Teamwork and social skills (21st CC skills: Communication, Collaboration and Information Skills; Social awareness, Relationship management)

Themes related to teamwork and social skills emerged during the interview although it was not specifically asked. The NP approach encouraged *more interaction* among peers and facilitated learners to *work cooperatively with each other* leading to *few arguments*. There were also opportunities for learners to *provide feedback* to each other since the role of the teacher was to guide rather than direct. These themes which emerged in the NP group are associated with interpersonal interactions and termed by Deci and Ryan (1985) as relatedness. It is not surprising that relatedness was indicated to be enhanced (in the interviews) as the NP approach embraces interacting constraints such as learner-learner and teacher-learner interactions, with the nature of the interactions being learner-centred (Author, et al., 2016). The NP approach which is aimed at encouraging learning through exploration,

problem-solving and creative thinking promotes a constructive relationship between the teacher and the students(s) as they co-evolve and co-create new functional movement solutions. This process facilitates both internal (i.e., autonomy, competence, relatedness) and external constraints (i.e., goals related to performance) of the learners to be met (Renshaw et al., 2012). Enhanced relatedness and the cooperative behaviours displayed by the NP group, as suggested in the interviews, has the potential to lead to the improved relationship management and social awareness (Renshaw et al., 2012), resulting in the development of better communication and collaboration skills which are an essential component of MOE's 21st century competencies.

On the other hand, as the teacher in the LP approach was required to direct students to execute skills correctly, the teachers indicated that the students often *waited to be told what to do*. The LP followed a top-down approach, creating a distance between the teacher and student(s) and was suggested by the teachers to result in minimal interaction between peers. In addition, the interviews from the teachers and students suggested that the LP approach was associated with the children *blaming others* and *getting into arguments*. This was similar to the theme mentioned earlier where the children pushed the responsibility of success or failure to others in attempt to avoid bearing the blame. An issue about a learning environment which is skill-focused is that skills have to be performed within a socially evaluative environment leading to fear of negative evaluation by others, avoidance behaviours or self-handicapping behaviours (Gray, et al., 2009).

Problem solving and creativity (21st CC: Critical and Inventive thinking)

Themes that emerged during the interview provided insights into the pedagogical principles and learning processes of the children in the NP group. The teachers shared that the NP group *learnt through exploration*. This consisted of *focusing on the outcome* such as

“keeping your eyes on the ball” or on the “flight of the ball” and the use of *analogies* such as “bounce-hit” to keep rhythm while hitting the ball continuously. The way in which the children learnt also seemed to influence their thought processes during a cooperative game. Firstly, the emphasis on exploration and the use of analogies encouraged learners to develop a *creative imagination*, where they invented their own analogies using fictional scenarios and characters as an effective way to hold longer rallies. In terms of a competitive game, the NP intervention also involved focusing on the outcome and the use of analogies to gain an advantage. These responses reflect how the NP approach indeed encouraged exploration within the task constraints set by the teacher, providing opportunities for learners to *problem-solve* and express *creativity and innovative* solutions to win a game. Creativity and innovation also likely emerged as the learners within the class interacted, adapted to the actions and ideas of other students and co-evolved, forming new behaviours (Hopper, 2010). These themes that surfaced during the interviews are in accordance with the concepts proposed for a NP approach (Hristovski et al., 2011; Renshaw et al., 2009) and are relevant for developing critical and inventive thinking, one of the core 21st century competencies.

The LP group on the other hand seem to encourage students to *follow without understanding*. Furthermore, the LP group ascertained that there was *only one correct way* to hit the ball which did not require them to explore and think critically. This trait is often seen in traditional instructional approaches, suggesting that an ‘ideal’ movement pattern had to be achieved in order to succeed (William & Hodges, 2005).

Conclusion

This study aimed to provide an in-depth understanding of the underlying processes and factors involved in teaching and learning a unit of modified-tennis from a NP approach, especially from a motivational standpoint. Based on the qualitative interviews, the NP approach was deemed to have created a learning environment that facilitated perceived competence, autonomy and relatedness, thus potentially enhancing intrinsic motivation and enjoyment during practice. The key factors embedded in the NP approach that enabled intrinsic motivation to enhance were the presence of a representative learning design through the inclusion of a variety of modified games, the freedom to choose, an emphasis on exploration and problem-solving as well as less prescription from the teacher since he/she assumes the role of a facilitator. The interviews indicated the potential contributions that the NP approach had in developing MOE's 21st century competencies such as building more confident persons, communication and collaboration skills as well as critical and inventive thinking skills among students

On the other hand, the LP approach characterised by repetitive drills and prescriptive instructions were indicated to lead to boredom experienced by the learners. The LP approach created a learning environment whereby perceived competence and autonomy of the learners were indicated to be threatened by being told how to perform the 'correct' movement pattern. Furthermore, the top-down approach represented by the LP method left little opportunities for interaction between teacher and students. The findings are consistent with previous research whereby students who experienced the NP approach showed higher levels of self-determination and intrinsic motivation as compared to the traditional approach (Moy, Renshaw, & Davids, 2016).

Nevertheless, we would also like to acknowledge that unfortunately, autonomy and relatedness were not measured as part of the IMI in this study. It is also interesting to note that the intrinsic motivation did not differ between the groups even though the qualitative

interviews suggest that autonomy, competence and relatedness were fostered through an NP intervention. Future work should be undertaken to better examine the reasons for the lack of improvement in intrinsic motivation over a more traditional pedagogical approach.

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