



Preservice teachers implementing a nonlinear physical education pedagogy

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1 **Preservice teachers implementing a nonlinear physical education**
2 **pedagogy**

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1 **Preservice teachers implementing a nonlinear physical education pedagogy**

2
3 *Background:* In recent years, there has been considerable interest in the evolution of physical education teaching
4 practice from a traditional *teacher-centred approach* to a *student-centred approach*. Consequently, research has
5 focused on questions about the changing conceptions of the teaching and learning process, that is, from how ‘we’
6 teach to how ‘they’ learn. A contemporary theoretical model of the teaching and learning process could
7 underpin learning design and delivery adopted in physical education. The Constraints Led Approach (CLA) is a
8 viable alternative as its practice design and delivery is grounded in the contemporary motor learning theory of
9 ecological dynamics within a nonlinear pedagogy framework. However, its implementation is thought to present
10 unique challenges to physical education practitioners due to the dynamic individual learner-environment
11 interactions from which learning occurs. For this reason, it has been suggested that researchers work
12 symbiotically with practitioners to help facilitate the adoption of nonlinear pedagogies and provide valuable
13 information regarding the application of theory into practice.

14 *Purpose:* This study sought to explore two PETE students’ experiences learning to implement a nonlinear
15 informed pedagogical approach, specifically the CLA, with physical education students in a school practicum
16 setting. The two PETE students were provided with support from the primary researcher during the experience.

17 *Participants and Setting:* A purposive sample of two second-year PETE students from an Australian university
18 were recruited for the study. Participant selection was based on meeting the pre-specified selection criteria of a
19 demonstrated receptiveness to the CLA and a demonstrated confidence, ability and enthusiasm to implement the
20 approach within a school setting. The two study participants were given the opportunity to implement the CLA
21 within a supportive school culture while on their first physical education teaching practicum.

22 *Data collection and analysis:* The data collection methods utilised were documentary evidence, in the form of
23 PETE students’ post lesson written reflections, primary researcher observations with written reflections and
24 semi-structured student interviews undertaken within 1 week of the culmination of the practicum. These data
25 sources were analysed collectively using thematic analysis to identify repeated patterns of meaning within the
26 data.

27 *Findings:* As expected, implementing the CLA presented significant challenges to novice practitioners, due to
28 the complex nature of student learning within a nonlinear informed approach. Specifically, the PETE students
29 rarely detected any of the multiple pupil responses that ‘unexpectedly’ emerged from their modified learning

1 environments. They also had difficulty manipulating the learning environment to facilitate the emergence of
2 learners' tactical problem solving behaviour through the natural learning processes underpinning the CLA.

3 *Conclusion:* For an evolution of physical education teaching practice to progress, it is important that PETE
4 educators work together with the physical education department of a local school to support PETE students to
5 effectively implement nonlinear informed approaches in a school environment. Opportunities need to be
6 provided to allow PETE students to progressively develop their experiential knowledge and conceptual
7 understanding of the exploratory learning processes underpinning a nonlinear approach.

8
9 **Keywords:** physical education; nonlinear pedagogy; constraints-led approach; ecological dynamics.

10

1 **Introduction**

2 In recent years, there has been considerable interest in the evolution of physical education
3 teaching practice from a traditional *teacher-centred approach* to a *student-centred approach*.
4 Rather than the teacher emphasising the reproduction of technical skills in a highly
5 structured, de-contextualised environment, in the student-centred approach teachers are
6 facilitators and students are challenged to critically interpret the practice environment and
7 solve problems through individual exploration (Davids, Chow, and Shuttleworth 2005; Lee
8 2003; Richard and Wallian 2005). Student-centred approaches, with their emphasis on
9 learning design that addresses individual needs, are important for effective learning as all
10 learners do not learn the same way or at the same rate and are capable of finding different
11 movement solutions in the same learning environment (Chow et al. 2011, 2013).
12 Consequently, research has focused on questions about the changing conceptions of the
13 teaching and learning process, that is, from how ‘we’ teach to how ‘they’ learn (Renshaw et
14 al. 2016; Thorpe 2005a).

15 A contemporary theoretical model of motor learning could underpin learning design
16 and the delivery of instruction and feedback adopted in physical education (Chow et al. 2013;
17 Davids et al. 2015). There is increasing evidence that motor learning is not a linear process
18 due to the differences between individual learners and the dynamic and complex interactions
19 that occur in learning environments (Chow et al. 2011, 2013). Sudden progressions and
20 regressions in performance level accompanied by periods of an absence of change are
21 typically observed during the learning of motor skills, suggesting that learners behave like
22 nonlinear systems (Liu, Mayer-Kress, and Newell 2006). To acknowledge that learners
23 behave like nonlinear, complex neurobiological systems is the platform for a nonlinear
24 informed physical education teaching approach, such as the Constraints-Led Approach
25 (CLA).

1 The CLA has similar practical operational principles to Teaching Games for
2 Understanding (TGfU) as both approaches challenge learners to solve common tactical
3 problems through active exploration of representative practice environments, modified to
4 regulate skill level and to emphasise particular aspects of performance (Bunker and Thorpe
5 1982; Thorpe 2005a; Renshaw et al. 2009). The essential distinguishing feature of the CLA is
6 that its practice design and delivery of feedback and instruction is grounded in the
7 contemporary motor learning theory of ecological dynamics within a nonlinear pedagogy
8 (NLP) framework (Chow et al. 2011, 2013). Because of this it can be more accurately
9 described as a learner-environment-centred approach rather than a student-centred approach
10 (Renshaw et al. 2016). There is extensive theoretically-informed and empirical research
11 evidence to demonstrate that adopting the CLA in practice effectively meets the skill
12 acquisition and psychological needs of the individual performer (Barris, Farrow, and Davids
13 2014; Chow et al. 2007; Moy, Renshaw, and Davids 2016; Pinder, Davids, and Renshaw
14 2012; Renshaw, Oldham, and Bawden 2012).

15 Whilst pedagogical approaches like TGfU and many of its derivatives such as Game
16 Sense have been proposed as being underpinned by more cognitivist frameworks, they could
17 also be categorised as nonlinear informed pedagogical approaches as the motor learning
18 theory of ecological dynamics has been proposed to provide a comprehensive theoretical
19 framework to support their learning design (see Chow et al. 2016; Renshaw et al. 2016; Stolz
20 and Pill 2014; Storey and Butler 2013; Tan, Chow, and Davids 2012).

21 According to Chow (2013), the CLA offers potential for enhancing teacher education in
22 the 21st century. However, implementing a nonlinear CLA is thought to present unique
23 challenges to physical education practitioners. For example, there is some concern that ‘the
24 dense academic language associated with the approach is acting as a key barrier in the take
25 up of the CLA and resulting in a limited understanding of the key underpinning concepts and

1 hence poor implementation' (Renshaw and Chow 2019, 103). Unlike a 'linear' traditional
2 approach where the teacher is in control of a learning environment that produces a single
3 predetermined and predictable learning outcome (Tinning and Rossi 2013), the emergence of
4 multiple learning outcomes that are not predetermined and are difficult to predict are
5 hallmarks of the complex nature of learning within a nonlinear approach (Chow et al. 2013;
6 Davids, Button, and Bennett 2008). These multiple, less predictable learning outcomes that
7 emerge as a consequence of the dynamic individual learner-environment interactions are
8 thought to present significant challenges to practitioners (Chow 2013; Renshaw and Chow
9 2019).

10 To successfully implement a nonlinear approach, research has suggested that it is
11 necessary for practitioners to have a clear understanding of the pedagogical principles of the
12 teaching approach and its underpinning learning theory, a competent level of expertise and
13 experiential knowledge in the sport being taught, the ability to effectively manipulate relevant
14 task constraints to channel the emergence of desirable movement behaviours, and advanced
15 observational and analytical skills including the ability to identify key rate limiters to an
16 individual's performance (Butler 2014; Chow 2013; Hopper, Butler, and Storey 2009;
17 Howarth 2005; Renshaw et al. 2016).

18 Physical Education Teacher Education (PETE) programmes have been identified as a
19 critical point in time in the professional development of teachers to encourage the exploration
20 of innovative teaching approaches (Light 2002; Moy et al. 2016). Therefore, empirical
21 research is needed to identify the specific challenges associated with the complex nature of
22 learning and the practical implications facing novice practitioners when adopting the CLA in
23 a school physical education context. This is an important step in supporting preservice
24 teachers to learn how to implement this and other complex nonlinear pedagogical approaches.

1 To this point, there is no empirical research that has investigated physical education
2 practitioners' experiences associated with the complex nature of learning when implementing
3 the CLA. However, there is empirical research that has investigated the learning related
4 challenges facing preservice physical education teachers learning to implement other
5 nonlinear informed approaches such as TGfU and the Games Concept Approach. These
6 studies have found that preservice teachers' inexperience with, and lack of conceptual
7 knowledge and understanding of the innovative teaching approach and its underpinning
8 learning theory made it challenging for them to design appropriate games and implement the
9 approach authentically using skills such as questioning (Gurvitch et al. 2008; Howarth 2005;
10 Li and Cruz 2008; McNeill et al. 2004; Rossi et al. 2007; Wang and Ha 2009, 2012; Wright
11 et al. 2006; Wright, McNeill, and Fry 2009).

12 Due to the uniqueness and complexity of these challenges, to help facilitate the
13 adoption of nonlinear pedagogies such as the CLA, Renshaw and colleagues (2016) have
14 suggested the engagement of researchers in supporting practitioners in the application of
15 theory into practice. These symbiotic interactions would provide valuable information to help
16 facilitate the adoption of nonlinear pedagogies by pre- and in-service teachers (Renshaw et al.
17 2016). PETE students are ideal candidates for research that investigates practitioners'
18 adoption of nonlinear pedagogies as researchers are readily available to support them during
19 their experience.

20

21 *Aim of the study*

22 This study aimed to explore two PETE students' experiences associated with the complex
23 nature of learning to implement a nonlinear informed pedagogical approach, specifically the
24 CLA, in a school physical education practicum setting. Aligned with the potential barriers
25 highlighted above, the two PETE students were provided with guidance and support from the

1 primary researcher and their supervising/co-operating teacher during the experience. Even
2 though this level of support is beyond what is considered normal during a practicum
3 experience, it was provided to enable the focus to be on the examination of the teaching and
4 learning processes associated with the key nonlinear pedagogical principles implemented
5 through the CLA. The practical implications of these findings would inform and improve the
6 design and delivery of PETE programmes in preparing and supporting students to overcome
7 identified challenges and effectively and authentically implement a NLP on practicum and in
8 their future teaching careers. This has the potential to result in opportunities for enhanced
9 student learning and performance of motor skills in physical education classes.

10

11 **Method**

12 *Study design*

13 A qualitative, case study methodology was employed since this research method allowed a
14 rich, detailed and in-depth insight of the PETE students' experiences and perceptions of
15 implementing a CLA (Creswell 2002). A qualitative case study is defined as an empirical
16 inquiry that investigates a contemporary phenomenon within its real-life context utilising
17 qualitative methods (Yin 2009). The 2 PETE students were the sole participants in the study
18 and an in-depth investigation was used to portray an accurate account of their experiences
19 transitioning from learning the CLA in their PETE programme to implementing CLA lessons
20 in the real-life and dynamic context of their practicum. To do this, multiple sources of
21 evidence were collected and triangulated. The case study research design has previously been
22 used to examine both PETE students' and in-service teachers' experiences when delivering
23 alternative pedagogies (Deenihan and MacPhail 2013; Ingersoll, Jenkins, and Lux 2014;
24 O'Leary 2014). The key pedagogical principles of NLP associated with the complex and less
25 predictable nature of learning within the nonlinear CLA, guided data collection and analysis.

1 Previous research indicates the school practicum is not a good place for novice
2 preservice teachers to experiment with innovative, alternative teaching approaches. This is
3 because of resistant conservative cultures of schools and many other hindrances such as
4 limited space, large class sizes, inadequate class time, poor student discipline, students
5 limited physical skill and lack of guidance by cooperating teachers (Gurvitch et al. 2008;
6 Howarth 2005; Light and Butler 2005; McNeill et al. 2004; Rossi et al. 2007; Tinning et al.
7 2001; Wang and Ha 2009; 2012; Wright et al. 2006; Wright, McNeill, and Fry 2009;
8 Zeichner and Tabachnik 1981). To overcome the research-identified hindrances, the study
9 participants' lack of teaching experience and the expected challenges associated with
10 implementing an emergent nonlinear approach, the research design incorporated a supportive
11 and simplified teaching environment. To that end, the practicum placement site was
12 deliberately chosen as it possessed a culture that encouraged innovative practice and acted as
13 a supportive partner in the study. For example, the school allowed the primary researcher to
14 embed himself full-time into the school physical education department throughout the study.
15 This environment allowed the study focus to be on the examination of the teaching and
16 learning process associated with implementing a nonlinear pedagogy, rather than previous
17 research identified contextual hindrances. Also, class sizes were small, adequate space, sports
18 equipment and lesson time was provided, selected classes consisted of pupils who were well-
19 behaved, and generally well-skilled and experienced in a variety of sports. In line with the
20 recommendation of Thorpe (2005b), to facilitate PETE students' identification of relevant
21 tactical concepts, the subsequent planning of relevant learning experiences to achieve
22 intended tactical outcomes, and the observation, interpretation and adaptation of game play,
23 each participant was allocated a familiar sport in which they had successful and extensive
24 playing experience and a self-reported depth of game content and tactical knowledge and
25 understanding.

1

2 *Participants*

3 The number of participants in the study was constrained by the partner school's Health and
4 Physical Education department who stipulated that they could only take two students in the
5 university practicum placement period. These two PETE teachers were selected from a
6 purposive sample of second-year PETE students from an Australian university. Participant
7 selection was based on meeting the pre-specified selection criteria of a demonstrated
8 receptiveness to the CLA and a demonstrated confidence, ability, willingness and enthusiasm
9 to implement the approach within a school setting (Denzin and Lincoln 2005). This selection
10 criteria would allow the best possibility to establish acceptable fidelity of the CLA and
11 therefore enable the study to accurately investigate the teaching and learning process. For this
12 study, potential participants were identified from within a group of ten PETE students who
13 were recruited for an earlier study by the same primary researcher (see Moy et al. 2016). That
14 study explored the features of a constraints-based PETE games unit that appealed to PETE
15 recruits who were highly successful products of the traditional physical education teaching
16 approach (i.e. state or national representative in sporting games). From this group two PETE
17 students who met the selection criteria were individually approached to participate in the
18 research study via email and subsequently accepted.

19 Max (pseudonym) was 20 years old at the time of the study and had a successful and
20 extensive sporting background in soccer, volleyball and basketball. Melinda (pseudonym)
21 was 19 years old at the time of the study and had a successful and extensive sporting
22 background particularly in basketball and volleyball. Both students were high achievers as
23 reflected by their outstanding university grades, and had ongoing experience outside
24 university working with secondary school aged pupils, Max as a school boarding master and
25 Melinda as a coach of various school sporting teams. The benefit of this previous experience

1 was evident in their confident manner and control over learning environments they
2 demonstrated in peer teaching episodes in the university setting. Both students were products
3 of a very sports-oriented family environment, Melinda's mother having represented Australia
4 in basketball and Max's father a long-term physical education teacher and sports coach. Max
5 and Melinda were initially exposed to the CLA approach in a games unit in the first year of
6 their PETE course, and further exposed to the CLA in two second-year units, including a
7 curriculum unit. In this curriculum unit, taken by the primary researcher, they successfully
8 implemented the CLA in small peer teaching environments. Melinda also independently
9 chose to experiment with the CLA in her basketball coaching at a local school. To improve
10 their knowledge and conceptual understanding of the alternative pedagogy and to gain further
11 practical experience in its implementation, both Max and Melinda worked as tutor assistants
12 in the introductory constraints-based PETE games unit immediately prior to the practicum
13 experience. This involved them working closely with the tutor as learning facilitators in 8 x
14 4-hour practical workshops that adopted the key pedagogical principles of NLP underpinning
15 the CLA. It is important to note that gender played no part in the choice of the two students
16 as we were only interested in how pre-service level teachers experienced the task of
17 implementing a CLA into a school setting, not to see if gender mediated their experiences.

18

19 ***Setting***

20 *The school*

21 The two study participants were given the opportunity to implement the CLA within a
22 supportive school culture while on their first physical education teaching practicum. The head
23 of Marcellin College's (pseudonym) physical education department offered the opportunity
24 for the research study to be undertaken with the school's physical education classes, as he
25 was a strong advocate of the CLA. At the time of the study the head of physical education

1 was employed by the primary researcher as a tutor in the constraints-based PETE games unit
2 and had also implemented the CLA in his physical education classes and sports coaching.
3 Marcellin College is an independent boys college in an inner city suburb of an Australian
4 capital city, comprising over 1500 students. The college has a proud sporting history and
5 culture and is well resourced in terms of oval space, equipment and facilities to run an
6 effective physical education program. The college has six full-time and three part time
7 physical education teachers, all male, covering the teaching of over 30 classes of physical
8 education from Years 5 (10 year olds) to year 12 (17 year olds).

9

10 *Practicum supervising teacher mentors*

11 The selection of supervising or cooperating teachers for the study was based on their
12 eagerness to be exposed to a new alternative pedagogy and a commitment to working with
13 the primary researcher and the study participants throughout the entire 4-week length of their
14 practicum. This commitment allowed both Max and Melinda to experiment implementing the
15 CLA in at least one of their physical education classes and allowing the primary researcher to
16 supervise and give guidance during this implementation. Melinda's allocated supervising
17 teacher, Peter (pseudonym) had over 25 years of experience teaching physical education,
18 while Max's cooperating teacher, Bernie (pseudonym), had over 12 years of experience. Both
19 Peter and Bernie self-reported, to the primary researcher, the predominant use of a traditional
20 drill-based physical education teaching approach in their classes. They both admitted to
21 having no practical experience implementing the alternative approach in their own classes.
22 This restricted their capability to provide feedback or advice specific to the CLA during the
23 practicum, thus their role was secondary to the primary researcher, giving feedback to
24 students purely from an organisational and discipline perspective such as behaviour
25 management strategies and teacher positioning.

1

2 *University mentor (primary researcher)*

3 The primary researcher possessed extensive experience within schools to qualify for the role
4 of mentor to the study participants, having taught physical education for over 25 years in
5 Australian schools and supervised numerous PETE students on practicum in that time. While
6 initially a ‘traditional’ teacher, he has gained much experience in the CLA through spending
7 the previous seven years researching and applying the CLA in the university setting. A
8 further layer of support was provided to the primary researcher by a university colleague,
9 considered an expert within the field of contemporary skill acquisition and NLP. This
10 colleague was readily available to the primary researcher throughout the practicum to discuss
11 any ideas or problems related to the study.

12

13 *CLA games teaching units*

14 Max was allocated 8 x 60 minute soccer lessons with a year 9 class of twenty 14-year-old
15 students, and Melinda was allocated 8 x 60 minute basketball lessons with a year 10 class of
16 eighteen 15-year-old students, in which to implement the CLA over the 4-week practicum.
17 As the CLA is an emergent pedagogical approach (Davids, Button, and Bennett 2008), and
18 each session builds on the specific learning that takes place in the previous lesson, rather than
19 following a set scheme of work that determines in advance each session's aims and
20 objectives, lessons were planned progressively to help learners solve identified game-related
21 tactical problems. The PETE students observed pupils’ participation in games in the first
22 lesson of their respective units. From these observations, and in collaboration with the
23 primary researcher, the PETE students identified common examples of pupils’ lack of tactical
24 awareness when responding to a tactical problem in a game. The associated possible causes

1 of their poor tactical response were also identified. The desired pupil learning outcome for
2 each lesson was then written in terms of this tactical problem-solving behaviour.

3

4 (Table 1 near here)

5

6 Lesson planning followed a supportive process to ensure that the CLA learning design
7 and delivery was authentically represented. Initially the PETE students independently
8 designed a lesson plan incorporating learning experiences to achieve the desired learning
9 outcome. To assist them they were provided with tutor workbooks used in the constraints-
10 based PETE games unit. These workbooks contained many examples of games manipulated
11 by constraints to solve common basketball and soccer related tactical and technical problems.
12 The day prior to the lesson, each PETE student individually met with the primary researcher,
13 who would evaluate their learning experiences with respect to the application of the key
14 pedagogical principles of NLP embedded into a CLA learning design. These key pedagogical
15 principles were self-organisation under constraint manipulation, representative practice
16 design, task simplification, and implicit learning aligned with feedback and instruction
17 focusing on external movement outcomes of an action (Chow et al. 2016). When required the
18 plan was accordingly modified and returned (see Table 1 for an example). During the latter
19 stage of the practicum, when the PETE students demonstrated increasing competence, they
20 were given the opportunity to independently design modified learning environments to
21 facilitate the emergence of a predetermined movement solution to a tactical problem.

22

23 ***Fidelity (valid representation of CLA and its implementation)***

24 When investigating learning outcomes associated with the implementation of an alternative
25 pedagogy, such as NLP, the learning experience design and delivery need to be considered as

1 authentically representative of that pedagogy (Hastie and Casey 2014; Smith and Ragan
2 1999). To ensure this authenticity the key operational and pedagogical principles of NLP, as
3 outlined by Renshaw et al. (2009) and Tan, Chow, and Davids (2012), guided the design and
4 delivery of learning environments to allow players the opportunity to learn to solve game-
5 related tactical problems. As the study participants were novice teachers and had limited
6 instructional experience with the CLA it was accepted that establishing an ‘ideal’ model of
7 the CLA would initially be beyond them. Therefore, for this study, a ‘ball park’ model of the
8 CLA was deemed acceptable, conditional on the presence of key pedagogical features. To
9 establish acceptable fidelity of the CLA this study incorporated a systematic observation of
10 classes using a validation tool (see Table 2) to verify that the key contextual, operational and
11 pedagogical requirements of the CLA were present in lessons conducted by the PETE
12 students (Metzler 2005). This checklist was specifically generated by the primary researcher
13 for use by tutors when observing PETE students implementing the CLA in university classes.
14 The primary researcher observed all lessons referring to the checklist to verify that features
15 were sufficiently present in the learning experiences for inclusion in the study. Acceptable
16 validity was also established using a method adopted in previous similar studies of an expert
17 independent observer who viewed and verified randomly selected lessons (Harvey, Cushion,
18 and Massa-Gonzalez 2010; Harvey et al. 2010). Upon completion of this process the
19 researcher was confident of the fidelity of implementation of lessons representing the key
20 features of the CLA.

21

22

(Table 2 near here)

23

1 ***Data collection***

2 The data collection methods utilised were documentary evidence, in the form of PETE
3 students' post lesson written reflections, primary researcher observations with written
4 reflections and semi-structured student interviews undertaken within 1 week of the
5 culmination of the practicum. Ethical approval to conduct this study was sought and granted
6 by the lead author's university's ethics committee.

7

8 *Post lesson written reflections (PETE students)*

9 Detailed post lesson written reflections acted as a means of creating the narrative of the PETE
10 students' experiences and perceptions in implementing the CLA in a physical education class.
11 The students completed a personal reflection using a structured template provided by the
12 primary researcher and submitted it within 24 hours of the lesson completion. The personal
13 reflection template incorporated contextual information about the lesson including date,
14 activity, year level, class size, lesson duration, lesson number in series, game-related problem
15 to address, and desired pupil problem-solving behaviour. PETE students' reflective responses
16 were guided by four questions/requests, which incorporated a critical incident reflection
17 (Flanagan 1954): (i) Reflecting on your knowledge about the constraints-led approach itself
18 please tell me about your personal experiences of the effectiveness of the learning
19 experiences in achieving the desired pupil learning outcome? (What happened? What
20 behaviour was emergent? Did the constraint work (were desired outcomes achieved)?
21 Anything unexpected, i.e. were different outcome achieved? Please provide evidence.); (ii)
22 Reflecting on your skills in planning, how well did you plan the constraints-based learning
23 experiences? (Identification of specific game problem and possible causes, design of game
24 with constraint to allow students to solve problem and for desired behaviour to emerge.
25 Please provide evidence); (iii) Reflecting on your skills in implementing the constraints-led

1 approach, please tell me about your personal experiences in the lesson today, i.e. how well
2 did you implement the learning experiences? (Hands-off involvement, class organisation,
3 observation of emergent behaviour, instruction); (iv) Describe one critical incident about the
4 constraints-led approach that you found particularly significant during the lesson (made you
5 excited, shocked, worried). Please explain why it was significant.

6

7 *Observations and post lesson written reflections (primary researcher)*

8 The primary researcher observed and reflected upon all intervention lessons. The purpose of
9 lesson observations was threefold: (1) to allow the researcher to ‘experience’ the lessons from
10 a PETE educators’ perspective (Cohen, Manion, and Morrison 2007); (2) to observe incidents
11 that may go unnoticed by the participants (Patton 2002); and (3), to compare what
12 experiences the PETE student reported in their reflections with what was observed. During
13 each lesson the primary researcher kept a written record of his immediate observations and
14 interpretations, and any reflective notes specifically focusing on the implementation of the
15 constraint-based learning experiences by the study participants and the associated emergent
16 pupil responses. Within 24 hours of the lesson observation, the researcher recorded his
17 reflective responses and interpretations based on the written observations and reflective notes
18 using the same personal reflection template completed by the PETE students.

19

20 *Post Practicum Semi-structured interviews (PETE students)*

21 At the completion of the practicum the primary researcher separately interviewed each PETE
22 student. The face-to-face interviews were semi-structured in nature, consisting of open-ended
23 questions designed to allow PETE students to elaborate on their perceptions and overall
24 experiences implementing the CLA. Each interview, which lasted approximately 60 minutes,
25 was audio taped and later transcribed verbatim. The following are examples of interview

1 prompts: How successful were you at observing pupils' emergent behaviours (i.e. the pupil
2 responses to game constraints)? From your experiences over the last four weeks, what have
3 you learned about the skill of designing practice environments using constraints to help
4 achieve specific student learning outcomes?

5

6 ***Data analysis***

7 For each lesson, the PETE students' and researcher's post lesson written reflection were
8 combined so all data relevant to each lesson were together. These data sources and the
9 transcribed interview data were analysed collectively using thematic analysis to identify
10 repeated patterns of meaning within the data (Braun and Clark 2006). This process involved
11 the following steps: (1) repeated reading to become familiar with data, (2) coding raw data,
12 (3) collating similar codes together into tentative themes, (4) reviewing, reducing and
13 refining themes, and (5), defining and naming themes. Identical methods of data collection
14 and data analysis have been adopted in recent similar studies investigating pre-service and in-
15 service teachers' experiences when implementing alternative pedagogies (Deenihan and
16 MacPhail 2013; Ingersoll, Jenkins, and Lux 2014; O'Leary 2014; Stran, Sinelnikov, and
17 Woodruff 2012).

18 ***Trustworthiness of data***

19 Trustworthiness is established when research findings authentically and accurately represent
20 meanings as described by the participants (Lincoln and Guba 1985). In this study
21 trustworthiness was established, and consequently findings were strengthened, through the
22 triangulation of data from multiple sources to cross check information and support similar
23 themes (Patton 2002). Further strategies used in this study to establish trustworthiness
24 included ongoing peer debriefing between the researcher and two colleagues experienced in
25 qualitative methodologies to check and share interpretations of data and arrive at consensus

1 (Creswell 2007). Participants were also given the opportunity to verify the accuracy of the
2 content and researcher interpretations of interview transcripts and lesson reflections (Merriam
3 1998). Finally, at the conclusion of the analysis, a competent qualitative researcher was asked
4 to review the original data and subsequent analysis of it (Lincoln and Guba 1985).

5

6 **Results and Discussion**

7 This empirical research study aimed to explore PETE students' experiences associated with
8 the complex nature of learning when implementing a nonlinear informed pedagogical
9 approach, specifically the CLA, with physical education students in a school practicum
10 setting. As predicted by Chow (2013), implementing the CLA presented significant
11 challenges to novice practitioners, due to the complex nature of student learning as a
12 consequence of the dynamic individual learner-environment interactions. Despite the
13 potential barriers, the support structure put in place enabled the students to successfully
14 implement a CLA, however, there were a number of challenges. The following section
15 identifies two prominent themes that were established from the data analysis related to this
16 aim, (i) the detection of less predictable emergent pupil responses, and (ii), the manipulation
17 of the learning environment to channel learners' search towards predetermined emergent
18 problem solving behaviours.

19

20 ***The detection of less predictable emergent pupil responses***

21 The PETE students had little difficulty detecting and interpreting the single predetermined
22 pupil response predicted to emerge through exploration of the modified learning
23 environment. For example, a modified football or soccer game was designed to solve the
24 identified problem of loss of possession, due to players taking too many individual touches
25 when under defensive pressure. The task constraint (rule) of a maximum of 8 consecutive

1 touches per team was introduced to guide individual learners to search for the desired
2 solution of taking fewer individual touches when under pressure, while scanning the
3 performance environment and making decisions related to passing to an unmarked teammate.
4 Max detected and interpreted the successful achievement of the predetermined intended
5 learning outcome by many pupils in the class.

6
7 I noticed that a highly skilled student, who was identified as a dominant selfish player, who
8 previously took too many individual touches, achieving success from this game. This problem
9 was solved in this game because I noticed him and other less skilled players, who previously just
10 'booted' the ball without looking, taking a touch and looking up for teammates who were
11 open/unmarked in space. This game directed him and others to play the ball to unmarked
12 teammates. (Reflection, Max)

13
14 However, as suggested by Chow (2013), the less predictable and complex nature of
15 student learning proved a significant challenge to our novice practitioners when
16 implementing a NLP. The PETE students rarely detected any of the multiple pupil responses
17 that 'unexpectedly' emerged from their modified learning environments. Their lack of
18 practical experience, experiential knowledge and conceptual understanding of this complex
19 and dynamic interacting emergent learning process made it challenging for them to detect and
20 interpret their learners' complex and less predictable responses to the game structures they
21 created. When questioned about how successful she was at observing pupil's behaviour
22 Melinda's response highlighted such difficulties.

23
24 I found that a little bit more difficult when I had to referee everything, and when I had to... I had a
25 lot on my mind, so I'm watching them to make sure that they're doing the rules properly, then I'm
26 watching them to make sure that they're enforcing the constraint that I wanted, and I felt like it
27 was a little bit harder to actually step back and see if they were doing the behaviour. You're not

1 constantly observing for the emergent behaviour, you're more focused on everything as a whole.

2 (Interview, Melinda)

3

4 These findings are consistent with previous research that has suggested this deep
5 understanding of the learning process, and advanced observational and analytical skills, are
6 necessities to successfully teach an emergent nonlinear curriculum (Butler 2014; Chow 2013;
7 Hopper, Butler, and Storey 2009; Howarth 2005). According to Howarth (2005) these skills
8 are more likely to be found in an expert teacher than in pre-service teachers. The primary
9 researcher in this study, who is considered an expert teacher, is testimony to this assumption.
10 He detected and interpreted multiple less predictable emergent responses when afforded the
11 luxury of observing lessons without the distraction of lesson management. For example, after
12 observing the maximum 8 team touches soccer game he reflected:

13

14 In the 8-touch soccer/football game I observed many 'unexpected' emergent behaviours.
15 Teammates, now expecting a pass, were no longer congested around the ball and spread out
16 across the width of the field to offer passing options. They received the ball in space, which
17 allowed them time on the ball. Some players were now passing long to gain as much ground as
18 possible with fewer touches remaining. So as not to waste touches, many players' body shape
19 adapted to side on to receive the ball, which also opened up their field of vision. Overall the
20 passing was quicker and more accurate, in response to the defence applying more pressure on the
21 ball. (Reflection, primary researcher)

22

23 These responses are difficult to predict as, operating as a nonlinear system, a learner's
24 response emerges as a consequence of the dynamic individual learner-environment
25 interactions within the complexities of a team game (Chow et al. 2013). These less
26 predictable individual responses are a consequence of the complex interactions of the
27 individual learner's intrinsic dynamics, the game environment and the task constraints, within

1 the game context (Chow and Atencio 2014; Chow et al. 2011, 2013; Renshaw et al. 2010).
2 For example, in the maximum 8 consecutive team touches soccer game, a player's passing
3 response is difficult to predict, as it is a consequence of the complex interaction of the
4 individual player's kicking ability, the playing surface, the positioning of opponents and
5 teammates, and the number of team touches remaining.

6 Adding to the difficulty in predicting learning outcomes within a NLP theoretical
7 framework is the notion that team games are complex adaptive dynamical systems made up
8 of a number of interacting sub-systems that can abruptly change (Davids et al. 2003).
9 Behaviour emerges in such complex systems as spontaneous patterns are formed from the
10 interactions of individual players within the team game (Kauffman 1993). Within a team
11 game, individual players function as part of this larger system co-adapting their actions to the
12 actions of teammates and opposition players (Kauffman 1993; Passos et al. 2008; Passos and
13 Davids 2015). For example, in the maximum 8 consecutive team touches soccer game the
14 actions of the player in possession of the ball, their teammates, and opposition players are
15 systematically related to each other, that is, when players started passing rather than
16 dribbling, teammates responded by moving into space to receive the ball and opponents
17 pressured the ball carrier. These co-adaptive and regulated interactions result in ongoing
18 information that is emergent, necessitating emergent actions in response, thus making it
19 difficult to predict or prescribe players' behaviours or sequences of play as a consequence of
20 the introduction of a constraint. These player interactions can be further influenced by factors
21 such as field location (Headrick et al. 2012). This unpredictability was highlighted and
22 interpreted by Melinda in the following reflection:

23

24 I think that the students did learn, however they did not often perform the way I intended or
25 predicted, that is, they did not utilize the wide immunity zones. From this lesson, I learned that

1 introducing a constraint can have several emergent behaviours, sometimes none of which are the
2 desired one. (Reflection, Melinda)

3

4 Further complicating game play prediction for practitioners is that, from an ecological
5 dynamics perspective, a player's behaviour is attuned to their own action capabilities and
6 those of their teammates and opponents, making affordances subjective to the individual
7 (Fajen, Riley, and Turvey 2009). Different opponents and teammates afford different
8 movement possibilities and different game play patterns emerge when challenged to play
9 with and against different opponents. For example, if a player has the capability to accurately
10 pass long to a competently skilled teammate who is in space, the free player acts as an
11 affordance for action. However, if the player in possession knows that the free player is
12 poorly skilled at controlling a long pass and that the closest defender is quick and skilful at
13 interception, the long pass may be considered, but not executed. To better understand and
14 interpret players' responses a teacher needs to be able to perceive these affordances from the
15 perspective of the players rather than their own (Fajen, Riley, and Turvey 2009).

16 However, with 2 weeks of experience of teaching a NLP, in combination with guidance
17 from the primary researcher, the PETE students quickly developed a better understanding and
18 awareness of the complex interactions that occur within the dynamics of a team game. This
19 resulted in improved detection of these varied and less predictable emergent game play
20 patterns. For example, to solve the problem of basketball players shooting from low
21 percentage court positions, Melinda introduced the task constraint of extra points if a team
22 scored from a shot taken from inside the keyway. As well as detecting the expected response
23 of players shooting from closer to the basket, Melinda detected and interpreted the
24 unpredicted emergent response from the offence of cutting towards the basket to receive the
25 ball rather than waiting outside the keyway for the pass, as they had done previously. PETE
26 students reported an improved ability to detect less predictable emergent behaviour with

1 experience. For example, in response to a question about how successful he was at observing
2 emerging behaviour over the four weeks, Max replied:

3

4 I wasn't very successful at the start. I did get better as the prac went on. At the start I had to focus
5 a lot about how to get the games going, and explaining the games, and refereeing the games. Once
6 I was able to implement them more successfully and easier, and take more of a hands-off
7 approach, I could just sit back and watch a game and really observe behaviours and adapt. So by
8 the end of it I think I was getting quite good at it. (Interview, Max)

9

10 *The manipulation of the learning environment*

11 The ability to manipulate the learning environment to facilitate the emergence of learners'
12 tactical problem solving behaviour is considered a crucial ingredient to successfully teach
13 student-centred, game-based approaches (Howarth 2005). In the first 2 weeks of the
14 practicum, to ensure that the CLA learning design and delivery was authentically represented,
15 modified learning environments were either taken directly from resources used in the
16 previously completed constraints-based PETE games unit or designed by the PETE students
17 in collaboration with the primary researcher. These learning environments were generally
18 successful in channelling learner's search towards predetermined emergent movement
19 solutions to tactical problems. For example, when asked what helped him most in the initial
20 weeks to design games Max responded:

21

22 It would have to be the games unit booklet, really, because even sports and game designs that
23 were in the games booklet, I could sometimes use the constraints from that for other sports.
24 (Reflection, Max)

25

26 During the latter stage of the practicum the PETE students were given the opportunity
27 to independently design and implement modified learning environments to achieve this same

1 outcome, without any collaboration with the primary researcher. This task proved challenging
2 for the PETE students as demonstrated by Max's quote below:

3

4because I was designing brand new games, to think of a basketball game and what behaviour
5 was going to emerge was... it was quite tough, even for me who had experience in basketball and
6 played quite a bit of basketball myself. (Interview, Max)

7

8 Although the modified learning environments they designed were often successful in
9 generating the predetermined movement solution to a tactical problem, their task constraints
10 provided limited opportunity for this problem-solving behaviour to emerge through the
11 natural, exploratory learning processes underpinning the CLA. For example, a tactical
12 problem identified in Melinda's basketball class was that the attacking players easily
13 penetrated forward through the defence, as the nearest defender did not pressure their
14 opponent with the ball when he threatened space in front of them. To achieve the desired
15 problem solving behaviour of defensive pressure on the attacker with the ball, Melinda
16 manipulated the game design by introducing the rule or instructional task constraint that, if
17 the player with the ball is tagged, possession is transferred to the defending team. Her
18 reasoning was that, by introducing a constraint that rewards defensive pressure, players
19 would pressure the ball carrier and force the attack back or across or force an error. The result
20 was that the nearest defending player constantly pressured the ball carrier.

21

22 Prior to this lesson, students all stood around and allowed the person with the ball to dribble or
23 pass forward without pressure. In this game, the desired behaviour emerged as students constantly
24 pressured the player with the ball. (Reflection, Melinda)

25

1 Although this instructional task constraint was successful in generating the
2 predetermined problem solving behaviour, it constructed a very narrow space for task
3 exploration, provoking learners' search for an imposed single solution of pressuring the ball
4 carrier. This happened regardless of the existence of the key affordance of an attacker
5 threatening to penetrate forward through the defence. This design feature denied learners the
6 opportunity to explore a range of possible solutions within a broader space for task
7 exploration and for their individual functional movement solution to emerge implicitly
8 through the process of self-organisation under interacting constraints (Chow 2013; Davids,
9 Button, and Bennett 2008). Finding the right balance to ensure that task constraints provide a
10 tight, controlled boundary, as well as opportunities for exploring functional problem solving
11 behaviours is a challenge even for experienced learning designers (Chow et al. 2011). When
12 the manipulated environment provokes learners' search for an imposed single 'selected'
13 solution, players learn the technical skills associated with '*what*' to do, but do not have the
14 opportunity to learn the perception and decision-making associated with that tactical
15 response, that is, '*when*' to do it. This type of restrictive instructional task constraint is better
16 used to pose a single tactical problem (key affordance) to the learner, necessitating the
17 generation of exploratory problem solving behaviours in response (action).

18 PETE students' use of instructional constraints, that prescribed tactical movement
19 solutions rather than facilitated opportunities for them to implicitly emerge, exposed a lack of
20 conceptual understanding of the natural exploratory learning processes underpinning the
21 CLA and the co-adaptive and regulated interactions that occur within the dynamics of a team
22 game. This finding is consistent with previous research suggesting that a conceptual
23 understanding of the learning process, necessary to successfully implement an emergent
24 nonlinear curriculum, would unlikely be found in a pre-service teacher (Butler 2014; Chow
25 2013; Hopper, Butler, and Storey 2009; Howarth 2005).

1 However, with some weeks of experience implementing the CLA and observing and
2 reflecting on pupil's responses, PETE students' game design demonstrated an improved
3 understanding of the implicit learning process underpinning the CLA. For example, Max
4 modified a soccer/football learning environment using a task (instructional) constraint of:
5 'when a player with the ball is tagged by an opponent they lose possession'. He did this to
6 exaggerate the tactical problem or affordance of defensive pressure, and challenge the
7 attacking team to search for functional movement solutions in response. When confronted
8 with defensive pressure, players' responses included Max's desired co-adaptive emergent
9 learning outcome of utilising the width of the field in attack to spread the defence as well as
10 other responses such as the use of a back pass to an unmarked teammate. Exaggeration of
11 affordances assists the learner in becoming more attuned to the pertinent environmental
12 parameters within their search for functional movement solutions (Tan, Chow, and Davids
13 2012). PETE students reported an improved ability to design games that worked in
14 facilitating the emergence of learners' tactical problem solving behaviour.

15

16 I think I was fairly successful. I think I got better as it went along. Initially I was very reliant on
17 the games booklet, but when I started teaching and started watching the students more and seeing
18 what they were capable of it got a bit easier. And then eventually I was starting to adapt a lot of
19 the games from the games booklet and use good constraints that worked well. (Interview,
20 Melinda)

21

22 ***Study limitations and practical implications***

23 This study was carried out with two participants over a relatively short duration of 4 weeks,
24 thus restricting the generalisability of the findings. However, recognising these limitations,
25 the study findings still achieved the aim of providing some useful insights for PETE
26 practitioners and PETE practice. These implementation challenges facing practitioners can be

1 used to inform and improve the design and delivery of PETE programmes in preparing and
2 supporting PETE students to effectively implement the CLA and other nonlinear informed
3 games based approaches in a school environment. Whilst the challenges of implementing
4 nonlinear pedagogical approaches such as the CLA must not be under-estimated, that the two
5 PETE students were able to become more effective highlights that implementation
6 opportunities early in teaching careers are highly beneficial (Stran and Curtner-Smith, 2010).
7 With the appropriate level of support novice teachers are able to implement a CLA without
8 in-depth understanding of the theoretical model, however, this process should be seen as a
9 journey and future research should follow the careers of preservice teachers to examine their
10 future engagement with a CLA. In line with the findings of Atencio and colleagues (2014) on
11 the implementation of the CLA in primary schools, and studies from other innovative
12 pedagogies (e.g. Stran and Curtner-Smith, 2010 in Sport Education and Wang and Ha 2012 in
13 TGfU) the results of this study go some way to allay fears that beginner level teachers need a
14 high level of theoretical and pedagogical knowledge before they can (and should) be allowed
15 to implement new pedagogical approaches such as CLA in their teaching practice.

16 These findings highlight the need for PETE students to develop their experiential
17 knowledge and conceptual understanding of how to teach using a CLA through authentic
18 games teaching experiences (Stran and Curtner-Smith 2010). To achieve this aim, university
19 PETE programmes must provide students with ‘safe’ opportunities to work with children so
20 they can understand the range of emergent behaviours possible within a constraint
21 manipulated game, and incorporate opportunities for PETE students to develop their skills in
22 the detection and interpretation of these multiple emergent player responses. This is a
23 difficult task, particularly when considering the dynamic and complex interactions between
24 teammates and opponents inherent in invasion games. Thus, these skills should be
25 progressively developed, starting with simple environments, for example, observing a 1 v 1

1 game from the ‘sideline’, and working towards more complex observations and
2 interpretations of small-sided team games from a teacher’s perspective. These observations
3 and interpretations would help PETE students gain a practical understanding of the dynamic,
4 complex, and interacting nature of a player’s emergent individual response resulting from
5 exposure to constraints.

6 PETE programmes must also incorporate opportunities for students to learn to design
7 modified learning environments that enable learners to attune to key information sources in
8 their search for solutions to a tactical or technical problem. This rigorous learning design
9 must follow a structure that incorporates the careful manipulation of representative practice
10 environments using task constraints that: (i) emphasise (exaggerate) the tactical problem or
11 key affordances for the desired action/outcome, to make them obviously detectable and
12 challenge learners to search for a solution, and (ii), channel learners’ search within a
13 narrower area (limited number of movement solutions) of the modified practice environment
14 towards ‘selected’ and more ‘obvious’ functional movement solutions (the ‘to-be-taught’
15 concept). These modified learning environments then should be implemented by PETE
16 students, ensuring that constraints are properly in place, and interpreted in terms of the
17 emergence of predetermined and less predictable solutions in accordance with the implicit
18 learning process of system self-organisation under interacting constraints.

19

20 ***Future research***

21 For physical education teaching practice to progress, it is important that the learning-related
22 practical recommendations from this research study are embedded into a PETE programme
23 and future research investigates their effectiveness in preparing PETE students to
24 authentically implement the CLA in a school environment. To support this process, PETE
25 educators need to work together with the physical education department of a local school to

1 provide opportunities for PETE students to independently apply their newly developed skills,
2 experiential knowledge and conceptual understanding of the CLA with smaller groups of
3 students in a physical education lesson. From such research, the effectiveness of the learning-
4 related practical recommendations can be evaluated and further issues surrounding the
5 practical challenges associated with the authentic design and delivery of a NLP in the school
6 environment can be identified.

7 8 **Conclusion**

9
10 This study has identified the challenges associated with implementing a NLP within a CLA
11 in a school setting. In contrast to popular traditional ‘linear’ pedagogies the physical
12 education teacher implementing a NLP must relinquish ‘control’ over the learning
13 environment, and be prepared for learning outcomes that are less predictable due to the
14 dynamic individual learner-environment interactions from which learning occurs. This is a
15 difficult process of change for practitioners comfortable in the predictability of traditional
16 teaching environments. However, unlike the traditional ‘linear’ pedagogies, NLP provides a
17 sound theoretical model of the learning process, which can inform learning design and
18 delivery within physical education. Incorporating these study recommendations into a PETE
19 programme can support students to effectively implement the CLA and other nonlinear
20 informed games based approaches in a school environment. The potential of a nonlinear
21 pedagogical approach for enhanced student learning of motor skills in physical education is
22 evident in a response by Max in summing up his practicum experience:

23

24 I believe in the constraints-led approach, because yeah, whenever I talk to anyone about it or teach
25 it in class, I really believe that it’s the best way to go. And my background being so traditional
26 and drill-based, to go and teach these boys this new approach, and to see the learning that occurs
27 implicitly, without me telling them to do anything, you know it still blows me away to this day.

1 Yeah. I saw it... like I've seen it working at uni now, and I've seen it working in schools, and I've
2 seen kids enjoying it. (Interview, Max)

3

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11 Table 1. Example of learning environment designed to solve an identified common game-
12 related problem, guided by key NLP pedagogical principles.

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Lesson Context:

Sport: Soccer/Football **Year Level:** 10 **CLASS SIZE:** 20 **Duration:** 60 mins

Principle of Play: Maintaining Possession

Common Student Tactical Awareness Problem: When players in possession of the ball are confronted with the tactical problem of defensive pressure they often surrender ball possession.

Possible Cause Of Problem: Support – Players do not have time to scan for available passing options, thus rush the pass.

Desired Pupil Tactical Problem Solving Behaviour: When a defender pressures the player with the ball (problem), they scan for opportunities and pass to an unmarked teammate (solution).

Modified Representative Practice Task: “Safe Passing” (6 v 6, normal rules)

Task Constraint to present ‘obvious’ solution (affordance/opportunity for action):

First touch immunity: Players with ball have a maximum of 3 touches before losing possession. However, after the first touch they are allowed 3 seconds of immunity, i.e. cannot be tackled by defenders who must retreat 1 metre.

Task Simplification: Floating player who plays on attacking team, creating 7 v 6

Justification of Constraint, i.e. how it emphasises the problem and channels students search towards the selected student learning outcome

The task constraint of a maximum of 3 touches will emphasise the problem of the player with the ball being under pressure to pass, channelling them to pass to a teammate to maintain possession. The attacking teammates should detect this affordance for action and support their teammate by moving into space off the ball to provide forward, lateral and backward passing options. The 3 second immunity allows players time and space to scan and look for unmarked teammates to pass to.

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Table 2. CLA Lesson Observation Checklist (adapted from Chow et al. 2016)

Key Contextual, Operational and Pedagogical Requirements of the CLA

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Practice Environment Representative of Performance Environment:

- Key information sources present (e.g. defenders)
- Simplified environment (e.g. small-sided game; immunity; floating player)

Task constraints in place to:

- Emphasise (exaggerate) the tactical problem
- Present ‘obvious’ solution to the tactical problem (affordance)

Exploratory Facilitation

- Teacher uses ‘hands off’ approach
- Learners given the freedom & time to subconsciously explore environment
- Problem solving behaviour allowed to emerge implicitly

Teacher Instruction and Feedback:

- Performance outcome oriented (tell pupils what to do, not how to do it)
 - Focus on external movement outcomes of action (e.g. kick ball at target)
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