TEACHING AGAINST THE GRAIN: LEARNING DESIGNS FOR EVOLVING PHYSICAL EDUCATION PRACTICE

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Abstract

This PhD programme set out to explore the evolution of physical education teaching practice through the introduction of an alternative pedagogy during Physical Education Teacher Education (PETE). The incompatibility of the dominant traditional drill-based physical education teaching approach with the development of a skilled performer, viewed from a contemporary motor learning perspective as an adaptive individual who can accurately achieve task goals using individualised functional movement capabilities in varying performance contexts (Araújo and Davids 2011), has highlighted the need for an alternative teaching approach. This prompted the Sport, Health and Physical Education discipline group within the Queensland University of Technology (QUT) to critically change the traditional delivery of a games unit within their PETE course and adopt an alternative physical education teaching approach. The Constraints-led Approach (CLA) was adopted as it provided a viable, alternative, teaching methodology to support the development of skilled, adaptive physical education performers. The essential distinguishing feature of the CLA is that its practice design and delivery of feedback and instruction is informed by key pedagogical principles of a nonlinear pedagogy (NLP), which provides a sound theoretical learning framework, based on a contemporary, ecological perspective of motor control and learning. While recognising the relevance and advancement of educational learning theory within physical education, the relevant theoretically based pedagogical framework and a major focus of this PhD programme is the contemporary motor learning theory informing the learning design and delivery of the CLA.

A major challenge to an evolution of physical education teaching practice is overcoming the powerful influence of prospective physical educators' acculturation or past physical education and sporting experiences. Since many PETE recruits come from a successful physical education and sporting background, they strongly identify with the pedagogical approach they were exposed to by their physical education teachers as it had seemingly worked effectively for them. Subsequently they have very resistant custodial physical education teaching beliefs and anticipate teaching in a manner similar to how they were taught (Lawson 1983). Over time this has resulted in the maintenance of the *status quo* of a teacher-driven, traditional paradigm.

The first two studies within this PhD programme contribute to the knowledge and understanding associated with successfully overcoming this powerful influence of acculturation to mediate PETE recruits' receptiveness to an alternative pedagogy. The initial study of this thesis investigated the significance of PETE recruits' acculturation on their receptiveness to the CLA, experienced in an eight- week games unit. Results showed that, contrary to prior expectations based on physical education teacher socialisation theory and previous research, PETE recruits who were highly successful products of the traditional approach, and who were expected to stay strongly committed to a process that had worked effectively for them, significantly changed their initial strongly held, custodial, traditional physical education teaching beliefs and demonstrated receptiveness to the CLA.

To date, limited information has been reported about the reasons why PETE recruits identified in the literature as most resistant to change demonstrate receptiveness to an alternative pedagogy. Therefore, the second study of this PhD programme sought to explore the features and experiences of the CLA games unit that appealed to PETE recruits who were highly successful products of a traditional culture. The study results indicated that the efficacy of the CLA in skill development was clearly an important mediator of receptiveness for these PETE recruits. The inclusive nature of the CLA also provided a solution to the problem of exclusion, which also made the approach attractive to them.

Many PETE students that participated in these initial studies, now equipped with a belief in the CLA, expressed an encouraging desire to implement the approach in schools on practicum. However, the less predictable and complex nature of student learning as a consequence of the dynamic individual learner-environment interactions within a NLP is thought to present significant implementation challenges to novice practitioners. To date, there is very little practical empirical research that identifies and investigates these challenges facing novice physical education practitioners when implementing a NLP. As a consequence, the third study of the PhD programme was designed to investigate two PETE students' experiences associated with the less predictable and complex nature of student learning when implementing a NLP, specifically the CLA, with school students in a physical education class on practicum.

Results of this study exposed significant challenges to the novice practitioners, highlighting the importance of experiential knowledge and a conceptual understanding of the complex and dynamic emergent learning processes underpinning the CLA and the co-adaptive and regulated interactions that occur within the dynamics of a performance environment such as a team game. The PETE students had difficulty designing modified learning environments to facilitate the emergence of a predetermined learning outcome in accordance with the CLA's implicit, exploratory learning process of system self-organisation under interacting constraints. They also found it challenging to detect and interpret their learners' multiple complex and less predictable responses to the manipulated environments they implemented.

Further highlighting the importance of an evolution of physical education teaching practice is the criticism of the prescriptive teaching philosophy of the traditional approach for failing to effectively provide learners with motivationally supportive experiences to engage in physical education. Providing motivationally supportive experiences for learners is crucial since empirical evidence in physical education research has associated intrinsic motivation with positive educational outcomes such as higher levels of active engagement, enhanced concentration and effort, and increased levels of student learning. Self-determination theory (SDT) provides a useful framework for examining motivationally supportive physical education experiences through satisfaction of three basic psychological needs of the individual: autonomy, competence and relatedness. Claims have been made that the CLA can effectively support more self-determined and intrinsically motivated engagement by students' in physical education by meeting all three basic psychological needs of the individual.

The aim of the final study within the PhD programme was to test these unverified claims by assessing the impact of the learning design and delivery of instruction and feedback of a CLA lesson on PETE students' self-reported levels of intrinsic motivation. The traditional approach was used as a comparison condition. The results supported these claims, indicating that participants' exhibited behaviour was substantially more self-determined and intrinsically motivated during the CLA lesson compared to during the traditional lesson.

The collective empirical findings of all studies of the PhD programme demonstrate a significant contribution to knowledge in the physical education discipline. Study 1 provides encouraging evidence to show that it is possible for PETE educators to overcome the powerful influence of acculturation and provide PETE students with the belief in an alternative approach to teaching games compatible with the skill acquisition needs of the individual. This is an important starting point in the evolution of physical education teaching practice, as a belief in an alternative pedagogy is a major determinant prior to changing pedagogical practice. The findings of study 2 have important implications for informing and improving the future design of alternative pedagogy PETE units aimed at challenging resistant custodial teaching beliefs of PETE recruits who are highly successful products of their custodial physical education culture. To mediate receptiveness, this study showed that it is important that the learning theory underpinning the alternative approach is operationalised in a research-informed pedagogical learning design that facilitates students' perceptions of the effectiveness of the approach in skill development and inclusivity through experiencing and or observing it working. The practical application of this knowledge would help improve the effectiveness and impact of PETE. The challenges facing practitioners when implementing a NLP, identified in Study 3, can also be used to inform and improve the design and delivery of PETE programmes. This would help in preparing and supporting PETE students to effectively implement the CLA and other nonlinear informed approaches in a school environment. The final study of the PhD programme provided empirical research evidence to support the CLA meeting the basic psychological needs of the individual performer in a pedagogical setting. The CLA, implemented within the dynamic individual-environment framework of a NLP, has the capacity to provide teachers with the tools to develop functional pedagogical climates, which result in students exhibiting more intrinsically motivated behaviours during learning. Physical education lessons that meet these basic psychological needs will produce more effort, enjoyment, interest and excitement in class, leading to greater task engagement, enhanced performance and persistence.

The practical application of the collective empirical findings of this PhD programme can influence the field by helping to guide PETE educators to commence an evolution of physical education teaching practice through the introduction of an alternative pedagogy during PETE. The CLA is presented as a viable alternative pedagogy, grounded in contemporary motor learning theory that can support the development of skilled and intrinsically motivated physical education performers.

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List of Abbreviations

CLA Constraints-led approach

NASPE National Association for Sport and Physical Education

NLP Nonlinear pedagogy

PETE Physical education teacher education

PT Pre-service teacher

QSA Queensland Studies Authority

QUT Queensland University of Technology

SDT Self-determination theory

TGfU Teaching games for understanding

Statement of Original Authorship

The work contained in this thesis has not been previously submitted to meet requirements for an award at this or any other higher education institution. To the best of my knowledge and belief, the thesis contains no material previously published or written by another person except where due reference is made.

QUT Verified Signature

Signature:

Date: 3rd August, 2016

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List of Publications and Research Outputs

Peer-reviewed journal articles

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Moy, B., I. Renshaw, K. Davids, and E. Brymer. 2016. Overcoming acculturation: Physical education recruits' experiences of an alternative pedagogical approach to games teaching. *Physical Education and Sport Pedagogy* 21, no. 4: 386-406.

Moy, B., I. Renshaw, and K. Davids. 2016. The impact of nonlinear pedagogy on physical education teacher education students' intrinsic motivation. *Physical Education and Sport Pedagogy,* DOI: 10.1080/17408989.2015.1072506.

Renshaw, I., D. Araújo, C. Button, J.Y. Chow, K. Davids and **B. Moy**. 2015. Why the constraints-led approach is not teaching games for understanding: A clarification. *Physical Education and Sport Pedagogy*, DOI: 10.1080/17408989.2015.1095870.

Non-peer reviewed journal articles

Renshaw, I., **B. Moy**, and M. Cook. 2015. A constraints-led approach for PE teachers. *Active + Healthy*, 22 2/3: 17-19.

Conference papers

Moy, B., and I. Renshaw. 2009. *How current pedagogy methods in games teaching in the UK, Australia and the US have been shaped by historical, socio cultural, environmental and political constraints*. In: Edited Proceedings of the 26th Australian Council for Health, Physical Education and Recreation (ACHPER) International Conference: Creating Active Futures, 8-10 July, Queensland University of Technology. 56, 95-106.

International Conference Presentations

Moy, B. 2009. *How current pedagogy methods in games teaching in the UK, Australia and US have been shaped by historical, socio cultural, environmental and political constraints.* 26th ACHPER International Conference, Brisbane, Australia, 8 July.

Moy, B. 2011. *Modifying games for a multi purpose*. 27th ACHPER International Conference, Adelaide, Australia, 20 April.

Renshaw, I. and **B. Moy**. 2011. *Adopting a theoretically driven approach to learning design changes students' beliefs in how to teach physical education*. Association Internationale des Ecoles Superieures d'Education Physique International Conference, UL Limerick, Ireland, 22-25 June.

Moy, B. 2012. *Receptiveness of physical education teacher education students to a constraint-led pedagogy*. 5th International Teaching Games for Understanding Conference, Loughborough, UK, July.

Moy, B. 2013. *Solving Game Related Problems through Learning Task Design,* 28th ACHPER International Conference, Melbourne, Australia, 29 November.

Moy, B. and I. Renshaw. 2016. *Implementing a nonlinear physical education pedagogy in an Australian school*. 6th International Teaching Games for Understanding Conference, Cologne, Germany, July.

State Conference Presentations

Moy, B. 2009. *Modifying invasion games using constraints*. ACHPER North Queensland Health and Physical Education Conference, Cairns, Australia, 2 December.

Moy, B. 2010. *Modifying games for a multi-purpose*. ACHPER Queensland Heath and Physical Education Conference, Brisbane, Australia, 12-13 July.

Moy, B. 2013. *Should we be teaching the 'classical movement technique' to all learners?* ACHPER Queensland Heath and Physical Education Conference, Brisbane, Australia, 16 August 2013.

Moy, B. 2014. Solving game related problems through learning task design. ACHPER Queensland Heath and Physical Education Conference, Brisbane, Australia, 14 August.

Moy, B. and M. Cook. 2015. *How we teach physical education should be based on contemporary theory about how the learner learns*. ACHPER Queensland Heath and Physical Education Conference, Brisbane, Australia, 13 August.

Moy, B. and M. Cook. 2016. *Learning design that allows technical and tactical skills to implicitly emerge.* ACHPER Queensland Heath and Physical Education Conference, Brisbane, Australia, 11 August.

Moy, B. 2016. *Learning design that motivates and engages HPE students.* ACHPER Queensland Heath and Physical Education Conference, Brisbane, Australia, 12 August.

Chapter 1: Introduction

Historically, physical education has maintained a place in the school curriculum for reasons physical rather than educational, such as military training and healthy lifestyle promotion (Kirk et al. 1996). Consequently, in attempts to advocate for physical education and justify its educational value within the school curriculum, Arnold (1988) proposed a model that positioned physical education as a medium involving cognitive processes including the acquisition of knowledge and understanding to solve movement-related problems. From this perspective the goal of physical education was to progress students beyond the scope of mindlessly reproducing physical responses to the development of the 'intelligent performer' who has the ability to use their mind to make strategic decisions in complex and dynamic situations (Kirk 1988; Kirk et al. 1996). The development of physical education students as 'intelligent performers' or active decision makers has since become a central aim in Physical Education curriculum documents worldwide, including the United Kingdom, Unites States of America and Australia (Australian Curriculum, Assessment and Reporting Authority 2015; Byra 2006; Department for Education 2013; Metzler 2005; National Association for Sport and Physical Education 2009; Queensland Studies Authority 2010). The strategic inclusion of the word 'intelligent' rather than 'skilled', suggests an attempt to explicitly link physical education with cognition for a wider audience. This link is evident in the definition of intelligent performance from the Studies Authority in Queensland, Australia (2010, 3):

> Intelligent performance is characterised by high levels of cognitive functioning, using both rational and creative thought. Students are decision makers engaged in the active construction of meaning through processing information related to their personal experience and to the study of physical activity.

This definition of intelligent performance has its roots in a cognitive perspective of motor control and learning, ascribing intelligence or skill to the mental processing of information controlled at a conscious level by the mind in order to understand and interpret the learning environment before producing functional behavioural outputs (Abernethy, Burgess-Limerick, and Parks 1994; Anson, Elliott, and Davids 2005). From a cognitive perspective, an intelligent or skilled performer is viewed as an individual who has acquired and stored in their memory increased amounts and complexity of movement representations as a result of practice. This stored, sophisticated knowledge allows them to make more accurate inferences for action from information perceived in the performance environment (Ericsson 2007; Schmidt and Lee 2006).

However, this primary focus on the internal conscious mental processes within the individual has neglected both the role of the environment and the subconscious control mechanisms of the body in the regulation of intelligent performance (Abernethy, Burgess-Limerick, and Parks 1994; Araújo and Davids 2011; Dunwoody 2006; Gallwey 1979). In contrast to a cognitive perspective, an ecological perspective, based on the contemporary motor learning theory of ecological dynamics, assumes an organism-environment mutuality and reciprocity, viewing the mind (the brain), the body (musculo-skeletal system) and the environment as jointly and continuously influencing each other to shape an individual's functional emergent behaviours (Araújo, Davids, and Hristovski 2006; Lombardo 1987; Renshaw et al. 2010; Renshaw et al. 2015). From an ecological perspective, the physical and social environment, the physical and mental capacities of each individual, and the specific task demands, all continuously interact to shape the acquisition of skill (Warren 2006). As these environmental, individual and task constraints can alter every time an action is performed, skill is viewed as the emergent behavioral movement outcome that is adaptable to a range of varying performance contexts (Araújo and Davids 2011). Subsequently a 'skilled performer' is viewed as an adaptive individual who can accurately achieve task goals using individualised functional movement capabilities as these conditions change (Araújo and Davids 2011; Davids, Bennett and Newell, 2006). Adaptive skilled behavior emerges from this confluence of constraints as learners seek individualised movement solutions to a specific performance problem through active exploration of a learning environment (Araújo and Davids 2011; Davids, Button and Bennett 2008; Davids et al. 2015; Gibson 1966).

A key aspect of an ecological perspective is that performers develop their knowledge and understanding of a learning environment without the need for a mental representation of it, by perceiving to act and acting to perceive (Araújo and Davids 2011). That is, a performer's actions, which are their decisions, are supported by perceptual information from the environment and, in turn, actions enable the performer to seek and directly perceive subsequent information in response to their action. This information from the environment can then be utilised to regulate individualised problem solving actions to performance problems (Araújo and Davids 2011; Davids and Araújo 2010; Davids et al. 2015; Gibson 1966). In contrast, from a cognitive perspective, understanding and decision-making using the mind intervenes the processes of perception and action, resulting in decision making preceding acting (Araújo and Davids 2011; Renshaw et al. 2015). With experience of this active exploratory process, a skilled performer enhances *knowledge of* the environment resulting in their perceptual systems becoming more 'attuned' to information useful for regulating action to achieve task goals in the scale of their body and action capabilities (Gibson 1966; Turvey and Shaw 1999).

This desired aim of the development of the skilled performer is an important factor in determining how physical education should be taught. To achieve this aim, Queensland physical education teachers have self-reported and been directly observed predominantly using reproductive approaches, particularly the 'practice' style from Mosston's Spectrum of Teaching Styles (Mosston 1966; Mosston and Ashworth 2002) (Cothran et al. 2005; SueSee and Edwards 2011). However, this teaching approach is not compatible with the ecologically based definition of the skilled performer. The reproductive 'practice' style, more commonly referred to as the traditional physical education teaching approach, restricts learners' involvement to imitation and the repetitive attempts to reproduce teacher-prescribed movement skill 'templates' in drills isolated from the performance environment, rather than challenging them to independently explore and discover individualised functional solutions to movement problems in complex and dynamic learning environments (Araújo and Davids 2011; Davids, Bennett and Newell, 2006; Davids, Chow, and Shuttleworth 2005; Hopper, Butler, and Storey 2009; Kirk 2010; Kirk et al. 1996; Renshaw and Clancy 2009). This traditional pedagogical approach has been criticised from a skill acquisition perspective because of the failure of skill transfer from practice to the performance environment. This is because drills isolate technique from perception and decision-making, which function together in the performance environment (Renshaw et al. 2009, 2010). Key information from the performance environment such as opposition players is also missing in drills, which could inhibit the coupling or coordination of information (perception) and movement (action) (Renshaw et al. 2009, 2010; Renshaw, Davids, and Savelsbergh 2010; Williams and Hodges 2005).

These limitations have highlighted the importance of an evolution of physical education teaching practice from the dominant teacher-centred traditional approach, where students reproduce knowledge or skills demonstrated by the teacher (Mosston and Ashworth 2002). Over time, a number of student-centred approaches, where teachers are facilitators and students are challenged to solve problems through individual exploration (Davids, Chow, and Shuttleworth 2005; Richard and Wallian 2005), have been proposed to address the limitations of the teacher-centred traditional approach. This most popular student-centred approach, Teaching Games for Understanding (TGfU), challenges learners to critically interpret the modified game environment and solve tactical problems through exploration (Bunker and Thorpe 1982; Thorpe 2005b; Thorpe, Bunker, and Almond 1984). However, although TGfU and its variations have been embraced by academics, research on the use of physical education teaching approaches indicates that the uptake of such student-centred approaches by practitioners has been limited (Almond 2010; Cothran et al. 2005; Kirk 2010).

Recently, the Constraints-led Approach (CLA) has been proposed as a viable alternative physical education teaching methodology to support the development of skilled physical education performers (Chow et al. 2016; Renshaw et al. 2010). The CLA challenges learners to solve common performance related problems through active exploration in representative practice environments modified to regulate skill level and to emphasise particular aspects of performance (Renshaw et al. 2009). The essential distinguishing feature of the CLA is that its practice design and delivery of feedback and instruction is informed by key pedagogical principles of a nonlinear pedagogy (NLP), which recognises that the learning of motor skills involves sudden progressions and regressions in performance levels (Liu, Newell, and Mayer-Kress, 2006). These key pedagogical principles are self-organisation under constraint manipulation, representative practice design, attunement to affordances, information-movement or perception-action couplings, task simplification, harnessing functional adaptive variability in practice, and implicit learning aligned with feedback and instruction focusing on external movement outcomes of an action (Chow 2013; Chow et al. 2016; Davids, Button, and Bennett 2008; Renshaw et al. 2009). These key NLP principles provide a sound theoretical model of the learner and of the processes of learning, based on the motor learning theory of ecological dynamics (Chow et al. 2011; Davids et al. 2015). The CLA subsequently assumes an organism-environment mutuality and reciprocity, viewing the mind, body and environment as jointly and continuously influencing each other to shape the emergence of individualised, functional movement solutions as learners adapt to satisfy unique combinations of changing and interacting individual constraints (or boundaries) and those of the task and performance environment (see Araújo, Davids, and Hristovski 2006; Chow et al. 2006, 2007, 2011; Newell 1986; Newell, Liu, and Mayer-Kress 2008; Renshaw et al. 2015; Tan, Chow, and Davids 2012). It is important to note that as the CLA is distinguished by its grounding in ecological dynamics, it can be more accurately described as a student or learner-environment-centred approach rather than a student-centred approach (Renshaw et al. 2015)

Physical education teacher education (PETE) programmes have been identified as a critical point in time in the professional development of teachers to encourage the exploration of alternative teaching approaches (Light 2002). However, there are many socio-cultural constraints that present a challenge to the commencement of this desired evolution of physical education teaching practice with PETE recruits. The socio-cultural constraint of acculturation or past physical education and sporting experience is particularly relevant to PETE programmes. Of prime importance in this socialisation process are prospective teachers' observations and interactions with physical education teachers, coaches and other significant individuals, termed by Lortie (1975, 61) the 'apprenticeship of observation'. Lortie (1975, 61) proposed that, through the internalisation of many years of observing teachers in class, teacher recruits develop specific views of what constitutes good pedagogical practice and they enter teacher education programmes thinking that they hold a 'subjective warrant to teach' (Lortie 1975, 39). That is, they believe that they already know what they need to be able to do in order to teach. Compounding this view is the fact that many prospective physical education teachers are successful products of this teaching approach, having had extensive, enjoyable and successful backgrounds in physical education and sport prior to entering a course of study in PETE (Curtner-Smith and Sofo 2004; Doolittle, Dodds, and Placek 1993; Sofo and Curtner-Smith 2005; Wright, McNeill, and Butler 2004). According to Lortie (1975) and Lawson (1983a) these recruits' custodial teaching beliefs are resistant to change and PETE programmes have little effect on them, resulting in the maintenance of the status quo of a teacher-driven, reproductive paradigm (Butler 2005; Curtner-Smith 2007; Doolittle, Dodds, and Placek 1993).

Since acculturation appears to be an important mediator in determining initial teaching perspectives and subsequent receptiveness to innovation, before introducing an alternative pedagogy it is important that PETE educators have an understanding of their recruits' prior experiences and perspectives about teaching, sport and physical education. Lawson (1983a, 1983b) hypothesised that perspectives formulated during acculturation produced two different types of recruits who entered formal PETE with varied receptiveness to innovation. PETE recruits who had limited involvement and success in interschool sport, he suggested, will possess an innovative orientation and are more likely to internalise and adopt a belief in the innovative perspectives and practices espoused by PETE faculty. Other PETE recruits, who had extensive involvement and success in interschool sport, were likely to be extremely conservative in their orientation towards physical education pedagogy, possessing a custodial orientation and were unlikely to internalise and adopt a belief in the innovative perspectives and practices espoused by PETE faculty. Lawson's hypothesis has been supported by research conducted by Sofo and Curtner-Smith (2005, 2010), and by Stran and Curtner-Smith (2009b) who found that North American PETE recruits' acculturation mediated their receptiveness towards an alternative pedagogy model presented during teacher education. Specifically, they found that PETE recruits who had limited involvement and success in interschool sport changed their beliefs much more easily about teaching physical education during PETE than those who had participated and succeeded at a high level in interschool sports, who were resistant to change.

Study 1: Research Problems and Significance

To date, the type of recruit studied in the literature to specifically test Lawson's hypothesis appears to be mainly restricted to PETE recruits from North America, who are typically products of a 'non-teaching' physical education culture, where the students play games and the teacher supervises or referees (Curtner-Smith 1997a, 1997b, 1998, 1999; Sofo and Curtner- Smith 2005, 2010). It would seem worthwhile to further test Lawson's hypothesis with PETE recruits who are products of a different physical education culture. Occupational socialisation, a theoretical framework that has guided researchers in understanding why teachers teach physical education as they do (Lawson 1983a, 1983b), and some research (e.g. Cothran et al. 2005; SueSee and Edwards 2011) suggest that Australian PETE recruits are products of a very different, traditional physical education teaching culture, where the students repetitively attempt to reproduce teacher-prescribed movement 'templates' in isolated drills, before endeavouring to apply the skills learned in a game or performance activity. At this point, no study exists that specifically looks at the previous sporting success of PETE recruits, who are products of a traditional physical education and sporting culture, as a primary acculturation mediating factor to receptiveness to a pedagogical innovation during PETE. The initial study in the PhD programme of work addresses this need by investigating the following research questions:

i. What are the past school physical education and sporting experiences of Queensland PETE recruits?
ii. What influence does past school physical education and sporting experiences have on Queensland PETE recruits' perspectives and initial personal beliefs about effective physical education teaching practice?
iii. How does the previous sporting success of Queensland PETE recruits, who are expected to be products of a traditional teaching approach, mediate the degree of receptiveness to the alternative CLA (experienced in an eight-week games unit), as captured by Lawson's (1983a, 1983b) physical education socialisation theory of acculturation?

It was expected that the previous physical education and sporting success of study participants would mediate their receptiveness to innovation, with those recruits who have played sport at higher representative levels being more resistant to a new pedagogical approach and stay strongly committed to a process that had worked effectively for them. These findings would have important implications for teacher educators interested in commencing an evolution of physical education teaching practice by presenting PETE recruits with an alternative pedagogical approach that addresses the limitations of the traditional approach. Findings would help teacher educators to recognise and understand potential differences in the receptiveness of PETE recruits to new pedagogical approaches shaped by past physical education and sporting experiences, and subsequently guide programme development to help improve the effectiveness and impact of teacher education on recruits' custodial teaching beliefs.

Study 2: Research Problem and Significance

According to Sofo and Curtner-Smith (2005) research is needed that investigates how PETE recruits' physical education and sporting acculturation influences their experiences and reactions during professional preparation. To date, some research studies have explored PETE students' experiences and reactions towards an alternative pedagogy during PETE and identified various reasons for its appeal (Gubacs-Collins 2007; Li and Cruz 2008; Light and Butler 2005; Wang and Ha 2009, 2013a). However, very limited data have been reported in these studies about PETE students' past physical education and sporting experiences to allow any link between acculturation and reasons for the appeal of the alternative pedagogy to be explored. This link is particularly important for PETE recruits identified in the literature as most resistant to change, that is, those with a strong custodial orientation who are high achieving sporting products of this custodial culture. These individuals are also, by default, the most influential in the continuation of custodial physical education teaching practice. Therefore, the second study of this PhD programme sought to identify reasons that make this significant change in teaching beliefs possible by investigating the following research question:

iv. What features and experiences of the alternative CLA appeal to Queensland PETE recruits with strong, custodial, traditional physical education teaching beliefs, and whom are high achieving sporting products of this traditional culture?

The contemporary motor learning theory that informs the CLA was expected to be the main facilitator of attraction for PETE students. Providing opportunities for students to experience the efficacy of the CLA in the development of skill as learners in practical workshops that adopt the underpinning motor learning theory was expected to strongly appeal to PETE students. In line with previous research findings from studies that investigated the appeal of TGfU and its variations (Gubacs-Collins 2007; Li and Cruz 2008; Light and Butler 2005; Wang and Ha 2009, 2013a), it was expected that the CLA would have some affective appeal for PETE students, such as the competent and equitable engagement of students of varying skill level, given the simplified, small-sided game learning design adopted by this approach and TGfU.

The findings of this study would be useful for informing and improving the future design of alternative pedagogy PETE units aimed at challenging resistant custodial teaching beliefs of PETE recruits who are highly successful products of this custodial physical education culture. This is an important starting point for teacher educators who wish to influence future teaching practice, as a belief in an alternative pedagogy is a major determinant prior to changing pedagogical practice

(Bechtel and O'Sullivan 2007; Borko and Putnam 1996; Butler 2005; Ennis 1994; Ernest 1989; Pajares 1992; Tsangaridou and O'Sullivan 2003).

Study 3: Research Problem and Significance

Once PETE students demonstrate a belief in an alternative pedagogy, such as the NLP informed CLA, the next step in the evolution of physical education teaching practice is for their PETE programme to prepare them for the challenges specifically associated with its implementation in schools on practicum. According to Chow (2013) CLA offers some potential for enhancing teacher education in the 21st century and more research is needed to identify the challenges and practical implications facing practitioners when implementing a physical education teaching approach informed by NLP in a school context. One significant challenge presented to novice practitioners is thought to be the less predictable and complex nature of student learning that emerges as a consequence of the dynamic individual learner-environment interactions within a NLP informed teaching approach (Chow 2013). Unlike a 'linear' informed traditional approach where the teacher is in control of a learning environment that produces a single predetermined and predictable learning outcome (Tinning and Rossi 2013), the emergence of multiple learning outcomes that are not predetermined and are difficult to predict are hallmarks of the complex nature of learning within a nonlinear informed approach (Chow et al. 2013; Davids, Button, and Bennett 2008). To date, there is very little practical empirical research that identifies and investigates this significant challenge facing physical education practitioners when implementing a teaching approach informed by NLP. Therefore, the third study of the PhD programme of work sought to investigate the following research question:

v. What are 2 PETE students' experiences associated with the less predictable and complex nature of student learning when implementing a NLP informed physical education teaching approach, specifically the CLA, in a school setting?

The practical implications of these findings would further build on the knowledge and understanding of the CLA and subsequently inform and improve the design and delivery of PETE programmes in preparing and supporting students to effectively implement a NLP informed teaching approach on practicum and in their future teaching careers.

Study 4: Research Problem and Significance

Further highlighting the importance of an evolution of physical education teaching practice is the criticism of the prescriptive teaching philosophy of the dominant traditional teaching approach for failing to effectively provide learners with motivationally supportive experiences to engage in physical education. Emphasising the mastery of specific techniques in repetitive, monotonous drills and competitive games can set significant motivational problems for less gifted and less confident individuals. Pedagogical researchers have claimed that such a pedagogical climate has been shown to enhance boredom, humiliation, marginalisation, passive class participation and disengagement (Bunker and Thorpe 1982; Carlson 1995;

Ennis 1999; Mitchell, Oslin, and Griffin 2006; Ntoumanis et al. 2004; Smith and Parr 2007). Providing motivationally supportive physical education experiences for learners is crucial, since empirical evidence in sport and physical education research has associated intrinsic motivation with positive educational outcomes such as higher levels of active engagement (Ntoumanis 2001), increased levels of student learning (Chen 2001; Hagger et al. 2003; Tjeerdsma-Blankenship 2008), enhanced concentration and effort (Standage, Duda, and Ntoumanis 2003), continued participation in physical activity (Ntoumanis 2005) and positive cognitive, psychomotor and social experiences (Vallerand 2001).

Self-determination theory (SDT) provides a valuable framework for examining motivationally supportive physical education experiences through satisfaction of three basic psychological needs of the individual: autonomy (choice), competence (success) and relatedness (belonging) (Deci and Ryan 2000; Hagger et al. 2003). Within the pedagogical framework of NLP, individual needs are recognised as constraints that need to be considered in learning design. This has led to claims that the CLA offers a viable alternative teaching approach that can effectively support students' self-determined and intrinsically motivated engagement in physical education by meeting all three basic psychological needs of the individual (Renshaw, Oldham, and Bawden 2012). As yet these claims have not been verified in empirical studies. To that end, Tan, Chow, and Davids (2012) have called for research to determine the motivational consequences of an alternative teaching approach informed by NLP. These claims were tested within the PhD programme of work by investigating the following research question:

vi. Does the adoption of the learning design and delivery of the CLA, informed by key pedagogical principles of NLP, result in the satisfaction of learners' basic psychological needs, resulting in enhanced self-reported levels of intrinsic motivation?

The findings of this study could present the CLA, informed by NLP, as a viable alternative pedagogy that effectively addresses the skill acquisition and psychological criticisms of the traditional approach, while supporting the development of skilled and intrinsically motivated physical education performers. The practical implications of these findings may provide physical education teachers and coaches with the evidence-based practical recommendations of how to develop functional pedagogical climates, which result in students exhibiting intrinsically motivated behaviours during learning. Physical education lessons that meet these basic psychological needs will produce more effort, enjoyment, interest and excitement in class, leading to greater task engagement, enhanced performance and persistence (Ryan and Deci 2000); surely the goal of all physical education teachers!

Thesis structure

This programme of work is presented as a 'Thesis by Published Papers', which together form a cohesive research narrative that articulates a significant and original contribution to knowledge in the discipline. The thesis includes a combination of chapters based on articles published in peer-reviewed journals (Chapters 3, 4, 6) and a manuscript in the final stages of preparation for submission

(Chapter 5). There is, therefore, a proportion of repetition throughout the thesis. This is necessary to allow the chapters to be read as standalone articles, and neatly demonstrate the contribution to the literature at each stage of the PhD programme. In such instances edits have been made to ensure language and formatting consistency throughout the thesis. The PhD programme was the result of an emergent process, where the development of study aims have flowed from a review of the relevant literature and the findings of the previous study. As a result, independent chapters link clearly back-to-back demonstrating this progression.

Chapter 2: Literature Review

Physical education curriculum aim of developing the 'intelligent performer'

Historically, physical education has maintained a place in the school curriculum for reasons physical rather than educational, such as military training, fitness for war, nationalism, social regulation and healthy lifestyle promotion (Kirk et al. 1996). Given the early militaristic nature of the physical education content and the desired behavioural outcomes of precision, control and conformity, the way the subject was taught reflected a dualist approach, viewing the mind and body as separate entities. That is, bodies were drilled in the gymnasium and minds were educated in the classrooms (Fowler 1975). The perceived absence of cognition within the physical education curriculum was problematic for practitioners with the status of the subject and their status as 'proper' teachers often questioned (Fowler 1975; McIntosh et al. 1986; Moy and Renshaw 2009). Consequently, in attempts to advocate for physical education and justify its educational value within the curriculum, Arnold (1988) proposed a model that positioned physical education as a medium involving cognitive processes including knowledge, understanding, and evaluation. From this perspective the goal of physical education was to progress students beyond the scope of mindlessly reproducing physical responses to the development of the 'intelligent performer' who has the ability to make strategic decisions in complex and dynamic situations (Kirk 1988; Kirk et al. 1996). It is interesting to speculate about the strategic inclusion of the word 'intelligent' rather than 'skilled', which to this author suggests an attempt to explicitly link physical education with cognition for a wider audience.

The development of physical education students as ‘intelligent performers’ and active decision makers has since become a central aim in Physical Education curriculum documents worldwide, including the United Kingdom, Unites States of America and Australia (Australian Curriculum, Assessment and Reporting Authority 2015; Byra 2006; Department for Education 2013; Metzler 2005; National Association for Sport and Physical Education 2009; Queensland Studies Authority 2010). For example, the Studies Authority in Queensland, Australia (2010, 3) states that:

> Intelligent performance is characterised by high levels of cognitive functioning, using both rational and creative thought. Students are decision makers engaged in the active construction of meaning through processing information related to their personal experience and to the study of physical activity.

This definition of intelligent performance has its roots in a cognitive perspective of motor control and learning, which has its origins in traditional cognitive psychology (Abernethy, Burgess-Limerick, and Parks 1994). This perspective ascribes intelligence or skill to mental processes controlled at a conscious level by the mind (brain), conceptualising skilled performers as active learners who engage in the processing of information in order to understand the learning environment and produce functional behavioural outputs (Anson, Elliott, and Davids 2005). A fundamental assumption of this cognitive perspective is the independence of the individual organism and the environment in which they act

(Turvey and Shaw 1979). A further assumption is that the physical body is independent and subservient to the conscious mind (Lombardo 1987). The consequences of this mind-body dualism or separation are, first, that some kind of symbolic representation of an intended movement like a schemata (Schmidt 1975) or mental action plan is necessary to allow the mind, body and environment to interact, and second, that movement is predominantly and centrally controlled within the brain and central nervous system, and minimal movement control is devolved to the body or musculo-skeletal system (Abernethy, Burgess-Limerick, and Parks 1994). This information processing model of motor control and learning within cognitive psychology, implicitly assumes that movement problems are firstly perceived, then processed, understood and solved by the mind or brain in a manner similar to a computer, which then controls the action or physical movement response (Abernethy, Burgess-Limerick and Parks 1994; Anson, Elliott, and Davids 2005). From a cognitive perspective a skilled performer is viewed as an individual who has acquired and stored in their memory increased amounts and complexity of movement representations as a result of practice. This stored, sophisticated knowledge allows them to make more accurate inferences for action from information perceived in the performance environment (Ericsson 2007; Schmidt and Lee 2006).

However, this primary focus on the internal conscious mental processes within the individual has neglected both the role of the environment and the subconscious control mechanisms of the body in the regulation of skilled performance (Araújo and Davids 2011; Dunwoody 2006; Gallwey 1979). In contrast to traditional cognitive psychology, the contemporary motor learning theory of ecological dynamics, which incorporates ecological psychology (explained in detail later in this section), assumes an organism-environment mutuality and reciprocity and rejects mind-body dualism (Araújo, Davids, and Hristovski 2006; Gibson 1979). Ecological dynamics views the skilled regulation of action distributed over the organism-environment system (Gibson 1979), that is, the mind (the brain), the body (musculo-skeletal system) and the environment as jointly and continuously influencing each other to shape functional emergent behaviours, such as thoughts, ideas, perceptions, and actions (Araújo, Davids, and Hristovski 2006; Lombardo 1987; Renshaw et al. 2010; Renshaw et al. 2015). From an ecological perspective, the physical and social environment, the physical and mental capacities of each individual, and the specific task demands, all continuously interact to shape the acquisition of skill (Warren 2006). As these environmental, individual and task constraints can alter every time an action is performed, skill is viewed as the emergent behavioral movement outcome that is adaptable to a range of varying performance contexts (Araújo and Davids 2011). Subsequently a 'skilled performer' is viewed as an adaptive individual who can accurately achieve task goals using individualised functional movement capabilities as these conditions change (Araújo and Davids 2011; Davids, Bennett and Newell, 2006). Adaptive skilled behaviour, rather than being imposed by a pre-existing structure, emerges from this confluence of constraints as learners seek individualised movement solutions to a specific performance problem through active exploration of a learning environment (Araújo and Davids 2011; Davids, Button and Bennett 2008; Davids et al. 2015; Gibson 1966). With experience of this active exploratory process, a skilled performer develops *knowledge of* the environment resulting in their perceptual systems become more ‘attuned’ to information useful for regulating action to achieve task goals in the scale of their body and action capabilities (Gibson 1966; Turvey and Shaw 1999). A key aspect of an ecological perspective is that adaptive skilled behaviours or individualised functional movement solutions emerge by learners perceiving to act and acting to perceive in a learning environment (Araújo and Davids 2011). Acting enables the learner to seek and directly perceive subsequent information in response to their action without the need for a mental representation of it, enhancing their knowledge and understanding of a learning environment (Davids and Araújo 2010; Davids et al. 2015). This information can then be utilised to regulate their individualised movement solution to a performance problem, that is, their action is the decision (Araújo and Davids 2011; Davids et al. 2015; Gibson 1966). In contrast, from a cognitive perspective, understanding and decision-making using the mind intervenes the processes of perception and action, resulting in decision making preceding acting (Araújo and Davids 2011; Renshaw et al. 2015). From an ecological perspective, actions are supported by perceptual information from the environment and, in turn, the perception of high quality information is acquired by acting.

There is evidence of a more ecological perspective of skill acquisition in recent physical education curriculum documents. For example, the Australian Curriculum: Health and Physical Education (Australian Curriculum, Assessment and Reporting Authority 2015, 16) aims to develop physical education students’ skills in ‘adapting and improvising their movements to respond to new, complex and challenging environments through participation in movement and physical activity contexts’.

According to Ovens and Smith (2006), skill is a complex phenomenon consisting of a number of inter-dependent components, inseparable from its context. They suggest that skill is characterised by technical competence (production of a movement pattern), performance outcome, perceptiveness of environment, appropriateness of tactics and strategy, and adaptability and/or creativity. To clarify, the skill of successfully passing in a game context extends beyond the act or technique of passing a ball to include the ability to read and interpret the play, such as detecting a wide opponent who is out of position, and appropriate tactical decision making in response, such as passing the ball wide to exploit this opportunity. In this case the technique is the movement pattern or tool produced to carry out the tactical solution.

Predominant physical education teaching approach

This desired aim of the development of the skilled performer is an important factor in determining how physical education should be taught. In worldwide studies the majority of physical education teachers self-report the predominant use of Mosston's 'reproductive' teaching styles over 'productive' styles (Cothran et al. 2005; Cothran and Kulinna 2008; Jaakkola and Watt 2011; Kulinna and Cothran 2003). Queensland teachers were included in the study by Cothran et al. (2005) and followed this trend, self-reporting the favoured use of Mosston's 'practice' reproductive teaching style over more productive styles (Mosston and Ashworth 2002). Reproductive and productive styles are the two clusters of teaching styles or approaches identified by Mosston's spectrum theory (Mosston 1966; Mosston and Ashworth 2002). Reproductive styles are 'teacher-centred' as pupils reproduce knowledge or skills demonstrated by the teacher using memory, such as the 'practice' style, which involves pupils individually practicing a memory/reproduction task while receiving individual performance-related feedback from the teacher. Productive styles are 'student-centred' as pupils produce knowledge or skills themselves through the process of discovery, such as the 'guided discovery' style, which involves the teacher using sequential questioning to lead pupils to discover a previously unknown predetermined response (Mosston and Ashworth 2002).

However, these results about teaching practice may have to be interpreted cautiously as self-reported use of teaching styles or approaches as an exclusive data collection method may be misleading and limited. Previous research has suggested that teachers may not be able to provide accurate descriptions of their own teaching behaviours (Good and Brophy 1997) and 'there are differences between what people say and what they do' (Lawson and Stroot 1993, 45). For example, is it possible that teachers report using the 'right' teaching approach because it aligns with the national curriculum goals, rather than what is actually their own practice? To strengthen findings it is important that research involves the collection of data using a variety of sources, such as direct observation of teaching, rather than exclusive self-reporting using surveys.

Congruent with this suggestion, in a local study of Queensland physical education teachers by SueSee and Edwards (2011), data were collected through direct observation of teaching rather than exclusively relying on self-reporting as in previous research (Cothran et al. 2005). The authors found that, despite the vast majority of physical education teachers self-reporting that they used a range of both reproductive and productive teaching styles, actual observations of teaching revealed that physical education teachers predominantly used reproductive styles, particularly the ‘practice’ style from Mosston’s Spectrum of Teaching Styles (1966). This reproductive ‘practice’ style is more commonly referred to in the literature as the traditional physical education teaching approach (Allison and Thorpe 1997; Hopper, Butler, and Storey 2009; Kirk 2010; Martens 2004; Metzler 2005).

Compatibility of the traditional teaching approach with development of the skilled performer

The traditional physical education teaching approach is characterised by: (i) conventional, highly structured teaching sequences which start with the introduction or demonstration of technique(s) or technical skill(s); (ii) students’ repetitive attempts to reproduce teacher-prescribed movement ‘templates’ in drills isolated from the competitive performance environment; (iii) the teacher providing regular, corrective verbal feedback; and (iv), a concluding game or performance activity where students endeavour to apply the technical skills learned (Allison and Thorpe 1997; Hopper, Butler, and Storey 2009; Martens 2004; Mosston and Ashworth 2002; Queensland Department of Education 1977). This de-contextualised approach, where technical skills are practiced in an environment significantly simpler and more controlled and predictable than the performance environment, is not compatible with the aim of developing more skilled physical education performers. This pedagogical climate, in which the teacher not the learner does the thinking and makes the majority of decisions, can restrict learners’ involvement to imitation and the reproduction of a prescribed movement skill template, rather than challenging them to independently seek functional solutions to movement problems (Renshaw and Clancy 2009). For example, successfully playing team games in physical education involves the skilled performer being challenged beyond mere template imitation to critically interpret the complex and less predictable game environment and for their individualised movement solutions to game problems to implicitly emerge without explicit instruction (Renshaw et al. 2010).

Traditional drills (i.e. repetitively practicing the same prescribed technical solution to the same problem in a controlled environment de-contextualised from the performance environment) have been criticised from a skill acquisition perspective because of the failure of technique or technical skill transfer from practice to the performance environment (Renshaw et al. 2009, 2010). This is because drills, such as dribbling around stationary markers, isolate the physical action or technical skill of dribbling from associated perception and decision-making (action), which function in tandem in the performance environment (Renshaw et al. 2009). For example, to skilfully dribble during a game of soccer/football a player needs to scan and interpret the play constantly looking for opportunities to dribble (perception), such as when two defenders leave a wide gap between themselves. The player then responds to this information through an action or a movement solution (decision), such as fast dribbling (technical skill) through the gap in the defence.

To effectively facilitate the transfer of technical skills from practice to the performance environment, practice should be representative, i.e. practice should include the key information present in the performance environment such as opponents and goals (Renshaw et al. 2009). The presence of opponents and goals enables the coupling of information (perception) and movement (action), allowing performers to learn to coordinate their movements in response to what they perceive (Renshaw et al. 2009, 2010; Renshaw, Davids, and Savelsbergh 2010; Williams and Hodges 2005). Representative practice such as a small-sided game allows technical skills to develop in tandem with associated perception and decision-making, which will facilitate transfer of technical skills from practice to the less predictable performance environment (Renshaw et al. 2009, 2010).

The historical context of the traditional physical education teaching approach

The evolution of the drill-based traditional physical education teaching approach can be understood in the context of the history of physical education in schools (Moy and Renshaw 2009). The earliest form of physical education in Australia and Britain was a military form of drilling (Kirk 1998). The efficacy of military practices in establishing order and discipline in large numbers of soldiers was adopted by school administrators as a control and disciplinary measure for the undisciplined working class masses in Britain's elementary state schools (Kirk 2003; Mangan 2003). As a result, the teaching approach adopted in physical education sessions of this period is typified by one teacher, typically an ex-army non commissioned officer, instructing a large group in a comparatively small area using a demonstration, then all children mindlessly following on command (Fowler 1975; Van Dalen and Bennett 1971). Drilling the body was entirely consistent with other school practices that adopted similar methods, such as the mechanistic recitation of times tables and the memorisation of spelling and grammar (Kirk 1998). The utilisation of monotonous, repetitive practice drills in physical education still appears to be viewed as being essential to ensure that children learn the necessary optimal technical skills before they can transfer these skills to the real game.

Compatibility of alternative student-centred teaching approaches with the development of the skilled performer

The incompatibility of the dominant teacher-centred traditional approach with the aim of developing skilled performers has highlighted the need for an evolution of physical education teaching practice. Student- centred approaches to teaching physical education offer a viable teaching alternative more compatible with the development of the skilled performer. Rather than the teacher emphasising the reproduction of technical skills in a highly structured environment, in student-centred approaches teachers are facilitators and students are challenged to critically interpret the practice environment and solve problems through exploration (Davids, Chow, and Shuttleworth 2005; Lee 2003; Richard and Wallian 2005). Student-centred approaches with their emphaisis on addressing individual needs are important for effective learning, as learners do not learn the same way and find the same movement solutions in the same learning environment (Chow et al. 2011, 2013)

The 'founding' student-centred games approach, Teaching Games for Understanding (TGfU) (Bunker and Thorpe 1982; Thorpe, Bunker, and Almond 1984), shifted the focus from the development of technical skills in isolated drills to a student-centred approach that linked tactics and technical skills in a game context. Many student-centred game-based pedagogies have derived from TGfU, such as an Australian variation, Game Sense (den Duyn 1996, 1997), a Singapore variation known as the Games Concept Approach (Tan et al. 2002) and the Tactical

Games Approach, which originated in the United States of America (Mitchell, Oslin, and Griffin 2012). However, although TGfU and its variations have been embraced by academics, research on the use of physical education teaching approaches indicates that the uptake of such student-centred approaches by physical education practitioners has been limited (Almond 2010; Cothran et al. 2005; Kirk 2010).

The perpetuation of the traditional physical education teaching approach

To start an evolution of teaching aproaches, it is important to understand why physical education teachers continue to utilise traditional teacher-centred methodologies at the expense of student-centred methodologies, more compatible with the development of the skilled performer. There is evidence that physical education teachers perceive more structured teacher-centred traditional lessons as a necessary behavioural management strategy (Cothran and Kulinna 2008; Curtner-Smith 2001). The traditional drill-based approach is seen by teachers as a very effective means of managing classes of children as students are all engaged in the same task and producing similar outcomes (Metzler 2000). In a study describing the teaching approaches employed by physical education teachers, Curtner-Smith (2001) speculated that difficult pupil behaviour is the main environmental factor influencing the choice of the traditional teaching approach. Using productive student-centred approaches that allow pupils prone to misbehaviour to explore the environment and make decisions in the teaching-learning process, maybe considered too risky particularly given the time constraints within which most physical education programmes must operate. According to Hoffman (1971, 57) the traditional teaching approach is a contingency shaped product of the 'unglamorous realities' of teaching a large physical education class of energetic, unruly students on a spacious oval in a short time period.

Many other reasons are thought to result in physical education teachers' use of the traditional teacher-centred approach such as: (i) the need to meet course requirements of exam syllabi and pressure in terms of general workload (Thorburn and Collins 2003); (ii) responding to their students' preferences for teacher-centred teaching approaches (Cothran, Kulinna, and Ward 2000); (iii) lacking experience with alternative student-centred approaches, impacting teachers' efficacy and consequently their use of these approaches (White 1998); (iv) believing that only they have the knowledge necessary for student learning to occur (Cothran and Kulinna 2008); and (v), aiming to reduce the attentional load on the learner through practicing technical skills independently of perception and decision-making (Kahneman 1973).

Occupational socialisation

Occupational socialisation theory has provided an insightful understanding of physical education teachers' continued use of the traditional teaching approach. Occupational socialisation is a theoretical framework that has guided researchers in understanding why teachers teach physical education as they do (Lawson 1983a, 1983b, 1986, 1988; Schempp and Graber 1992; Stroot 1993; Templin and Schempp 1989). Lawson (1986, 107) defined occupational socialisation as 'all kinds of socialisation that initially influence persons to enter the field of physical education and later are responsible for their perceptions and actions as teacher educators and teachers'. Three distinct types of socialisation are identified, acculturation or past physical education and sporting experience, professional socialisation or formal PETE, and organisational socialisation or the teacher's workplace, all of which are likely to shape physical education teachers' perspectives and their adopted pedagogical practices (Lawson 1983a, 1983b; Templin and Schempp 1989).

The socialisation process of acculturation is particularly relevant, as it appears to have a powerful influence on prospective physical education teachers' beliefs and values about the subject, and how it should be taught, well before they begin professional socialisation or formal PETE (Hutchinson 1993; Lave and Wenger 1991). Of prime importance in this socialisation process are prospective teachers' observations and interactions with physical education teachers, coaches and other significant individuals, while experiencing school life, physical education and sport. Lortie (1975, 61) termed this aspect of experience the 'apprenticeship of observation' (Curtner-Smith 1999; Dewar and Lawson 1984; Mawer 1996; Templin 1979). Lortie (1975, 39) proposed that, through the internalisation of many years of observing teachers in class, teacher recruits develop specific views of what constitutes good pedagogical practice and they enter teacher education programmes thinking that they hold a 'subjective warrant to teach'. That is, they believe that they already know what they need to be able to do in order to teach along with a self-evaluation of their abilities to meet those requirements. Compounding this view is the fact that many prospective physical education teachers have had extensive, enjoyable and successful backgrounds in physical education and sport prior to entering a course of study in PETE (Curtner-Smith and Sofo 2004; Doolittle, Dodds, and Placek 1993; Sofo and Curtner-Smith 2005; Wright, McNeill, and Butler 2004). These positive and affirming experiences and associations with coaches and teachers help guide an individual's decision to become a physical educator (Hutchinson 1993). Consequently, these recruits have a deeply engrained interest in a custodial approach to teaching, meaning that they strongly identify with the pedagogical approach they were exposed to by their physical education teachers, and subsequently anticipate teaching in a manner similar to how they were taught (Bain 1990; Curtner-Smith et al. 2008; Lawson 1983a; Lortie 1975).

According to Lortie (1975) and Lawson (1983a), these recruits' custodial beliefs are resistant to change and professional socialisation or formal PETE programmes have little effect on them, particularly if recruits are not challenged to critically examine these pre-entry beliefs during their professional training (Butler 2005; Curtner-Smith 2007; Doolittle, Dodds, and Placek 1993). Although not all recruits may possess this custodial orientation, this socialisation process clearly has the capacity to inhibit pre-service teachers (PTs) from adopting new teaching approaches in the profession, particularly when PETE programmes emphasise innovative approaches to teaching physical education that contradict what recruits learned during their acculturation (Richards, Templin and Graber 2014). Several studies have found that, despite being exposed to innovative practices during PETE, recruits revert to traditional methodologies to which they themselves were exposed when they begin teaching (See Stroot and Ko, 2006).

Organisational socialisation is also an influential factor likely to shape beginning physical education teachers' perspectives and the pedagogical practices they employ. Despite the impact of a progressive teacher education programme, practices and beliefs appropriated rarely manifest themselves in the beginning teacher’s classroom. This phenomenon described by Zeichner and Tabachnick (1981) as the ‘wash out effect’ is the period of time when school practices progressively erode the knowledge and perspectives gained during teacher education, resulting in beginning teachers’ adoption of more conservative and traditional behaviours and objectives congruent with the perceived norms of their workplace (Smyth 1995).

Acculturation and PETE students’ receptiveness to an alternative pedagogy

Although these key socio-cultural constraints on behaviour present a challenge, focusing on the next generation of teachers via a PETE programme is a good place to start an evolution of physical education teaching to encompass approaches that are more in line with the development of the skilled performer. According to Light (2002), pre service teacher education programmes offer a critical point in the professional development of teachers during which they might be encouraged to explore alternative teaching approaches. This idea was confirmed in a study involving Australian university graduates, who identified relevant, research-led teaching that introduced them to new, innovative concepts and ideas as important components of their university experience (Scott 2005). However, before introducing an innovative pedagogy, it is important that teacher educators have a better understanding of who their recruits are, and what their prior experiences and perspectives are about teaching, schooling, sport and physical education. This knowledge is important, since initial beliefs of teaching recruits influence their receptivity to messages received in teacher education (Cothran, Kulinna, and Ward 2000; Lawson 1983a; Pajares 1992).

Specifically, the level and type of sport played prior to entry into PETE appear to be important influences in determining teaching recruits' receptiveness to innovation. Lawson (1983a, 7) noted that 'sport has been identified as a carrier of conservative values', which led him to hypothesise that perspectives formulated during acculturation produced two types of recruits who entered professional socialisation with varied receptiveness to innovation (Lawson 1983a, 1983b). PETE recruits who attended schools with high quality physical education programmes, and had limited involvement and success in mainstream interschool sport, he suggested, would tend to be attracted to teaching physical education and not coaching. Many of them will possess an innovative orientation and are more likely to be inducted; that is, they internalise and adopt a belief in the perspectives and practices espoused by PETE faculty when their beliefs are challenged such as through the introduction of an alternative teaching approach (Dewar and Lawson 1984; Lawson 1983a; Richards and Templin 2011). Other PETE recruits, who had extensive involvement and success in mainstream interschool sport at schools in which sport performance was prioritised over physical education instruction, Lawson (1983a) suggested, would tend to be attracted to coaching not teaching. Additionally, he hypothesised that many of these recruits were likely to be extremely conservative in their orientation towards physical education, possessing a custodial orientation and were unlikely to be inducted, thus would seek to maintain the status quo of teaching methodologies. These orientations likely lie along a continuum from highly innovation oriented to highly custodial oriented (Richards et al. 2013; Richards, Templin and Graber 2014). According to Curtner-Smith (2009) when the individual and context, such as a PETE programme, share the same orientation, perspectives align and there is less conflict. However, when the context and individual share differing orientations, as would be the case when an individual with a custodial orientation enters an innovatively oriented PETE programme, the transition can be challenging and individuals resist socialisation efforts.

Lawson's hypothesis has been supported by research conducted on 17 PTs by Sofo and Curtner-Smith (2005, 2010), and two PTs by Stran and Curtner-Smith (2009b) who found that PTs' acculturation mediated their receptiveness towards an alternative pedagogy model presented during teacher education. Specifically they found that PTs with an innovative orientation changed their beliefs much more easily about teaching physical education during PETE than those with a custodial orientation. However, they found that it was still possible for PETE to induct a PT with a weak or moderate custodial orientation, but those with strong custodial orientations remained more resistant. Contradicting these results, Curtner-Smith (1997a, 1997b, 1998) found that it was possible to partially induct PETE students, who entered programmes with strong custodial orientations. However, as each of these studies by Curtner-Smith involved only two PTs, conclusions about the influence of PETE programmes on PTs need to be made with caution and generalisations cannot be made.

There is a need for researchers to further study the significance of prospective physical educators' biographies on their receptiveness to alternative PETE pedagogies. These findings could have important implications for PETE design, helping teacher educators to recognise and understand potential differences in the receptiveness of PTs to new pedagogical approaches shaped by past physical education and sporting experiences.

Overcoming the powerful influence of acculturation

Previous studies have reported successfully overcoming the powerful influence of acculturation resulting in PETE students' receptiveness to an alternative physical education teaching approach (Gurvitch et al. 2008; Li and Cruz 2008; Wang and Ha 2012; Wright, McNeill, and Fry 2009). Exploring the features and student experiences of PETE programmes that overcome acculturation and make this receptiveness to an alternative pedagogy possible is an important next step (Light and Tan 2006; McMahon and MacPhail 2007; Philpot and Smith 2011; Sofo and Curtner-Smith 2005). To date, some research studies have explored PETE students' experiences of TGfU and reported various reasons for its appeal. Most notably was the capacity of TGfU to physically and cognitively engage students of varying skill levels in games, and the associated affective benefits such as the feeling of achievement when making correct tactical decisions as well as the social and emotional benefits from working in a team environment (Gubacs-Collins 2007; Li and Cruz 2008; Light and Butler 2005; Wang and Ha 2009, 2013a).

To build on these findings, it is important to investigate how PETE students' acculturation shaped their reasons for receptiveness to an alternative teaching approach. However, very limited information has been reported in these previous PETE studies about students' past personal physical education and sporting experiences to allow any link to be explored. A series of studies by Light (2002) and Light and Georgakis (2005, 2007) has explored how Australian generalist primary teacher education students’ acculturation shaped their reasons for receptiveness to Game Sense (den Duyn 1997). The majority of participants in these studies were females who reported memories of experiences of marginalisation, exclusion, humiliation and failure due to their low skill level and an emphasis on skill mastery and competition in their traditional physical education classes. The modified games associated with Game Sense strongly appealed to the study participants. This is because the reduced technical skill demands of these modified games were perceived to successfully address PTs’ negative physical education experiences, encouraging more competent and equitable participation by engaging students of varying skill levels in games. These studies have provided strong evidence to suggest how PTs’ receptiveness to an alternative teaching approach might be shaped by past negative personal physical education experiences. However, a key limitation of these studies from a physical education perspective is that their focus was on female generalist primary teacher education students who had largely negative personal traditional physical education experiences. Specialist PETE students have reportedly had contrasting positive and successful backgrounds in physical education and sport (Doolittle, Dodds, and Placek 1993; Sofo and Curtner- Smith 2005; Wright, McNeill, and Butler 2004). Further research is, therefore, necessary to explore how specialist PETE recruits’ acculturation can shape their receptiveness or otherwise to an alternative teaching approach. In particular, work is needed on the perception of samples of PETE recruits identified in the literature as very resistant to change, that is those with a strong custodial teaching orientation who are high-achieving sporting products of this custodial culture (Lawson 1983a). These findings could have important implications for guiding PETE programme development to help improve the effectiveness and impact of teacher education.

Changing conceptions of the teaching-learning process

The popularity of student-centred physical education teaching approaches over teacher-centred approaches has prompted research to focus on questions about the changing conceptions of the teaching and learning process, that is, from how 'we' teach to how 'they' learn (Thorpe 2005a). Undoubtedly, a contemporary theoretical model of the teaching and learning process should underpin learning design and the delivery of instruction and feedback adopted in physical education (Davids et al. 2015).

Three categories encompass the basics of educational learning theories: behaviourism; cognitivism; and constructivism. Behaviourism views learning as simplistic and linear, believing that learning is a change in behavior or a response to a direct change in the environment or stimulus (Light 2008). Cognitivism theories view the mind, exemplified as the thinking processes which result in learning, as the critical aspect upon which to formulate a theory of learning (Eggen and Kauchak 2006). Constructivism takes on board the input from both behaviourist and cognitivist theories and stresses the interaction between these influences. From a constructivist perspective, learning occurs through active engagement with the environment and the processing and interpreting or constructing of knowledge to create an understanding of the experience in the mind. Constructivism views knowledge as being actively constructed from prior knowledge, rather than being transferred from an expert to a learner in a ready-made format (Hinshaw, Burden, and Shriner 2012). Constructivism is a collective term for two types of constructivist learning theory – social constructivism and cognitive constructivism (Stolz and Pill 2014). Light (2008) argues that the term 'complex learning theory' is better suited to describe the continuous, dynamic and complex forms of constructivism.

The most popular student-centred games approach, TGfU (Bunker and Thorpe 1982; Thorpe, Bunker, and Almond 1984), was designed for physical education teachers as a practical approach aimed at improving the learning experiences of children (Bunker 2012; Thorpe 2015). The TGfU model uses four pedagogical principles, sampling, modification-representation, modification-exaggeration and tactical complexity, to provide a framework to guide teachers in TGfU game design (Thorpe and Bunker 1989). This model contains embedded assumptions about learning, but was not explicitly underpinned by a theoretically-based pedagogical framework to empirically support the design of learning environments (Chow et al. 2007; Kirk and MacPhail 2002; Thorpe 2015). Rather it was originally developed with teachers' practical needs in mind (Renshaw et al. 2015; Thorpe 2015). Subsequently, advocates for TGfU have proposed a variety of theoretical frameworks to retrospectively explain how learning might occur when adopting this approach in practice (Kirk and Macdonald 1998; Kirk and MacPhail 2002; Stolz and Pill 2014; Rovegno and Dolly 2006; Storey and Butler 2013).

Over the past two decades, both constructivist theories of learning, cognitive and social constructivism, have been proposed in the physical education and coaching literature to explain how learning occurs in game-centered approaches such as TGfU. Cognitive constructivism or, from a motor learning perspective, cognitive psychology, conceptualises students as active learners who individually construct knowledge and understanding (or cognition) controlled at a conscious level using the mind while engaging with the environment (Eggen and Kauchak 2006; Griffin, Brooker, and Patton 2005). Cognitive constructivism views knowledge as mental models or schemas created and refined through individual experience (Eggen and Kauchak, 2006). To develop tactical awareness and game playing ability in team games the assumption is that the learner thinks then acts, that is, mentally processes information in order to explicitly 'understand' and interpret the learning environment before producing functional behavioural outputs (Abernethy, Burgess-Limerick, and Parks 1994; Anson, Elliott, and Davids 2005; Stolz and Pill 2014; Wiggins 1998). The TGfU model proposes that game understanding and problem-solving ability is acquired through a student's conscious, cognitive reflective responses to teacher guided questioning, during and after participation in a modified game (see Butler 2014; Griffin, Brooker, and Patton 2005; Richard and Godbout 2000).

Social constructivism has been proposed in the physical education and coaching literature to explain the central role that social interaction plays in learning in game-centered approaches such as TGfU (see Kirk and MacPhail 2002; Light 2002). Unlike cognitive constructivism, social constructivism sees cognition occurring beyond the body of the individual learner (Vygotsky 1978). The biological body is seen as being more than just a structure through which we learn, instead the body itself is seen to learn (Light 2008). According to social constructivism, learning or cognition occurs in game-centered approaches in physical education through social interactions and dialogue between the teacher and students or between students (Light 2008; Light and Fawns 2003). During game activities students regularly stop and reflect to collaboratively develop strategies to solve tactical problems presented by the game through group discussions and focused teacher questioning (Griffin, Brooker, and Patton 2005; Light and Fawns 2003; Light and Georgakis 2005). The implicit assumption from this constructivist perspective is that the learner's games playing ability or performance could be enhanced by acquiring a greater cognitive processing capacity in the form of 'understanding' of games (Renshaw et al. 2015).

As well as recognising the cognitive aspects of learning, a major emphasis of constructivist theory is the recognition that cognition (knowing) cannot be separated from context (doing). Situated cognition is a theory that argues that all knowledge is situated in activity bound to social, cultural and physical contexts (Schunk 1996). The 'enactivism' of Varela and colleagues (1991) arises from the linking of cognitive science with human experience. Such approaches strive to capture the nature of learning and the central role that human experience plays in it (Light 2008). Lave and Wenger (1991) developed the notion of 'situated learning' as a means of understanding the ways in which we learn in day-to-day life through participation in the practices of particular communities. For example, children in Australian beach communities typically learn to surf without formally learning the basic techniques before entering the ocean. They learn to surf by engaging in practice that simultaneously involves the drawing on what they already know, and then, the engagement of their bodies and minds in experimenting and adapting in relation to a dynamic and unpredictable physical environment (Light 2008).

Regardless of these largely retro-fitted rationales, many contemporary motor learning researchers have continued to express concerns about the ability of these cognitive theoretical frameworks to examine the efficacy of TGfU (e.g. Chow et al. 2007; Davids et al. 2005; Stolz and Pill 2014; Tan, Chow, and Davids 2012).

The constraints-led approach

The Constraints-led Approach (CLA) has been proposed as a viable, alternative physical education teaching approach underpinned by a theoretical model of the teaching and learning process, and able to facilitate the development of skilled, adaptive physical education performers. (Chow et al. 2016; Davids, Chow, and Shuttleworth 2005; Renshaw et al. 2010). In contrast to TGfU's development as an operational model by 'practitioners for practitioners' (Butler 2012, p 467), the CLA's learning design and delivery of instruction and feedback is grounded in contemporary advancements in motor learning research (Chow et. al. 2007; Davids, Button, and Bennett 2008; Renshaw et al. 2015), a link perceived as neglected in physical education research (Abernethy 1999; Renshaw et al. 2010). The essential distinguishing feature of the CLA from student-centred approaches is that its learning design and delivery is informed by the theoretical pedagogical framework of a nonlinear pedagogy (NLP), which provides a sound theoretical model of the learner and of the processes of learning, based on the contemporary motor learning theory of ecological dynamics (Chow et al. 2009, 2011; Renshaw et al. 2009, 2015). Recently, the motor learning theory of ecological dynamics within a nonlinear pedagogy (NLP), has been proposed as a strong contender to provide an appropriate theoretical framework to support learning design in pedagogical approaches like TGfU (see Stolz and Pill 2014; Chow et al. 2016; Tan, Chow, and Davids 2012). Previously more broadly aligned with applications to games and other physical activities by sport and human movement scientists rather than physical education teachers, the CLA has similar operational principles in practice to TGfU. Both approaches challenge learners to solve common tactical problems through active exploration in representative practice environments modified to regulate skill level and to emphasise particular aspects of performance (Bunker and Thorpe 1982; Thorpe, Bunker, and Almond 1984; Renshaw et al. 2009). However, unlike TGfU, the CLA is an interdisciplinary methodology that has been successfully applied beyond the tactical focus of games to performance activities such as long jumping (Greenwood, Davids, and Renshaw 2014), swimming (Seifert et al. 2014) and spring-board diving (Barris, Farrow, and Davids 2014), where constraints manipulation such as modifying task conditions or the physical environment, has been used to encourage exploratory behaviours of athletes in overcoming common technical errors. This interdisciplinary application makes it an attractive alternative physical education pedagogy.

Ecological dynamics

The motor learning theory of ecological dynamics is an integration of ecological psychology and dynamical systems theory and provides the theoretical principles for a NLP (Chow et al. 2009, 2011; Renshaw et al. 2009). Ecological dynamics views the acquisition of skilled behaviour as an emergent property of an individual's complex, nonlinear neurobiological systems, predicated on continuous information-based interactions between the individual and their specific performance environment (Davids et al. 2012). This dynamic individual-environment interactive process leads to the coupling of key information sources from the performance environment to goal directed movements as each individual continuously adapts and changes their organisational states in response to changes in their performance environment (Chow et al. 2016).

Ecological psychology proposes that the behaviours of individuals cannot be understood without reference to their specific environments, thus the information present in a learning task, such as opponents, playing surfaces, and goals is critical for helping learners to regulate ongoing actions (Araújo et al. 2004; Chow et al. 2011; Gibson 1986). In comparison, traditional approaches have focussed primarily on the processes and structures within organisms to understand behaviour, described as an organismic asymmetry (Davids and Araújo 2010). Describing behaviour from the individual-environment scale takes into account how perceptions, actions, intentions and cognitions emerge under the constraints of information shared between the individual and environment (Seifert and Davids 2012). This assumption has implications for physical education teachers and highlights the need to ensure congruence of practice environments with dynamic performance environments (Davids et al. 2007).

Dynamical systems theory, based on a model of the learner as a complex, nonlinear, adaptive system, can be used to explain the important dynamic of individual learner-environment interactions at a micro level (Davids et al. 2015). From a dynamical systems theory perspective, human behaviours are emergent properties of complex neurobiological systems that continuously adapt and change their organisational states by exploiting inherent, spontaneous self-organisation processes while seeking stable movement patterns as solutions to performance problems (Chow et al. 2013). This process is regulated by the continuous, dynamic interactions of each performer's unique individual constraints, and those of the task and performance environment, which creates instability in the learner who self-organises from within facilitating the emergence of functional movement patterns (Newell 1986, 1996; Newell, Liu, and Mayer-Kress 2008; Renshaw et al. 2010; Tan, Chow, and Davids 2012).

Constraints are defined as boundaries that shape each learner's emergent behaviours by limiting the number of available actions (Davids et al. 2003; Davids, Chow, and Shuttleworth 2005; Newell 1986). Performer or individual constraints refer to the specific physical, physiological and psychological characteristics of learners, such as height, physical fitness, and motivation levels. Environmental constraints refer to physical, social and cultural factors surrounding the performer, such as practice surface, the teacher or coach, and availability of facilities. The goals and rules of the activity, scoring systems, equipment and field dimensions are examples of task constraints (Newell 1986).

The key role of physical educators is not to simply allow 'freedom of play' during lessons, but rather to carefully manipulate task constraints to guide learners in adapting their movements to solve movement challenges (Tan, Chow, and Davids 2012). To illustrate how the interaction of constraints shape emergent behaviour, a learner's unique running technique can be allowed to emerge as a function of the continuous, dynamic interactions of their unique individual constraints (e.g. body weight), the task constraints (e.g. running distance) and environmental constraints (e.g. hilly terrain) imposed on him or her (Figure 2.1).

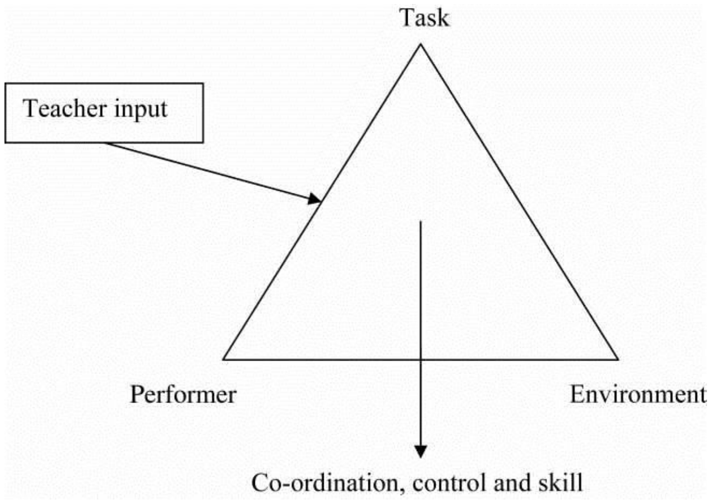

Figure 2.1. The emergence of movement behavior from the interaction of key performer, environmental, and task constraints on the learner (adapted from Newell 1986).

In contrast to a constructivist perspective that constructing understanding in the mind is central to improving sports performance, the CLA emphasizes performance improvement through the quality of the individual-environment relationship (Renshaw et al. 2015; Araújo and Davids 2010). Over time an individual's relationship to specific environmental properties can become more functional, allowing the achievement of task goals, fluently, accurately and energy efficiently.

NLP and implications for structuring learning design

Informing the learning design and delivery of instruction and feedback by a contemporary framework of motor learning is critical in influencing the learning of movement skills (Chow et al. 2013; Davids, Button, and Bennett 2008). There is increasing evidence that motor learning is not a linear process due to the differences between individual learners and the dynamic and complex interactions present in learning environments (Chow et al. 2011, 2013). Sudden progressions and regressions in performance level accompanied by periods of an absence of change are typically observed during the learning of motor skills, suggesting that learners behave like nonlinear systems (Liu, Newell, and Mayer-Kress, 2006). To acknowledge that learners behave like nonlinear, complex neurobiological systems is the platform for a physical education teaching approach, such as the CLA, whose learning design and delivery of instruction and feedback is informed by the theoretical pedagogical framework of a NLP that addresses the needs of such nonlinearity (Chow et al. 2013). To understand the learner as a complex neurobiological system, Chow et al. (2011, 2013) highlighted the key differences that describe nonlinear and linear systems (see Table 2.1). These key nonlinear features have implications for learning design and delivery.

The CLA approach to learning design adopts these key learning processes espoused within NLP to enhance learning by empowering learners to subconsciously and actively engage with the learning environment to explore, discover and allow potential individualised movement solutions to emerge (Chow et al. 2006, 2007, 2011; Davids, Chow, and Shuttleworth 2005). This rigorous learning design follows a structure that incorporates the careful manipulation of representative practice environments using task constraints that channel learners' search within a narrower area (limited number of movement solutions) of the modified practice environment towards 'selected' and more 'obvious' functional movement solutions (the 'to-be-taught' concept) (Chow 2013). Theory and evidence has strongly indicated how functional behaviours can emerge from learners as they seek individualised solutions to a specific performance problem by 'acting' in a learning environment. Thus, learners need to be allowed to actively search, discover and exploit in order to enhance their ‘knowledge of’ (and therefore understanding of) a learning or performance environment (Davids and Araújo 2010; Davids et al. 2015; Gibson 1966). The key point is that if we let it, the body (musculo-skeletal system) will solve problems exploiting subconscious control mechanisms (Bernstein 1967; Davids, Button, and Bennett 2008).

Table 2.1. Key differences between linear and nonlinear systems (adapted from Chow et al., 2011, 2013)

Nonlinear	**Linear**
• Non-proportional change (minute changes to practice task constraints may lead to non-proportional changes to performance)	• Proportionate change (minute changes to practice task constraints leads to a proportionate change in performance)
• Multi-stability (single cause may have multiple behavioural effects; learner can utilise different movement solutions to achieve the same outcome)	• Mono-stable (a single cause will result in a single behavioural effect)
• Parametric control (by altering factors external to individual, physical educators can guide learners to explore various functional organisational states within the system)	• Centralised control – alter factors within the individual.
• Functional role of variability (noise) (Variability in practice can encourage the learning system to explore multiple solutions possibilities for a task goal)	• Variability (noise) is undesirable

NLP pedagogical principles

Based on the theoretical framework of ecological dynamics, proponents of NLP have identified pedagogical principles to effectively channel learning design and delivery of instruction and feedback for coaches, performance analysts, movement practitioners and physical education teachers (Chow 2013; Davids 2012; Renshaw et al. 2009). The key pedagogical principles of NLP are (see Figure 2.2): self-organisation under constraint manipulation, representative practice design, attunement to affordances, information-movement or perception-action couplings, task simplification, harnessing functional adaptive variability in practice, and implicit learning aligned with feedback and instruction focusing on external movement outcomes of an action (Chow 2013; Chow et al. 2016; Davids, Button, and Bennett 2008; Renshaw et al. 2009).

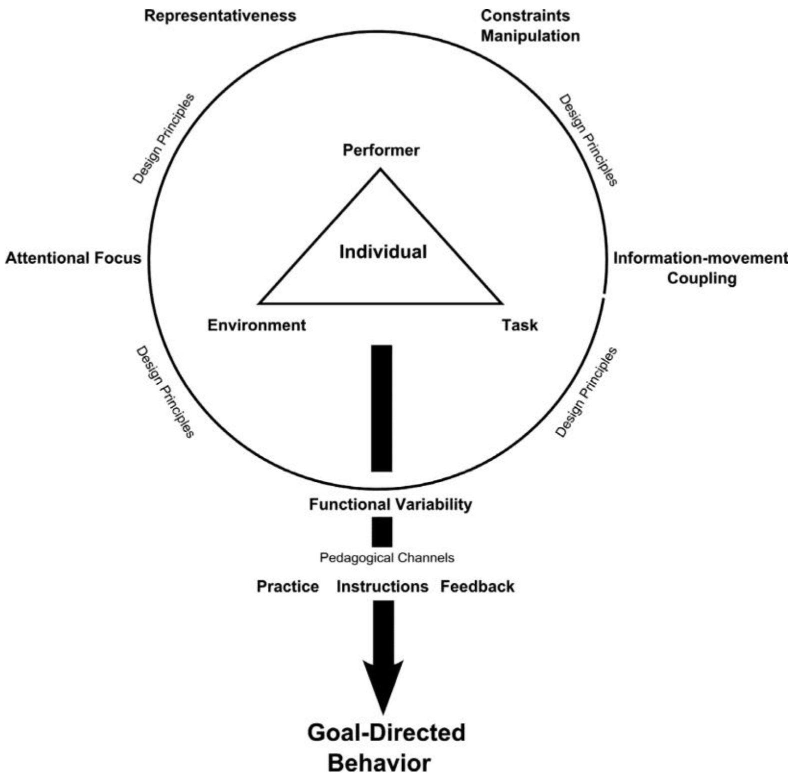

Figure 2.2. Nonlinear pedagogy and its key pedagogical principles. The CLA is embedded within the model. (Chow 2013).

The NLP pedagogical principle of self-organisation under constraint manipulation challenges the misconception that there is one common optimal movement solution for a task towards which all learners should aspire. This principle is predicated on the inherent adaptive movement variability and degeneracy of human movement systems, that is, learners have the capacity to self-organise in many different ways to develop a variety of coordination patterns to achieve the same outcome or task goal (Davids, Button, and Bennett 2008; Lee et al. 2014). To exemplify, a learner's kicking technique can be allowed to emerge as a function of the continuous, dynamic interactions of their unique individual personal constraints (e.g. leg strength), the task constraints (e.g. game rules) and environmental constraints (e.g. playing surface) imposed on him/her.

A key concept underpinning ecological psychology is the mutual interdependence of an individual's actions and their perceived environment (Gibson 1986). Learning takes place as a consequence of these interactions between the learner and the environment (Chow 2013). The implication of this concept for physical educators is the need to design practice environments that are representative of the performance environment containing key information sources such as, for example, in team games, location of defenders and attackers, goals and field markings (Pinder et al. 2011; Silva et al. 2014; Vilar et al. 2014). Representative practice task designs allow learners to perceive and detect affordances for action (i.e. information in the environment that supports an opportunity for action relative to an individual's action capabilities such as a narrow gap between defenders for a player with speed to run through, see Fajen, Riley, and Turvey 2009). The detection and learning of affordances is not an automatic process, thus performance environments need to be carefully replicated during practice so that individuals can engage in exploratory behaviour and learn to detect this key information (Renshaw et al. 2009). The more representative a practice task is, the more specific is transfer to a performance environment (Davids et al. 2015).

In ecological psychology the theory of direct perception signifies how the perception and action systems in individuals can become tightly coupled (Gibson, 1979). Gibson's theory of direct perception (1979) suggests how information drives movements, but also how movements influence what information can be picked up by performers or learners. The principle of perception-action coupling has meaningful implications for the design of physical education practice tasks, which should aim to keep specifying information sources and actions together (Renshaw et al. 2009). This type of practice will enable performers to learn to attune or coordinate their movements to these key information sources, thus establishing functional perception-action couplings, which they can use to achieve different task goals (Renshaw, Davids, and Savelsbergh 2010). For example, a cricket batter should face a bowler in practice rather than a bowling machine. This is because, unlike a bowling machine, facing a bowler affords the opportunity for a batter to pick up specifying information from the bowler's actions upon which to coordinate their movements, a key component of expert batting performance (Müller, Abernethy, and Farrow, 2006; Pinder, Renshaw, and Davids 2009; Renshaw et al. 2007).

Allied with representative practice design is task simplification, that is, preserving the coupling of actions to key information sources but simplifying the task (Renshaw et al. 2009). For example, allowing learners to practise the sub-components of the complex hurdling coordination pattern together, that is, lead leg and trail leg in tandem with upper body movements, in a representative practice task of running over flights of hurdles simplified by manipulating the task constraints of hurdle height (lowered) and hurdle interval (decreased). Task simplification allows learners to practice 'whole' coordinated movement patterns at a level of complexity that matches their individual characteristics and action capabilities. Task simplification differs considerably from task decomposition, which is a default way of structuring learning environments. The decomposed practice of isolated components of the whole task (e.g. hurdle trail leg practice) separates the relevant information-movement couplings, leading to the re-organisation of the timing and coordination of a movement pattern (Handford 2006; Renshaw et al. 2007; Renshaw, Davids, and Savelsbergh 2010; Williams and Hodges 2005). This can present a challenge for learners to successfully transfer isolated movement patterns from decomposed practice drills to the performance of the 'whole' coordinated movement pattern in the competitive environment.

The variability and less predictability within sporting performance environments supports the efficacy of performers developing functionally variable movement patterns. For example, during competition a long jumper may need to make adjustments to their run up in response to fatigue, running surface and weather conditions (Renshaw et al. 2009). The implication for NLP learning design is that the coach or teacher might seek to replicate the dynamics of a performance environment by incorporating functional variability in practice. For example, a teacher or coach may vary the length of the long jumper's run up in practice to enable them to learn to adjust their step patterns to hit the take-off board under varying conditions. This would encourage learners to explore multiple individualised functional coordination patterns to cope with subtle changes in the performance environment (Bernstein 1967; Chow and Atencio 2014; Renshaw et al. 2009). This will result in participants becoming more adaptable and flexible performers with greater levels of functional variability within their movement patterns (Barris, Farrow, and Davids 2014; Davids et al. 2007; Seifert and Davids 2012).

Within the NLP pedagogical framework, learning takes place implicitly through natural subconscious exploratory processes with feedback self-generated (Beek 2000; Chow et al. 2009). To illustrate this point, consider how gymnastics teachers might use equipment to shape the learning of a cartwheel. A common error in performing the cartwheel is for the gymnast to 'pike' or bend at the hips, thus the performer fails to keep a straight-line shape during rotation. A common traditional approach to solve this problem is to point out the error and use verbal instructions or feedback to correct it, such as 'keep your feet in line with your shoulders'. A constraint-based approach to correct the error would be to use two crash mats placed vertically in parallel, requiring the gymnast to cartwheel between them without touching either surface. Performers can gain feedback from the legs touching the mats. As they become better at keeping the straight-line body position, the mats are brought closer together (Renshaw et al. 2009).

To complement exploratory self-organising processes, CLA methods of instruction largely direct learners' focus of attention on external movement outcomes of an action (i.e. run in a straight line; or use of an analogy such as ball flight like the shape of a rainbow) rather than on an internal focus on control of body movements or limb segments (i.e. slight forward rotation of the hip) involved in (re)producing an action (Chow et al. 2009; Peh, Chow, and Davids 2011). Typically movements are not controlled at a conscious level and instruction with an internal focus on the body directs learners to more conscious control of movement, interfering with automatic control mechanisms that regulate movements of the body subconsciously (Bernstein 1967; Davids, Button, and Bennett, 2008). A focus on the external movement outcome of an action compliments learner exploration and promotes a more automatic mode of control resulting in a positive effect on learning and performance (Peh, Chow, and Davids 2011; Wulf and Su 2007). Recent studies have consistently demonstrated that instructions or feedback that induce an external focus by directing performers' attention to the effects of their movements, rather than an internal focus on their body movements, result in more effective motor performance and learning of a variety of different skills in learners of differing levels of expertise (for reviews, see Lohse, Wulf, and Lewthwaite 2012; Wulf 2007, 2012; Wulf and Lewthwaite 2010). For example, studies have demonstrated performance or learning advantages of an external focus for discrete sports skills, including hitting golf balls (Wulf and Su 2007), basketball free-throw shooting (Al-Abood et al. 2002), long jump (Porter, Wu, and Partridge 2010), swimming (Freudenheim et al. 2010), and volleyball serves and soccer kicks (Wulf et al. 2002). However, it should be noted that many of the previous findings on the impact of different attentional focus of attention instructions have greater relevance to skilled participants for various movement tasks as early efforts by beginners in sport are said to be based on conscious control processes (Chow 2013; Masters and Maxwell 2004). By using these instructional approaches teachers might be going 'back to the future' and promoting natural implicit learning by creating environments that typify the exploratory behaviour of young children who learn to crawl, walk and run without recourse to verbal instruction (see Laurentino 2008).

Adopting NLP pedagogical principles in practice

There is some theoretically-informed research evidence to demonstrate that adopting these NLP pedagogical principles in practice effectively meets the skill acquisition needs of the individual performer (Chow 2013; Chow et al. 2007; Renshaw et al. 2010; Tan, Chow, and Davids 2012). This theoretical grounding has been supported by many empirical studies that have demonstrated performance improvement in athletes in an elite sports coaching setting (Barris, Farrow and Davids, 2014; Greenwood, Davids, and Renshaw 2014; Pinder, Davids, and Renshaw 2012; Seifert et al. 2014). However, there needs to be more practical empirical research that investigates the application of the NLP principles with physical education students in a school setting. According to Chow (2013) the CLA offers some potential for enhancing teacher education in the 21st century and more research is needed to identify the challenges and practical implications facing practitioners when implementing a physical education teaching approach informed by NLP in a school context

Unlike a 'linear' informed traditional approach where the teacher is in control of a learning environment that produces a single predetermined and predictable learning outcome (Tinning and Rossi 2013), the emergence of multiple learning outcomes that are not predetermined and are difficult to predict are hallmarks of the complex nature of learning within a nonlinear informed approach (Chow et al.

2013; Davids, Button, and Bennett 2008). These less predictable learning outcomes that emerge as a consequence of the dynamic individual learner-environment interactions within a NLP informed teaching approach are thought to present significant challenges to novice practitioners (Chow 2013). To successfully teach using an emergent NLP informed teaching approach, such as the CLA, previous research has suggested that it is necessary to have a clear understanding of the learning process, and advanced observational and analytical skills (Butler 2014; Chow 2013; Hopper, Butler, and Storey 2009; Howarth 2005). According to Howarth (2005) these skills are unlikely to be found in novice teachers, such as PETE students.

To date, there is very little practical empirical research that identifies and investigates the challenges facing physical education practitioners when implementing the CLA. It is important that future research explores PETE students' experiences associated with the less predictable and complex nature of student learning when implementing a NLP informed teaching approach, specifically the CLA, in a school setting. The practical implications of these findings would further build on the knowledge and understanding of the CLA and subsequently inform and improve the design and delivery of PETE programmes in preparing and supporting students to effectively implement a NLP informed teaching approach on practicum and in their future teaching careers. This has the potential to result in opportunities for enhanced student learning and performance of motor skills in physical education classes.

Overcoming implementation challenges facing PETE students

Previous research indicates the school practicum is not a good place for novice PTs to experiment with innovative teaching approaches because of resistant conservative cultures of schools and many other contextual factors (Howarth 2005; Lawson 1983a, 1983b; Tinning et al. 2001; Zeichner and Tabachnik 1981). To overcome these barriers and facilitate PETE students' successful and authentic implementation of an alternative pedagogy previous research has proposed recommendations to create a contextually supportive and simplified teaching environment (Brooker at al. 2000; Gurvitch et al. 2008; Hastie and Curtner-Smith 2006; Howarth 2005; Li and Cruz 2008; Light 2004; Light and Butler 2005; McNeill et al. 2004; Rossi et al. 2007; Wang and Ha 2009, 2012, 2013a, 2013b; Wright et al. 2006; Wright, McNeill, and Fry 2009). To achieve this the practicum placement site should possess a culture that encourages innovative practice, providing PTs with guidance and support. Additionally, adequate space, sporting equipment and lesson time should be provided. The class sizes should be small and consist of well-behaved pupils, who are generally well skilled and experienced in a variety of sports. To further facilitate the successful implementation of an alternative pedagogy PTs should be allocated a familiar sport in which they have successful and extensive playing experience and an assumed depth of game content, and tactical knowledge and understanding.

Motivation and physical education

Further highlighting the need for an evolution of physical education teaching practice is the criticism of the traditional approach for failing to effectively provide learners with motivationally supportive experiences to engage in physical education. Emphasising the mastery of specific techniques in repetitive, monotonous drills and competitive games sets significant motivational problems for less gifted and confident individuals. Such a pedagogical climate has been shown to enhance boredom, humiliation, marginalisation, passive participation in class and disengagement (Bunker and Thorpe 1982; Carlson 1995; Ennis 1999; Light and Georgakis 2005; Mitchell, Oslin, and Griffin 2006; Ntoumanis et al. 2004; Smith and Parr 2007). Empirical evidence in physical education research has associated the intrinsically motivated student with higher levels of active engagement (Ntoumanis 2001), increased levels of learning (Chen 2001; Hagger et al. 2003; Tjeerdsma-Blankenship 2008), enhanced concentration and effort (Standage, Duda, and Ntoumanis 2003), continued participation in physical activity (Ntoumanis 2005) and positive cognitive, psychomotor and social experiences (Vallerand 2001). It is, therefore, reasonable to suggest that providing motivationally supportive physical education experiences for students is crucial to their continued engagement and participation, and a number of theoretical frameworks exist for addressing this issue.

Self-determination theory

Self-determination theory (SDT) provides a valuable framework for examining motivationally supportive physical education experiences (Hagger et al. 2003). Motivation is defined as the desire to improve oneself by engaging in behaviours that an individual deems important towards his/her development (Deci and Ryan 2000). According to SDT, motivation can be ordered along a continuum corresponding to the degree to which an individual's behaviour is self-motivated and self-determined. The continuum ranges from a complete absence of motivation to engage in a specific setting (i.e. amotivation), through to engagement in activities to attain some means such as an external reward, social recognition or avoidance of punishment, resulting in regulation that is controlling (i.e. non-self-determined extrinsic motivation) to activities that are personally valued and internalised, resulting in identified and integrated regulation that is non-controlling (i.e. self-determined extrinsic motivation). Finally, the most self-determined behaviour is engagement in activities for inherent enjoyment, pleasure and interest rather than achievement of outcomes (i.e. intrinsic motivation). One key principle of SDT is that individuals are more likely to continually engage in behaviours for which they feel intrinsically motivated rather than feeling compelled externally to do so (Deci and Ryan 2000).

According to SDT, the mechanism through which individuals move toward more self-determined and intrinsically motivated behaviour is the satisfaction of three basic psychological needs: (a) autonomy; (b) competence; and (c), relatedness (Deci and Ryan 2000; Ryan and Deci 2000). For example, pupils in physical education are more likely to be intrinsically motivated when they perceive that they are provided with a freedom of choice or control over their behaviour (autonomy), when they experience the feeling of success or mastery of the activity (competence), and when they feel a sense of belonging or connection and are supported by significant people, such as a teacher or classmates (relatedness). SDT proposes that pedagogical climates in which students can exhibit intrinsically motivated behaviours will produce greater effort and enjoyment, which will then lead to greater task engagement, persistence and learning (Ryan and Deci 2000).

The traditional approach and SDT

In order to influence a students' self-motivated engagement in physical education and enhance their educational experience it is important to implement learning experiences within a physical education pedagogical approach that can satisfy all three basic psychological needs of the individual (Ntoumanis et al. 2004; Vallerand 2001). However, the capacity of the prescriptive teaching philosophy of the dominant traditional physical education teaching approach to effectively satisfy the psychological needs of students to engage in physical education has been questioned on a number of levels, including its impact on individual intrinsic motivation (Chow et al. 2013). First, a lesson taught using the traditional approach typically fails to provide autonomy or choice for students due to a 'one-way-fits-all' pedagogical climate that erroneously assumes that one movement pattern acts as an optimal template suitable for all individual learners (for rejection of this idea see empirical data reported by Chow et al. 2009; Schöllhorn, Hegen, and Davids 2012). The futile attempt to achieve mastery of a putatively optimal technique, usually modelled on the 'adult' version of skill performance, is an unrealistic expectation for many students, undermining their perception of competence or success (Bartholomew et al. 2011; Renshaw et al. 2010). Finally, since the vast majority of teacher-student interactions in a traditional lesson are prescriptive and hierarchically organised, with the 'expert' teacher often giving constructive performance related feedback regarding what technically students are doing wrong, feelings of relatedness or connection between the teacher and students can be compromised (Tinning 2006).

The CLA and SDT

Renshaw, Oldham, and Bawden (2012) have claimed that adopting NLP pedagogical principles in practice can meet all three basic psychological needs of the individual, resulting in an intrinsically motivated performer. According to Renshaw, Oldham, and Bawden (2012) adopting this NLP principle of self-organisation under constraint manipulation in practice can meet the psychological needs of the individual performer by enhancing learners' perceptions of autonomy and competence. This is because individuals are in control of their own learning as they are given the freedom to explore practice environments and seek their own optimal functional movement solutions (e.g. coordination patterns), enabling them to match performance problems with their unique individual characteristics and action capabilities to experience success. Adopting the NLP pedagogical principles of representative practice design, allied with task simplification can also enhance perceptions of competence and autonomy during practice and competition. This learning design provides performers with opportunities to experience success when learning in conditions that mirror the performance environment but are simplified or constrained in a way that matches their action capabilities (Renshaw, Oldham, and Bawden 2012). This pedagogical climate allows learners the autonomy to set their own realistically challenging goals, creating opportunity for developing competence.

The use of exploratory facilitation within a NLP results in a shared responsibility for learning, enhancing the perceptions of relatedness between the teacher and student (Renshaw, Oldham, and Bawden 2012). This is because the nature of their communications is not hierarchical. The CLA can also incorporate the use of interactive practice and cooperative learning for problem resolution, encouraging greater interpersonal exchange between individual students. This degree of interaction should develop a sense of connectedness between learners, enhancing perceptions of relatedness (Renshaw, Oldham, and Bawden 2012).

To this point these claims made by Renshaw, Oldham, and Bawden (2012) have not been verified in empirical studies. To that end, Tan, Chow, and Davids (2012) have called for future research to determine the motivational consequences of an alternative pedagogy underpinned by NLP. In essence, it is important that research verifies the claims that learning design underpinned by NLP will result in the satisfaction of basic psychological needs and can act as an energising individual constraint that enhances intrinsically motivated behaviours, such as increased effort and persistence, leading to greater enjoyment in physical education and ultimately enhanced sports performance (Renshaw, Oldham, and Bawden 2012). A key aim of all pedagogues is to continually seek to improve practice through uptake of modern ideas and verification through empirical investigations and reflection (Chow et al. 2016).

Motivational consequences of adopting NLP pedagogical principles

Previous empirical research has demonstrated that the operational principles adopted in practice by alternative pedagogical approaches, for example, TGfU and Sport Education (Siedentop 2002), such as team membership, student-centred responsibility, differentiated instruction, small-sided games orientation, problem exploration and questioning are superior to the operational principles of the traditional approach in the facilitation of pupils' basic psychological needs and intrinsically motivated behaviours (Goudas et al. 1995; Griffin, Oslin, and Mitchell 1995; Jones, Marshall, and Peters 2010; McNeill, Fry, and Hairil 2011; Perlman 2010, 2011; Perlman and Goc Karp 2010; Sinelnikov and Hastie 2010; Spittle and Byrne 2009; Wallhead and Ntoumanis 2004). Although the CLA has similar operational principles in practice to TGfU and its variations, the theoretical principles of NLP align the CLA methodology more closely with SDT, as both are strongly focused on the needs of the individual. Within a NLP framework, individual needs are recognised as constraints that need to be considered in learning design, just as SDT recognises that the satisfaction of individual psychological needs is essential for intrinsically motivated behaviour (Renshaw, Oldham, and Bawden 2012).

To this point, no study has directly investigated the impact of the key pedagogical principles of an alternative physical education teaching approach on the motivational needs of the individual. If the CLA was found to be significantly more effective than the traditional approach in facilitating learner's self-determined intrinsic motivation, a viable alternative pedagogy would be presented to PETE students to actively engage students in physical education and enhance positive motivational outcomes. This outcome, combined with previous skill acquisition related research evidence, would strengthen the validity of the CLA in the context of physical education in educational settings.

Summary of key issues

Research suggests that the traditional teaching approach is the predominant approach used by physical education teachers in Queensland, Australia (Cothran et al. 2005; SueSee and Edwards 2011). However, the incompatibility of this pedagogical approach with the aim of developing skilled physical education performers and its failure to effectively meet the motivational needs of the individual learner, has highlighted the need for an evolution of teaching practice (Renshaw et al. 2010; QSA 2010). The CLA, grounded in contemporary advancements in motor learning research, offers a viable alternative with an appropriate theoretical framework for facilitating learning design that would support the development of skilled and intrinsically motivated physical education performers (Chow et al. 2007). Although the CLA has a strong empirical research base in the elite sports coaching setting, it has yet to be applied in pedagogical settings, such as a school or university.

Research suggests that PETE programmes are a critical point in time in the professional development of teachers to encourage the exploration of alternative teaching approaches such as the CLA (Light 2002). However, according to Lawson's occupational socialisation theory, a recruit's acculturation (previous physical education and sporting experience), specifically the degree of sporting success experienced prior to entry into PETE, appears to be an important influence in determining their receptiveness to innovation (Lawson 1983a, 1983b). Since many prospective physical education teachers come from a successful physical education and sporting background, they strongly identify with the pedagogical approach they were exposed to by their physical education teachers as it had worked effectively for them. Subsequently, these recruits have strong custodial physical education teaching beliefs and anticipate teaching in a manner similar to how they were taught (Bain 1990; Lawson 1983a; Lortie 1975; Richards, Templin, and Graber 2014). According to Lawson's occupational socialisation hypothesis, these recruits' custodial physical education teaching beliefs are resistant to change and PETE programmes aimed at introducing an alternative teaching approach have little effect on them. Alternatively, recruits that have experienced limited success in sport, Lawson suggested, would more likely adopt a belief in an alternative teaching approach.

Lawson's hypothesis has been supported and contradicted by research conducted on North American PETE recruits who were products of a 'non teaching' physical education culture (Sofo and Curtner- Smith 2005, 2010). However, Lawson's hypothesis has not been tested with PETE recruits who are products of the worldwide dominant traditional teaching culture. Therefore, to start a teaching evolution it is important that these prospective physical education teachers are exposed to a viable alternative pedagogy during PETE aimed at challenging their resistant, custodial, traditional teaching beliefs.

Once PETE recruits demonstrate a receptiveness to an alternative pedagogy, the logical next step is to identify the reasons for its appeal and explore any link with PETE recruits' acculturation. These findings would help teacher educators to recognise and understand potential differences in the receptiveness of PETE recruits to new pedagogical approaches shaped by past physical education and sporting experiences, and subsequently guide programme development to help improve the effectiveness and impact of teacher education on improving teaching practice. To date, some research studies have explored PETE students' experiences of TGfU and its variations and reported various reasons for its appeal (Gubacs-Collins 2007; Li and Cruz 2008; Light and Butler 2005; Wang and Ha 2009, 2013a). However, very limited information has been reported in these previous studies about PETE students' past personal physical education and sporting experiences to allow any link between acculturation and reasons for receptiveness to an alternative pedagogy to be explored. This link is particularly important for PETE recruits identified in the literature as most resistant to change, that is, those with a strong custodial orientation who are high achieving sporting products of this custodial culture.

Equipped with a belief in an alternative pedagogy, the next step in an evolution of physical education teaching practice would be for PETE programmes to prepare novice teachers for the challenges specifically associated with the implementation of the CLA in schools on practicum. According to research, the CLA is thought to present significant challenges to novice practitioners associated with the less predictable and complex nature of student learning within a nonlinear approach (Chow 2013). To date, there is very little practical empirical research that identifies and investigates these significant challenges facing practitioners when implementing a nonlinear approach in a pedagogical setting. This highlights the important need to investigate PETE students' experiences associated with the less predictable and complex nature of student learning when implementing the CLA in a school setting. The practical implications of these findings would inform and improve the design and delivery of PETE programmes in preparing and supporting students to effectively implement the CLA on practicum and in their future teaching careers.

Further highlighting the need for an evolution of physical education teaching practice is the criticism of the prescriptive teaching philosophy of the dominant traditional teaching approach for failing to effectively provide learners with motivationally supportive experiences to engage in physical education (Carlson 1995; Ennis 1999; Light and Georgakis 2005; Ntoumanis et al. 2004). Providing motivationally supportive physical education experiences for learners is crucial, since empirical evidence in sport and physical education research has associated intrinsic motivation with many positive educational outcomes (Chen 2001). Self-determination theory (SDT) provides a valuable framework for examining motivationally supportive physical education experiences through satisfaction of three basic psychological needs of the individual: autonomy, competence and relatedness (Deci and Ryan 2000). There are claims that the CLA can effectively support students' self-motivated engagement in physical education by meeting all three basic psychological needs of the individual (Renshaw, Oldham and Bawden 2012). As yet these claim have not been verified in empirical studies. The findings of a study aimed at testing these claims could present the CLA, underpinned by NLP, as a viable alternative pedagogy that effectively addresses the criticisms of the traditional approach, while supporting the development of skilled, intrinsically motivated physical education performers.

Chapter 3: Variations in acculturation and Australian PETE students' receptiveness to an alternative pedagogical approach to games teaching

Background: The inability to support the development of intelligent performers, a central theme in physical education curriculum documents worldwide, including Queensland, Australia, and criticism from a skill acquisition perspective, has highlighted the need for an alternative to the dominant reproductive traditional physical education teaching approach. This prompted the Sport, Health and Physical Education discipline group within the Queensland University of Technology (QUT) to change the traditional delivery of a games unit within their PETE course and adopt an alternative approach. The Constraints-led Approach (CLA), underpinned by key pedagogical principles of a nonlinear pedagogy (NLP), was adopted as it provided a viable alternative student centred teaching methodology to support the development of intelligent physical education performers, while effectively meeting their skill acquisition needs. Introducing a new alternative teaching approach during physical education teacher education (PETE) is not easy as PETE students' strongly identify with the approach their physical education teacher used and these beliefs are resistant to change. The significance of prospective physical educators' past school and sporting experiences on their receptiveness to this pedagogical innovation was studied.

This chapter is based on the following peer-reviewed published article:

Moy, B., I. Renshaw, and K. Davids. 2014. Variations in acculturation and Australian physical education teacher education students' receptiveness to an alternative pedagogical approach to games teaching. *Physical Education and Sport Pedagogy* 19, no. 4: 349-369.

Note: Since this publication the author has become aware of the need to provide a more contemporary ecologically based definition of 'intelligent performance' for physical education practitioners, rather than the standard cognitive definition as was used in this journal article. Hence the literature review has been updated to include this contemporary motor learning perspective.

Statement of Contribution of Co-Authors for Thesis by Published Paper

The authors listed below have certified* that:

1. They meet the criteria for authorship in that they have participated in the conception, execution, or interpretation, of at least that part of the publication in their field of expertise;
2. They take public responsibility for their part of the publication, except for the responsible author who accepts overall responsibility for the publication;
3. There are no other authors of the publication according to these criteria;
4. Potential conflicts of interest have been disclosed to (a) granting bodies, (b) the editor or publisher of journals or other publications, and (c) the head of the responsible academic unit
5. They agree to the use of the publication in the student's thesis and its publication on the Australasian Research Online database consistent with any limitations set by publisher requirements.

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Contributor	Statement of contribution*
Brendan Moy	Designed and conducted research, collected and analysed data, and wrote all sections of publication.
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Abstract

Background: The development of intelligent performers as a central theme in Physical Education curriculum documents worldwide has highlighted the need for an evolution of teaching approaches from the dominant reproductive approach. This has prompted an Australian university to change the content and delivery of a games unit within their Physical Education Teacher Education (PETE) course and adopt a productive student-centred approach that is compatible with current curriculum directives. The significance of prospective physical educators' biographies on their receptiveness to this pedagogical innovation was studied.

Purpose: To investigate whether past school and sporting experiences are powerful influences on Australian PETE recruits' initial perspectives about effective physical education teaching practice and their receptiveness to an alternative pedagogical approach.

Participants and Setting: A total of 49 first year pre-service PETE students volunteered to take part in the study and were grouped according to their highest level of representation in games, either school/club, regional, or state/national. Students experienced the constraints-led approach during an eight-week games unit informed by nonlinear pedagogy and underpinned by motor learning theory.

Data collection and Analysis: Prior to the commencement of the unit, participants completed a mixed response questionnaire aimed at gathering data about their physical education and sporting background. The data were summarised using descriptive statistics. Before and after taking part in the games unit, participants also completed a questionnaire, responding with their opinion of the

importance of each sub-component of the traditional, reproductive approach for an effective games teaching session. This resulted in a ‘traditional reproductive games teaching’ belief score. For each sub-component, participants were invited to respond in more detail to justify their opinions. A one-way between-groups analysis of variance, Tukey’s HSD Post Hoc Test and a two-tailed, paired-samples *t* test were used to analyse the quantitative data. Content analysis was used to analyse the qualitative data.

Findings: The traditional, reproductive approach was the most frequently reported teaching approach used by the physical education teachers and sports coaches of participants in all groups. Prior to the commencement of the alternative games unit, participants in each representative level group held very strong beliefs in this reproductive approach, responding that an effective games teaching session should consist of a visual demonstration of the ‘ideal’ performance model, repetitive practice of the model using isolated drills with corrective feedback by the teacher, before the playing of the actual game. After experiencing the alternative games unit, there were statistically significant differences in the traditional reproductive games teaching belief mean scores for each group. This combined with participants’ qualitative responses indicated receptiveness to the alternative pedagogy.

Conclusions: The results of this present study show that, contrary to the mixed success found in previous research undertaken in North America, in Australia, we found strong evidence to show that it is possible for PETE educators to change beliefs in order to overcome the constraint of acculturation. Participation in the alternative games unit provided PETE students with the knowledge, understanding and belief in an alternative approach to teaching games compatible with curriculum documents.

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Introduction

The UK National Curriculum Physical Education and USA National Association for Sport and Physical Education emphasise the development of independent and thoughtful performance in their definition of a physically educated person (Byra 2006; Metzler 2005). Additionally, innovative pedagogical approaches, such as Teaching Games for Understanding (TGfU) (Bunker and Thorpe 1982) and Sport Education (Siedentop 1998) have emerged with the aim of creating learning experiences that are more than just about developing techniques. To this end, and in tune with thinking across the world, the development of intelligent performers is also a central theme in the Physical Education Senior Syllabus in Queensland, Australia. The Queensland Studies Authority (QSA 2010, 3) states that:

> Intelligent performance is characterised by high levels of cognitive functioning, using both rational and creative thought. Students are decision makers engaged in the active construction of meaning through processing information related to their personal experience and to the study of physical activity.

However, there is some evidence to indicate that Queensland physical education teachers continue to use highly reproductive teaching approaches. For example, in a local study of Queensland physical education teachers by SueSee and Edwards (2011), data were collected through direct observation of teachers' instructions rather than exclusively relying on self-reporting as in previous research (Cothran et al. 2005). They found that, despite the vast majority of Queensland physical education teachers self-reporting that they used a range of both reproductive and productive teaching approaches 'here and there to most of the time', actual observations of teaching revealed that Queensland physical education teachers predominantly used reproductive approaches, particularly the 'practice' style from Mosston's Spectrum of Teaching Styles (1966). These reproductive approaches are characterised by isolated drills and de-contextualised practices (see Martens 2004; Mosston and Ashworth 2002). In this approach the teacher tends to prescribe a movement solution to pupils, limiting their involvement to imitation and the reproduction of knowledge (Renshaw and Clancy 2009). This imitation approach contrasts with the expectation of the intelligent, problem-solving games player who should be able to critically interpret play and make appropriate decisions to solve game-related problems (Renshaw et al. 2010).

To start an evolution of teaching approaches, it is important to understand why Queensland physical education teachers continue to utilise traditional, reproductive teaching methodologies, despite verbal reports to the contrary. One answer may lie in occupational socialisation theory. Occupational socialisation is a theoretical framework that has guided researchers in understanding why teachers teach physical education as they do (Lawson 1983a, 1983b, 1986, 1988; Schempp and Graber 1992; Stroot 1993; Templin and Schempp 1989). Lawson (1986, 107) defined occupational socialisation as 'all kinds of socialisation that initially influence persons to enter the field of physical education and later are responsible for their perceptions and actions as teacher educators and teachers'. He proposed a number of hypotheses, which attempted to explain how and why three distinct types of socialisation (acculturation or past school experience, professional socialisation or formal physical education teacher education (PETE), and organisational socialisation or the teacher's workplace) were likely to shape American physical education teachers' perspectives and the pedagogical practices they employed (Lawson 1983a, 1983b). The socialisation process of acculturation or past school experience is particularly relevant, as it appears to have a powerful influence on prospective physical education teachers' beliefs and values about the subject, and how it should be taught, well before they begin professional socialisation or formal PETE (Hutchinson 1993). According to Doolittle, Dodds, and Placek (1993) and Curtner-Smith (2007) PETE has little impact on these prospective physical education teachers' beliefs.

Of prime importance in this socialisation process are prospective teachers' observations and interactions with physical education teachers and coaches, while experiencing school life and physical education and sport. Lortie (1975, 61) termed this aspect of experience the 'apprenticeship of observation' (Curtner-Smith 1999; Dewar and Lawson 1984; Mawer 1996; Templin 1979). Lortie (1975, 39) proposed that, through the internalisation of many years of observing teachers in physical education classes, teacher recruits develop specific views of what constitutes good pedagogical practice and they enter teacher education programmes thinking that they hold a 'subjective warrant to teach'. That is, they believe that they already know what they need to be able to do in order to teach. Compounding this view is the fact that many prospective physical education teachers have had extensive, enjoyable and successful backgrounds in physical education and sport prior to entering a course of study in PETE (Doolittle, Dodds, and Placek 1993; Sofo and Curtner-Smith 2005; Wright, McNeill, and Butler 2004). Consequently, these recruits have a strong interest in a custodial approach to teaching, meaning that they strongly identify with the pedagogical approach they were exposed to by their physical education teachers, and subsequently anticipate teaching in a manner similar to how they were taught (Bain 1990; Lawson 1983a; Lortie 1975). These custodial beliefs are somewhat resistant to change (Lortie 1975) and attempts to introduce new, innovative teaching approaches during a recruit's professional socialisation is not easy as it challenges the maintenance of the physical education *status quo* of a teacher-driven, reproductive paradigm.

Although these key socio-cultural constraints on behaviour present a challenge, focusing on the next generation of teachers via a PETE programme is a good place to start an evolution of teaching practice to encompass approaches that are more in line with current curriculum directives. According to Light (2002), pre-service teacher (PT) education programmes offer a point in the professional development of teachers at which they might be encouraged to embrace innovation in physical education teaching. This idea was confirmed in a study involving Australian university graduates, who identified relevant, research-led teaching that introduced them to new, innovative concepts and ideas as important components of their university experience (Scott, 2005). However, before introducing an innovative pedagogy, it is important that teacher educators have a better understanding of who their recruits are, and what their prior experiences and perspectives are about teaching, schooling, sport and physical education. This knowledge is important, since initial beliefs of teaching recruits influence their receptivity to messages received in teacher education (Cothran, Kulinna, and Ward 2000; Lawson 1983a; Pajares 1992).

Specifically, the level and type of sport played prior to entry into PETE appear to be important constraints in determining teaching recruits' receptiveness to innovation. Lawson (1983a) noted that 'sport has been identified as a carrier of conservative values', which led him to hypothesise that perspectives formulated during acculturation produced two types of recruits who entered professional socialisation with varied receptiveness to innovation (Lawson 1983a, 1983b). PETE recruits, who attended schools with high quality PE programmes, and had limited involvement and achievement in traditional interschool sport, he suggested, would tend to be attracted to teaching physical education and not coaching (a teaching orientation). Many of them will possess an innovative orientation and are more likely to be inducted; that is, they internalise and adopt a belief in the perspectives and practices espoused by PETE faculty (Dewar and Lawson 1984; Lawson 1983a). Other PETE recruits, who had participated and achieved at a high level in traditional interschool sports at schools in which sport performance was prioritised over physical education instruction, Lawson (1983a) suggested, would tend to be attracted to coaching not teaching (coaching orientation). Additionally, he hypothesised that many of these recruits were likely to be extremely conservative in their orientation towards physical education, possessing a custodial orientation and were unlikely to be inducted.

Lawson's hypothesis has been supported by research conducted on 17 PTs by Sofo and Curtner-Smith (2005, 2010), and two PTs by Stran and Curtner-Smith (2009b) who found that PTs acculturation mediated their receptiveness towards an alternative pedagogy model presented during teacher education. Specifically, they found that PTs oriented toward teaching changed their beliefs much more easily about teaching physical education during PETE than those orientated toward coaching. However, they found that it was still possible for PETE to induct a PT with a weak or moderate coaching orientation, but those with strong coaching orientations remained more resistant. Contradicting these results, Curtner-Smith (1997a, 1997b; 1998) found that it was possible to partially induct PETE students, who entered programmes with strong coaching orientations. However, as each of these studies by Curtner-Smith involved only two PTs, conclusions about the influence of PETE programmes on PTs need to be made with caution and generalisations cannot be made.

There is a need for researchers to further study the significance of prospective physical educators' biographies on their receptiveness to innovative PETE programmes. It would help teacher educators to recognise and understand potential differences in the receptiveness of PTs to new pedagogical approaches, and subsequently guide programme development to help improve the effectiveness and impact of teacher education. To date, the type of recruit studied in the literature appears to be mainly restricted to coaching- and teaching-oriented individuals from the United States of America, who are typically products of a 'non teaching' physical education culture, where the students play games and the teacher supervisors or referees (Curtner-Smith 1997a, 1997b, 1998, 1999; Sofo and Curtner-Smith 2005, 2010). Occupational socialisation theory and some research (e.g. Cothran et al. 2005; SueSee and Edwards 2011) suggest that Australian recruits are products of a different, traditional reproductive physical education teaching culture. It would be interesting then, to investigate their beliefs about how physical education should be taught on entering a PETE programme and their subsequent receptiveness to an alternative pedagogical innovation, when it is introduced into a PETE programme. Since many Australian recruits seem to be successful products of this traditional reproductive culture, it would logically follow that they would be strongly committed to a process that worked effectively for them and would, therefore, be less receptive to new ideas. To date, no study exists that specifically looks at the previous sporting success of PETE recruits, who are products of a reproductive teaching approach, as a sole acculturation mediating factor to receptiveness to a pedagogical innovation during PETE.

An alternative pedagogy: nonlinear pedagogy and the constraints-led approach

Given the Queensland Physical Education Senior Syllabus definition of the intelligent performer (QSA 2010, 3) a viable alternative teaching approach is needed that is specifically suited to developing a high level of cognitive functioning in individuals. Nonlinear pedagogy (NLP), underpinned by the constraints-led approach, is an innovative pedagogy that provides the necessary theoretical framework for facilitating learning design that would support the development of intelligent problem-solving games players (Chow et al. 2007; Davids, Chow, and Shuttleworth 2005; Renshaw et al. 2010). This student-centred pedagogy provides physical educators with a sound theoretical model of the learner and of processes of learning underpinned by motor learning theory based on the ideas and concepts of ecological psychology and dynamical systems theory (see Chow et al. 2009; Chow et al. 2011; Renshaw et al. 2009; Renshaw et al. 2010). NLP is based on the learner conceptualised as a nonlinear dynamical system (Davids, Chow, and Shuttleworth 2005). NLP recognises the emergent, self-organising nature of learning by empowering learners to individually and actively explore, and solve game problems and make decisions in representative practice environments without prescriptive instruction (Chow et al. 2009; Davids, Button, and Bennett 2008; Pinder et al. 2011). These environments are shaped by practice task constraints (or boundaries), which create instability in the learner who self-organises from within facilitating the emergence of functional movement solutions and decision making in sport (Chow et al. 2006). This approach has been shown elsewhere to provide a theoretical underpinning for student-centred approaches to learning, such as Bunker and Thorpe's (1982) TGfU approach (see also Chow et al. 2009; Renshaw et al. 2010 who demonstrate how NLP can underpin the design of games in TGfU). Adopting a constraints-led approach accords with the expectations of the Queensland Physical Education Senior Syllabus, as the performance contexts within lessons may be considered 'authentic' (QSA 2010, 29). This is because technical, decision making and perceptual skills are developed in faithful simulations of team game performance environments where constraints, such as field size, player density and game rules are manipulated, with all key information sources representative of the game being present (Renshaw et al. 2010).

Aims of the Study

The principal aims of this study were to investigate whether past school and sporting experiences are powerful influences on PETE recruits' perspectives and initial personal beliefs about effective physical education teaching practice. Additionally, we were interested in how these experiences influenced their receptiveness to an alternative pedagogical approach, as captured by Lawson's (1983a, 1983b) physical education occupational socialisation theory of acculturation. Specifically we sought to test the hypothesis in a Queensland context by identifying the physical education teaching and coaching approaches that PETE recruits have predominantly been exposed to, and which have subsequently influenced their initial personal physical education games teaching beliefs. In line with Lawson's (1983a, 1983b) model of physical education teacher socialisation, we expected that Queensland PETE recruits would hold strong custodial, traditional physical education games teaching beliefs. We predicted that this would lead to them anticipating teaching in a manner similar to how they were taught and result in the continuity of traditional, reproductive practice in physical education in Queensland schools. We also expected that performance level of sport played prior to entry into PETE would mediate the receptiveness to innovation of these products of the traditional, reproductive approach, with those recruits who have played higher representative levels being more resistant to a new pedagogical approach. These findings would have important implications for teacher educators, who present PETE recruits with an alternative pedagogical approach to teaching games that is aligned with curriculum document objectives across the world. A secondary aim of the study was to provide more self-reported evidence regarding how Australian high school students are taught physical education.

Method

Instrument Development (Questionnaire)

A two-part questionnaire was developed, the first part consisting of short open-ended and closed response questions aimed at gathering data about the PETE students' gender, current year of degree, date of birth, physical education and sporting background including their competitive games playing experience and how they were taught and coached in games. To identify the physical education and coaching approach that the participants were exposed to prior to entry into PETE, they were asked to choose a description of an approach that was closest to the predominant method used by their physical education teachers and coaches. Three alternative models were given, each based on common teaching and coaching approaches identified in the literature (see Table 3.1). Studies (Bunker and Thorpe 1986b; Cothran et al. 2005; Launder 2001) have clearly identified the existence of a dominant, traditional, reproductive skills-based approach to games teaching/coaching. This approach (alternative A) is characterised by a focus on the teaching of specific skills and technique within a highly structured lesson, usually following the format of a general warm up, demonstration of the 'ideal model', repetitive practice of the 'ideal model' in isolated drills with the teacher giving corrective verbal feedback and a concluding game, where students apply skills learned (Allison and Thorpe 1997; Martens 2004; Mosston and Ashworth 2002; Queensland Department of Education 1977). Alternative B was modelled on the Game Sense approach, which is the Australian variation of the TGfU model (Bunker and Thorpe 1982). The distinctive aspects of this approach are the use of modified and conditioned games to develop games players' tactical awareness and decision-making, with the teacher/coach acting as a facilitator using questioning to promote problem solving and decision-making (Den Duyn 1996). Alternative C was modelled on what Crum (1993) referred to as a 'non-teaching ideology', reportedly common among physical education teachers in the USA (Stran and Curtner-Smith 2009a) and identified within Australia (Morgan and Hansen 2008). Referred to as 'game supervisors', 'newspaper readers' and 'free play monitors', the key characteristics of this approach are that the students play games and the teacher supervisors or referees.

The second part of the questionnaire consisted of six short descriptive statements that were based on each of the sub-components of the dominant, traditional, reproductive skills-based approach to games teaching/coaching, that is, general warm-up consisting of a run and stretching, visual demonstration and verbal instruction of the desired 'ideal' performance model, repetitive isolated skill drills, and continuous corrective verbal feedback compared to an 'ideal' movement response (Allison and Thorpe 1997; Martens 2004; Mosston and Ashworth 2002; Queensland Department of Education 1977). The statements required participants to respond with their opinion of importance for an effective games teaching session via a five-point Likert Scale (5-very important to 1-not at all important). After each question, participants were invited to respond in more detail by providing a written explanation to support and justify their opinions.

Validity and reliability (Questionnaire)

A process similar to that used by many authors (Cothran, Kulinna, and Ward 2000; Ha et al. 2004; Kulinna and Cothran 2003; Kulinna, Cothran, and Regualos 2003; Kulinna and Silverman 1999; Kulinna, Silverman, and Keating 2000; Lund, Gurvitch, and Metzler 2008) was used to establish content validity of the questionnaire through the logical linking of the content and objectives of the study. Initially, a panel of five physical education pedagogy experts were asked to review the descriptions of the three alternative teaching/coaching methods and the six statements related to a traditional, reproductive games session. All five experts were very familiar with the different teaching/coaching approaches and have had extensive school and university physical education teaching experience. Each expert was asked to review the descriptions and statements and provide feedback regarding wording and content appropriateness. Using this feedback the authors revised the content to reflect the experts' suggestions resulting in 100% agreement among the panel that all items adequately reflected the teaching approaches they were designed to represent and measure.

To ensure that the descriptions and statements were clearly structured and generated data were not limited by the participant's misinterpretation of key terminology, the items were then placed into a questionnaire and pilot tested with a group of final year PETE students not involved in the study. Students were asked to complete the questionnaire, review the content and specifically highlight any words that were unknown or confusing. Students reported some confusing terms leading to the modification of wording and the inclusion of descriptions of terminology. This process along with the feedback received from the panel of five physical education pedagogy experts resulted in the creation of the final version of the questionnaire.

To determine if the items on the questionnaire could produce reliable scores in the population, Cronbach's alpha (ά) coefficient was employed as a measure of the internal reliability. Reliability assessments showed a high level of inter item agreement among the six questionnaire items with a Cronbach alpha reliability coefficient of .84.

Participants

Participants were pre-service PETE students undertaking a compulsory unit on games teaching in 2010. Although students of varying ages and course progressions took the unit, only first year students who had finished school in Queensland within the last five years were chosen for the study, ensuring that this unit would be the student's first practical unit aimed at developing skills in teaching practice. The study sample (n=49) consisted of an approximately equal gender breakdown (53% male; 47% female) with a mean age (18.88 ± 1.57 years) representative of a typical PETE cohort at a university in Queensland. All participants in the sample had an extensive competitive games playing background and were grouped according to their self-reported highest level of representation in games; either school/club (n=13), regional (Queensland consists of twelve regions, n=20), or state/national (n=16). To confirm accuracy of the researchers' classification of participants into groups, an independent expert also classified the participants and agreement was reached on 100% of the sample. The participants also confirmed their satisfaction with their allocated grouping. The names of participants used in this paper are pseudonyms used to protect their anonymity.

Data Generation

Pre-intervention

To address our aims, a mixed mode methodology consisting of both quantitative and qualitative research methods was used to generate a more comprehensive and accurate understanding of the perceptions and experiences of participants (Lomas and McLuskey 2005). Immediately prior to the first lecture of the unit, the study was described in the most general of terms to ensure no bias in responses and the mixed response questionnaire was administered by a third party, and completed individually and anonymously by all volunteer participants. Participants' qualitative responses, designed to further explore their quantitatively measured opinions on an effective games teaching session, provided us with the opportunity to corroborate the data and help ensure the accuracy of the collection techniques used (Carpenter and Suto 2008). This triangulation between different information sources was used to strengthen the study's credibility, validity and rigour and to provide a richness and depth of data (Denzin and Lincoln 2005).

Intervention: games based learning in physical activity and sport

Learning design. The delivery of the unit was via practical workshops to separate groups of students (8 x 4-hour sessions) and supporting lectures delivered to all students in the unit (4 x 2-hour sessions). The unit content was informed by research evidence from contemporary thinking in pedagogy, motor learning and educational psychology, specifically, NLP (e.g., Chow et al. 2009; Renshaw et al. 2010; Renshaw, Davids, and Savelsbergh 2010) and self-determination theory, a theory of human intrinsic motivation (Deci and Ryan 2002). The unit was delivered to students so that they experienced the constraints-led approach as learners and teachers.

Tutor Training and ensuring consistency of experience of students. To help ensure consistency of delivery of the unit, tutors were provided with in-service training consisting of a 4-hour workshop delivered by the second author. The workshop consisted of an interactive tutorial highlighting the key underpinning theory adopted in the unit and a practical component, where tutors experienced some of the activities that they were to use later in their teaching. To ensure that they were confident in their own knowledge of the materials, tutors were provided with the resources identified above and encouraged to ask questions about any aspects of theory they were unsure about. Finally, each tutor was provided with a detailed 'tutor guide' that documented the specific workshop content and delivery method to be used for each session.

Delivery of the unit. Lectures were delivered in the first four weeks of the unit and provided theory and practical examples of how teachers and coaches might implement a NLP into their practice, as well as contrasting the approach with discussion of traditional, reproductive practice in physical education. During the eight, 4-hour practical workshop sessions with the PETE students, learning was contextualised where invasion, net/court and striking and fielding games were modified to present players with problem-solving scenarios based on principles of game play. In line with NLP, tutors adopted a more 'hands-off' teaching approach, acting as a learning facilitator and using strategies, such as questioning and more natural implicit learning strategies (see Jackson and Farrow 2005; Renshaw et al. 2010) to guide learners through multiple opportunities to explore and work out solutions themselves in satisfying different task constraints. The three innate, and psychological needs of self-determination; autonomy (choice), competence (success) and relatedness (connection), were embedded into the design of the unit to intrinsically motivate student engagement thus increasing the opportunity for student appreciation, understanding and learning of the constraints-led approach (Deci and Ryan 2002). Competence and autonomy were typically addressed by providing differentiated learning opportunities, where students could choose the difficulty level of games. Particular emphasis was placed on creating relatedness with students being randomly allocated into teams (usually 5-7 students) that they stayed in throughout the unit. Team members undertook all activities together, culminating in a ‘Festival Day’ (in line with Sport Education model).

Reflections. After experiencing specific games during sessions, players were quizzed about their critical thinking and decision-making options during play. Students were also presented with game design problems and were challenged to solve them from a teacher’s perspective. At the end of each practical workshop session, students were required to reflect on their experiences in the session making a connection between them and their previous physical education experiences. Short written responses to (typically) 3-5 questions required them to demonstrate what they had learned in the session paying particular attention to demonstrating an understanding of how the motor learning theory had been applied in the workshop.

Post -intervention

In the last workshop session, students in the unit voluntarily completed the same mixed response questionnaire. Additionally, students completed a summary reflection, where they were asked to think about how the unit had impacted on their thinking about how games should be taught.

Data Analysis

Data from the first part of the questionnaire were summarised using descriptive statistics to identify the most frequently reported predominant games coaching and teaching approach experienced by the participants in each of the three groups; school/club, regional, and state/national. A chi-square test (using an α of .05) was then used to assess whether any variation existed among the three groups regarding the exposure to this teaching and coaching approach.

Pre- and post-games unit Likert Scale closed responses from the second part of the questionnaire were coded for analysis (Very Important = 5; Somewhat important = 4; Neither important nor unimportant = 3; Not very important = 2; Not at all important = 1) and the six response codes added together resulting in a traditional, reproductive games teaching belief score for each respondent out of a possible score of 30. A one-way between groups analysis of variance (ANOVA) was used to investigate the impact that level of games playing success had on PETE students' pre- and post-intervention traditional games teaching belief scores and their degree of change in scores. Further analysis was done using Tukey's Honestly Significant Difference Post Hoc Test (using an α of .05) to determine which groups differed significantly from one another, pre- and post-intervention and in their degree of change. A two-tailed, paired-samples t test with an α of .05 was used to compare the pre- and post-intervention traditional games teaching belief mean scores in each of the school/club, regional and state/national representative groups. Cohen's d was used to assess the size of the effect for each group.

Content analysis was used to analyse the qualitative open-ended questionnaire data to describe and interpret pattern (Morgan 1993). Codes were developed based on data generated categories. The frequency of each code was analysed to detect patterns in the data. The patterns in the data were interpreted to produce an understanding of why and how these patterns occurred. The lead researcher and an experienced colleague completed this exercise independently and achieved 100% agreement on categories, and the detection and interpretation of patterns.

To corroborate the part two-questionnaire data, participants' quantitative responses (Likert Scale) were compared to content from their corresponding written qualitative responses for consistency. To ensure accuracy, a panel of three physical education pedagogy experts carried out this comparison task for each participant, resulting in matching occurring in over 98% of responses.

Results

Influence of acculturation on Queensland PETE recruits' initial physical education games teaching beliefs

The traditional, reproductive approach was the most frequently reported teaching approach used by the physical education teachers and sports coaches of participants in the state/national, regional and school/club groups (Table 3.1). The chi-square test indicated no significant differences among the three groups regarding the exposure to this traditional, reproductive teaching and coaching approach for the percentages observed and expected based on the overall percentage of 87.8% (teaching) and 83.7% (coaching) expected for each subsection of the overall group (critical value CV = 3.84; School/club w = 0.1 teaching; 0.1 coaching; Regional w = 0.1, 0.03; State/national w = 0.001, 0.2).

Participants in each representative level group held very strong custodial traditional physical education games teaching beliefs. The mean traditional reproductive games teaching belief scores (/30) for each group were state/national representatives (M = 24.25, SD = 1.84, p < .001); regional representatives (M = 27.70, SD = 1.84, p < .001); school/club representatives (M = 27.46, SD = 1.85, p < .001).

Table 3.1. PETE students' self-reported description of the predominant method used by their physical education teacher and coach by level of games playing success.

PETE students self-reported description of the predominant teaching and coaching method used by their physical education teacher and coach	State/National (N=16)		Regional (N=20)		School/club (N=13)	
	How Taught	How coached	How Taught	How coached	How Taught	How coached
A. Traditional, Reproductive Approach **Warm up**; **Demonstration** of **'ideal model'** of technical skill; **Practice** of demonstrated model in **repetitive isolated drills; Corrective verbal feedback** regularly provided by the teacher/coach; Application of technical skill in a **small-sided game** and/or the **actual full game**.	14 (88)	15 (94)	19 (95)	16 (80)	11 (85)	10 (77)
B. Game Sense Approach Playing of **small-sided/modified games** (i.e. modified scoring, playing dimensions, equipment, rules) that replicate competitive performance environments including defenders; Teacher/coach uses **questioning** to encourage players to **reflect** and make **own decisions** to solve problems; Playing of the actual full game	1 (6)	1 (6)	1 (5)	4 (20)	0 (0)	3 (23)
C. Non- Approach Playing of small-sided games and/or the actual full game with predominantly **no teaching/coaching**. Teacher/coach simply supervises or referees.	1 (6)	0 (0)	0 (0)	0 (0)	2 (15)	0 (0)

Note: Figures in parentheses are percentages

Variation in Queensland PETE recruits' acculturation and receptiveness to alternative pedagogy

The representative level of sport played prior to entry into PETE mediated participants' pre-and post-intervention belief in a traditional, reproductive approach to teaching games and their receptiveness to an alternative pedagogy. The mean scores for each representative level group both pre- and post-intervention are presented in Figure 1. The one-way between-groups ANOVA was statistically significant, indicating that the PETE students' pre-intervention traditional reproductive games teaching beliefs, F (2, 46) = 17.91, p = .001, their post-intervention beliefs, F (2, 46) = 9.85, p = .001, and their change in beliefs, F (2, 46) = 12.16, p = .001, were all influenced by their level of games playing success.

Pre-intervention

Post hoc analyses with Tukey's HSD revealed that the PETE students who were state/national representatives (M = 24.25, SD = 1.84, p < .001) had significantly lower traditional reproductive games teaching belief scores than school/club (M = 27.46, SD = 1.85, p < .001) and regional representatives (M = 27.70, SD = 1.84, p < .001). No significant differences were found between school/club and regional representatives.

Post-intervention

Post hoc analyses with Tukey's HSD revealed that the PETE students who were school/club representatives (M = 13.77, SD = 5.89) had significantly lower traditional reproductive game teaching belief scores than regional (M = 20.55, SD = 3.59, p < .001) and state/national representatives (M = 18.69, SD = 3.66, p < .001). No significant differences were found between regional and state/national representatives.

Degree of change in belief scores

Post hoc analyses with Tukey's HSD (using an α of .05) revealed that the school/club representatives (M = 13.69, SD = 5.84) had a significantly greater change in their traditional reproductive games teaching belief scores than regional (M = 7.15, SD = 3.92, p < .001) and state/national representatives (M = 5.56, SD = 4.40, p < .001). No significant differences were found in traditional games teaching belief scores of regional and state/national representatives.

Pre- and post-intervention differences

A two-tailed, paired-samples *t*-test revealed statistically significant differences between the pre- and post-games teaching belief mean scores for each group. In the school/club group, post-intervention games belief mean scores (M = 13.77, SD = 5.89) were on average 13.69 points lower than their pre-intervention scores (M = 27.46, SD=1.85), 95% CI [10.17, 17.22], t (12) =8.46, p = .001. Cohen's d for this test was 3.54, which can be described as a very large effect. In the regional group, games belief mean scores (M = 20.55, SD = 3.59) were on average 7.15 points lower than their pre-intervention scores (M = 27.70, SD = 1.84), 95% CI [5.31, 8.99], t (19) = 8.15, p =. 001. Cohen's d = 2.64, a very large effect. In the state/national group, post-intervention games belief mean scores (M = 18.69, SD = 3.66) were on average 5.56 points lower than their pre-intervention scores (M = 24.25, SD = 1.84), 95% CI [3.22, 7.91], t (15) = 5.06, p = .001. Cohen's d = 2.02, a very large effect.

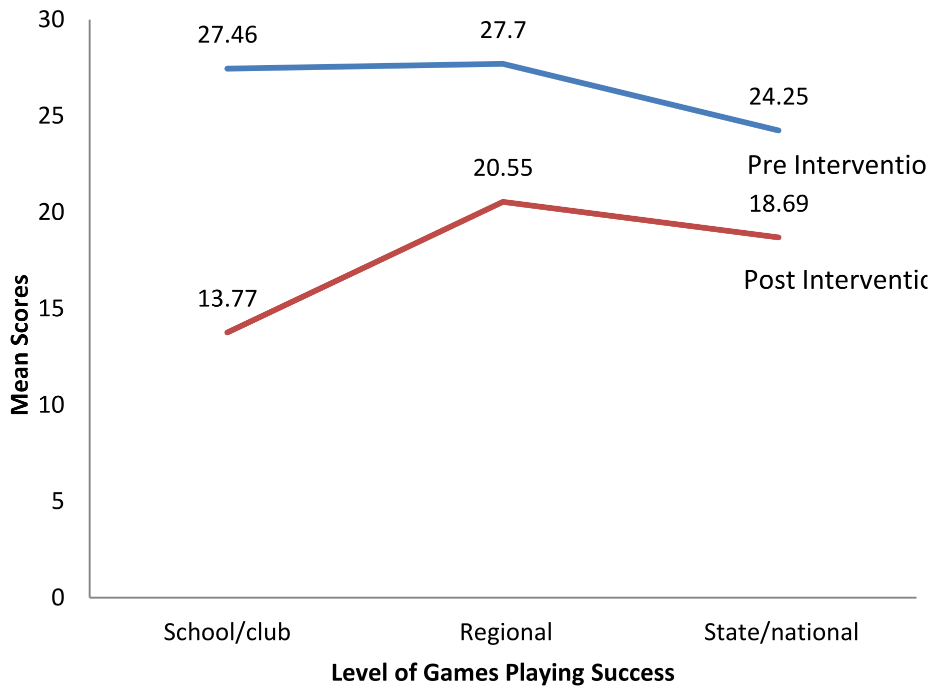

Figure 3.1. Mean traditional games teaching belief scores for each group pre- and post-intervention.

Interpretation of the patterns in participants' post-intervention questionnaire qualitative responses indicated receptiveness to an alternative pedagogy. Pre- intervention, participants in all three representative level groups demonstrated very strong custodial traditional physical education games teaching beliefs by frequently using distinctively traditional reproductive reasoning when justifying their opinion of the importance of sub-components of the traditional, reproductive skills-based approach for effective games teaching. For example, prior to participation in the games unit the most frequent category in participants' justification of their opinion of the importance of teaching students specific technical skills using drills before playing the game was that drills were important as they lay the foundation for the learning of technical skills required to play the game properly. This is reflected in the following individual response by Lauren, a regional representative in netball and softball and a product of the traditional, reproductive approach: 'This [teaching technical skills using drills] is important to ensure the children are able to do the skills in the game correctly'. Post-intervention, participants demonstrated their receptiveness to the constraints-led approach by frequently using theory distinctively linked to the alternative pedagogy when justifying their opinion about the importance of drills. After completion of the games unit the most frequent category identified in participant responses was that technical skills could be more effectively learned when performing in 'real' representative game situations such as small-sided or modified games not isolated drills. This is reflected in the following individual responses by Tony, a club rugby union and football representative and a product of the traditional, reproductive approach: 'These technical skills need to be embedded into a representative game, to let the students explore the skills'; and by Gary, a national touch football representative and a product of the traditional, reproductive approach: 'In a drill markers don't move and the player has no pressure or unpredictable actions of other players to deal with unlike a game'.

Prior to participation in the games unit the most frequent category was identified in participants' responses justifying their opinion of the importance of a visual demonstration and verbal instruction of the desired 'ideal' model for effective games teaching. Visual demonstrations and verbal instructions were considered an important component of teaching as they show students the required execution of the correct technique. This is reflected in the following individual response by Megan, a school basketball representative and a product of the traditional, reproductive approach: '[Visual demonstrations with verbal instructions] allow students to see and understand the technique correctly and gives them something to follow'. After completion of the games unit the most frequent category identified in participant responses was that there is no correct 'ideal' technique; therefore, students should be allowed to explore their own solutions for themselves. This is reflected in the following individual response by Maddie, a state football and national futsal representative and a product of the traditional, reproductive approach: 'There is no "perfect" way of doing a skill, every player is different and will find their own solutions to problems'.

Discussion

The principal aims of this study were to investigate whether past school and sporting experiences are powerful influences on Queensland PETE recruits' perspectives and initial personal beliefs about effective physical education teaching practice. Additionally, we were interested in how these experiences influenced their receptiveness to an alternative pedagogical approach, as captured by Lawson’s (1983a, 1983b) physical education socialisation theory of acculturation. As predicted, our results indicate that exposure to a traditional, reproductive physical education teaching approach appears to have had a very powerful influence on Queensland PETE recruits’ perspectives and initial personal beliefs about effective physical education teaching practice. These recruits possessed very strong custodial, traditional, reproductive physical education games teaching beliefs. However, contrary to our prediction, these products of the traditional, reproductive approach were receptive to an alternative pedagogical approach regardless of the performance level of sport played prior to entry into PETE.

Influence of acculturation on Queensland PETE recruits’ initial physical education games teaching beliefs

The traditional, reproductive approach was the predominant approach to games coaching and teaching that Queensland PETE recruits were exposed to, and that influenced their initial personal games teaching beliefs. 90% of the PETE recruits reported that this approach was how they were taught physical education and 84% reported being coached in sport using the same approach. This finding is consistent with the results of previous studies of teaching approaches used by Queensland physical education teachers (Cothran et al. 2005; SueSee and Edwards 2010) providing more evidence regarding how Australian high school students are taught physical education. The findings are also consistent with the results of a previous study that also used PETE students’ reported memories to identify physical education teaching approaches (Cothran, Kulinna, and Ward 2000).

As predicted, exposure to a traditional, reproductive approach appears to have had a very powerful influence on Queensland PETE recruits as they possessed very strong custodial, traditional, reproductive physical education games teaching beliefs. These recruits strongly believed in the importance of a general warm up, a visual demonstration of the 'ideal' performance model, the teaching of skills using repetitive, isolated drills before the game is played, and the use of corrective verbal feedback. These results are consistent with Lawson's (1983a, 1983b) physical education socialisation theory of acculturation that past school and sporting experiences are powerful in influencing PETE recruits' perspectives and initial personal beliefs about effective physical education teaching practice. They also confirm our predictions about the incompatibility of the Queensland based PETE recruits beliefs regarding effective games teaching practice with the Queensland Senior Physical Education syllabus requirement of developing intelligent performers. This highlights the need to introduce students to alternative pedagogical approaches to teaching games.

When considering the PETE recruits' sporting backgrounds, all three groups had strong initial traditional games teaching beliefs, however, the state/national group displayed significantly lower scores that the school/club and regional groups. This is surprising as it would have been expected that state/national recruits would have a stronger affiliation with this approach than the other two groups as their greater success could personally be attributed to it. A potential explanation could be that state/national players are more likely to come into contact with more coaches, thus increasing the possibility of being exposed to alternative coaching methods, despite an overall predominance of being taught in a traditional way.

Variation in Queensland PETE recruits' acculturation and receptiveness to alternative pedagogy

Experiences of participation in the alternative games teaching unit had a significant impact on PETE students' personal beliefs about effective physical education games teaching practice. Prior to participation in the games unit all three groups of PETE students' possessed very strong custodial, traditional, reproductive physical education games teaching beliefs. After participation, there was a significant, meaningful change in beliefs in all three groups of PETE students', regardless of their previous level of games playing success. After experiencing the games unit, participants placed significantly less importance on the sub-components of a traditional, reproductive teaching session, and when justifying their reasoning, demonstrated receptiveness to the productive student-centred constraints-led teaching approach presented in the unit. For example, Sally, a regional tennis and football representative, responded, 'Students don't need to practice skills in lines before playing. Modified games can be played and different constraints put in, so they can develop this skill without focusing on it'.

Consistent with Lawson's (1983a, 1983b) physical education socialisation theory, and research by Sofo and Curtner-Smith (2005, 2010), and Stran and Curtner-Smith (2009b) we found that PETE recruits' acculturation, in this study level of games playing success, did mediate the degree of receptiveness to the alternative pedagogical approach. PETE students with a background of limited achievement in competitive sports, that is, the highest level represented was their school or club, were significantly more receptive to the constraints-led approach, than those students with a background of moderate (regional) and high (state/national) achievement. However, contrary to our expectations and Lawson's physical education socialisation theory (1983a, 1983b) highly successful products of the traditional, reproductive approach significantly changed their custodial beliefs in this approach.

The results of this present study advance our understanding of professional socialisation, acculturation and receptiveness to alternative pedagogy. Previous research (e.g., Curtner-Smith 2007) has highlighted the difficulty in changing PT students' thinking about physical education and identified that the issues acting as rate limiters on the acceptance of new pedagogy are complex and a function of personal and cultural factors. In this study, we have provided some encouraging evidence to show that it is possible for PETE educators to change beliefs in order to overcome the constraint of acculturation and provide PETE students with the knowledge, understanding and belief in an alternative approach to teaching games in physical education. In this study, PETE students, regardless of level of previous sporting success, developed a belief in the constraints led approach as a viable and realistic alternative to a traditional, reproductive approach to teaching games. A belief in an alternative pedagogy is an important starting point in changing educational practice, as beliefs are major determinants of change in the use of teaching approaches (Borko and Putnam 1996; Butler 2005; Ennis 1994; Ernest 1989; Pajares 1992). This change in belief is an encouraging first step for teacher educators, who wish to influence future teaching practice so that it is better aligned with curriculum document objectives and is based on sound pedagogical evidence for their practice.

There are some potential reasons that can be used to explain the success of this programme in reducing the influences of acculturation and impacting PETE students' physical education teaching beliefs. The significant changes in beliefs support the efficacy of the learning design and delivery of the unit within a research-informed pedagogical framework. The presentation and integration of motor learning theory and practice; an emphasis on students' experiencing the alternative approach as learners; and the challenging of custodial beliefs through critical reflection of traditional and alternative teaching approaches all appeared to interact to influence beliefs of the PETE students (Deenihan, MacPhail, and Young 2011; Lawson 1988; Light 2008; Rink 2001). Previous authors have also credited their pedagogical frameworks for playing a significant part in a positive change in PTs' attitudes towards alternative games pedagogy (Jenkins 2004; Light and Georgakis 2005). Results of our study also support the efficacy of the model for effective PETE programmes described by Lawson (1983a, 1983b). The PETE tutors who took classes in this study agreed on a professional ideology and what Lortie (1975) called a 'shared technical culture' (i.e. the knowledge and skills required for physical education teaching). They demonstrated an innovative orientation towards physical education by employing the constraints-led approach in their own teaching and coaching practice. Lawson's model is also recognised as a key component in many successful recruit induction studies (Curtner-Smith 1997a, 1997b, 1998; Sofo and Curtner-Smith, 2005, 2010; Stran and Curtner-Smith 2009b). Exposure to the alternative pedagogy clearly had an impact on changing students' beliefs about how physical education should be taught. The emphasis on inclusion and the individual learner characteristic of the constraints-led approach may have been inherently attractive to many PETE students. However, at this stage, the specific reasons for this change remain unclear and need further investigation.

There are, however, a number of potential reasons for this change in thinking. As highlighted by Renshaw et al. (2010), the principles of NLP based on motor learning theory have great potential within physical education, as it can substantially underpin practice in the field. However, such advances in knowledge about the processes involved in the acquisition of movement skills have not previously been identified by physical education specialists and rarely applied in pedagogical practice. Metzler (2000) and Rink (1999) have argued that pedagogical strategies should be based on learning theory to achieve intended learning outcomes. The constraints-led approach may have appealed to PETE students as the motor learning theory underpinning the approach provided them with a convincing theoretical framework for facilitating learning design in the development of intelligent performers.

Light (2008) suggests that this understanding of how the learner learns is a particularly important catalyst for change when an alternative pedagogy challenges the beliefs about learning that PTs hold. The constraints-led approach to teaching games may also have attracted PETE students because the approach is somewhat compatible with their sporting background as (mainly) team games players (Curtner-Smith and Sofo 2004; Hastie, Curtner-Smith, and Kinchin 2005). This requires further investigation.

An alternative explanation could be that the way that the unit was delivered led to positive *affect* for the participants, as the programme structure embedded self-determination theory into the design of the learning experiences in attempts to enhance intrinsic motivation (Deci and Ryan 2002). All students were afforded the opportunity to be included in all activities and to be successful, as games were played that allowed them to manipulate constraints to match their own ability level. Students also worked as part of a team for the entire duration of the unit (in games and when completing accompanying written tasks), allowing them the opportunity to connect with others in the group and creating a supportive environment that facilitated a sense of relatedness and positive experiences for individuals, particularly those who were not confident in their ability. Light and Butler (2005) have suggested that the PTs in their study had a personal and affective dimension to their belief in TGfU, and it appealed to them due to the social relationships and interaction fostered between learners and between learners and the teacher. The approach adopted in this unit, may have had a similar effect. For example, the use of a more hands-off teaching approach and more natural implicit learning strategies (see Jackson and Farrow 2005) may be particularly attractive for females and the less confident males, who often tend to be marginalised and excluded by **e**mphasis on the mastery of technique through isolated drills (Ennis 1999). However, in a cohort that consists of specialist physical education PTs, the success of the programme might also have been influenced by the fact that the majority of the PETE tutors who delivered the unit were confident, enthusiastic, experienced and successful practicing physical education teachers with the ability to influence the PTs during the unit (Graber 1995).

Although researchers (Jenkins 2004; Light and Butler 2005) have explored the unit experiences that have influenced PT's receptiveness to an alternative pedagogy, other authors have suggested that future research is needed that takes this a step further by investigating how PT's acculturation influences their reactions and learning during professional preparation (Sofo and Curtner Smith 2005). This study has provided preliminary evidence of variations in acculturation and receptiveness to an alternative pedagogy, however; further qualitative research data using interviews to explore these issues in greater depth would strengthen our findings. Further research is also needed to explore how the specific games unit learning experiences interacted with the PETE students' acculturation and existing games teaching beliefs to influence their receptiveness to an alternative pedagogy.

Conclusion

In conclusion, while the findings in this study are promising and indicate that, despite the relatively brief exposure to the constraints led approach, PETE students developed a belief in an alternative approach to the traditional, reproductive approach so widely used in Queensland schools, these results in no way suggest that PETE students will necessarily be successful in taking the constraints-led approach into their practical teaching experiences. However, while the majority of the participants had limited or no teaching experience, many expressed confidence and enthusiasm to try the constraints- led approach when teaching, as typified by the comment below taken from a PETE student's individual reflection at the end of the unit (not included in the study):

> As a student who was always taught physical education in the 'old military style' of teaching, I was so grateful to hear there was an alternative but had no idea that the alternative could be so rewarding, so fun and it works! I cannot wait to share my experiences with other students, other teachers

> and hopefully use it on my practicum at the beginning of next year. (Susan; a school volleyball representative and a product of the traditional, reproductive approach).

This is an encouraging comment for teacher education programmes and supports the need for further research to move the area forward.

Chapter 4: Overcoming acculturation: Physical education recruits' experiences of an alternative pedagogical approach to games teaching

Background: The initial study of PhD programme (Chapter 3) investigated the significance of QUT PETE recruits' acculturation on their receptiveness to the CLA, experienced in an eight week games unit. Results showed that, contrary to prior expectations based on physical education teacher socialisation theory and previous research, QUT PETE recruits who were highly successful products of the traditional approach, and who were expected to stay strongly committed to a process that had worked effectively for them, significantly changed their initial strongly held, custodial, traditional physical education teaching beliefs and demonstrated receptiveness to the CLA. To date, limited information has been reported about the reasons why PETE recruits identified in the literature as most resistant to change, demonstrate receptiveness to an alternative pedagogy. Therefore, the second study of this PhD programme sought to explore the features and experiences of the CLA games unit that appealed to these QUT PETE recruits who unexpectedly changed their custodial teaching beliefs.

This chapter is based on the following peer-reviewed published article:

Moy, B., I. Renshaw, K. Davids, and E. Brymer. 2015. Overcoming acculturation: Physical education recruits' experiences of an alternative pedagogical approach to games teaching. *Physical Education and Sport Pedagogy*, DOI: 10.1080/17408989.2015.1017455.

Note: Reviewers comments on the initial submission of this journal publication requested clarification regarding the similarities and differences between the CLA and TGfU, which was subsequently addressed in the accepted version. This led to the development of a published paper, *Why the Constraints-led Approach is not Teaching Games for Understanding: A Clarification*, which extensively details the important theoretical and pedagogical concepts that distinguish the approaches, as well as recognise where commonalities exist (see Appendix 1).

Statement of Contribution of Co-Authors for Thesis by Published Paper

The authors listed below have certified* that:

1. They meet the criteria for authorship in that they have participated in the conception, execution, or interpretation, of at least that part of the publication in their field of expertise;
2. They take public responsibility for their part of the publication, except for the responsible author who accepts overall responsibility for the publication;
3. There are no other authors of the publication according to these criteria;
4. Potential conflicts of interest have been disclosed to (a) granting bodies, (b) the editor or publisher of journals or other publications, and (c) the head of the responsible academic unit
5. They agree to the use of the publication in the student's thesis and its publication on the Australasian Research Online database consistent with any limitations set by publisher requirements.

In the case of this chapter:

Publication title and date of publication: Moy, B., I. Renshaw, K. Davids, and E. Brymer. 2015. Overcoming acculturation: Physical education recruits' experiences of an alternative pedagogical approach to games teaching. *Physical Education and Sport Pedagogy*, DOI: 10.1080/17408989.2015.1017455.

Contributor	Statement of contribution*
Brendan Moy 27/01/2016	Designed and conducted research, collected and analysed data, and wrote all sections of publication.
Ian Renshaw	Aided in research design, data analysis, and provided feedback on manuscript sections.
Keith Davids	Aided in research design, data analysis, and provided feedback on manuscript sections.
Eric Brymer	Aided in research design, data analysis, and provided feedback on manuscript sections.

Principal Supervisor Confirmation

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Abstract

Background: Physical education teacher education (PETE) programmes have been identified as a critical platform to encourage the exploration of alternative teaching approaches by pre-service teachers. However, the socio-cultural constraint of acculturation or past physical education and sporting experiences results in the maintenance of the *status quo* of a teacher-driven, reproductive paradigm. Previous studies have reported successfully overcoming the powerful influence of acculturation, resulting in a change in PETE students' custodial teaching beliefs and receptiveness to alternative teaching approaches. However, to date, limited information has been reported about how PETE students' acculturation shaped their receptiveness to an alternative teaching approach. This is particularly the case for PETE recruits identified in the literature as most resistant to change.

Purpose: To explore the features and experiences of an alternative games teaching approach that appealed to PETE recruits' identified as most resistant to change, requiring a specific sample of PETE recruits with strong, custodial, traditional physical education teaching beliefs, and whom are high achieving sporting products of this traditional culture. The alternative teaching approach explored in this study is the constraints-led approach (CLA), which is similar operationally to TGfU, but distinguished by a neurobiological theoretical framework (nonlinear pedagogy) that informs learning design.

Participants and Setting: A purposive sample of 10 Australian PETE students was recruited for the study. All participants initially had strong, custodial, traditional physical education teaching beliefs, and were successful sporting products of this

teaching approach. After experiencing the CLA as learners during a games unit, participants demonstrated receptiveness to the alternative pedagogy.

Data collection and analysis: Semi-structured interviews and written reflections were sources of data collection. Each participant was interviewed separately, once prior to participation in the games unit to explore their positive physical education experiences, and then again after participation to explore the specific games unit learning experiences that influenced their receptiveness to the alternative pedagogy. Participants completed written reflections about their personal experiences after selected practical sessions. Data were qualitatively analysed using grounded theory.

Findings: Thorough examination of the data resulted in establishment of two prominent themes related to the appeal of the CLA for the participants: (i) psychomotor (effective in developing skill) and (ii) inclusivity (included students of varying skill level). The efficacy of the CLA in skill development was clearly an important mediator of receptiveness for highly successful products of a traditional culture. This significant finding could be explained by three key factors: the acculturation of the participants, the motor learning theory underpinning the alternative pedagogy and the unit learning design and delivery. The inclusive nature of the CLA provided a solution to the problem of exclusion, which also made the approach attractive to participants.

Conclusion: PETE educators could consider these findings when introducing an alternative pedagogy aimed at challenging PETE recruits' custodial, traditional teaching beliefs. To mediate receptiveness, it is important that the learning theory underpinning the alternative approach is operationalised in a research-informed pedagogical learning design that facilitates students' perceptions of the effectiveness of the approach through experiencing and or observing it working.

Introduction

In recent years there has been considerable interest in the evolution of physical education teaching practice away from the dominant traditional approach. This traditional approach is characterised by a conventional practice sequence, which starts with the introduction of technical skill(s), followed by students' repetitive attempts to reproduce teacher-prescribed movement 'templates' in isolated drills, finishing with a game (Hopper, Butler, and Storey 2009). This de-contextualised approach to practice is not compatible with the aim of developing intelligent performers, a central theme in physical education curriculum documents worldwide (e.g., Department for Education 2013; NASPE 2009; QSA 2010). For example, successfully playing team games in physical education involves the intelligent performer being challenged beyond mere template imitation to critically interpret play and make their own decisions to solve game-related problems (Renshaw et al. 2010).

The traditional 'one-way-fits-all' pedagogical approach, which erroneously assumes that one movement pattern acts as an optimal template suitable for all individual learners (Chow et al. 2009; Schöllhorn, Hegen, and Davids 2012), is also failing physical education students on a psychological level. Emphasising the mastery of specific techniques in drills and competitive games can sometimes humiliate, marginalise and exclude less gifted and confident individuals (Ennis 1999; Light and Georgakis 2005). In contrast, student-centred, inquiry-based approaches to teaching physical education games such as Teaching Games for Understanding (TGfU) (Bunker and Thorpe 1982), offer viable teaching alternatives more compatible with the development of the cognitive and affective dimensions of the games performer.

Physical Education Teacher Education (PETE) programmes have been identified as a critical point in time in the professional development of teachers to encourage the exploration of alternative teaching approaches (Light 2002). However, there are many socio-cultural constraints that present a challenge to this desired evolution of physical education teaching approaches. Occupational socialisation is a theoretical framework that has guided researchers in understanding the socialisation process that explains why teachers teach physical education as they do (Lawson 1983a, 1983b). Lawson (1986, 107) defined occupational socialisation as ‘all kinds of socialisation that initially influence persons to enter the field of physical education and later are responsible for their perceptions and actions as teacher educators and teachers’. He proposed a number of hypotheses, which attempted to explain how and why three distinct types of socialisation: (i) acculturation or past physical education and sporting experience, (ii) professional socialisation or formal PETE and (iii) organisational socialisation or the teacher’s workplace, were likely to shape American physical education teachers’ perspectives and pedagogical practices they employed (Lawson 1983a, 1983b). The socialisation process of acculturation is particularly relevant to PETE as observations and interactions with physical education teachers and coaches appears to have a powerful influence on prospective physical education teachers’ beliefs about how the subject should be taught (Lave and Wenger 1991; Moy, Renshaw and Davids 2014). Lortie (1975) proposed that, through internalisation of many years of observing physical education teachers and coaches, PETE recruits strongly identify with the pedagogical approaches to which they have been exposed. Consequently, these recruits have a strong interest in adopting a *custodial approach* to teaching and anticipate teaching in a manner similar to how they were taught (Lawson 1983a; Lortie 1975). According to Lortie (1975) and Lawson (1983a) these recruits' custodial beliefs are resistant to change and PETE programmes have little effect on them, particularly if recruits are not challenged to critically examine these pre-entry beliefs during their professional training (Butler 2005; Curtner-Smith 2007). Although not all recruits may possess this custodial orientation, this socialisation process clearly has the capacity to inhibit pre-service teachers (PTs) from adopting new teaching approaches in the profession.

Previous studies have reported successfully overcoming the powerful influence of acculturation resulting in a change in PETE students' preconceived custodial teaching beliefs and receptiveness to an alternative physical education teaching approach (Gurvitch et al. 2008; Li and Cruz 2008; Moy, Renshaw, and Davids 2014; Wang and Ha 2012; Wright, McNeill, and Fry 2009). Exploring the features and student experiences of alternative pedagogy programmes during PETE that overcome acculturation and make this receptiveness possible is an important next step (Light and Tan 2006; McMahon and MacPhail 2007; Philpot and Smith 2011; Sofo and Curtner-Smith 2005). To date, some research studies have explored PETE students' experiences of TGfU and reported various reasons for its appeal (Gubacs-Collins 2007; Li and Cruz 2008; Light and Butler 2005; Wang and Ha 2009, 2013a). Most notably was the capacity of TGfU to physically and cognitively engage students of varying skill levels in games, and the associated affective benefits such as the feeling of achievement when making correct tactical decisions as well as the social and emotional benefits from working in a team environment.

To build on these findings, the next step is to explore how PETE students' acculturation shaped their reasons for receptiveness to an alternative teaching approach. However, very limited information has been reported in these previous PETE studies about students' past personal physical education and sporting experiences to allow any link to be explored. A series of studies by Light (2002) and Light and Georgakis (2005, 2007) has explored how Australian generalist primary teacher education students' acculturation shaped their reasons for receptiveness to Game Sense, an Australian variation of TGfU (den Duyn 1997). The majority of participants in these studies were females who reported memories of experiences of marginalisation, exclusion, humiliation and failure due to their low skill level and an emphasis on skill mastery and competition in their traditional physical education classes. The reduced technical skill demands of modified games, associated with Game Sense, strongly appealed to the study participants since they were perceived to successfully address these negative physical education experiences, encouraging more competent and equitable participation by engaging students of varying skill levels in games. These studies have provided strong evidence to suggest how PTs' receptiveness to an alternative teaching approach might be shaped by past negative personal physical education experiences.

However, a key limitation of these studies from a physical education perspective is that their focus was on female *generalist* primary teacher education students who had largely negative personal traditional physical education experiences. Future *specialist* physical education students have reportedly had contrasting positive and successful backgrounds in physical education and sport (Doolittle, Dodds, and Placek 1993; Sofo and Curtner-Smith 2005; Wright, McNeill, and Butler 2004). Further research is, therefore, needed to explore how specialist PETE recruits' acculturation can shape their receptiveness or otherwise to an alternative teaching approach. In particular, work is needed on perception of samples of PETE recruits' identified in the literature as very resistant to change, that is those with a strong custodial orientation who are high-achieving sporting products of this custodial culture (Lawson 1983a).

Aim of study

A recent study by Moy, Renshaw, and Davids (2014) investigated how acculturation mediated Australian PETE students' receptiveness to an alternative pedagogical approach to teaching games. Contrary to prior expectations based on Lawson's (1983a, 1983b) physical education teacher socialisation theory and previous research (Sofo and Curtner-Smith 2005, 2010; Stran and Curtner-Smith 2009), PETE recruits who were highly successful products of the traditional approach (i.e. state or national representative in sporting games), and who were expected to stay strongly committed to a process that had worked effectively for them, significantly changed their strongly held, custodial, traditional physical education teaching beliefs and demonstrated receptiveness to the alternative approach to teaching games. However, that study did not seek to identify the reasons that made this significant change in teaching beliefs possible. The aim of this present study is to build on this work, and that of other investigators who have gained similar success using related games-based pedagogies, by exploring features and experiences of an alternative games teaching approach that appealed to PETE recruits with strong, custodial, traditional physical education teaching beliefs, and whom are high-achieving sporting products of this traditional culture. These findings could have important implications for PETE design, helping teacher educators to recognise and understand potential differences in the receptiveness of PTs to new pedagogical approaches shaped by past physical education and sporting experiences. The alternative teaching approach adopted in the study by Moy, Renshaw, and Davids (2014) was the constraints-led approach (CLA). Like TGfU, it is specifically suited to the development of intelligent, problem-solving, autonomous performers capable of exploring different movement patterns to find functional performance solutions (Davids, Chow, and Shuttleworth 2005). The study provides an opportunity to gain an insight into the CLA, which has previously been more broadly aligned with applications by sport and human movement scientists rather than physical education teachers. Although the CLA has a strong empirical research base, the study described in this paper was its first documented application in a pedagogical setting.

The CLA and TGfU approaches to games teaching have similar operational principles in practice. Both are student-centred approaches that challenge students to solve common tactical problems through performance exploration in representative games modified to regulate skill level and to emphasise particular tactical aspects of the game (Bunker and Thorpe 1982; Thorpe, Bunker, and Almond 1984). For TGfU, guided questioning by a teacher, based upon set learning objectives, and the cognitive reflective activity of the student, are core features of the learning process (Richard and Godbout 2000). However, for CLA this is just one possibility to achieve learning objectives among many others including little reflection (for a detailed description see Davids, Button, and Bennett 2008).

Although the two approaches have some commonalities at an operational level, the theoretical framework that informs TGfU and the CLA learning design is substantially different. The TGfU model uses four pedagogical principles, sampling, modification-representation, modification-exaggeration, and tactical complexity, to provide a framework to guide teachers in TGfU game design (Thorpe and Bunker 1989). This model contains embedded assumptions about learning, but it does not seek to provide a theoretical framework to empirically support the learning process (Chow et al. 2007; Kirk and Mac Phail 2002). The essential distinguishing feature of the CLA is that its practice design and delivery is informed by a nonlinear pedagogy (NLP), which provides a sound theoretical model of the learner and of the processes of learning, based on key ideas and concepts of ecological dynamics (an integration of ecological psychology and dynamical systems theory) (expounded in substantial detail by Chow et al. 2009, 2011). In contrast to TGfU, the CLA is focused at the student-environment scale of analysis, providing a pedagogy that is based on a model of the learner as a complex adaptive system (Davids, Button, and Bennett 2008). The CLA proposes that human behaviours are an emergent property of self-organising, nonlinear dynamical movement systems, which are regulated by the continuous interaction of personal, task and environmental constraints (Davids, Handford, and Williams 1994; Newell 1986). The CLA framework for learning design empowers learners to actively discover and explore individualised, functional movement solutions to satisfy this unique combination of interacting task (e.g. rules), environment (e.g. playing surface) and individual (fitness level) constraints (or boundaries) imposed on them (for more detailed overview, see Chow et al. 2006, 2013; Davids, Chow, and Shuttleworth 2005). The motor learning principles of NLP that underpin the CLA have been shown to provide a theoretical framework to support the principles of learning designs like TGfU (see Chow et al. 2007; Tan, Chow, and Davids 2012).

Based on the powerful theoretical framework of ecological dynamics, NLP has identified principled pedagogical features such as representative learning design, affordances (invitations for action), perception-action coupling (rejecting traditional reductionist pedagogical practices such as task decomposition), constraints manipulation, implicit learning (exploiting intrinsic self-organisation tendencies) and harnessing functional adaptive variability in practice, to guide the practice of coaches, performance analysts and sport scientists, movement practitioners and physical education teachers (see Davids, Button, and Bennett 2008; Renshaw et al. 2009).

An important distinguishing feature of the CLA is that it is an interdisciplinary approach that has been directly applied beyond the tactical focus of games. TGfU and the CLA both acknowledge that technical skills are generally developed in tandem with tactical awareness within a game context (Kirk and MacPhail 2002; Light 2012). However, the TGfU model advocates 'technical instruction' to address poor technical skill execution within the game (Bunker and Thorpe 1986a; Werner, Thorpe, and Bunker 1996). The motor learning principles of NLP offers a viable solution to address common technical skill problems by using a modified representative practice design that enhances transfer of cognitions, perceptions and actions during learning (see Renshaw 2012; Renshaw et al 2010, for specific examples). The key features of a NLP have also been successfully investigated and applied beyond games to performance activities such as gymnastics, swimming and springboard diving where constraints manipulation has been used to encourage exploratory behaviours of athletes in overcoming common technical errors (see Barris, Farrow, and Davids 2014; Renshaw et al. 2009; Seifert et al. 2014 for examples).

The contemporary motor learning theory that informs the CLA was expected to be the main facilitator of attraction for PETE students. Providing opportunities for students to personally experience the efficacy of the CLA in the development of skill as learners in practical workshops that adopt the underpinning motor learning theory, was expected to strongly appeal to PETE students. This learning design, integrating motor learning theory and practice, was expected to allow participants the opportunity to develop a clear understanding and appreciation of the principles of the motor learning theory underpinning the CLA, providing them with a deep theoretical framework for informing their physical education practice. In line with previous TGfU research findings (Gubacs-Collins 2007; Light and Butler 2005; Wang and Ha 2009, 2013a) it was expected that the CLA would have some affective appeal for PETE students, such as the equitable engagement of students of varying skill level given the very similar operational principles of this approach and TGfU.

Method

Participants and setting

A purposive sample of 10 pre-service PETE students was recruited for the study from a cohort of 100 first-year students undertaking a compulsory unit on games teaching at an Australian university. Although students of varying ages and course progressions took the unit, only first year students who had finished school the previous year were chosen for the study, ensuring that this unit was the student's first practical higher education unit aimed at the professional development of teaching skills. The purposive study sample was not homogenous, that is, mixed gender (6 females and 4 males), varied school background (co-educational, n=7, same sex, n=3; private, n=3, public, n=7), and mean age (18.88 ± 1.57 years). To increase the trustworthiness of the research findings, participants were selected from 2 different year cohorts (4 from 2010, 6 from 2012). To help ensure consistency of experience for all students across the two cohorts, lecture content was identical, the same teaching personnel was used, and a detailed 'tutor guide' was provided that prescribed the exact content and delivery method for each practical workshop. Study participants were not identified to tutors, thus ensuring parity of experience to enhance external validity. All names used in this paper are pseudonyms to ensure participant anonymity.

Purposive sampling involves the selection of participants based on pre-specified criteria (Denzin and Lincoln 2005). For this study, potential participants who met the selection criteria were identified through analysis of their responses to the questionnaire used in the study by Moy, Renshaw, and Davids (2014). The first part of the two-part questionnaire was used to gather data about PETE students' physical education and sporting background. Respondents who were successful products of the traditional approach, as defined by their achievement of an A or B standard for school physical education and state or national representation in school sport, were identified as potential study participants. The second part of the questionnaire was used to measure respondents' traditional games teaching beliefs. It consisted of six short descriptive statements that were based on each of the sub-components of the traditional approach to games teaching, that is, about the value of repetitive isolated skill drills. The statements required participants to respond with their opinion of the importance of the sub-components for an effective games teaching session via a five-point Likert Scale. The six response scores added together resulted in a traditional games teaching belief score for each respondent out of a possible score of 30. Respondents, who were successful products of the traditional approach, recorded a high pre-intervention traditional games teaching belief score, participated in the games unit, then recorded a significantly lower traditional games teaching belief score, as revealed by a two-tailed, paired-samples *t*-test, were selected as study participants.

Data collection

To address the study aims, a qualitative case study methodology was employed since the research methods allowed the researchers to explore and gather rich, detailed and in-depth information of an interpretative nature (Creswell 2002). Face-to-face, semi-structured interviews and written reflections were the sources of data collection. Each participant was interviewed separately, once prior to participation in the alternative games unit to explore and gain an in-depth understanding of their positive physical education experiences and then again after participation in the games unit to explore the specific games unit learning experiences that influenced their receptiveness to the alternative pedagogy.

Interviews were conducted by the first author who was also the games unit coordinator and lecturer. There are key advantages of using an interviewer who is involved in the research, the delivery of the unit and who is also familiar to the participants. According to Bonner and Tolhurst (2002), these individuals typically possess a wealth of knowledge and expertise in the field, a superior understanding of the research context, and an ability to naturally interact with students, which promotes a more insightful understanding of the students' opinions. Previously established trustful relations between participants and the interviewer also allows the possibility for interviewees to feel comfortable and free to talk openly, potentially increasing validity due to the added richness, honesty, fidelity and authenticity of the information acquired (Hammersley and Atkinson 1983; Tierney 1994).

However, this 'insider research' where the researcher has a direct connection with the research setting, also has the potential to compromise the validity of the research as the power relationship between the interviewer/lecturer and participant/student may result in socially desirable responses (Unluer 2012). To enhance validity and allow participants the opportunity to provide authentic, reliable accounts of their games unit experiences the research was conducted in a rigorous manner and steps were taken to minimise the impact of bias associated with the researcher's involvement within the research context. The first step was for all interview questions to be developed by the first author in collaboration with three colleagues, all of whom used their extensive experience of qualitative research methods and of teaching physical education to formulate a set of questions designed to test the study aims (see Table 4.1 for example questions). The next step was for interviews to be conducted in an informal, neutral setting where participants were likely to feel comfortable and `in control' (Unluer 2012).

The interviewer attempted to minimise the power differential by acting as a co-learner and maintaining a professional, honest and transparent manner throughout each interview (Harklau and Norwood 2005). The final step incorporated a technique called *respondent validation* (Cohen, Manion, and Morrison 2000). All interviews were audio taped and transcribed verbatim, with transcripts being returned to participants to review the reported information to check that it corresponded to their own `subjective reality'. Participants were provided an opportunity to modify or clarify any aspect of the interview transcripts before the researcher embarked on data analysis. In summary, it is acknowledged that bias associated with this power relationship between the interviewer/lecturer and participant/student cannot be totally eliminated and complete objectivity is thus impossible (Cohen, Manion, and Morrison 2000). However, it is important to ensure that a concerted effort is made to minimise the impact of biases and enhance validity.

Participants also completed qualitative documents in the form of personal student written reflections after four selected practical tutorial sessions and at the conclusion of the games unit (see Table 4.1 for example reflection questions). They were required to reflect on their personal experiences and observations during the session and also attempt to make a connection between these experiences and their previous physical education experiences. This triangulation between different information sources provided the opportunity to crosscheck the data and ensure that findings were accurate as well as providing a richness and depth of data (Carpenter and Suto 2008; Denzin and Lincoln 2005).

Intervention: Games unit

The delivery of the games unit was via practical workshops (8 x 4-hour practical sessions on invasion, net/court, striking and fielding games) and supporting theory lectures. Lectures were delivered in the first four weeks of the unit and presented the motor learning principles of NLP that inform the CLA, as well as practical examples of how teachers might implement a NLP into their practice. Also, a deliberate attempt was made in lectures and practical workshops to critically challenge PETE recruits' custodial, traditional teaching beliefs, through highlighting the contemporary skill acquisition and psychological failings of traditional physical education practice environments. For example, traditional practice drills isolate technical skills from relevant perceptual and decision-making skills, in contrast to an authentic games context where all three skills are performed simultaneously (Renshaw et al. 2009). The traditional approach also allows confident and aggressive males and females to dominate games and excludes girls and less skilled and less confident boys (Ennis 1999).

The motor learning theory underpinning the CLA was adopted in the practical workshops allowing students the opportunity to experience the approach as learners. During the practical workshop sessions, PETE students were exposed to a variety of representative game environments with key constraints manipulated such as game rules and field size to facilitate active exploration and the emergence of individual functional movement patterns and decision-making behaviours to solve technical and tactical related problems (Chow et al. 2013; Renshaw et al. 2010). For example, students were challenged to explore technical and tactical solutions to the problem of attacking and defending an opponent in 1 v 1 soccer/football dribbling game. The playing area was manipulated with a 1 m wide goal set up at each point of a triangle with 10 m long sides. Players could score by dribbling between any goals in control of the ball, from any direction. In line with NLP, tutors adopted a more 'hands-off' teaching approach, acting as a learning facilitator and guiding learners using questioning and more natural implicit learning strategies (see Jackson and Farrow 2005; Renshaw et al. 2010). For example, in the 1 v 1 dribbling game, students were allowed to individually explore multiple solutions to beat their opponent without explicit instruction.

As previously mentioned, students completed written reflections on their personal experiences and observations during the practical activities. For example, students were asked to reflect on their experiences during the 1 v 1 dribbling game and give a specific example of the implicit learning of one trick or dribbling skill (perceptual, decision making or technical) that they personally experienced or observed in any game. At the conclusion of each session, students were also required to give short written responses to (typically) three to five questions to demonstrate an understanding of the motor learning theory and how it had been applied in the workshop. After the 1 v 1 dribbling game, students were asked to demonstrate their understanding of 'repetition without repetition' (Bernstein 1967) or functionality variability, a key principle of NLP used to create instabilities in the learner essential in producing an adaptable performer. Students were, therefore, asked to respond to the following questions:

i. In the 1 v 1 dribbling game what was the skill learning advantage of changing opponents after each game?

ii. How would constantly changing opponents during practice help a player perform in an actual game of soccer/football?

Data analysis

Data from interviews and student reflections were qualitatively analysed using the grounded theory operational steps (Glaser and Strauss 1967). The objective of this analysis was to organise and interpret the qualitative data through an ongoing process of generating, examining and comparing data to establish prominent themes (Denzin and Lincoln 2005). Data analysis consisted of three main operations: (1) breaking down the data into meaningful units through a detailed line-by-line examination, (2) grouping units with similar meanings into broader categories and (3) organising categories into larger and more inclusive themes (Table 4.1). The adoption of a case study methodology and data analysis using the grounded theory operational steps is well established and has been successfully utilised in previous comparable qualitative investigations (Harvey, Cushion, and Massa-Gonzalez 2010; Light and Evans 2010; Light and Tan 2006; Roberts 2011; Smith and Cushion 2006).

Trustworthiness is established when research findings authentically represent meanings as described by the participants as closely as possible (Lincoln and Guba 1985). In this study, trustworthiness was established and consequently findings strengthened through the use of triangulation between different information sources (Patton 2002; see Table 4.1), ongoing peer debriefing with two colleagues to check and share interpretations of data and arrive at consensus (Creswell 2007), and the conducting of member checking and verification of interview transcripts and researcher interpretations by participants (Merriam 1998). These same strategies were successfully utilised to establish trustworthiness and strengthen findings in previous comparable qualitative investigations (Deglau and O'Sullivan 2006; Tsangaridou 2008; Wang and Ha 2009, 2013b; Wright, McNeill, and Fry 2009).

Table 4.1. Resultant theme example from data analysis process linking participant interview and reflection raw data.

Major Theme	Categories	Raw Data
Psychomotor: CLA Effective in Skill Development	Personal Experience of Effectiveness (Seeing that CLA works)	<u>Reflection Question:</u> Reflecting back on the games unit, what were the specific personal experiences that appealed to you and possibly helped shape new teaching perspectives? *It appealed to me how effective the CLA is and it is something I'd definitely use as a teacher. I have witnessed and experienced how more effective it is in developing decision-making, perceptual awareness and technical skills than isolated drills. (Harry, state representative rugby union player)* <u>Interview Question:</u> You said that you personally experienced the effectiveness of the CLA, could you please tell me about a specific example? *Probably soccer, 'cause I don't really play soccer but I found, like doing the, where we'd go against one person and try and get past them and score a goal. I was trying new things, like dribbling between my legs and stuff and trying to decide which way to go like around people and stuff and as we got through it, I noticed that I did improve a fair bit from like the beginning. I learnt something, yeah. That I was able to see other people learning and also myself learning something has led me to think that I'm going to teach that way. (Harry, state representative rugby union player)*
	Underpinning Motor Learning Theory (Knowing how CLA works)	<u>Reflection Question:</u> Reflecting back on the games unit, what were the specific personal experiences that appealed to you and possibly helped shape new teaching perspectives? *The learning theory was a powerful eye opener for me coming from a very drill-driven background. (Melinda, state representative basketball player)* <u>Interview Question:</u> What are your personal thoughts about the learning theory underpinning the CLA? *Yeah applying the learning theory in tutorials, getting the background of it I believe actually helped me understand it, especially towards the later stages when I was more accepting of it. So to be exposed to learning theory and having that background about how it worked probably helped quite a fair bit to instigate the game base approach in my coaching. (Melinda, state representative basketball player)*

Results and discussion

The principal aim of the study was to explore the features and experiences of the CLA games unit that appealed to Australian PETE recruits with a positive and highly successful background in traditional physical education and sport. The following section identifies two prominent themes, in order of significance, that were established from the data analysis related to this aim: (i) psychomotor appeal and (ii) inclusivity appeal.

Psychomotor appeal: The CLA was effective in skill development.

The efficacy of the CLA in the development of perceptual, technical and decision-making skills was the most important factor in its appeal to the PETE recruits in this study. This is a significant finding as, to date, previous research in the area has identified only the inclusive (e.g. engaging students with varying skill levels), affective (e.g. fun) and cognitive (e.g. tactical problem solving) appeal of similar alternative pedagogies for PTs (Li and Cruz 2008; Light 2002; Light and Butler 2005; Light and Georgakis 2005, 2007; Wang and Ha 2009, 2013a). Although skill acquisition is an expected learning outcome from participation in game-situated learning (MacPhail, Kirk, and Griffin 2008; Turner and Martinek 1999), the psychomotor dimension has not been previously reported as a reason for PTs' receptiveness to an alternative pedagogy. It is an important dimension for PETE students to recognise and appreciate within an alternative physical education pedagogical practice, since psychomotor, cognitive and affective learning outcomes are common features of physical education curriculum documents in Australia (QSA 2010), the USA (NASPE 2009), the UK (Department for Education 2013) and China (Chinese Ministry of Education 2002). This significant finding in this study could be explained by three key factors, the acculturation of the participants, the motor learning theory underpinning the alternative pedagogy and the unit learning design and delivery.

Participants' acculturation or previous level of success as games players helped shape their initial strong custodial belief in the traditional physical education teaching approach. Prior to experiencing the CLA, study participants unanimously justified their future intention to teach physical education using the traditional approach because of its effectiveness in personal skill development and their resultant high level of success as a games player:

> *My teachers and coaches always used drills, and that's how I learnt and I've been successful like being good at a sport, I was always MVP (most valuable player) of my team. The traditional approach worked fine for me and I believe that it can work for the students that I'm teaching as well. (Interview, Harry, state representative in rugby union)*

The CLA offered these highly successful products of a traditional physical education culture an alternative teaching approach that was also effective in skill development. When applied in tutorials, participants unanimously reported a strong attraction to the CLA, facilitated by their personal experience of the successful acquisition of movement skills. The following quote is an example of a participant's personal experience and observations of the efficacy of the CLA in the learning of perceptual, technical and decision-making skills associated with dribbling when playing a previously described 1 v 1 soccer/football dribbling game:

> *With constraints we see that they actually worked on us and like if I see how it works I'll believe in it more. Other subjects they just tell us that it works*

and then they expect you to understand; we don't see that it works. I saw it work. I've probably played soccer once in my life. And just learning dribbling in the unit – the first time I did it was just completely slow, and I think by the end of it I was trying new things, and I was starting to dribble faster. I could read the game better as well. I learnt something, yeah. That I was able to see other people learning and also myself learning something has led me to think that I'm going to teach that way. (Interview, Sandy, state representative in netball)

Many participants were surprised that they observed learning without novice learners practising the prescribed optimal model in a traditional environment of teacher-led isolated drills. This personal experience of observing skill development through representative practice environments seemed to challenge participants' custodial beliefs about teaching practice and enabled them to recognise and appreciate the effectiveness of the CLA. In the following quote, the participant reports on the experience of observing technical skills such as passing emerge from novice touch football players through participation in representative touch football games without a demonstration and explicit teacher instruction. This game required the attacking team to advance the ball up field against a retreating defence. Players self-organised under the constraints of a narrow field and a time limit of 20 seconds facilitating the emergent skill of quick, lateral passing and direct running to solve the problem of gaining maximum distance in the time limit:

The approach is based on learning theory that I think works for the students. Like for example, we had the group of Norwegian girls who'd never played touch footy before, and with no explanation really of how to play the game, *or how to throw a pass, or what to look for, or where to stand, you know it was just amazing the progress that they made from a relatively small amount of time under this more games based approach. I saw learning. I just saw them learn pretty much every part of it, like learning how to pass a football and the positioning aspect especially through games with constraints and that's sort of when it really hit home. Just seeing it from a beginner's perspective, it was pretty eye opening to tell you the truth. (Interview, Max, state representative in volleyball)*

The motor learning theory underpinning the CLA facilitated participants' psychomotor attraction to the alternative pedagogy. Many participants reported that the understanding of the motor learning theory underpinning the CLA was a very important factor in the appeal of the alternative pedagogy as it provided them with a convincing theoretical framework that explained how and why the approach worked:

Yeah, I think it all makes sense. It's not just random stuff, it actually fits. Having a reason for using the constraints led approach like how the learner learns is important. Knowing how the different constraints worked and how they affected learning, and applying the theory in tutorials and seeing and experiencing it work really helped my understanding and acceptance of the approach. Before the unit, I didn't really even think about how individuals learn how to play games. (Interview, Bridget, state representative in hockey)

Metzler (2000) and Rink (1999) have argued that to achieve intended skill learning outcomes, pedagogical strategies should be based on learning theory. The distinguishing feature of the CLA among alternative pedagogies is that it is underpinned by the principles of NLP based on motor learning theory, which provides a detailed theoretical framework to empirically augment its perceived effectiveness (see Chow et al. 2007). The appeal of the learning theory for participants supports the suggestion by Light (2008) that this understanding of 'how the learner learns' is a particularly important catalyst for change when an alternative pedagogy challenges the beliefs about learning that PTs hold.

Participants reported personal experiences of the successful acquisition of movement skills and also a clear understanding and appreciation of the motor learning theory underpinning the CLA, findings that support the efficacy of the learning design and delivery of the unit within a research-informed pedagogical framework (Dewey 1938; Lawson 1986; Light 2008; Rink 2001). The integration of motor learning theory and practice, the engagement of the body in learning through students experiencing the CLA as learners in practical workshops, ongoing immediate student reflections on these personal experiences and observations, and written revision questions requiring an application of the motor learning theory enhanced students' experience, appreciation and understanding of how the learner learns using this approach. Previous authors have also credited similar learning design and delivery with an enhanced appreciation and understanding of an instructional model introduced during PETE (Light and Georgakis 2005).

As predicted, adopting the motor learning theory underpinning the CLA in practical tutorials gave participants the opportunity to experience for themselves as learners the effectiveness of this individualised student-centred approach. Even though they were high achieving performers in at least one sport, the range of sports played by students in the unit meant that, on many occasions, they were exposed to sports where they had little experience or at times were complete novices, as evidenced in some participants' comments included in this paper. This personal experience of the acquisition of movement skills facilitated a change in participants' beliefs about physical education teaching practice and resulted in a psychomotor attraction to the CLA.

This finding is consistent with Guskey's (1986, 2002) research and model of professional development for teacher change which states that changes in teachers' beliefs are more likely to occur only after they witness improved student learning resulting from the proposed change in teaching practice. According to Tom (1997), PETE students typically do not change strongly held beliefs unless they are challenged through powerful and meaningful experiences that cause them to recognise and value the consequence of the change process for themselves and their learners. An example of a powerful and meaningful learning experience from the unit that mediated receptiveness is illustrated in a reflection from a female participant after playing the 1 v 1 soccer/football dribbling game:

> *I have never really had the chance to play soccer until today. Today my skills improved in a way that I didn't think possible in such a short amount of time and this was because I was given a chance to play and make mistakes. 10 minutes in – I had a busted lip and had been knocked over twice because I was too focused on the ball-so I learned to LOOK UP! As I watched other players I found myself using my body more to 'block' my opponent and would look for an opportunity to play the ball backwards or turn it away from them on their weaker side. I wasn't criticised by focusing on HOW to*

perform; in the end I just did. My body was starting to make decisions for me because I was learning implicitly from my mistakes. (Reflection, Bella, state representative in softball)

A belief in the efficacy of an alternative pedagogy is a major determinant prior to changing pedagogical practice (Bechtel and O'Sullivan 2007; Butler 2005; Pjares 1992; Tsangaridou and O'Sullivan 2003). Supporting evidence for this was provided by three of the study participants who were already coaching junior sporting teams before taking the unit. After exposure to the initial lectures and practical workshops, independently, they chose to change from their traditional coaching practice and experimented with the CLA. These participants all reported observations of improved skill performance by their young learners and the successful transfer of skills learned in practice to the competitive performance environment. This coaching experience seemed to further convince participants of the effectiveness of the CLA in skill development over isolated drills and strengthened their attraction to it. The following quote from a participant who implemented the approach in her basketball coaching illustrates this psychomotor appeal as well as an affective appeal:

The unit coincided directly with the beginning of my basketball coaching of 14-year-old boys, and initially I wasn't much of a believer of the constraint based learning just because of how I'd been taught. I've always done drills so I just figured I've learnt that way, I've been successful, it must work, and I wasn't very open to the idea of constraint based learning. But after the first two drill-based training sessions that I held with the boys and noticed that in their first game they hadn't really taken many of the skills that I'd tried to *teach them in isolated drills, they hadn't really carried them over into a game, I thought why not, let's try this game based learning, it seems to be working in our tutorial. And immediately they were showing some of the skills and actually implementing them into a game, and by the end of the season I was just so impressed with how much they'd learnt and how much they'd actually learnt to take into a game that I wouldn't go back to drills based learning. When I saw them develop their skills it made me feel proud and successful as a coach. I would definitely implement the constraints based theory into my teaching and coaching because kids learn more without being told exactly what to do and have fun while doing it, which is amazing. You not only get results but you get smiles! And kids who want to learn more and train harder. It's brilliant!! (Interview, Melinda, state representative in basketball)*

Inclusivity appeal: the CLA facilitated the inclusion of students of all skill levels

Prior to participation in the games unit, study participants unanimously reported the game as the most enjoyable aspect of their traditional physical education lesson, particularly when the game involved students of similar high skill and motivation level. This enjoyment was derived from participants' dominant involvement in the game and the subsequent success they experienced as illustrated in this quote:

Most enjoyable aspect was the game at end of the PE lesson. I was quite good at sports and it fuelled my confidence and brought out my competitive side. Loved the high intensity games with people of similar skill level and motivation to participate as always challenging and we won. Winning is fun.

PE was fun because I was always involved and I kind of did well at it. (Interview, Amelia, state representative in hockey and volleyball)

However, several participants reported that it was frustrating and boring playing games in physical education with students who lacked motivation and preferred not to get involved in the game. These feelings toward these excluded students were derived from the subsequent lack of competition and challenge provided within the game. Bridget's reflection typifies this common personal perspective of student exclusion prior to participation in the games unit:

Core PE, they mainly separated us into girls and boys, but I played games with the boys not the girls just because it was boring to play with girls in my PE class because they didn't participate as much so, it wasn't really competitive so yeah, it frustrated me. I thought that it was pathetic that they played tennis and volleyball but they would just stand there and not hit the ball. (Interview, Bridget, state representative in hockey)

Experiences gained from participation in the games unit prompted a change in participants' perspective of student exclusion within their traditional school physical education classes. Upon reflection, participants personal feelings of frustration and boredom were replaced by empathy for these excluded students and the realisation of the importance of their inclusion in games. The inclusive nature of the CLA provided a solution to the problem of exclusion, which made the approach attractive to participants. The following post games unit reflection by Bridget illustrates her pronounced change in perspective:

The games unit appeals to me because I used to see a lot of students not included and who wanted to sit out in PE. PE should be about including *everyone and having fun, not be about getting embarrassed because you're not skilful enough. I believe that the constraint led approach allows for these things to occur. (Reflection, Bridget, state representative in hockey)*

Specifically chosen PETE students with a positive and highly successful background in traditional physical education were not expected to be as strongly attracted to an alternative approach because it engaged students of low skill level. This expectation was based on previous research which provides compelling evidence to suggest that the inclusive appeal of an alternative pedagogy is profoundly shaped by past negative personal physical education experiences of failure, exclusion and marginalisation (Light 2002; Light and Georgakis 2005, 2007). It was, therefore, assumed that contrasting past positive personal physical education experiences of dominant involvement and successful performance in team games would not facilitate a similar strength of attraction for participants in this study. However, this finding is consistent with previous similar research involving one American PETE student with a positive and moderately successful background in traditional physical education who was attracted by the inclusive nature of TGfU (Light and Butler 2005).

Two aspects of the research informed unit design and delivery can offer a credible explanation for the pronounced change in participants' perspective of exclusion in physical education (Lawson 1986; Rink 2001). First, a deliberate attempt was made in lectures and practical workshops to challenge participants' custodial, traditional beliefs through the presentation of personal reflections of PTs who had not enjoyed traditional physical education. Many of these personal reflections recounted experiences of humiliation, failure and exclusion caused by a traditional teaching approach that focused on the performance of technique that was beyond their personal capabilities and allowed skillful males to dominate games (see Light 2002; Light and Georgakis 2007; Morgan and Hansen 2008). These reflections enabled participants to gain an insight into the perspectives of less skilled and less motivated students who viewed traditional physical education differently to them. This understanding of the reasons for exclusion resulted in a more empathetic, teacher-centred perspective facilitating participants' strong attraction to the inclusivity of the CLA:

> *Why the games unit appealed to me and shaped my perspectives about teaching was the way it incorporated inclusion, which would make lessons more enjoyable for students. I guess, when I first started the games unit I wasn't really looking at the other kids in my class. I was looking at me and the people I was friends with in that class who were the real sporty kind, and I probably wasn't thinking about the other kids and how they felt in the classes. But in the lectures, it said sort of …mostly…primary school teachers - they look back and say they hated PE, and I didn't really think about those kids until it was put to me that they are embarrassed and bored. I could see it, but to me it was…they didn't want to be there full stop. (Interview, Sandy, state representative in netball)*

Second, participants experiencing the individualised practice design and delivery of the CLA as learners in practical workshops allowed them to personally experience inclusive game environments. All learning tasks afforded students the opportunity to be included in all activities and to have opportunities to experience and demonstrate success. This was because learning design incorporated small-sided games and individualised practice tasks with constraints manipulated to match students' ability level. These experiences appealed to participants as they highlighted the potential of the CLA in providing a solution for the exclusion of less skilled students in physical education classes:

> *You don't realise how much some students are excluded and embarrassed in classes until-well, I realised that in this unit, how everyone always wanted to do play and was involved in the game regardless of skill level and everyone loved it, which is very different to what I have previously experienced in schools. This was done in the unit by allowing the pairing of students of similar abilities, so that they have a chance to win and feel good and have fun. (Interview, Maddie, state representative in soccer/football)*

Practical implications of the findings

Most often, recruits' existing beliefs tend to shape the professional knowledge they acquire through teacher education programmes, rather than vice versa (Tsangaridou 2006). These findings emphasise the importance of challenging initial, custodial teaching beliefs through the introduction of alternative pedagogies at the commencement of PETE programmes. The findings of this study can be useful for informing and improving the design of alternative PETE games units aimed at challenging resistant custodial teaching beliefs of recruits who are highly successful products of a traditional physical education culture. The efficacy of a physical education teaching approach in skill development is clearly an important mediator of receptiveness for highly successful products of a traditional culture. Thus to facilitate receptiveness to an alternative pedagogy, PETE students should be given the opportunity to personally experience and observe it 'work' through the successful acquisition of movement skills as learners, just as they have previously experienced as successful products of the traditional approach. This aim can be achieved in practical workshops that adopt the principles of practice design and delivery of the alternative pedagogy. To provide the opportunity to personally experience skill development, it is important to cover a range of sports to allow students the opportunity to experience a sport as a novice. It is also important that these experiences are offered in conjunction with a clear understanding and appreciation of the learning theory that empirically supports the learning process within the design and delivery of the alternative pedagogy. The operationalised theoretical framework within a research-informed pedagogical unit design will provide students with a theoretical rationale for the perceived effectiveness of an alternative approach, and a framework for application of key principles and a justification for its future use. This receptiveness can be further enhanced if PETE recruits' custodial, traditional teaching beliefs are critically challenged through highlighting the contemporary skill acquisition and psychological failings of traditional physical education practice environments.

Future research

The impact that the CLA games unit had on the teaching beliefs of PETE recruits is encouraging. An attempt was made to maintain this attraction to an alternative pedagogy beyond the initial experience. This was undertaken through an increased intensity of exposure within the PETE programme as a result of the integration of the CLA across other units. However, the challenge is to maintain this attraction for PETE students through school practicums. Many participants in this study showed an encouraging desire to implement the CLA in schools but highlighted potential problems:

> *I'd definitely try and use the constraints led approach. It will be hard to think about all the games and stuff and try and make them up, but yeah, it just means that you've got to think about it and prepare yourself a lot more. (Interview, Josh, state representative in touch football and cricket)*

Future research is planned to investigate these PETE students' experiences implementing the CLA in a school setting on practicum and the subsequent impact these experiences have on their physical education teaching practice when they become in-service teachers. These findings would enable the constraints-based model to continue to evolve by exploring the issues that impact upon its successful teaching and learning. Knowledge gained from such studies would subsequently inform and improve the design of PETE games units and programmes aimed at changing traditional physical education teaching practice. As previous research indicates, the school practicum is not a good place for PTs to experiment with innovative practice approaches due to resistant conservative cultures of schools and many other contextual factors (Howarth 2005; Lawson 1983a, 1983b; McNeill et al. 2004; Zeichner and Tabachnik 1981). To overcome these barriers, and facilitate PETE student's successful implementation of CLA, this planned research programme will adhere to recommendations that the practicum placement site should have a culture that encourages innovative practice, with PETE students being provided with guidance and support from a university mentor and the co-operating teacher during the experience (Gurvitch et al. 2008; Howarth 2005).

Conclusion

This study has presented the features and experiences of an alternative pedagogy games unit that appealed to highly successful Australian PETE recruits with a positive background in traditional physical education. PETE educators should consider these findings when introducing an alternative pedagogy aimed at challenging PETE students' resistant, custodial, traditional teaching beliefs. This is an important first step in the evolution of physical education teaching practice towards an approach that is more compatible with the development of the psychomotor, cognitive and affective dimensions of the physical education performer.

Chapter 5: Implementing a Nonlinear Physical Education Pedagogy in an Australian School

Background: Unlike a 'linear' traditional approach where the teacher is in control of a learning environment that produces predetermined and predictable learning outcomes, the emergence of multiple learning outcomes that are not predetermined and are difficult to predict are hallmarks of the complex nature of learning within a nonlinear pedagogy (NLP). The less predictable learning outcomes that emerge as a consequence of the dynamic individual learner-environment interactions can present significant challenges to novice practitioners. This empirical research study aimed to explore PETE students' experiences associated with the less predictable and complex nature of student learning when implementing a NLP, specifically the CLA, with physical education students in a school setting.

This chapter is based on a manuscript that is to be submitted for publication in a peer-reviewed journal.

Abstract

The multiple, less predictable learner responses that emerge as a consequence of the complex nature of learning within a nonlinear pedagogy (NLP) can present significant challenges to novice practitioners. The purpose of this study was to explore two Physical Education Teacher Education (PETE) students' experiences associated with this learning process when implementing a NLP, specifically the Constraints-Led Approach (CLA), with physical education students in a school setting. Data were collected using participant and primary researcher written reflections and semi-structured interviews. The results demonstrated major challenges facing PETE students when implementing a NLP. Participants experienced difficulty detecting the less predictable pupil responses that emerged from the game structures they created. They also had difficulty manipulating constraints to allow problem solving behaviour to emerge through the natural, exploratory learning processes underpinning the CLA. These study findings can be used to inform and improve the design and delivery of PETE programmes in supporting students to effectively implement a NLP.

Introduction

In recent years there has been considerable interest in the evolution of physical education teaching practice from a traditional *teacher-centred approach* to a *student-centred approach.* Rather than the teacher emphasising the reproduction of technical skills in a highly structured, de-contextualised environment, in the student-centred approach teachers are facilitators and students are challenged to critically interpret the practice environment and solve problems through individual exploration (Davids, Chow, and Shuttleworth 2005; Lee 2003; Richard and Wallian 2005). Student-centred approaches, with their emphaisis on learning design that addresses individual needs, are important for effective learning as all learners do not learn the same way and are capable of finding different movement solutions in the same learning environment (Chow et al. 2011, 2013). Consequently, research has focused on questions about the changing conceptions of the teaching and learning process, that is, from how “we” teach to how “they” learn (Renshaw et al. 2015; Thorpe 2005a).

Undoubtedly, a contemporary theoretical model of the teaching and learning process should underpin learning design and the delivery of instruction and feedback adopted in physical education (Davids et al. 2015). The ‘founding’ *student-centred* games approach, Teaching Games for Understanding (TGfU) (Bunker and Thorpe 1982; Thorpe, Bunker, and Almond 1984), was designed for physical education teachers as a *practical approach* aimed at improving the learning experiences of children (Bunker 2012; Thorpe, 2015). The TGfU model uses four pedagogical principles: sampling, modification-representation, modification-exaggeration and tactical complexity, to provide a framework to guide teachers in

TGfU game design (Thorpe and Bunker 1989). This model contains embedded assumptions about motor learning, but was not explicitly underpinned by a theoretically-based pedagogical framework to empirically support the design of learning environments (Chow et al. 2007; Kirk and MacPhail 2002; Thorpe 2015). Rather, it was originally developed as an operational model, with teachers' practical needs in mind (Butler 2012; Renshaw et al. 2015; Thorpe 2015). Subsequently, advocates for TGfU have proposed a variety of theoretical models to retrospectively explain how learning might occur when adopting this approach in practice (Kirk and Macdonald 1998; Kirk and MacPhail 2002; Rovegno and Dolly 2006; Stolz and Pill 2014; Storey and Butler 2013).

Many of these theories have their roots in the educational learning theory of cognitive constructivism or, from a motor learning perspective, cognitive psychology, which conceptualises students as active learners who construct knowledge and understanding (or cognition) controlled at a conscious level using the mind while engaging with the environment (Eggen and Kauchak 2006; Griffin, Brooker, and Patton 2005). To develop tactical awareness and game playing ability in team games the assumption is that the learner thinks then acts, that is, mentally processes information in order to explicitly ‘understand’ and interpret the learning environment before producing functional behavioural outputs (Abernethy, Burgess-Limerick, and Parks 1994; Anson, Elliott, and Davids 2005; Wiggins 1998). Researchers have proposed that within the TGfU model, game understanding and problem-solving ability is acquired through a student’s conscious, cognitive reflective responses to teacher guided questioning during and after participation in a modified game (see Butler 2014; Griffin, Brooker, and Patton 2005; Richard and Godbout 2000).

Regardless of these largely retro-fitted rationales, many contemporary motor learning researchers have continued to express concerns about the ability of these cognitive theoretical frameworks to examine the efficacy of TGfU (e.g. Chow et al. 2007; Davids, Chow, and Shuttleworth 2005; Stolz and Pill 2014; Tan et al. 2012). This is because this primary focus on the internal conscious mental processes within the individual has neglected both the role of the environment and the subconscious control mechanisms of the body in the regulation of skill development (Abernethy, Burgess-Limerick, and Parks 1994; Araújo and Davids 2011; Dunwoody 2006; Gallwey 1979). In contrast to a cognitive perspective, an ecological perspective, based on the contemporary motor learning theory of ecological dynamics (an integration of ecological psychology and dynamical systems theory, expounded in substantial detail by Chow et al. 2009, 2011), assumes an organism-environment mutuality and reciprocity, viewing the mind (the brain), the body (musculo-skeletal system) and the environment as jointly and continuously influencing each other to shape an individual's functional emergent behaviours, such as thoughts, ideas, perceptions, and actions (Araújo, Davids, and Hristovski 2006; Gibson 1979; Lombardo 1987; Renshaw et al. 2010; Renshaw et al. 2015).

From an ecological perspective, the physical and social environment, the physical and mental capacities of each individual, and the specific task demands, all continuously interact to shape the acquisition of skill (Warren 2006). Adaptive skilled behavior emerges from this confluence of constraints as learners seek individualised movement solutions to a specific performance problem through active exploration of a learning environment (Araújo and Davids 2011; Davids, Button and Bennett 2008; Davids et al. 2015). A key aspect of an ecological perspective is that a learner's understanding of a learning environment is gained through the direct processes of perception and action, without the intervention of the mind (Davids and Araújo 2010; Davids et al. 2015). That is, a learner's decisions or actions are directly linked to perceptual information from the learning environment and, in turn, the perception of high quality information is directly linked to and acquired through their actions (Araújo and Davids 2011; Gibson 1966). This assumption has implications for physical education teachers and highlights the need to ensure congruence of practice environments with dynamic performance environments for assisting learners to regulate ongoing actions (Araújo et al. 2004; Chow et al. 2011; Davids et al. 2007; Gibson 1986).

Informing physical education learning design and delivery of instruction and feedback by a contemporary framework of motor learning, a link perceived as neglected in physical education research (Abernethy 1999; Renshaw et al. 2010), is critical in influencing the learning of movement skills (Chow et al. 2013; Davids, Button, and Bennett 2008). There is increasing evidence that motor learning is not a linear process due to the differences between individual learners and the dynamic and complex interactions present in learning environments (Chow et al. 2011, 2013). Sudden progressions and regressions in performance level accompanied by periods of an absence of change are typically observed during the learning of motor skills, suggesting that learners behave like nonlinear systems (Liu, Newell, and Mayer-Kress, 2006). To understand the learner as a complex neurobiological system, Chow et al. (2011, 2013) highlighted the key differences that describe nonlinear and linear systems (see Table 5.1). These key nonlinear features have implications for physical education learning design and delivery.

Table 5.1. Key differences between linear and nonlinear systems (adapted from Chow et al., 2011, 2013)

Nonlinear	**Linear**
• Non-proportional change (minute changes to practice task constraints may lead to non-proportional changes to performance)	• Proportionate change (minute changes to practice task constraints leads to a proportionate change in performance)
• Multi-stability (single cause may have multiple behavioural effects; learner can utilise different movement solutions to achieve the same outcome)	• Mono-stable (a single cause will result in a single behavioural effect)
• Parametric control (by altering factors external to individual, physical educators can guide learners to explore various functional organisational states within the system)	• Centralised control – alter factors within the individual.
• Functional role of variability (noise) (Variability in practice can encourage the learning system to explore multiple solutions possibilities for a task goal)	• Variability (noise) is undesirable

To acknowledge that learners behave like nonlinear, complex neurobiological systems is the platform for a physical education teaching approach, such as the Constraints-Led Approach (CLA). The CLA addresses the needs of such nonlinearity as its learning design and delivery of instruction and feedback is informed by the theoretical pedagogical framework of a NLP, which provides a sound theoretical model of the learner and of the processes of learning based on the contemporary motor learning theory of ecological dynamics (Chow et al. 2011, 2013; Renshaw et al. 2015). Previously more broadly aligned with applications to games and other physical activities by sport and human movement scientists rather than physical education teachers, the CLA has similar practical operational principles to TGfU. Both approaches challenge learners to solve common tactical problems through performance exploration in representative practice environments, modified to regulate skill level and to emphasise particular aspects of performance (Bunker and Thorpe 1982; Thorpe 2005a; Thorpe, Bunker, and Almond 1984; Renshaw et al. 2009). The essential distinguishing feature of the CLA is that its practice design and delivery of feedback and instruction is grounded in a contemporary, ecological perspective of motor control and learning within a NLP framework (Chow et al. 2011). Because of this it can be more accurately described as a student or learner-environment-centred approach rather than a student-centred approach (Renshaw et al. 2015). Furthermore, unlike TGfU, the CLA is an interdisciplinary methodology that has been successfully applied beyond the tactical focus of games to performance activities such as long jumping (Greenwood, Davids, and Renshaw 2014), swimming (Seifert et al. 2014) and spring- board diving (Barris, Farrow, and Davids 2014).

TGfU and many of its derivatives, such as Game Sense, could also be categorised as nonlinear informed pedagogical approaches (see Renshaw et al. 2015 for an extended discussion of this point). Although TGfU was not explicitly built on a theory of motor control and learning, recent literature has proposed the motor learning theory of ecological dynamics within a NLP to provide a comprehensive theoretical framework to support the principles of learning design in pedagogical approaches like TGfU (see Chow et al. 2016; Stolz and Pill 2014; Storey and Butler 2013; Tan, Chow, and Davids 2012).

From a pedagogical perspective, the CLA views human behaviours as emergent properties of complex, nonlinear neurobiological systems that continuously adapt and change their organisational states by exploiting inherent, spontaneous self-organisation processes while seeking stable movement patterns as solutions to performance problems (Chow et al. 2013). This process is regulated by the continuous, dynamic interactions of each learner's unique individual constraints (defined as boundaries that shape each learner's emergent behaviours by limiting the number of available actions, see Davids et al. 2003; Newell 1986), and those of the task and performance environment. These interactions create instability in the learner who self-organises from within facilitating the emergence of functional movement patterns (Newell 1986; Newell, Liu, and Mayer-Kress 2008; Tan, Chow, and Davids 2012). Performer or individual constraints refer to the specific physical, physiological and psychological characteristics of learners, such as height, physical fitness, and motivation levels. Environmental constraints refer to physical, social and cultural factors surrounding the performer, such as practice surface, the teacher or coach, and availability of facilities. The goals and rules of the activity, scoring systems, equipment and field dimensions are examples of task constraints (Newell 1986). To illustrate how the interaction of constraints shape emergent behaviour, a learner's unique running technique can be allowed to emerge as a function of the continuous, dynamic interactions of their unique individual constraints (e.g. body weight), the task constraints (e.g. running distance) and environmental constraints (e.g. hilly terrain) imposed on him or her. The CLA approach to learning design is not to simply allow 'freedom of play' during lessons, but rather to carefully manipulate representative learning environments using task constraints that channel learners' search within a narrower area (limited number of movement solutions) of the modified practice environment towards 'selected' and more 'obvious' functional movement solutions (Chow 2013; Tan, Chow, and Davids 2012).

Based on the theoretical framework of ecological dynamics, proponents of NLP have identified key pedagogical principles to effectively channel learning design and delivery of instruction and feedback for coaches, performance analysts, movement practitioners and physical education teachers (Chow 2013; Renshaw et al. 2009). The key pedagogical principles of NLP are: self-organisation under constraint manipulation, representative practice design, attunement to affordances, information-movement or perception-action couplings, task simplification, harnessing functional adaptive variability in practice, and implicit learning aligned with feedback and instruction focusing on external movement outcomes of an action (see Chow 2013; Chow et al. 2016; Davids, Button, and Bennett 2008; Renshaw et al. 2009).

The NLP pedagogical principle of self-organisation under constraint manipulation challenges the misconception that there is one common optimal movement solution for a task towards which all learners should aspire (Chow et al. 2007). This principle is predicated on the inherent adaptive movement variability and degeneracy of human movement systems, that is, learners have the ability to self-organise in many different ways to develop a variety of coordination patterns to achieve the same outcome or task goal (Davids, Button, and Bennett 2008; Lee et al. 2014). To exemplify, a learner's kicking technique can be allowed to emerge as a function of the continuous, dynamic interactions of their unique individual personal constraints (e.g. leg strength), the task constraints (e.g. game rules, scoring, equipment, playing dimensions) and environmental constraints (e.g. playing surface) imposed on him/her. Task constraints are the most important constraints for physical educators as they can be easily manipulated within learning design.

A key concept underpinning ecological psychology is the mutual interdependence of an individual's actions and their perceived environment (Gibson 1986). Learning takes place as a consequence of these interactions between the learner and the environment (Chow 2013). The implication of this concept for physical educators is the need to design practice environments that are representative of the performance environment containing key information sources such as, location of defenders and attackers, pitch size and field markings (Pinder et al. 2011; Silva et al. 2014; Vilar et al. 2014). Representative practice task designs allow learners to perceive and detect affordances for action (i.e. information in the environment that supports an opportunity for action relative to an individual's action capabilities, such as a narrow gap between defenders for a player with speed to dribble through, see Fajen, Riley, and Turvey 2009). Through practice, learners attune their movements to these key information sources, thus establishing functional information-movement or perception-action couplings which they can use to achieve different task goals and which are transferrable to performance in competitive games (Renshaw, Davids, and Savelsbergh 2010). The more representative a practice task is, the more specific is transfer to a competitive game environment (Davids et al. 2015).

Allied with representative practice design is task simplification, which preserves the coupling of actions to key information sources but simplifies the task (see Renshaw et al. 2009). For example, simplifying the whole hurdling action by manipulating the task constraints of hurdle height and hurdle interval (see Moy, Renshaw, and Davids 2016). Task simplification differs considerably from task decomposition, which is a default way of structuring learning environments. The decomposed practice of isolated sub-components of the 'whole' task (e.g. hurdle trail leg) separates the relevant information-movement couplings, leading to the re-organisation of the timing and coordination of a movement pattern (Handford 2006; Renshaw et al. 2007; Renshaw, Davids, and Savelsbergh 2010).

The dynamics of sporting performance environments supports the efficacy of performers developing functionally variable movement patterns. For example, during competition a long jumper may need to subconsciously make adjustments to their run up in response to fatigue, running surface and weather conditions (Renshaw et al. 2009). The implication for NLP learning design is that the coach or teacher might seek to replicate the dynamics and unpredictability of a performance environment by incorporating functional variability in practice such as changing opponents in 1 v 1 games. This would encourage learners to explore multiple individualised functional coordination patterns to cope with subtle changes in the performance environment (Bernstein 1967; Chow and Atencio 2014; Renshaw et al.

2009). This will result in participants becoming more adaptable performers with greater levels of functional variability within their movement patterns (Barris, Farrow, and Davids 2014; Davids et al. 2007; Seifert and Davids 2012).

Within the NLP pedagogical framework, learning takes place implicitly through natural subconscious exploratory processes with feedback self- generated (Chow et al. 2009). To complement exploratory self-organising processes, CLA methods of instruction largely direct learners' focus of attention on external movement outcomes of an action (i.e. run in a straight line) rather than on an internal focus on control of body movements or limb segments (i.e. slight forward rotation of the hip) involved in (re)producing an action (Chow et al. 2009; Peh, Chow, and Davids 2011). Typically movements are not controlled at a conscious level and instruction with an internal focus on the body directs learners to more conscious control of movement, interfering with automatic control mechanisms that regulate movements of the body subconsciously (Bernstein 1967; Davids, Button and Bennett, 2008). A focus on the external movement outcome of an action compliments learner exploration and promotes a more automatic mode of control resulting in a positive effect on learning and performance (Peh, Chow, and Davids 2011; Wulf and Su 2007).

There is extensive theoretically-informed research evidence to demonstrate that adopting these NLP pedagogical principles in practice effectively meets the skill acquisition and psychological needs of the individual performer (Chow 2013; Chow et al. 2007; Renshaw et al. 2010; Renshaw, Oldham, and Bawden 2012; Tan, Chow, and Davids 2012). This theoretical grounding has been supported by many empirical studies that have demonstrated performance improvement in athletes in an elite sports coaching setting (Barris, Farrow, and Davids 2014; Greenwood, Davids, and

Renshaw 2014; Pinder, Davids, and Renshaw 2012; Seifert et al. 2014) and performance and psychological enhancement in Physical Education Teacher Education (PETE) students in a university setting (Moy, Renshaw, and Davids 2016; Moy et al. 2016). However, it is important that more practical empirical research investigates the application of the NLP principles with physical education students in school settings. According to Chow (2013), the CLA offers some potential for enhancing teacher education in the 21st century and more research is needed to identify the challenges and practical implications facing practitioners when implementing a nonlinear pedagogical approach in a school context.

Unlike a 'linear' traditional approach where the teacher is in control of a learning environment that produces a single predetermined and predictable learning outcome (Tinning and Rossi 2013), the emergence of multiple learning outcomes that are not predetermined and are difficult to predict are hallmarks of the complex nature of learning within a nonlinear approach (Davids et al. 2008; Chow et al. 2013). The less predictable learning outcomes that emerge as a consequence of the dynamic individual learner-environment interactions are thought to present significant challenges to novice practitioners (Chow 2013). To successfully teach using an emergent nonlinear approach, previous research has suggested that it is necessary to have a clear understanding of the learning process and advanced observational and analytical skills (Butler 2014; Chow 2013; Hopper, Butler, and Storey 2009; Howarth 2005). According to Howarth (2005) these skills are unlikely to be found in novice teachers, such as PETE students.

Aim of the study

This empirical research study aimed to explore PETE students' experiences associated with the less predictable and complex nature of learning when implementing a nonlinear informed pedagogical approach, specifically the CLA, with physical education students in a school setting. The practical implications of these findings would further build on the knowledge and understanding of the CLA and subsequently inform and improve the design and delivery of PETE programmes in preparing and supporting students to effectively and authentically implement a NLP on practicum and in their future teaching careers. This has the potential to result in opportunities for enhanced student learning and performance of motor skills in physical education classes.

Method

Study design

Previous research indicates the school practicum is not a good place for novice PTs to experiment with innovative teaching approaches because of resistant conservative cultures of schools and many other hindrances (Howarth 2005; Lawson 1983a, 1983b; Tinning et al. 2001; Zeichner and Tabachnik 1981). Contextual hindrances identified were limited space, sports facilities, and equipment and short class duration (Gurvitch et al. 2008; Li and Cruz 2008; Light and Butler 2005; McNeill et al. 2004; Wang and Ha 2013a, 2013b; Wright et al. 2006; Wright, McNeill, and Fry 2009). Hindrances related to the pupils were poor behaviour and discipline (Wang and Ha 2009, 2013b), limited physical and cognitive skills to play games properly (McNeill et al. 2004; Rossi et al. 2007; Wang and Ha 2009, 2013b; Wright et al. 2006; Wright, McNeill, and Fry 2009) and pupils' unfamiliarity with the innovative approach (McNeill et al. 2004; Wright et al. 2006; Wright, McNeill, and Fry 2009). Hindrances related to the PTs themselves were the challenge of managing large class sizes (Li and Cruz 2008; McNeill et al. 2004; Wang and Ha 2009, 2013b; Wright et al. 2006), PTs' lack of game experience and associated technical and tactical knowledge and understanding (Gurvitch et al. 2008; Howarth 2005; Li and Cruz 2008; Light and Butler 2005; Wang and Ha 2012, 2013b) and increased lesson planning time (Gurvitch et al. 2008; Light and Butler 2005; McNeill et al. 2004; Wang and Ha 2009). PTs' inexperience with, and lack of conceptual knowledge and understanding of the innovative teaching approach and its underpinning learning theory made it challenging for them to design appropriate games and implement the approach authentically using skills such as questioning (Gurvitch et al. 2008; Howarth 2005; Li and Cruz 2008; McNeill et al. 2004; Rossi et al. 2007; Wang and Ha 2009, 2013b; Wright et al. 2006; Wright, McNeill, and Fry 2009). A lack of support and guidance by cooperating teachers was also found to be a hindrance for PTs when implementing an innovative teaching approach (Gurvitch et al. 2008; Light and Butler 2005; McNeill et al. 2004; Wang and Ha 2009, 2013b; Wright, McNeill, and Fry 2009).

To overcome these identified hindrances, and facilitate PETE students' successful and authentic application of the pedagogical principles of NLP underpinning the CLA in their first ever school teaching experience, this study aimed to create a contextually supportive and simplified teaching environment. Thus, the practicum placement site was deliberately chosen as it had a culture that encouraged innovative practice. Additionally, the 2 PETE students were provided with guidance and support from the primary researcher and their supervising/cooperating teacher during the experience. Also, class sizes were small, adequate space, sports equipment and lesson time was provided, selected classes consisted of pupils who were well-behaved, and generally well-skilled and experienced in a variety of sports. In line with the recommendation of Thorpe (2005b), to facilitate PETE students' identification of relevant tactical concepts, the subsequent planning of relevant learning experiences to achieve intended tactical outcomes, and the observation, interpretation and adaptation of game play, each participant was allocated a familiar sport in which they had successful and extensive playing experience and a self-reported depth of game content and tactical knowledge and understanding. This action-based research design incorporated a level of support for PETE students beyond what is considered normal during a practicum experience. However, this enabled the focus to be on the examination of the teaching and learning processes associated with the key pedagogical principles of NLP implemented through the CLA.

Participants

A purposive sample of two second-year PETE students from an Australian university was recruited for the study. Participant selection was based on meeting the pre-specified selection criteria of a demonstrated receptiveness to the CLA and also a demonstrated confidence, ability, willingness and enthusiasm to implement the approach within a school setting (Denzin and Lincoln 2005). For this study, potential participants were identified from within a group of ten PETE students who were recruited for an earlier study by the same primary researcher (see Moy et al. 2016). That study explored the features of a constraints-based PETE games unit that appealed to PETE recruits who were highly successful products of the traditional physical education teaching approach (i.e. state or national representative in sporting games). From this group two PETE students who met the selection criteria were individually approached to volunteer for the research study via email and subsequently accepted with great enthusiasm. Max (pseudonym) was 20 years old at the time of the study and had a successful and extensive sporting background in soccer, volleyball and basketball. Melinda (pseudonym) was 19 years old at the time of the study and also had a successful and extensive sporting background particularly in basketball and volleyball. Both students were high achievers as reflected by their outstanding university grades, and had ongoing experience working with secondary school aged pupils, Max as a school boarding master and Melinda as a coach of school sporting teams. The benefit of this previous experience was evident in their confident manner and control over learning environments they demonstrated in peer teaching episodes in the university setting. Both students were products of a very sports-oriented family environment, Melinda's mother having represented Australia in basketball and Max's father a successful, long-term physical education teacher and sports coach. Max and Melinda were initially exposed to the CLA approach in a games unit in the first year of their PETE course, and further exposed to the CLA in two second-year units, including a curriculum unit. In this curriculum unit, taken by the primary researcher, they successfully implemented the CLA in small peer teaching environments. Melinda also independently chose to experiment with the CLA in her basketball coaching at a local school. To improve their knowledge and conceptual understanding of the alternative pedagogy and also to gain further practical experience in its implementation, both Max and Melinda worked as tutor assistants in the constraints-based PETE games unit immediately prior to the practicum experience. This involved them working closely with the tutor as learning facilitators in 8 x 4-hour practical workshops that adopted the key pedagogical principles of NLP underpinning the CLA.

Setting

The school

The two study participants were given the opportunity to implement the CLA within a supportive school culture while on their first physical education teaching practicum. The head of Marcellin College's (pseudonym) physical education department offered the opportunity for the research study to be undertaken with the school's physical education classes. At the time of the study the head of physical education was employed by the primary researcher as a tutor in the constraints-based PETE games unit and had also successfully implemented the approach in his physical education classes and sports coaching. Marcellin College is an independent boys college in an inner city suburb of an Australian capital city, comprising over 1500 students. The college has a proud sporting history and culture and is well resourced in terms of oval space, equipment and facilities to run an effective physical education program. The college has six full-time and three part time physical education teachers, all male, covering the teaching of over 30 classes of physical education from Years 5 (10 year olds) to year 12 (17 year olds).

University mentor (primary researcher)

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

Practicum supervising teacher mentors

The selection of supervising or cooperating teachers for the study was based on an eagerness to be exposed to a new alternative pedagogy and a commitment to working with the primary researcher and the study participants throughout the entire 4-week length of their practicum. This commitment necessitated allowing both Max and Melinda to experiment implementing the CLA in at least one of their physical education classes and allowing the primary researcher to supervise and give guidance during this implementation. Melinda's allocated supervising teacher, Peter (pseudonym) had over 25 years experience teaching physical education, while Max's cooperating teacher, Bernie (pseudonym), had over 12 years experience. Both Peter and Bernie self-reported, to the primary researcher, the predominant use of a traditional drill-based physical education teaching approach in their classes. Although having previous exposure to Game Sense through professional development sessions, they both admitted to having very limited practical experience implementing the alternative approach in their own classes. This restricted their capability to provide feedback or advice specific to the CLA during the practicum, thus their role was secondary to the primary researcher, giving feedback to students purely from an organisational and discipline perspective such as behaviour management strategies and teacher positioning.

CLA games teaching units

Max was allocated 8 x 60 minute soccer lessons with a year 9 class of twenty 14-year-old students, and Melinda was allocated 8 x 60 minute basketball lessons with a year 10 class of eighteen 15-year-old students, in which to implement the CLA over the 4-week practicum. Both PETE students reported that their previous sporting experience had allowed them to gain an in-depth knowledge and understanding of the tactics and strategies associated with these sports.

As the CLA is an emergent pedagogical approach (Davids, Button, and Bennett 2008), and each session builds on the specific learning that takes place in the previous lesson, rather than following a set scheme of work that determines in advance each session's aims and objectives, lessons were planned progressively to help learners solve identified game-related tactical problems. The PETE students observed pupils' participation in games in the first lesson of their respective units. From these observations, and in collaboration with the primary researcher, the PETE students identified common examples of pupils' lack of tactical awareness when responding to a tactical problem in a game. The associated possible causes of their poor tactical response were also identified. The desired pupil learning outcome for each lesson was then written in terms of this tactical problem-solving behaviour and associated principles of game play (see Table 5.2 for an example).

Table 5.2. Example of learning environment designed to solve an identified common game-related problem, guided by key NLP pedagogical principles.

LESSON CONTEXT:
SPORT: Soccer/Football **YEAR LEVEL:** 10 **CLASS SIZE:** 20 **DURATION:** 60 minutes

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 by rushing a pass forward to a marked teammate.

POSSIBLE CAUSE OF PROBLEM: Support - No safe backward or lateral passing option available as teammates are not in supporting positions to the side and behind the player in possession of the ball.

DESIRED PUPIL PROBLEM SOLVING BEHAVIOUR: When a defender pressures the player with the ball and teammates forward are marked (problem), the player with the ball maintains possession by looking for and choosing the safer option of passing the ball backwards or across to an unmarked teammate (solution).

MODIFIED REPRESENTATIVE PRACTICE TASK: "SAFE PASSING" (6 v 6, normal rules)

(i) **Problem:** Player with the ball under pressure to pass

Task Constraint to emphasise (exaggerate) the tactical problem: Players in possession have a maximum of 3 touches on the ball, before losing possession.

(ii) **Desired problem-solving behaviour:** Player with the ball maintains possession by looking for and choosing the safer option of passing the ball backwards or across to an unmarked teammate.

Task Constraint to present 'obvious' solution (affordance for action): One allocated player in each team wears a different coloured bib, who must be positioned in line with or behind the ball and has 3 touch/5 seconds of immunity when in possession of the ball, that is, cannot be tackled by defenders, who must stay 5 metres away for 3 touches/5 seconds).

These learning environments were planned progressively by the PETE students in collaboration with the primary researcher to ensure that the CLA learning design and delivery was authentically represented. Tutor workbooks used in the constraints-based PETE games unit were provided to Max and Melinda as they contained many examples of games manipulated by constraints to solve common basketball and soccer related tactical and technical problems. The day prior to each lesson the PETE student would submit a lesson plan to the primary researcher, who would evaluate and then give feedback related to the application of the key pedagogical principles of NLP and the plan was accordingly modified. During the latter stage of the practicum the PETE students were given the opportunity to independently design modified learning environments to facilitate the emergence of a predetermined movement solution to a tactical problem.

Fidelity (valid representation of CLA and its implementation)

When investigating learning outcomes associated with the implementation of an alternative pedagogy, such as NLP, the learning experience design and delivery need to be considered as authentically representative of that pedagogy (Hastie and Casey 2014; Smith and Ragan 1999). To ensure this authenticity the key operational and pedagogical principles of NLP, as outlined by Renshaw et al. (2009) and Tan, Chow, and Davids (2012), guided the design and delivery of learning environments to allow players the opportunity to learn to solve game-related tactical problems (see Table 5.2 for an example). As the study participants were novice teachers and had limited instructional experience with the CLA it was accepted that establishing an 'ideal' model of the CLA would be beyond them. Therefore, for the purpose of this study, a 'ball park' model of the CLA was deemed acceptable, conditional on the presence of the key pedagogical features applicable to this study. To establish acceptable fidelity of the CLA this study incorporated a systematic observation of classes using a validation tool (see Table 5.3) to verify that the key contextual, operational and pedagogical requirements of the CLA were present in lessons conducted by the PETE students (Metzler 2005). This checklist was specifically generated for use by tutors when observing PETE students implementing the CLA in university classes. The primary researcher observed all lessons referring to the checklist to verify that features were sufficiently present in the learning experiences for inclusion in the study. Acceptable validity was also established using a method adopted in previous similar studies of an expert independent observer who viewed and verified randomly selected lessons (Harvey, Cushion, and Massa-Gonzalez 2010; Harvey et al. 2010). Upon completion of this process the researcher was confident of the fidelity of implementation of lessons representing the key features of the CLA.

Table 5.3. CLA Lesson Observation Checklist (adapted from Chow et al. 2016)

Key Contextual, Operational and Pedagogical Requirements of the CLA	**√**
Practice Environment Representative of Performance Environment: • Key information sources present (e.g. defenders) • Simplified environment (e.g. small-sided game) • Replicates less predictability/variability (e.g. game)	
Task constraints in place to: • Emphasise (exaggerate) the tactical problem • Present 'obvious' solution to the tactical problem (affordances for action)	
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	

Data collection

To address the study aims a qualitative, case study methodology was employed since this research method allowed a rich, detailed and in-depth interpretation of the PETE students' experiences and perceptions of implementing a

CLA (Creswell 2002). The case study research design has previously been used to examine both PETE students' and in-service teachers' experiences when delivering alternative pedagogies (Deenihan and MacPhail 2013; Ingersoll, Jenkins, and Lux 2014; O'Leary 2014). The key pedagogical principles of NLP associated with the complex and less predictable nature of learning within the nonlinear CLA, guided data collection and analysis. The data collection methods utilised were documentary evidence, in the form of post lesson written reflections, observations with written reflection and semi-structured interviews.

Post lesson written reflections (PETE students)

Detailed post lesson written reflections acted as a means of creating the narrative of the PETE students' experiences and perceptions in implementing the CLA in a physical education class. A personal reflection was completed using a structured template provided by the primary researcher and submitted by PETE students within 24 hours of lesson completion. The personal reflection template incorporated contextual information about the lesson including date, activity, year level, class size, lesson duration, lesson number in series, game-related problem to address, and desired pupil problem-solving behaviour. PETE students' reflective responses were guided by four questions/requests, which incorporated a critical incident reflection (Flanagan 1954; Tripp 2011): (i) Reflecting on your knowledge about the constraints-led approach itself please tell me about your personal experiences of the effectiveness of the learning experiences in achieving the desired pupil learning outcome? (What happened? What behaviour was emergent? Did the constraint work? Anything unexpected, i.e. different outcome achieved? Please provide evidence.); (ii) Reflecting on your skills in planning, how well did you plan the constraints-based learning experiences? (Identification of specific game problem and possible causes, design of game with constraint to allow students to solve problem and for desired behaviour to emerge. Please provide evidence); (iii) Reflecting on your skills in implementing the constraints-led approach, please tell me about your personal experiences in the lesson today, i.e. how well did you implement the learning experiences? (Hands-off involvement, class organisation, observation of emergent behaviour, instruction); (iv) Describe one critical incident about the constraints-led approach that you found particularly significant during the lesson (made you excited, shocked, worried). Please explain why it was significant.

Observations and post lesson written reflections (primary researcher)

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

Semi-structured interviews

At the completion of the practicum the primary researcher separately interviewed each PETE student. The face-to-face interviews were semi-structured in nature, consisting of open-ended questions designed to allow PETE students to elaborate on their perceptions and overall experiences implementing the CLA. Each interview, which lasted approximately 60 minutes, was audio taped and later transcribed verbatim. The following are examples of interview prompts: How successful were you at observing pupils' emergent behaviours (i.e. the pupil responses to game constraints)? From your experiences over the last four weeks, what have you learned about the skill of designing practice environments using constraints to help achieve specific student learning outcomes?

Data analysis

For each lesson, the PETE students' and researcher's post lesson written reflection were combined so all data relevant to each lesson were together. These data sources and the transcribed interview data were analysed collectively using thematic analysis to identify repeated patterns of meaning within the data (Braun and Clark 2006). This process involved the following steps: (1) repeated reading to become familiar with data, (2) coding raw data, (3) collating similar codes together into tentative themes, (4) reviewing, reducing and refining themes, and (5), defining and naming themes. Identical methods of data collection and data analysis have been adopted in recent similar studies investigating pre-service and in-service teachers' experiences when implementing alternative pedagogies (Deenihan and

MacPhail 2013; Ingersoll, Jenkins, and Lux 2014; O'Leary 2014; Stran, Sinelnikov, and Woodruff 2012).

Trustworthiness of data

Trustworthiness is established when research findings authentically and accurately represent meanings as described by the participants (Lincoln and Guba 1985). In this study trustworthiness was established, and consequently findings strengthened, through the triangulation of data from multiple sources to cross check information and support similar themes (Patton 2002). Further strategies used in this study to establish trustworthiness included ongoing peer debriefing between the researcher and two colleagues experienced in qualitative methodologies to check and share interpretations of data and arrive at consensus (Creswell 2007). Participants were also given the opportunity to verify the accuracy of the content and researcher interpretations of interview transcripts and lesson reflections (Merriam 1998). Finally, at the conclusion of the analysis, a competent qualitative researcher was asked to review the original data and subsequent analysis of it (Lincoln and Guba 1985). Similar strategies were successfully utilised to establish trustworthiness and strengthen findings in previous comparable qualitative investigations (Deenihan and MacPhail 2013; Ingersoll, Jenkins, and Lux 2014; O'Leary 2014; Wang and Ha 2009).

Results and Discussion

This action-based empirical research study's aim was to explore PETE students' experiences associated with student learning when implementing a NLP, specifically the CLA, in a school setting. As predicted by Chow (2013), implementing the CLA presented significant challenges to novice practitioners, due to the less predictable and complex nature of student learning as a consequence of the dynamic individual learner-environment interactions. The following section identifies two prominent themes that were established from the data analysis related to this aim, (i) the detection of less predictable emergent pupil responses, and (ii), the manipulation of the learning environment to channel learners' search towards predetermined emergent problem solving behaviours.

The detection of less predictable emergent pupil responses

The PETE students had little difficulty detecting and interpreting the single predetermined or 'linear' pupil response predicted to emerge through exploration of the modified learning environment. For example, a modified football or soccer game was designed to solve the identified problem of loss of possession, due to players taking too many individual touches when under defensive pressure. The task constraint (rule) of a maximum of 8 consecutive touches per team was introduced to guide individual learners to search for the desired solution of taking fewer individual touches when under pressure, while scanning the performance environment and making decisions related to passing to an unmarked teammate. Max detected and interpreted the successful achievement of the predetermined intended learning outcome by many pupils in the class.

> *I noticed that a highly skilled student, who was identified as a dominant selfish player, who previously took too many individual touches, achieving success from this game. This problem was solved in this game because I noticed him and other less skilled players, who previously just 'booted' the ball without looking, taking a touch and looking up for teammates who*

were open/unmarked in space. This game directed him and others to play the ball to unmarked teammates. (Lesson Reflection, Max)

However, as suggested by Chow (2013), the less predictable and complex nature of student learning when implementing a NLP proved a significant challenge to our novice practitioners. The PETE students rarely detected any of the multiple pupil responses that 'unexpectedly' emerged from their modified learning environments, as detected by the primary researcher. These responses are difficult to predict as, operating as a nonlinear system, a learner's response emerges as a consequence of the dynamic individual learner-environment interactions within the complexities of a team game (Chow et al. 2013). These less predictable individual responses are a consequence of the complex interactions of the individual learner's intrinsic dynamics (e.g. passing skill), the game environment (e.g. weather conditions) and the task constraints (e.g. game rules), within the game context (Chow and Atencio 2014; Chow et al. 2011, 2013; Renshaw et al. 2010). For example, in the maximum 8 consecutive team touches soccer game, a player's response of a long or short pass is difficult to predict, as kicking distance is a consequence of the complex interaction of the individual player's kicking ability, the presence of any strong tail or head wind, and the number of team touches remaining.

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

Further complicating game play prediction for practitioners is that, from an ecological dynamics perspective, a player's behaviour is attuned to their own action capabilities and those of their teammates and opponents, making affordances subjective to the individual (Fajen, Riley, and Turvey 2009). Different opponents and teammates afford different movement possibilities and different game play patterns emerge when challenged to play with and against different opponents. For example, if a player has the capability to accurately pass long to a competently skilled teammate who is in space, the free player acts as an affordance for action. However, if the player in possession knows that the free player is poorly skilled at controlling a long pass and that the closest defender is quick and skilful at interception, the long pass may be considered, but not executed. To better understand and interpret players' responses a teacher needs to be able to perceive these affordances from the perspective of the players rather than their own **(**Fajen, Riley, and Turvey 2009). The teacher also needs to understand that, through practice and learning in lessons, pupils can begin to share affordances, enhancing their opportunities to co-operate in team work and enhance their knowledge of the competitive performance environment (Silva et al. 2013).

The PETE students' apparent lack of experiential knowledge and conceptual understanding of this complex and dynamic interacting emergent learning process made it challenging for them to detect and interpret their learners' complex and less predictable responses to the game structures they created. These findings are consistent with previous research that has suggested a deep understanding of the learning process, and advanced observational and analytical skills, are necessities to successfully teach an emergent nonlinear curriculum (Butler 2014; Chow 2013**;** Hopper, Butler, and Storey 2009; Howarth 2005). According to Howarth (2005) these skills are more likely to be found in an expert teacher than in pre-service teachers. The primary researcher in this study, who is considered an expert teacher, is testimony to this assumption. He detected and interpreted multiple less predictable emergent responses when afforded the luxury of observing lessons without the distraction of lesson management. For example, after observing the maximum 8 team touches soccer game he reflected:

> *In the 8-touch soccer/football game I observed many 'unpredicted' emergent behaviours. Teammates, now expecting a pass, were no longer congested around the ball and spread out across the width of the field to offer passing options. They received the ball in space, which allowed them*

time on the ball. Some players were now passing long to gain as much ground as possible with fewer touches remaining. So as not to waste touches, many players' body shape adapted to side on to receive the ball, which also opened up their field of vision. Overall the passing was quicker and more accurate, in response to the defence applying more pressure on the ball. (Reflection, Primary Researcher)

However, with 2 weeks of experience of teaching a NLP, in combination with guidance from the primary researcher, the PETE students quickly developed a better understanding and awareness of the complex interactions that occur within the dynamics of a team game. This resulted in improved detection of these varied and less predictable emergent game play patterns. For example, to solve the problem of basketball players shooting from low percentage court positions, Melinda introduced the task constraint of extra points if a team scored from a shot taken from inside the keyway. As well as detecting the expected response of players shooting from closer to the basket, Melinda detected and interpreted the unpredicted emergent response from the offence of cutting towards the basket to receive the ball rather than waiting outside the keyway for the pass, as they had done previously. To solve the problem of the attacking team being slow on transitions and allowing the defence time to reorganise, Melinda introduced the constraint that when a player committed a rule violation each member of the violating team had to run around a different cone on the sideline before re-joining play. This created the affordance of a disorganised and vulnerable defence. Melinda detected the expected response of the non-offending team urgently restarting play from the sideline/baseline. She also detected and interpreted the less predictable emergent response of players advancing the ball up the court quickly by passing not dribbling, and attacking teammates running into space to support the ball carrier and provide numerical superiority.

The manipulation of the learning environment

The ability to manipulate the learning environment to facilitate the emergence of learners' tactical problem solving behaviour is considered a crucial ingredient to successfully teach student-centred, game-based approaches (Howarth 2005). In the first 2 weeks of the practicum, to ensure that the CLA learning design and delivery was authentically represented, modified learning environments were either taken directly from resources used in the previously completed constraints-based PETE games unit or designed by the PETE students in collaboration with the primary researcher. These learning environments were generally successful in channelling learner's search towards predetermined emergent movement solutions to tactical problem. During the latter stage of the practicum the PETE students were given the opportunity to independently design and implement modified learning environments to achieve this same outcome, without any collaboration with the primary researcher. This task proved challenging for the PETE students. Although the modified learning environments they designed were often successful in generating the predetermined movement solution to a tactical problem, their task constraints provided limited opportunity for this problem solving behaviour to emerge through the natural, exploratory learning processes underpinning the CLA. For example, a tactical problem identified in Melinda's basketball class was that the attacking players easily penetrated forward through the defence, as the nearest defender did not pressure their opponent with the ball when he threatened space in front of them. To achieve the desired problem solving behaviour of defensive pressure on the attacker with the ball, Melinda manipulated the game design by introducing the rule or instructional task constraint that, if the player with the ball is tagged, possession is transferred to the defending team. Her reasoning was that, by introducing a constraint that rewards defensive pressure, players would pressure the ball carrier and force the attack back or across or force an error. The result was that the nearest defending player constantly pressured the ball carrier.

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

Although this instructional task constraint was successful in generating the predetermined problem solving behaviour, it constructed a very narrow task space, provoking learners' search for an imposed single solution of pressuring the ball carrier. This happened regardless of the existence of the key affordance of an attacker threatening to penetrate forward through the defence. This design feature denied learners the opportunity to explore a range of possible solutions within a broader task space and for their individual functional movement solution to emerge implicitly through the process of self-organisation under interacting constraints (Chow 2013; Davids, Button, and Bennett 2008). Finding the right balance to ensure that task constraints provide a tight, controlled boundary, as well as opportunities for exploring functional problem solving behaviours is a challenge even for experienced learning designers (Chow et al. 2011).

When the manipulated environment provokes learners' search for an imposed single 'selected' solution, players learn the technical skills associated with '*what*' to do, but do not have the opportunity to learn the perception and decision-making associated with that tactical response, that is, '*when*' to do it. For example, in this case the key affordance of an opponent with the ball threatening to penetrate space in front of a defender (i.e. the 'when') needed to be emphasised within the learning environment. This would allow players the opportunity to learn to detect and become attuned to the key information associated with the problem that would necessitate the search for a particular tactical response or decision from the defender (i.e. the 'what'), such as applying defensive pressure or alternatively defending the basket (Chow et al. 2007; Renshaw, Davids, and Savelsbergh 2010; Tan, Chow, and Davids 2012). This decision of what to do in this situation is also dependent upon many other factors such as court position, game score and the skill level of the player with the ball. If players are constantly engaging in the tactic of applying defensive pressure, over time they may still learn to detect the key affordances associated with when they should immediately close down the player with the ball and when they should search for an alternative problem solving behaviour such as defending the basket.

This type of restrictive instructional task constraint is better used to pose a single tactical problem (key affordance) to the learner, necessitating the generation of exploratory problem solving behaviours in response (action). As previously mentioned, within a team game individual players function as part of this larger system co-adapting their actions to the actions of teammates and opposition players (Passos and Davids 2015). In Melinda's modified basketball game, the tactical problem of defensive pressure on the player in possession of the ball was posed to the attacking team through the instructional task constraint of the player with the ball losing possession if tagged. This necessitated the exploration of a functional problem solving action by the attacking team in response. This responsive behaviour was allowed to implicitly emerge through the typical exploratory learning processes underpinning the CLA. The primary researcher detected such emergent problem solving behaviour in the modified basketball game:

> *In this learning environment I observed that attacking players implicitly responded to the defensive 'on ball' pressure by dribbling less, scanning the court for opportunities to pass before and after gaining possession of the ball and executing quick passing. Attacking players now provided passing options for the ball carrier, moving into space away from defenders to prevent being immediately tagged and losing possession when catching a pass. The whole game intensity also increased. (Reflection, Primary Researcher)*

PETE students' use of instructional constraints, that prescribed tactical movement solutions rather than facilitated opportunities for them to implicitly emerge, exposed a lack of conceptual understanding of the natural exploratory learning processes underpinning the CLA and the co-adaptive and regulated interactions that occur within the dynamics of a team game. This finding is consistent with previous research that suggested that a conceptual understanding of the learning process is necessary to successfully implement an emergent nonlinear curriculum and would unlikely be found in a pre-service teacher (Butler

2014; Chow 2013; Hopper, Butler, and Storey 2009; Howarth 2005). This was evident in a study by Wang and Ha (2013b), who found that a barrier to implementing TGfU was PTs' lack of conceptual understanding of the role of questioning within the learning process.

However, with some weeks of experience implementing the CLA and observing and reflecting on pupil's responses, PETE students' game design demonstrated an improved understanding of the learning process underpinning the CLA. For example, Max successfully modified a soccer/football learning environment using an instructional constraint of 'if a player is tagged they lose possession' to exaggerate the tactical problem of defensive pressure and challenge the attacking team to search for functional movement solutions in response. The exaggeration of this tactical problem or affordance necessitated the generation of a co-adaptive problem solving behaviour by the attacking team in response to the defensive pressure. This included Max's predicted co-adaptive learning outcome of players utilising the width of the field in attack to spread the defence and create more space and also the use of a back pass to an unmarked teammate.

The full game provides ever-changing problems to be solved, and without boundaries constructed by the exaggeration of tactical concepts through task constraint manipulation (e.g. field dimensions, rules, scoring), learners become less attuned to the key affordances and 'blindly' search for functional movement solutions (Chow et al. 2007; Tan, Chow, and Davids 2012). According to Tan, Chow, and Davids (2012) exaggeration of affordances or key information in the learning environment is especially critical at the Control stage of learning, a level at which most of the pupils involved in the study were situated as they were still refining skills and making mistakes in the process (see Newell 1986). Exaggeration of affordances assists the learner at this level in becoming more attuned to the pertinent environmental parameters within their search for functional movement solutions.

Max and Melinda effectively used the NLP principle of task simplification to help overcome students' lack of game experience, as well as to cater for the variety of skill levels within each class. For example, Melinda designed a simplified 1 v 1 basketball game to allow students the opportunity to learn how and when to perform a lay up in a game. The player with the ball attempted to score from a fast break (i.e. the key affordance for a layup within a game) with their opponent starting a few metres behind. The game was further simplified by modifying the rules and allowing players unlimited steps without dribbling in the keyway. Max simplified a game of soccer/football by using a small-sided game of 6 v 6 plus a 'floating' player, who played on the team that had possession of the ball, thus creating numerical superiority in attack.

Study limitations and practical implications

This study was carried out on a small scale of 2 participants and over a relatively short duration of 4 weeks with a level of support provided to participants beyond what would be considered normal during practicum, thus restricting the generalisability of the findings. However, recognising these limitations, the study findings still achieved the aim of providing some useful insights for PETE practitioners and PETE practice. These implementation challenges facing practitioners can be used to inform and improve the design and delivery of PETE programmes in preparing and supporting PETE students to effectively implement the CLA and other nonlinear informed games based approaches in a school environment. These findings highlight the important need for PETE students to develop their experiential knowledge and conceptual understanding of the subconscious exploratory learning processes underpinning a nonlinear approach like the CLA and the co-adaptive and regulated interactions that occur within the dynamics of a team game. To achieve this aim, PETE programmes must incorporate opportunities for students to develop their skills in the detection and interpretation of the multiple less predictable player responses within a constraint manipulated team game. This is a difficult task, thus these skills should be progressively developed, starting with simple environments, for example, observing a 1 v 1 game from the ‘sideline’, and working towards more complex observations and interpretations of small-sided team games from a teacher’s perspective. These observations and interpretations would help PETE students gain a practical understanding of the dynamic, complex, and interacting nature of a player’s emergent individual response resulting from exposure to constraints. This process would also prepare the novice teachers psychologically for the unexpected responses to the manipulated environments they implemented.

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

To better prepare and support PETE students to effectively implement the CLA on practicum, rather than implementing these modified environments in an 'ideal' setting, that is with peers in a university class, they should be implemented with pupils in a physical education lesson with restraints in place such as limited space, time and equipment. An important reason for using pupils was highlighted by the study participants. Both Max and Melinda reported a significant difference in response to manipulated learning environments by pupils compared to their university peers in the constraints-based games unit. They reported that pupils often weren't 'switched on' and thinking about how to exploit the manipulated learning environments and 'blindly' played games. For example, in the 'safe passing game' players ignored their teammate who had 3-touch immunity, thus missing the opportunity to secure possession when under pressure. This was in stark contrast to the 'game awareness' displayed by their university peers, which consistently resulted in players quickly interpreting and exploiting the learning environment to solve game related problems. It is important to note that Max overcame this problem in the above example by choosing his 'smartest' soccer/football player to have immunity. According to Davids (2012), in an ecological dynamics approach, the nature of the performer-environment relationship is not the same for beginners and experts, since experts are more capable of exploiting information about environmental and task related constraints. In a similar study, McNeill and colleagues (2004, 19) reported that PTs had difficulty implementing the Games Concept Approach as their pupils 'were not used to thinking during physical education lessons' and consequently were not learning how to solve game problems.

PETE students also need experience incorporating the following strategies successfully used by Melinda and Max to cognitively and emotionally engage pupils in subsequent lessons. These included, allowing pupils time to explore the manipulated learning environment without interjection by the teacher, allocating pupils with 'game awareness' to key positions, further exaggerating the key information in the learning environment to make the tactical concepts and possible solutions easier to detect, creating a competitive environment by keeping score and developing team affiliations, challenging pupils through game scenarios, and the strict enforcement of rules by a referee or umpire.

Impact on primary researcher's practice to enhance PETE training

To support PETE students' future implementation of the CLA the author has integrated these practical study recommendations into his practice through the addition of an assessment task within the PETE constraints-based games unit. This task was incorporated to allow PETE students the opportunity to gain some experiential knowledge and practical understanding of the emergent learning process within the nonlinear CLA, and also to develop their observational and analytical skills. In groups, PETE students observe a small-sided game and identify specific game-related problems and associated possible causes. Each group is then allocated a different identified game-related problem to address through the design of a representative modified game using constraint manipulation to emphasise the game-related problem and to channel learners' search towards a desired movement solution. Their learning design must be justified in terms of how it allows problem solving behaviour to implicitly emerge through the natural, exploratory learning processes underpinning the CLA. PETE students then play the modified game, while the group who designed the game observe and interpret players' emergent responses, in relation to the desired movement solution and any unpredicted or unexpected emergent behaviour. Students then complete a written worksheet based on their observations and interpretations, citing specific examples as evidence, as well as proposing modifications to improve their learning design. To facilitate students' learning, the tutor initially models each step of the task. This learning experience should better prepare and support PETE students to effectively implement the CLA and other nonlinear informed games based approaches in a school environment on practicum.

Future research

The founding student-centred approach, TGfU, has been around for over 30 years. In that time it has been embraced and developed by researchers, however, there is still a challenge in terms of its adoption by practitioners (Almond 2010; Renshaw et al. 2015; Thorpe 2015b). According to Renshaw and colleagues (2015), in order to increase the likelihood of the CLA being adopted by practitioners in schools, it is vitally important that researchers and practitioners work symbiotically in embedding new thinking into practice. Thus, for an evolution of physical education teaching practice to progress, it is important that the learning-related practical recommendations from this research study are embedded into a PETE programme and future research investigates their effectiveness in preparing and supporting PETE students to authentically implement the CLA in a school environment.

The ‘realistic’ resistant conservative culture of the school practicum environment is too big a step from the ‘unrealistic’ supportive innovative PETE teaching environment for novice teachers to authentically implement a NLP, such as the CLA. Thus, an in between step is necessary to support this process. Such an environment can be achieved through PETE educators working together with the physical education department of the local school to provide opportunities for PETE students to independently apply their newly developed skills, experiential knowledge and conceptual understanding of the CLA with smaller groups of students in a physical education lesson. From such research, the effectiveness of the learning-related practical recommendations can be evaluated and further issues surrounding the practical challenges associated with the authentic design and delivery of a NLP in the school environment can be identified.

As previously mentioned the extensive theoretical grounding of NLP and the CLA has been supported by many empirical studies that have demonstrated performance improvement in athletes in an elite sports coaching setting (Barris, Farrow, and Davids 2014; Greenwood, Davids, and Renshaw 2014; Pinder, Davids, and Renshaw 2012; Seifert et al. 2014). To date, there are no empirical studies that test the efficacy of the CLA in terms of performance improvement in the pedagogical setting. To fill this void, future practical empirical research is planned to investigate if adopting the NLP pedagogical principles in practice enhances pupils' performance of motor skills in physical education lessons. This research is important as the CLA is theoretically richer in motor learning theory than other alternative physical education teaching approaches and empirical data would demonstrate its benefits within the discipline of physical education.

Conclusion

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

> *I believe in the constraints-led approach, because yeah, whenever I talk to anyone about it or teach it in class, I really believe that it's the best way to*

go. And my background being so traditional and drill-based, to go and teach these boys this new approach, and to see the learning that occurs implicitly, without me telling them to do anything, you know it still blows me away to this day. Yeah. I saw it... like I've seen it working at uni now, and I've seen it working in schools, and I've seen kids enjoying it. (Interview, Max)

Chapter 6: The impact of nonlinear pedagogy on physical education teacher education students' intrinsic motivation

Background: It is important that the alternative pedagogy presented during PETE addresses the criticisms of the predominantly used traditional physical education teaching approach. At this point the CLA has been shown to effectively address the criticisms of the traditional approach in terms of skill acquisition and the development of intelligent, physical education performers. However, the prescriptive teaching philosophy of the traditional approach has also been criticised for failing to effectively provide learners with motivationally supportive experiences to engage in physical education. Claims have been made that the CLA can effectively support students' self-motivated engagement in physical education by meeting all three basic psychological needs of the individual. This chapter documents a study testing these unverified claims by assessing the impact of the learning design and delivery of instruction and feedback of a CLA lesson on PETE students' self-reported levels of intrinsic motivation.

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The authors listed below have certified* that:

1. They meet the criteria for authorship in that they have participated in the conception, execution, or interpretation, of at least that part of the publication in their field of expertise;

2. They take public responsibility for their part of the publication, except for the responsible author who accepts overall responsibility for the publication;

3. There are no other authors of the publication according to these criteria;

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Contributor	Statement of contribution*
Brendan Moy 27/01/2016	Designed and conducted research, collected and analysed data, and wrote all sections of publication.
Ian Renshaw	Aided in research design, data collection and analysis, and provided feedback on manuscript sections.
Keith Davids	Aided in research design, data collection and analysis, and provided feedback on manuscript sections.

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Ian Renshaw 3/8/2016

Abstract

Background: Providing motivationally supportive physical education experiences for learners is crucial, since empirical evidence in sport and physical education research has associated intrinsic motivation with positive educational outcomes. Self-determination theory (SDT) provides a valuable framework for examining motivationally supportive physical education experiences through satisfaction of three basic psychological needs: autonomy, competence and relatedness. However, the capacity of the prescriptive teaching philosophy of the dominant traditional physical education teaching approach to effectively satisfy the psychological needs of students to engage in physical education has been questioned. The constraints-led approach (CLA) has been proposed as a viable alternative teaching approach that can effectively support students' self-motivated engagement in physical education.

Purpose: We sought to investigate whether adopting the learning design and delivery of the CLA, guided by key pedagogical principles of nonlinear pedagogy (NLP), would address basic psychological needs of learners, resulting in higher self-reported levels of intrinsic motivation. The claim was investigated using action research. The teacher/researcher delivered two lessons aimed at developing hurdling skills: one taught using the CLA and the other using the traditional approach.

Participants and Setting: The main participant for this study was the primary researcher and lead author who is a PETE educator, with extensive physical education teaching experience. A sample of 54 pre-service PETE students undertaking a compulsory second-year practical unit at an Australian university was

recruited for the study, consisting of an equal number of volunteers from each of two practical classes. A repeated measures experimental design was adopted, with both practical class groups experiencing both teaching approaches in a counterbalanced order.

Data collection and analysis: Immediately after participation in each lesson, participants completed a questionnaire consisting of 22 items chosen from validated motivation measures of basic psychological needs and indices of intrinsic motivation, enjoyment and effort. All questionnaire responses were indicated on a 7-point Likert scale. A two-tailed, paired-samples *t*-test was used to compare the groups' motivation subscale mean scores for each teaching approach. The size of the effect for each group was calculated using Cohen's *d*. To determine whether any significant differences between the subscale mean scores of the two groups was due to an order effect, a two-tailed, independent samples *t*-test was used.

Findings: Participants' reported substantially higher levels of self-determination and intrinsic motivation during the CLA hurdles lesson compared to during the traditional hurdles lesson. Both groups reported significantly higher motivation subscale mean scores for competence, relatedness, autonomy, enjoyment and effort after experiencing the CLA than mean scores reported after experiencing the traditional approach. This significant difference was evident regardless of the order that each teaching approach was experienced.

Conclusion: The theoretically based pedagogical principles of NLP that inform learning design and delivery of the CLA may provide teachers and coaches with tools to develop more functional pedagogical climates, which result in students exhibiting more intrinsically motivated behaviours during learning.

Introduction

Previous research has reported that the most prevalent physical education teaching approach adopted worldwide is the traditional approach (Cothran et al. 2005; Moy, Renshaw, and Davids 2014; SueSee and Edwards 2011). This traditional approach is characterised by (i) conventional, highly structured teaching sequences which start with the introduction of technical skill(s) in isolation from the competitive performance environment; (ii) students' repetitive attempts to reproduce teacher-prescribed movement 'templates' in drills; (iii) the teacher providing regular, corrective verbal feedback; and (iv), a concluding game or performance activity where students endeavour to apply the motor skills learned (Allison and Thorpe 1997; Hopper, Butler, and Storey 2009; Martens 2004). This pedagogical approach has been criticised from a skill acquisition perspective because it is somewhat de-contextualised from the performance setting, and it decomposes tasks, which could inhibit the coupling of information and movement (Renshaw et al. 2010; Renshaw, Davids, and Savelsbergh 2010; Williams and Hodges 2005). Additional concerns include the limitation of this pedagogical climate in restricting learners' involvement to imitation and the reproduction of a prescribed movement skill template, rather than seeking functional solutions to movement problems. The prescriptive teaching philosophy of the traditional approach has also been criticised for failing physical education students at a psychological level. Emphasising the mastery of specific techniques in repetitive, monotonous drills and competitive games sets significant motivational problems for less gifted and confident individuals. Such a pedagogical climate has been shown to enhance boredom, humiliation, marginalisation, passive participation in class and disengagement (Bunker and Thorpe 1982; Carlson 1995; Ennis 1999; Mitchell, Oslin, and Griffin 2006; Ntoumanis et al. 2004; Smith and Parr 2007). Empirical evidence in physical education research has associated intrinsic motivation with higher levels of active engagement (Ntoumanis 2001), increased levels of student learning (Chen 2001; Hagger et al. 2003; Tjeerdsma-Blankenship 2008), enhanced concentration and effort (Standage, Duda, and Ntoumanis 2003), continued participation in physical activity (Ntoumanis 2005) and positive cognitive, psychomotor and social experiences (Vallerand 2001). It is, therefore, clear that providing motivationally supportive physical education experiences for students is crucial to their continued engagement and participation, and a number of theoretical frameworks exist for addressing this issue.

Self-determination theory

Self-determination theory (SDT) provides a valuable framework for examining motivationally supportive physical education experiences (Hagger et al. 2003). Motivation is defined as the desire to improve oneself by engaging in behaviours, which an individual deems important towards his/her development (Deci and Ryan 2000). According to SDT, motivation can be ordered along a continuum corresponding to the degree to which an individual's behaviour is self-motivated and self-determined. The continuum ranges from a complete absence of motivation to engage in a specific setting (i.e. amotivation), through to engagement in activities to attain some means such as an external reward, social recognition or avoidance of punishment resulting in regulation that is controlling (i.e. non-self-determined extrinsic motivation) to activities that are personally valued and internalised, resulting in identified and integrated regulation that is non-controlling (i.e. self-determined extrinsic motivation). Finally, the most self-determined behaviour is engagement in activities for inherent enjoyment, pleasure and interest rather than achievement of outcomes (i.e. intrinsic motivation). One key principle of SDT is that individuals are more likely to continually engage in behaviours for which they feel intrinsically motivated rather than feeling compelled externally to do so (Deci and Ryan 2000).

According to SDT, the mechanism through which individuals move toward more self-determined and intrinsically motivated behaviour is the satisfaction of three basic psychological needs: (a) autonomy, (b) competence and (c) relatedness (Deci and Ryan 2000; Ryan and Deci 2000). For example, pupils in physical education are more likely to be intrinsically motivated when they perceive that they are provided with a freedom of choice or control over their behaviour (autonomy), when they experience the feeling of success or mastery of the activity (competence), and when they feel a sense of belonging or connection and are supported by significant people, such as a teacher or classmates (relatedness). SDT proposes that pedagogical climates in which students can exhibit intrinsically motivated behaviours will produce greater effort and enjoyment, which will then lead to greater task engagement, persistence and learning (Ryan and Deci 2000).

The traditional approach and SDT

In order to influence a students' self motivated engagement in physical education and enhance their educational experience it is important to implement learning experiences within a physical education pedagogical approach that can satisfy all three basic psychological needs (Ntoumanis et al. 2004; Vallerand 2001). However, the ability of the prescriptive teaching philosophy of the dominant traditional physical education teaching approach to effectively satisfy the psychological needs of students to engage in physical education has been questioned on a number of levels, including its impact on individual intrinsic motivation (Chow et al. 2013). First, a lesson taught using the traditional approach typically fails to provide autonomy or choice for students due to a ‘one-way-fits-all’ pedagogical climate that erroneously assumes that one movement pattern acts as an optimal template suitable for all individual learners (for rejection of this idea see empirical data reported by Chow et al. 2009; Schöllhorn, Hegen, and Davids 2012). The futile attempt to achieve mastery of a putatively optimal technique, usually modelled on the ‘adult’ version of skill performance, is an unrealistic expectation for many students that can undermine their perception of competence (Bartholomew et al. 2011; Renshaw et al. 2010). Finally, since the vast majority of teacher-student interactions in a traditional lesson are hierarchically organised, prescriptive and focusing on what students’ are doing wrong (resulting in corrective feedback), feelings of relatedness between the teacher and students can be compromised (Tinning 2006).

While a number of pedagogical approaches have recently been put forward to address the motivational weaknesses of traditional physical education, for example, Teaching Games for Understanding (TGfU) and Sport Education (SE), a common criticism is that these approaches are largely operational and lack an empirically-supported theoretical basis for the learning process and to develop principled practice (see Chow et al. 2007; Kirk and MacPhail 2002). Additionally, these operational models have been mainly limited to games teaching (with the exception of SE) and have rarely been applied to other areas of the physical education curriculum such as track and field, aquatics, dance and outdoor activities. One contemporary, alternative pedagogical approach that provides a powerful conceptual framework for the learning process in physical education is the constraints-led approach (CLA). In this paper we seek to verify that the CLA is a powerful model that addresses the skill acquisition and psychological needs of individuals across all physical education contexts.

Nonlinear pedagogy: The constraints-led approach

The CLA, which is situated in a nonlinear pedagogy (NLP) (Chow 2009; Davids, Chow, and Shuttleworth, 2005), provides a viable alternative physical education pedagogical approach to support the development of intelligent, intrinsically motivated physical education performers to actively engage in physical education (Renshaw, Oldham, and Bawden 2012). A NLP is based on key ideas and concepts of ecological dynamics (an integration of ecological psychology and dynamical systems theory, see Chow et al. 2009), such as environment-individual mutuality, affordances, self-organisation under constraints, perception-action coupling, co-adaptability, stability and instability and that learning is a nonlinear process (Renshaw et al. 2009). From a pedagogical perspective, the CLA focuses on the individual learner-environment relationship and proposes that functional movement solutions are an emergent property of humans considered as self-organising, nonlinear dynamical movement systems. Nonlinear pedagogy proposes that human intentions are constrained by a number of cognitive, physical, social and biological factors, an idea supported by the notion of 'embodiment' in constructivist and situated learning approaches (Davids, Button, and Bennett 2008). However, ecological dynamics is predicated on the primacy of the individual-environment scale of analysis for understanding learning processes (Davids et al. 2015). Consequently, it is advocated that learners in physical education should be considered as complex adaptive systems and that movements are self-organised under interacting constraints (Chow et al. 2013). Behaviours emerge from the continuous interaction of each learner's unique individual constraints (e.g. speed), and those of the task (e.g. competition rules) and performance environment (e.g. running surface) (for a more detailed overview see Chow et al. 2007, 2013; Davids, Chow, and Shuttleworth 2005; Newell 1986; Tan, Chow, and Davids 2012). However, while much research has highlighted how NLP facilitates the skill learning needs of students in physical education, the psycho-emotional impact of adopting the approach in practice has not been considered. We address this issue in this paper.

NLP and SDT

Proponents of NLP have identified pedagogical principles to guide learning design and delivery of instruction and feedback (see Davids, Button, and Bennett 2008; Renshaw et al. 2009). There is extensive empirical and theoretical research evidence to demonstrate that adopting these principles in practice meets the skill acquisition needs of the individual performer, while at the same time explaining why traditional approaches are failing students (Chow et al. 2007; Renshaw et al. 2010). The NLP pedagogical principle of self-organisation under constraints challenges the misconception that there is one common optimal movement solution for a task towards which all learners should aspire. This principle is predicated on the inherent adaptive movement variability and degeneracy of human movement systems, that is, learners have the ability to self-organise in many different ways to achieve the same outcome or task goal (Davids, Button, and Bennett 2008; Lee et al. 2014). Degeneracy is important in skill acquisition as it empowers the individual with a variety of movement possibilities or solutions that may be exploited to fulfill the demands of the task and a dynamic environment (Chow et al. 2008; Lee et al. 2014). According to Renshaw, Oldham, and Bawden (2012), adopting this NLP principle of self-organisation under constraints in practice can also meet the psychological needs of the individual performer by enhancing learners' perceptions of autonomy and competence. This is because individuals are in control of their own learning as they are given the freedom to explore practice environments and seek their own optimal functional movement solutions (e.g. coordination patterns), enabling them to match performance problems with their unique individual characteristics and action capabilities to experience success.

Adopting the NLP pedagogical principles of representative practice design (practice environments contain the key information sources that are present in a performance environment; see Pinder et al. 2011), allied with task simplification (preserving the coupling of actions to key information sources but simplifying the task; see Renshaw et al. 2009), can also enhance perceptions of competence and autonomy during practice and competition. This learning design provides performers with opportunities to experience success when learning in conditions that mirror the performance environment but are simplified/constrained in a way that matches their action capabilities (Renshaw, Oldham, and Bawden 2012). This pedagogical climate allows learners the autonomy to set their own realistically challenging goals, creating opportunity for developing competence.

Within the NLP framework learning takes place implicitly through exploratory processes with feedback self- generated (Beek 2000; Jackson and Farrow 2005). In contrast to traditional explicit teacher instructions, which focus on the internal control of prescriptive movement form, exploratory facilitation is used in which the teacher directs learners' focus of attention on external movement outcomes of an action rather than on the action itself (Chow et al. 2009; Wulf, Lauterbach, and Toole 1999). This shared responsibility for learning enhances the perceptions of relatedness between the teacher and student (Renshaw, Oldham, and Bawden 2012) because the nature of their communications is not hierarchical, as can exist in a pedagogical climate based on the continuous use of explicit 'corrective' instructions and feedback. The CLA can also incorporate the use of interactive practice and cooperative learning for problem resolution, encouraging greater interpersonal exchange between individual students. This degree of interaction should develop a sense of connectedness between learners enhancing perceptions of relatedness (Renshaw, Oldham, and Bawden 2012).

Renshaw, Oldham and Bawden (2012) have claimed that adopting NLP pedagogical principles in practice can meet all three basic psychological needs of the individual, that is competence, autonomy and relatedness, resulting in an intrinsically motivated performer. As yet this claim has not been verified in empirical studies. To that end, Tan, Chow, and Davids (2012) have called for future research to determine the motivational consequences of an alternative pedagogy underpinned by NLP. In essence, research needs to verify the claims that learning design underpinned by NLP will result in the satisfaction of basic psychological needs and can act as an energising individual constraint that enhances intrinsically motivated behaviours such as increased effort and persistence leading to greater enjoyment in physical education and ultimately enhanced sports performance (Renshaw, Oldham, and Bawden 2012).

Aim of the study

The present study aimed to verify the claims made by Renshaw, Oldham, and Bawden (2012) using the primary researcher and lead author's own teaching practice, that is, the teacher as embedded researcher (Stenhouse 1975). The impact of the learning design and delivery of the CLA on Physical Education Teacher Education (PETE) students' self-reported levels of intrinsic motivation was assessed in a track and field lesson. The traditional physical education teaching approach was informed by experiential knowledge of all co-authors as practitioners, as well as previous research, and used as a comparison condition. Such self-inquiry undertaken by a practitioner to test wisdom in practice using a single practical intervention is considered action research (Casey 2013; Stenhouse 1975). Action research aims to generate knowledge about teaching and learning, increase understanding of practice, and improve teaching and learning (Kemmis and McTaggart 1988). A key aim of all pedagogists is to continually seek to improve practice through uptake of modern ideas and verification through empirical investigations and reflection (Chow et al. 2016). Here we undertook this process through the attempt to generate knowledge and understanding of the impact of the CLA on intrinsic motivation that could theoretically inform teaching practice improvements within physical education training programmes.

Intrinsic motivation was assessed in terms of the satisfaction of the basic psychological needs of competence, autonomy and relatedness in combination with the enhancemnent of positive indices of intrinsic motivation, enjoyment and effort (Deci and Ryan 1985, 2000), after participants experienced a lesson utilising each teaching approach. The individual track event of hurdles was chosen for this study as previous research on motivation and physical education teaching approaches has focused almost exclusively on team games. Hurdles also presented an opportunity to demonstrate the application of the key operational and pedagogical principles of a NLP beyond games to an individual performance activity. It was also expected that participants would not have much experience in hurdling relative to team games of which would avoid biasing initial levels of perceived competence towards the task, allowing scope for improved performance.

Previous empirical research relevant to this study has demonstrated that the operational principles adopted in practice by alternative pedagogical approaches (e.g. TGfU and SE) such as team membership, student-centred responsibility, differentiated instruction, small-sided games orientation, problem exploration and questioning are superior to the operational principles of the traditional approach in the facilitation of pupils' basic psychological needs and intrinsically motivated behaviours (Goudas et al. 1995; Griffin, Oslin, and Mitchell 1995; Jones, Marshall, and Peters 2010; McNeill, Fry, and Hairil 2011; Perlman 2010, 2011; Perlman and Goc Karp 2010; Sinelnikov and Hastie 2010; Spittle and Byrne 2009; Wallhead and Ntoumanis 2004). Although the CLA has similar operational principles in practice to TGfU, such as performance exploration in modified representative games, its distinguishing features are the theoretical principles of NLP, steeped in ecological dynamics, which inform learning design and delivery of instruction and feedback. This same theoretical framework has also been shown to provide a detailed and comprehensive rationale for the principles of learning design in TGfU (see Chow et al. 2007; Tan, Chow, and Davids 2012; Chow et al. 2016). These pedagogical principles align the CLA more closely with SDT than other alternative pedagogies, as both are strongly focused on the needs of the individual. Within a NLP framework, individual needs are recognised as constraints that need to be considered in learning design, just as SDT recognises that the satisfaction of individual psychological needs is essential for intrinsically motivated behaviour. To this point no study has directly investigated the impact of the pedagogical principles of an alternative physical education teaching approach on the motivational needs of the individual.

On the basis of previous relevant research and the theoretical underpinnings of the claims, it was predicted that the CLA would facilitate the satisfaction of the basic psychological needs of competence, autonomy and relatedness, as well as enhance the positive indices of intrinsically motivated behaviour, that is, effort and enjoyment, resulting in an intrinsically motivated performer. If the CLA was found to be significantly more effective than the traditional approach in facilitating learner's self-determined intrinsic motivation, a viable alternative pedagogy would be presented to PETE students to actively engage students in physical education and enhance positive motivational outcomes. This outcome would strengthen the validity of the CLA in the context of physical education in educational settings.

Note: The study was an action research project undertaken by the first author with guidance from the coauthors. Consequently, this chapter has been written from the perspective of the team of authors.

Method

Participants and setting

The main participant for this study was the primary researcher and lead author who is a PETE educator. He taught the hurdles lessons using each approach in tutorial classes taken by his PETE students. He possessed extensive experiential knowledge and experience to enable successful implementation of authentic representations of both teaching approaches. This is evidenced by his 25 years of experience teaching physical education and coaching track and field in Australian schools predominantly using the traditional approach, as well as 7 years experience teaching, coaching and researching the CLA in the university, school and sporting club settings. The student participants for this study were pre-service PETE students undertaking a compulsory second-year practical unit on contemporary approaches to the teaching and learning of performance activities, primarily swimming and track and field, at an Australian university. The study sample (n = 54) consisted of an equal number of participants from each of two practical classes in 2014 with an approximately equal gender breakdown (28 male; 26 female) and a mean age of 20.5 years (SD = 2.34 years). In relation to hurdling background, 30 participants (56%) had no hurdling experience, 19 participants (35%) had limited hurdling experience (2 - 4 physical education lessons) and 5 participants (9%) had represented their school at hurdling. All participants reported that they had been taught track and field from a traditional approach. All students had previous experience with the CLA in a first year unit that primarily focused on the practical application of the underpinning motor learning theory using team games.

Design and procedure

The study adopted a crossover, repeated measures experimental design (Field and Hole 2003). Both practical class (experimental) groups experienced both teaching approaches (independent variable) and the impact on student intrinsic motivation (dependent variable) was measured. In the first practical tutorial of the unit, participants from both tutorial classes experienced two 50-minute hurdles lessons: one taught using the traditional approach and the other using the CLA. The traditional condition was utilised as a comparison condition to evaluate the effect of the CLA condition on student intrinsic motivation. The order of the teaching approaches was counterbalanced, so that one class group experienced the traditional approach first, followed by the CLA. The other class group experienced the CLA first, followed by the traditional approach.

Data collection

Prior to participation in their first hurdles lesson, participants were required to individually and anonymously complete the first part of a two-part questionnaire aimed at gathering data about their personal hurdles background. Immediately after participation in each lesson, participants were required to complete the second part of the questionnaire consisting of 22 items chosen from validated measures of the basic psychological needs and positive indices of intrinsic motivation used in previous similar research and deemed relevant to this study's purpose and theoretical framework. These chosen items were suitably reworded to reflect the nature of the current task, that is, hurdling (see example items in next section).

Measures (questionnaire)

Basic psychological needs (competence, autonomy and relatedness)

To assess participants' perceptions of their own hurdling competence, they responded to five items taken from the corresponding subscales of a version of the intrinsic motivation inventory (IMI; Ryan 1982) reworded for use in sport settings by McAuley, Duncan and Tammen (1989). For example, questions included 'I am pretty skilled at hurdling'. These subscales have been used in previous physical education-based studies in which adequate validity and acceptable internal reliability was demonstrated (Koka and Hagger 2010; Mandigo et al. 2008; Ntoumanis 2001; Standage, Duda, and Ntoumanis 2003, 2005, 2006; Wallhead and Ntoumanis 2004). Participants' sense of autonomy was measured using five questionnaire items collated from previous research (Blais, Vallerand, and Lachance 1990; Ntoumanis 2001). These items were adapted for use in physical education studies to assess autonomy from a SDT perspective (Standage, Duda, and Ntoumanis 2003, 2005, 2006). For example, questions included 'I felt a certain freedom of action'. Support for the internal reliability of the version of this scale has been shown in this previous physical education work. The extent to which participants perceived a connection between each other was measured using two questionnaire items developed by Ntoumanis (2001), for example, 'The lesson activities made me feel more connected to other students'. This example questionnaire item was suitably reworded to develop a third item to measure the connection between the student and the teacher, that is, 'The lesson activities made me feel more connected to the teacher'. This relatedness subscale has demonstrated acceptable internal reliability in a previous physical education-based research study (Mandigo et al. 2008).

Positive indices of intrinsic motivation (enjoyment and effort)

To assess participants' sense of enjoyment and effort in each hurdles lesson, participants responded to nine items (enjoyment five, effort four) taken from the corresponding subscales of a version of the IMI (Ryan 1982) and reworded for use in sport settings by McAuley, Duncan and Tammen (1989). These subscales have been used in previous physical education-based studies in which adequate validity and acceptable internal reliability was demonstrated (Mandigo et al. 2008; Ntoumanis 2001; Perlman 2010; Wallhead and Ntoumanis 2004; Wang and Liu 2007).

All questionnaire responses were evaluated on a 7-point Likert scale from 1 (not at all true) to 7 (very true). Prior to the actual study the questionnaire items were pilot tested with pre-service PETE students not involved in the study to ensure that the descriptions and statements were clear, structured and generated data that were not likely to be limited by participants' misinterpretation of key terminology.

Conditions: Teaching approaches

Traditional approach

The traditional hurdles lesson design and delivery of instruction and feedback followed the same format as the conventional, highly structured, prescriptive teaching sequence identified in physical education literature (Allison and Thorpe 1997; Hopper, Butler, and Storey 2009; Martens 2004). The teacher decomposed the hurdling technique and demonstrated isolated sub-components for the trail leg (e.g. lean forward, hips straight and high) and the lead leg (e.g. drive/swing lead leg over hurdle). Students repetitively practiced the reproduction of each of these 'ideal' models separately in a progressive sequence of isolated drills (i.e. walking, jogging), with the teacher regularly giving corrective verbal performance-related feedback on observed errors. After practising the skills, students then attempted to apply the whole movement pattern in competitive races over 50 m with 3 flights of hurdles. All females raced over hurdles set for 14-year girls competition (76 cm high at 8 m intervals) and all males raced over hurdles set for 16-year boys competition (84 cm high at 8.5 m intervals).

Constraints-led approach

The learning design and delivery of instruction and feedback of the CLA hurdles lesson were guided by key pedagogical principles of NLP. The learning environment consisted of eight lanes of four hurdles with each lane of hurdles set at different distances and heights. However, for each lane the hurdles were set at the same height and interval distance. The task constraints of hurdle height and interval distance increased progressively through the 8 lanes, for example, Lane 1: height 60 cm, interval 5 m; Lane 4: height 68 cm, interval 6.5 m; Lane 8: height 84 cm, interval 7 m.

Students were given the choice of lane in which to commence practice. The teacher took a 'hands off' approach advocated in NLP, not providing any verbal, augmented instructions or feedback on performance in relation to the internal body movements of an 'ideal' technical hurdling action (the 'how to do it'). Instead, the teacher provided 'broad statements' that acted as boundary constraints on the search activities of the learners (Handford et al. 1997). These types of broad statements were performance outcome oriented, with an external focus of attention, for example, ‘try to get 3 steps in between each hurdle’. They did not address specific movement components in terms of how to coordinate limb segments and joints in achieving the task goals. They allowed students time to subconsciously explore the practice environment and seek their own optimal functional movement solutions with feedback self-generated. When able to achieve theses outcomes, students were encouraged to progress through the lanes of increasing difficulty. In ecological dynamics learning tasks are intended to simulate performance environments, thus the concluding activity was competitive racing over 50 m (three flights of hurdles), with students choosing their opponent and preferred lane in which to race.

Fidelity of teaching approaches

As the study served to assess the impact of the learning design and delivery of informational constraints and feedback of two teaching aproaches on PETE students’ self-determined motivation, it is critical to verify that the key components of both physical education teaching approaches were accurately represented. To establish fidelity a combination of guidelines were used that have been adopted in previous similar comparative studies (Perlman 2010, 2011; Perlman and Goc Karp 2011).

Written lesson preparation

A wide range of track and field coaching manuals and teaching resources were used to identify common components to include in a typical traditional hurdles lesson (Brown 2013; Guthrie 2003; Jarver 1980; Queensland Department of Education 1982; USA Track and Field 2000). Once lesson planning was completed, two independent expert physical education teachers with over 15 years experience in the traditional teaching and coaching of track and field in schools reviewed the lesson content and verified its authenticity in representing the traditional approach. The CLA lesson was generated based on practitioner-based publications and CLA specific texts (Renshaw et al 2009, 2010; Chow et al. 2013). Once completed a group of three university academics with a significant research and publication record relating to the CLA collaboratively reviewed and modified the lesson content for authenticity resulting in learning experiences representative of the CLA.

Teacher's interpersonal style

How teachers interact with students is of major educational importance in SDT research as the interpersonal style teachers adopt can either support or thwart students' basic individual needs (Ryan and Deci 2006; Hassandra, Goudas, and Chroni 2003). The teacher in this study had extensive experiential knowledge, a positive disposition towards physical education, was energetic, had an enthusiastic tone of voice and adopted a consistent genuine caring and empathetic style in his interactions with students. It was most important that the teacher was sensitive to ensuring that he adopted this interpersonal style *irrespective* of the teaching approach used. This teaching behaviour created a comfortable social context that supported the satisfaction of students' need for autonomy, competence and relatedness. For example, the teacher knew many of the students from a previous unit and thus his interactions with students in all lessons were positive, personalised, warm and friendly, that is, relatedness supportive (Soenens et al. 2007). When instructing students during all lessons, the teacher used scripted non-controlling language such as 'I would like you to try to land on the ball of your foot' rather than 'you must land on the ball of your foot', which avoided placing individual students under excessive pressure, that is, autonomy supportive (Simons, Dewitte, and Lens 2003). During the traditional lesson, the teacher often interrupted the drill practice to highlight common observed errors to the class, for example, 'when clearing the hurdle most of you are making the mistake of rotating your hips'. However, the teacher also spent considerable time helping individual students during the traditional practice drills through delivering specific corrective performance-related feedback in a constructive way, such as 'to stop your hips rotating you need to pull your trail leg through parallel to the ground and snap it down quicker', that is, competence enhancing (Jang, Reeve, and Deci 2010; Koka and Hein 2005). Throughout all lessons, the teacher consistently provided students with positive motivational feedback, such as 'well done' or 'good effort' to recognise achievement or to encourage effort.

Implementation of teaching approaches

To confirm fidelity of the implementation of each approach, the teacher piloted the two hurdles lessons with a class unaffiliated with the study. Each lesson was observed and validated by a different colleague with expertise in the observed approach. This validation was accomplished using checklists with key descriptors that typified specific instructional features of each approach, which had been generated for use by supervising teachers when observing PETE students on practicum. This same validation process was repeated for the implemented lessons that formed the research study. Upon completion of this process, the researcher/teacher and colleagues were confident of the fidelity of implementation of lessons representing the traditional approach and the CLA.

Data analysis

To determine whether the items on the questionnaire could produce reliable scores in the population, Cronbach's alpha coefficient (α) was employed as a measure of the internal reliability. Kolmogorov-Smirnov and Shapiro-Wilk statistics (α = .05) were used to test the normality of the distribution of questionnaire scores and Levene's test was used to test the assumption of equality of variance in scores. Each experimental group's (i.e. traditional, CLA; CLA, traditional) descriptive statistics (mean and standard deviation) were calculated for both conditions (i.e. teaching approach) of each dependent variable (i.e. subscales of competence, autonomy, relatedness, enjoyment and effort).

A two-tailed, paired-samples *t*-test with a .05 level of significance (α) was used to compare the groups' motivation subscale mean scores for each teaching approach (i.e. traditional approach and CLA). The size of the effect for each group was calculated using Cohen's *d*. To determine whether any significant differences between the subscale mean scores of the two groups were due to the order that each group experienced the teaching approaches, a two-tailed, independent samples *t*-test with a .05 level of significance was used.

Results

Descriptive statistics and questionnaire internal reliability

Descriptive statistics (mean M, standard deviation SD) and internal reliability analysis (Cronbach's α) of all dependent variables, under both conditions, are displayed in Table 6.1 Cronbach's α coefficients for the six subscales of the questionnaire ranged from .75 to .93 and the overall reliability score for the instrument was .93. These values represent a high level of inter-item agreement among the questionnaire items and are deemed acceptable, with the instrument considered to be internally reliable, based on Nunnally and Bernstein's (1994) cut-off criterion of .70 for the psychological domain.

Table 6.1. Questionnaire reliability analysis (Cronbach's α) and experimental groups' (1, 2) descriptive statistics for both conditions of each dependent variable

Dependent Variable	**Condition**	**Experimental Group 1 (N=27) Traditional (1st), CLA (2nd)**		**Experimental Group 2 (N=27) CLA (1st), Traditional (2nd)**		**Cronbach's α**
		M	SD	M	SD	
Competence	CLA	4.49	0.67	4.18	1.06	.90
	Traditional	3.16	1.19	3.33	1.23	.91
Relatedness	CLA	5.25	0.89	5.06	0.80	.79
	Traditional	4.00	1.49	2.79	1.25	.93
Autonomy	CLA	5.39	1.00	5.47	0.83	.75
	Traditional	3.11	1.56	2.36	1.09	.89
Enjoyment	CLA	5.54	1.03	5.33	0.75	.86
	Traditional	3.73	1.62	2.60	1.24	.93
Effort	CLA	5.39	1.11	5.05	1.14	.89
	Traditional	4.36	1.30	3.52	1.50	.91

Order effect

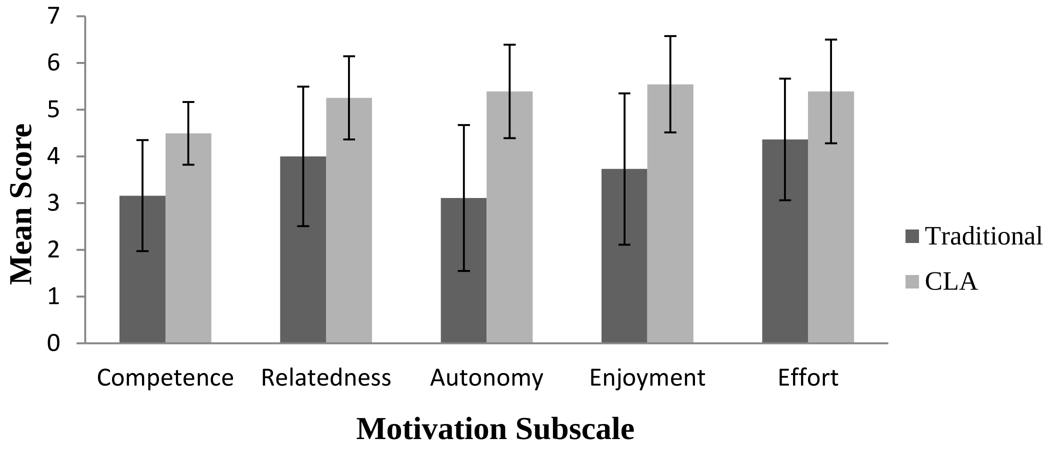
A two-tailed, independent samples *t*-test with a .05 level of significance (α) revealed statistically significant differences between the subscale mean scores of the two experimental groups due to the order that each group experienced the traditional teaching approach. The group that experienced the traditional teaching approach after the CLA reported statistically significantly lower mean scores for relatedness (M = 2.79, SD = 1.25), $t(52)$ = 3.24; autonomy (M = 2.36 , SD = 1.09), $t(47)$ = 2.04; enjoyment (M = 2.60 , SD = 1.24), $t(52)$ = 2.89 and effort (M = 3.52 , SD = 1.50), $t(52)$ = 2.21 compared to the group that experienced the traditional teaching approach before the CLA, relatedness (M = 4.00, SD = 1.48), $t(52)$ = 3.24;

autonomy (M = 3.11 , SD = 1.56), t(47) = 2.04; enjoyment (M = 3.73 , SD = 1.62), t(52) = 2.89 and effort (M = 4.36 , SD = 1.30), t(52) = 2.21. The same independent samples t-test revealed no significant difference between the subscale mean scores of the 2 groups due to the order that each group experienced the CLA.

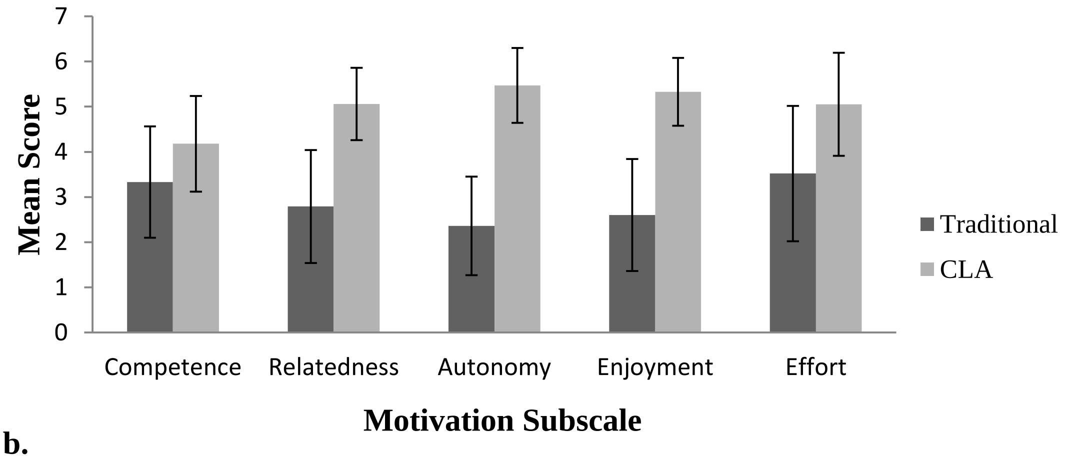
Kolmogorov-Smirnov and Shapiro-Wilk statistics (α = .05) confirmed that the distribution of scores was normal in 17 of the 20 sets of scores. The t-test is considered robust against such small variations of the normality assumption, as the sample is of reasonable size and group sizes are equal. Levene's test confirmed that equal variances can be assumed in all but one set of scores, that is, autonomy traditional. In this case, the t-test value for equal variances for assumed and not assumed were the same, but statistical significance levels were .047 and .046 respectively.

Mean Differences

A two-tailed, paired-samples t-test with a .05 level of significance (α) revealed statistically significant differences in the groups' motivation subscale mean scores for each teaching approach. The two experimental groups' reported motivation subscale mean scores for competence, relatedness, autonomy, enjoyment and effort after experiencing the CLA were significantly higher than motivation subscale mean scores reported after experiencing the traditional approach (Figures 1(a) and (b)). Based on the calculation of Cohen's d, all effects were very large, indicating that participants were substantially more intrinsically motivated during the CLA hurdles lesson compared to during the traditional lesson. This significant difference was evident regardless of the order that each teaching approach was experienced. All specific related t-test values are displayed in Table 6.2.



a.



b.

Figure 6.1. (a) Comparison between traditional approach and CLA motivation subscale mean scores for Group 1 (Order: Traditional, CLA). (b) Comparison between traditional approach and CLA motivational subscale mean scores for Group 2 (Order: CLA, Traditional).

Table 6.2. Difference in motivation subscale mean scores between CLA and Traditional approach for each experimental group.

Pair	Motivation Subscale	Group	Mean Difference	*t*	df	Sig. (*p*) (two-tailed)	*d*
1	Competence Mean Scores (CLA)	1	1.33	6.17	26	.000	1.38
	Competence Mean Scores (Traditional)	2	0.85	3.41	26	.002	0.74
2	Relatedness Mean Scores (CLA)	1	1.25	5.53	26	.000	1.02
	Relatedness Mean Scores (Traditional)	2	2.27	7.26	26	.000	2.17
3	Autonomy Mean Scores (CLA)	1	2.27	6.11	26	.000	1.73
	Autonomy Mean Scores (Traditional)	2	3.10	11.74	26	.000	3.20
4	Enjoyment Mean Scores (CLA)	1	1.81	5.49	26	.000	1.34
	Enjoyment Mean Scores (Traditional)	2	2.73	11.10	26	.000	2.67
5	Effort Mean Scores (CLA)	1	1.03	3.51	26	.002	0.80
	Effort Mean Scores (Traditional)	2	1.53	4.97	26	.000	1.15

Group 1: Traditional (1^{st}), CLA (2^{nd}); Group 2: CLA (1^{st}), Traditional (2^{nd}).

Discussion

The aim of this study was to test the claims made by Renshaw, Oldham, and Bawden (2012) that the learning design and delivery adopted by the CLA can facilitate the satisfaction of the three basic psychological needs of the individual, resulting in an intrinsically motivated performer. As predicted, our results supported these claims. PETE participants' self-reported motivation subscale mean scores for perceived competence, relatedness, and autonomy and their mean scores for the positive indices of intrinsically motivated behaviour, effort and enjoyment were significantly higher after experiencing the CLA hurdles lesson than they were after experiencing the traditional lesson. This significant difference was evident regardless of the order that each teaching approach was experienced. These results indicated that participants' exhibited behaviour was substantially more self-determined and intrinsically motivated during the CLA hurdles lesson compared to during the traditional hurdles lesson.

These findings are consistent with previous empirical research relevant to this study in demonstrating the superiority of an alternative pedagogical approach over the traditional approach in terms of the facilitation of individuals' basic psychological needs and intrinsically motivated behaviours (Goudas et al. 1995; Jones, Marshall, and Peters 2010; McNeill, Fry, and Hairil 2011; Perlman 2010, 2011; Wallhead and Ntoumanis 2004). These previous studies explained their results in terms of the operational principles of the alternative pedagogy, however, our study focuses on the unique theoretically based pedagogical principles of NLP to explain the motivational superiority of the CLA over the traditional approach. These key pedagogical principles of NLP, that inform learning design and delivery of instruction and feedback of the CLA, provide the framework of the discussion that follows (Davids, Button, and Bennett 2008; Renshaw et al. 2009, 2010).

Self-organisation under constraints

The CLA learning design based on the NLP principle of self-organisation under constraints, which embraces system degeneracy and movement adaptation, can explain the enhancement of participants' perceptions of the closely linked psychological needs for competence, autonomy and enjoyment (Renshaw, Oldham, and Bawden 2012). Each participant's movement behaviour/technique was allowed to emerge as a function of the continuous interaction of their unique individual personal constraints (e.g. flexibility), the task constraints (e.g. hurdle height) and environmental constraints (e.g. running track surface) imposed on him/her. Adopting this principle in the CLA hurdles learning design provided participants with the freedom to explore hurdling techniques that match their unique individual characteristics and for their most functional/successful movement behaviours to emerge, facilitating perceptions of autonomy, competence and enjoyment. Physical education students who perceive autonomy for their actions are more intrinsically motivated and find participation in physical activity and sport more enjoyable (Carlson 1995; Goudas et. al. 1994).

By comparison, in the traditional hurdles lesson students had no choice but to imitate the teacher-prescribed ‘ideal’ hurdling technique, limiting participants' perceptions of autonomy. Replication of a ‘one-way-fits-all’ technique, modelled on an idealised hurdling technique from a coaching manual, was an unrealistic expectation for many students who differ physically from the ‘ideal’ performer in terms of flexibility, strength, morphology and limb length. Failure to achieve mastery of the prescribed hurdling technique offers a valid explanation for participants’ lower levels of perceived competence and enjoyment within the traditional lesson.

Representative practice design: Task simplification

The pedagogical principles of representative practice design through task simplification applied in the individualised learning design of the CLA lesson can explain the enhancement of participants’ perceptions of competence and autonomy and their greater enjoyment and invested effort (Renshaw, Oldham, and Bawden 2012). A key concept underpinning ecological psychology is the mutual interdependence of an individual’s actions and their perceived environment (Gibson 1986). In NLP, this is reflected in the primacy of the learner-environment scale of analysis for understanding how to design practice task constraints (Davids, Chow, and Shuttleworth 2005). The implication of this concept for physical educators is the need to design practice environments that are representative of the performance environment containing all key information sources (Pinder et al. 2011). Representative practice design enables learners to attune their movements to this key information through practice, thus establishing functional information-movement couplings (Renshaw, Davids, and Savelsbergh 2010). In the CLA lesson, learners practised the sub-components of the complex hurdling coordination pattern together, that is, lead leg and trail leg in tandem with upper body movements, in a representative practice task of running over flights of hurdles. Adopting this representative practice design provided 'real' learning opportunities for participants to successfully couple (coordinate) actions (e.g. driving the lead leg over the hurdle) with the key information sources in the performance environment (e.g. distance from the hurdle and running speed) and enhance perceptions of competence.

In contrast, in the traditional lesson, participants repetitively practised the reproduction of isolated sub-components of the hurdling technique separately, that is, lead leg followed by trail leg, in a progressive sequence of highly structured prescribed practice drills. This traditional learning design of the decomposed practice of isolated components of the 'whole' technique separates the relevant information-movement couplings, leading to the re-organisation of the timing and coordination of a movement pattern (Handford 2006; Renshaw et al. 2007). This can present a challenge for learners to successfully transfer technique from decomposed practice drills to performance of the 'whole' coordinated movement pattern, offering an explanation for participants' lower levels of perceived hurdling competence in the traditional lesson.

In the CLA learning design, the representative hurdling practice task was simplified by manipulating the task constraints of hurdle height and hurdle interval, preserving the coupling of actions to key information sources (Renshaw et al. 2009). This approach provided participants with multiple practice options of varying complexity level and allowed them the freedom to choose practice lanes that matched their individual characteristics and action capabilities, providing them with the opportunity to experience feelings of autonomy and success. As participants improved they were observed challenging themselves by moving between lanes as they attempted to match their ongoing [perceptions of] competence to task difficulty. The perception of competence and an associated feeling of enjoyment are key factors that determine effort and contribute to increased levels of intrinsic motivation to participate in physical education (Deci and Ryan 1985, 2000). A number of studies have shown that perceived competence is positively associated with intrinsic motivation, that is, if students perceive competence in a physical education class, they enjoy their participation and invest more effort (Goudas, Biddle, and Fox 1994; Goudas et al. 1995; Goudas, Dermitzaki, and Bagiatis 2000; Gray, Sproule, and Wang 2008; Lee, Carter, and Xiang 1995).

Rather than provide multiple practice options of varying difficulty level, the teacher in the traditional lesson prescribed practice activities, which progressed from simple isolated drills directly to the complex performance environment of competitive races over prescribed flights of hurdles, one for females and one for males. Even though the flights of hurdles were set at competition heights and intervals for 14-year-old females and 16-year-old males, researcher observation of the races indicated that such competitive level hurdling tasks seem to be beyond the average 18 – 20-year-old PETE students' capabilities, limiting their chance of mastering the activity and experiencing success and associated enjoyment.

Implicit learning

The type of verbal instruction and amount of technical feedback provided by the teacher within each teaching approach can help explain the differences in participants' perceptions of competence and relatedness (Renshaw, Oldham, and Bawden 2012). In the CLA hurdles lesson, the teacher provided instructions that were performance outcome oriented with an external focus of attention, for example, 'try to run fast over the hurdles'. Directing learners' focus of attention on external movement outcomes has been found to complement exploration, allow less conscious control of movement, and have a positive effect on learning and performance (Peh, Chow, and Davids 2011; Wulf et al. 2000; Wulf and Shea 2002). The opportunity to successfully learn hurdling skills implicitly through explorative subconscious processes with feedback self-generated could therefore explain participants' higher perceptions of competence and associated effort and enjoyment in the CLA lesson. In contrast, in the traditional lesson, the teacher provided learners with explicit instructions, emphasising internal body movements involved in the action itself (e.g. heel towards backside). This internally directed instruction and related feedback could explain participants' lower perceptions of competence and associated effort and enjoyment, as their intrinsic dynamics (the inherent repertoire of movement solutions that exist within the individual) were not matched to the task demands of achieving the optimal movement model (Renshaw et al. 2009).

In the CLA lesson, given that the teacher provided no feedback related to technique, practice was interactive and learning became a co-operative and positively connected activity, enhancing perceptions of relatedness. In contrast the vast majority of teacher-student verbal interactions in the traditional hurdles lesson were prescribed in a hierarchical manner, with the teacher often telling students what technically they were doing wrong. Although delivered in a constructive way, this technical feedback reinforced negative perceptions of competence, encouraging a negative connection between teacher and student (Tinning 2006). As the teacher is considered the 'expert' in control within the traditional approach, cooperative interactions were not incorporated into the traditional lesson learning design, signifying that learning is an isolated task and as a result participants may have felt little connection with each other.

Order effect

An interesting finding of the study was that the group that experienced the traditional teaching approach *after* the CLA reported statistically significantly lower motivation subscale mean scores compared to the group that experienced the traditional teaching approach *before* the CLA. It seems that experiencing the CLA hurdles lesson first, led PETE students to appreciate even more the negative impact of the traditional approach in meeting learners' basic psychological needs. A study by Ward et al. (2008) reported a similar order effect when they examined the effect of choice on girls' self-determined motivation.

Study limitations

Although the findings of the current study extend the existing CLA evidence base by supporting claims of the facilitation of intrinsic motivation, there were several study limitations that restrict the generalisability of the findings. These limitations include the adoption of an action research methodology, participants' prior positive experience with the CLA in a previous unit, the exclusion of an external process to validate the consistency of the teacher's interpersonal style, a short intervention length and the undertaking of the study with only one exemplar activity, hurdling, to test the claims of Renshaw, Oldham, and Bawden (2012). Although it was not the intention of this study to readily generalise findings to physical education students, we acknowledge that our PETE students might potentially have higher levels of intrinsic motivation towards physical education in general because of the expectation of past positive, enjoyable and successful physical education experiences (Moy, Renshaw, and Davids 2014; Wright, McNeill, and Butler 2004); an arguably very different characteristic to the motivational profile of a typical physical education class.

To address these limitations future studies need to investigate how the CLA impacts the intrinsic motivation of school students who have no previous experience with the approach. To eliminate potential experimenter bias, the teacher that delivers the lessons should not be associated with the research study. Additionally, consistency of the teacher's interpersonal style should be externally validated within the study methodology to ensure that differences in student motivation between the two teaching approaches was not the result of differing amounts or types of support offered by the teacher to the students during the lessons (see De Meyer et al. 2014; Goudas et al. 1995; Wallhead and Ntoumanis 2004). Finally, to avoid the likelihood of a novelty effect the length of intervention could be increased to assess its impact over the equivalent of a full school length unit (typically 6 - 8 weeks in U.K. schools and 8 - 10 weeks in Australian schools), and be examined across a wider variety of sports (aquatics, gymnastics, dance, outdoor activities, games).

Future research

This study is the first to provide empirical research evidence to support the CLA meeting the psychological needs of the individual performer in a pedagogical setting. Whilst there is extensive theoretically informed research evidence to support the CLA meeting the skill acquisition needs of the individual performer (Chow et al. 2007; Renshaw et al. 2010), there is little empirical evidence in a pedagogical setting. Although some anecdotal research evidence of personal accounts of the efficacy of the CLA in skill development (learning) in a practical setting has been reported (Moy et al. 2016), this evidence needs to be verified by practical, empirical research studies with a range of children (e.g., socio-economic backgrounds, gender and ages) in a variety of educational settings (e.g. primary, secondary and co-educational). This need is in line with suggestions made by Van den Berghe and colleagues (2014) and Sun and Chen (2010) for more intervention and experimental studies aimed at demonstrating the connection between self-determined motivation and student learning of motor skills in physical education (as proposed by Kirk 2010). Previous SDT studies that have included a motor skill outcome have used measures that reflected a students' performance level such as the number of successful shots in a basketball drill (Simons, Dewitte, and Lens

2003), rather than students' learning such as improvement on a motor task (Van den Berghe et al. 2014). This study addressed how the CLA, informed by a sound framework of contemporary motor learning theory, could facilitate the basic psychological needs of PETE students, which has received limited attention in the extant literature. Additionally, this study revealed that it would be an ideal vehicle to research the connection between self-determined motivation and student learning of motor skills in a primary or secondary school setting. This evidence of the realisation of skill learning outcomes will also help afford educational accountability to physical education and justify its place in the curriculum (Hay 2006).

Conclusion

Given that this study adopted an action research methodology, further work is needed to verify the recommendations made as a consequence of the findings. This study provided a good starting point in contributing to the formulation of evidence-based practical recommendations on how to enhance students' intrinsic motivation in the context of physical education. We observed that the CLA underpinned by NLP could offer an alternative pedagogy that effectively addresses the skill acquisition and motivational criticisms of the traditional approach, supporting the development of intelligent, intrinsically motivated physical education performers. In summary, the complementary theories of ecological dynamics expressed via the individual-environment focus of NLP and SDT may provide teachers and coaches with the tools to develop functional pedagogical climates, which result in students exhibiting more intrinsically motivated behaviours during learning. Physical education lessons that meet these basic psychological needs will produce more effort, enjoyment, interest and excitement in class, leading to greater task engagement, enhanced performance and persistence (Ryan and Deci 2000); surely the goal of all physical education teachers!

Chapter 7: General Discussion

The physical education teaching approach used predominantly by Queensland physical education teachers is reported to be the traditional approach (Cothran et al. 2005; SueSee and Edwards 2011). This prescriptive drill-based teaching methodology is, however, not compatible with the aim of developing skilled physical education performers, viewed from a contemporary motor learning perspective as adaptive individuals who can accurately achieve task goals in varying performance contexts (Araújo and Davids 2011; QSA 2010). The traditional approach has also been criticised for failing to meet the basic psychological needs of the individual (Chow et al. 2013; Renshaw et al. 2010; Renshaw, Davids, and Savelsbergh 2010), highlighting the need for an alternative physical education teaching approach. Physical education teacher education (PETE) programmes have been identified as a critical point in time in the professional development of teachers to encourage the exploration of alternative teaching approaches (Light 2002). This prompted the Sport, Health and Physical Education discipline group within the Queensland University of Technology (QUT) to critically change the traditional delivery of a games unit within their PETE course and adopt an alternative approach. The Constraints-led Approach (CLA), grounded in contemporary advancements in motor learning research, was adopted as it provided a viable alternative teaching methodology to support the development of skilled physical education performers, while potentially meeting their basic psychological needs (Chow et al. 2016; Renshaw et al. 2010). The introduction of the CLA into the PETE course at QUT was the impetus for a PhD programme of study following an evolution of physical education teaching practice, contributing some significant implications for PETE practitioners and PETE practice along the way.

Learning designs for evolving physical education practice: Developing a belief in an alternative pedagogy during PETE (Studies 1 and 2)

Findings

The principal aims of studies 1 and 2 were to investigate whether past school and sporting experiences are powerful influences on Queensland PETE recruits' perspectives and initial personal beliefs about effective physical education teaching practice. Additionally, how these experiences influenced their receptiveness to the CLA, as captured by Lawson's (1983a, 1983b) physical education occupational socialisation theory of acculturation, was investigated.

As predicted, results indicated that the physical education teaching approach that Queensland PETE recruits' are exposed to appears to have a very powerful influence on their perspectives and initial personal beliefs about effective physical education teaching practice. The traditional, reproductive approach was the predominant approach to games coaching and physical education teaching that Queensland PETE recruits were exposed to, and these recruits possessed very strong custodial, traditional physical education games teaching beliefs. These results are consistent with Lawson's (1983a, 1983b) physical education socialisation theory of acculturation that past school and sporting experiences are powerful in influencing PETE recruits' perspectives and initial personal beliefs about effective physical education teaching practice. They also confirm predictions about the incompatibility of Queensland PETE recruits' beliefs regarding effective teaching practice with the Queensland Senior Physical Education syllabus requirement of developing skilled physical education performers. This highlights the need to introduce PETE students to an alternative physical education teaching approach.

After experiencing the CLA during an eight-week games unit, we found that, contrary to our expectations and Lawson's physical education socialisation theory (1983a, 1983b), these products of the traditional, reproductive approach were receptive to an alternative pedagogical approach regardless of the performance level of sport played prior to entry into PETE. Most significantly, PETE recruits who were highly successful products of a traditional physical education culture and who were expected to stay strongly committed to a process that had worked effectively for them, changed their strongly held, custodial physical education teaching beliefs and developed a receptiveness to the CLA. When exploring how PETE students' acculturation shaped their reasons for receptiveness to the CLA, it was found that the efficacy of the alternative physical education teaching approach in skill development and its inclusive nature were clearly important mediators of receptiveness for highly successful products of a traditional culture.

Practical Implications for PETE Educators

Most often, recruits' existing custodial beliefs tend to shape the professional knowledge they acquire through teacher education programmes, rather than vice versa (Tsangaridou 2006). Significantly, this PhD programme has identified a viable alternative pedagogy and a pedagogical unit design that can shape the physical education teaching beliefs of recruits identified in the literature as most resistant to change, that is, those with a strong custodial orientation who are high achieving sporting products of this custodial culture (Lawson 1983a). PETE educators could consider these findings when introducing an alternative pedagogy aimed at overcoming the powerful constraint of acculturation and challenging the resistant, custodial teaching beliefs of PETE recruits.

To facilitate receptiveness to an alternative pedagogy, PETE students should be given the opportunity to personally experience it ‘work’ for themselves and observe it ‘work’ for their peers through the successful acquisition of movement skills as learners, just as they have previously experienced as successful products of a custodial teaching approach. This aim can be achieved through participation in practical workshops that adopt the pedagogical principles of practice design and delivery of a NLP such as self-organisation under constraint manipulation and perception-action coupling. To provide the opportunity to personally experience skill development it is important to cover a range of sports to allow students the opportunity to experience a sport as a novice. These powerful and meaningful experiences enable PETE students to recognise and value the consequence of the change process for themselves and their learners, and develop a belief in the efficacy of the approach.

It is also important that these experiences are offered in conjunction with a clear understanding and appreciation of the learning theory that empirically supports the learning process within the design and delivery of the alternative pedagogy. This can be achieved by integrating the underpinning motor learning theory and practice and by engaging the body in learning through students experiencing the alternative approach as learners in practical workshops. This understanding and appreciation can be enhanced through the presentation of supporting theory lectures and ongoing and immediate student written reflections on their personal experiences in practical workshops, while making connections with their previous physical education experiences and the motor learning theory. The operationalised theoretical framework within a research-informed pedagogical learning design should provide students with a convincing theoretical rationale for the perceived effectiveness of an alternative approach, a framework for the application of key principles and a justification for its future use.

Receptiveness to an alternative pedagogy can be further enhanced if PETE recruits' custodial, traditional teaching beliefs are critically challenged through highlighting the contemporary skill acquisition and psychological failings of traditional physical education practice environments in lectures and practical workshops. For example, the failure of skill transfer from traditional practice drills to the performance environment as drills isolate technical skills from the relevant information-movement couplings present in the performance environment. Psychological failings can be highlighted in lectures by including the presentation of personal reflections of pre-service teachers who had not enjoyed traditional physical education due to experiences of humiliation, failure and exclusion. These reflections allow participants to gain an insight into the perspectives of less skilled and less motivated students who view traditional physical education differently to them. Following this, the potential of the alternative pedagogy in providing a solution for the exclusion of less skilled and less motivated students in physical education classes should be highlighted by allowing students to personally experience its inclusive nature and to have opportunities to experience and demonstrate success. This can be achieved through participation in an inclusive learning design that incorporates small-sided games and individualised practice tasks with constraints manipulated to match students' ability level.

Future Research

The impact that the CLA games unit had on the teaching beliefs of PETE recruits is encouraging. Many participants in this study showed an encouraging desire to implement the CLA in schools but highlighted potential problems:

I'd definitely try and use the constraints-led approach. It will be hard to think about all the games and stuff and try and make them up, but yeah, it just means that you've got to think about it and prepare yourself a lot more. (Interview, Josh, state representative in touch football and cricket)

Future research is planned to investigate these PETE students' experiences implementing the CLA in a school setting on practicum. These findings would enable the constraints-based model to continue to evolve by exploring the issues that impact upon its successful teaching and learning. Knowledge gained from such studies would subsequently inform and improve the design of PETE games units and programmes aimed at changing traditional physical education teaching practice. As previous research indicates the school practicum is not a good place for PTs to experiment with innovative practice approaches due to resistant conservative cultures of schools and many other contextual factors (Howarth 2005; Lawson 1983a, 1983b; McNeill et al. 2004; Zeichner and Tabachnik 1981). To overcome these barriers, and facilitate PETE student's successful implementation of CLA, it is important that this planned research programme adheres to recommendations proposed in previous research studies to create a contextually supportive and simplified teaching environment (Brooker at al. 2000; Gurvitch et al. 2008; Hastie and Curtner- Smith 2006; Howarth 2005; Li and Cruz 2008; Light 2004; Light and Butler 2005; McNeill et al. 2004; Rossi et al. 2007; Wang and Ha 2009, 2012, 2013a, 2013b; Wright 2007; Wright et al. 2006; Wright, McNeill, and Fry 2009). For example, the practicum placement site should have a culture that encourages innovative practice, with PETE students being provided with guidance and support from a university mentor and the co-operating teacher during the experience.

Learning designs for evolving physical education practice: Preparing and supporting PETE students to implement the CLA on practicum (Study 3)

Findings

This action-based empirical research study's aim was to explore PETE students' experiences associated with student learning when implementing a NLP, specifically the CLA, in a school setting. As expected, results of this study exposed significant challenges to novice practitioners when implementing the CLA, due to the less predictable and complex nature of student learning that emerges as a consequence of the dynamic individual learner-environment interactions within a NLP (Chow 2013). Participants had difficulty designing modified learning environments to channel learners' search towards predetermined problem solving behaviours in accordance with the CLA's implicit, exploratory learning process. They also found it challenging to detect and interpret their learners' multiple complex and less predictable responses to the constraint manipulated environments they implemented. These findings highlight the important need for PETE students to develop their experiential knowledge and conceptual understanding of the complex and dynamic emergent learning processes underpinning a nonlinear approach like the CLA and the co-adaptive and regulated interactions that occur within the dynamics of a team game.

Practical Implications for PETE Educators

These implementation challenges facing practitioners can be used to inform and improve the design and delivery of PETE programmes in preparing and supporting PETE students to effectively and authentically implement the CLA and other nonlinear informed games based approaches in a school environment. These findings highlight the important need for PETE students to develop their experiential knowledge and conceptual understanding of the subconscious exploratory learning processes underpinning a nonlinear approach like the CLA and the co-adaptive and regulated interactions that occur within the dynamics of a team game. To achieve this aim, PETE programmes must incorporate opportunities for students to develop their skills in the detection and interpretation of the multiple less predictable player responses within a constraint manipulated team game. This is a difficult task, thus these skills should be progressively developed, starting with simple environments, for example, observing a 1 v 1 game from the 'sideline', and working towards more complex observations and interpretations of small-sided team games from a teacher's perspective. These observations and interpretations would help PETE students gain a practical understanding of the dynamic, complex, and interacting nature of a player's emergent individual response resulting from exposure to constraints. This process would also prepare the novice teachers psychologically for the unexpected responses to the manipulated environments they implement.

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

To better prepare and support PETE students to effectively and authentically implement the CLA on practicum, rather than implementing these modified environments with peers in a university class it is important to implement them with pupils in a physical education lesson. The reason for this was highlighted by both study participants when reflecting on their pupils' response to their teaching. Both Max and Melinda reported a significant difference in response to manipulated learning environments by pupils compared to their university peers in the constraints-based games unit. Melinda and Max reported that pupils often weren't 'switched on' and thinking about how to exploit the manipulated learning environments and 'blindly' played games. This was in stark contrast to the 'game awareness' displayed by their university peers, which consistently resulted in players quickly interpreting and exploiting the learning environment to solve game related problems. According to Davids (2012), in an ecological dynamics approach, the nature of the performer-environment relationship is not the same for beginners and experts, since experts are more capable of exploiting information about environmental and task related constraints. In a similar study, McNeill and colleagues (2004, 19) reported that PTs had difficulty implementing the Games Concept Approach as their pupils 'were not used to thinking during PE lessons' and consequently were not learning how to solve game problems.

It is important that PETE students gain experience incorporating the following strategies, successfully trialled by Melinda and Max, to cognitively and emotionally engage pupils in subsequent lessons. These include, allowing pupils more time to explore the manipulated learning environment, allocating pupils with 'game awareness' to key positions, such as the player with immunity in the 'safe passing' game, further exaggerating the key information in the learning environment to make the tactical concepts easier to detect, creating a competitive environment, challenging pupils through game scenarios, and the strict enforcement of rules.

Impact on the author's practice

To support PETE students' future implementation of the CLA the author has integrated these practical study recommendations into his practice through the addition of an assessment task within the PETE constraints-based games unit. This task was incorporated to allow PETE students the opportunity to gain some experiential knowledge and practical understanding of the emergent learning process within the nonlinear CLA, and also to develop their observational and analytical skills. In groups, PETE students observe a small-sided game and identify specific game-related problems and associated possible causes. Each group is then allocated a different identified game-related problem to address through the design of a representative modified game using constraint manipulation to emphasise the game-related problem and to channel learners' search towards a desired movement solution. Their learning design must be justified in terms of how it allows problem solving behaviour to implicitly emerge through the natural, exploratory learning processes underpinning the CLA. PETE students then play the modified game, while the group who designed the game observe and interpret players' emergent responses, in relation to the desired movement solution and any unpredicted or less expected emergent behaviour. Students then complete a written worksheet based on their observations and interpretations, citing specific examples as evidence, as well as proposing modifications to improve their learning design. To facilitate students' learning, the tutor initially models each step of the task. This learning experience should better prepare and support PETE students to effectively implement the CLA and other nonlinear informed games based approaches in a school environment on practicum.

Future Research

The founding student-centred approach, TGfU, has been around for over 30 years. In that time it has been embraced and developed by researchers, however, there is still a challenge in terms of its adoption by practitioners (Almond 2010; Renshaw et al. 2015; Thorpe 2015b). According to Renshaw and colleagues (2015), in order to increase the likelihood of the CLA being adopted by practitioners in schools, it is vitally important that researchers and practitioners work symbiotically in embedding new thinking into practice. Thus, for an evolution of physical education teaching practice to progress, it is important that the learning-related practical recommendations from this research study are embedded into a PETE programme and future research investigates their effectiveness in preparing and supporting PETE students to authentically implement the CLA in a school environment.

The 'realistic' resistant conservative culture of the school practicum environment is too big a step from the 'unrealistic' supportive innovative PETE teaching environment for novice teachers to authentically implement a NLP, such as the CLA. Thus, an in between step is necessary to support this process. Such an environment can be achieved through PETE educators working together with the physical education department of the local school to provide opportunities for PETE students to independently apply their newly developed skills, experiential knowledge and conceptual understanding of the CLA with smaller groups of students in a physical education lesson. From such research, the effectiveness of the learning-related practical recommendations can be evaluated and further issues surrounding the practical challenges associated with the authentic design and delivery of a NLP in the school environment can be identified.

Learning designs for evolving physical education practice: Presenting a viable alternative pedagogy (Study 4)

Findings

It is important that the alternative pedagogy presented during PETE addresses the criticisms of the predominantly used traditional physical education teaching approach. At this point the CLA has shown potential to effectively address the failings of the traditional approach in terms of the development of skilled physical education performers. However, the prescriptive teaching philosophy of the traditional approach has also been criticised for failing to effectively provide learners with motivationally supportive experiences to engage in physical education (Carlson 1995; Ennis 1999; Ntoumanis et al. 2004). Self-determination theory (SDT) provides a valuable framework for examining motivationally supportive physical education experiences through satisfaction of three basic psychological needs of the individual: autonomy, competence and relatedness. Claims have been made that the learning design and delivery adopted by the CLA can facilitate the satisfaction of the three basic psychological needs of the individual, resulting in an intrinsically motivated performer (Renshaw, Oldham, and Bawden 2012). This study aimed to verify these claims using the author's own PETE teaching practice. As predicted, this study provided empirical research evidence to support the CLA effectively facilitating students' self-motivated engagement in physical education by meeting all three basic psychological needs of the individual performer, autonomy, competence and relatedness.

Practical Implications for PETE Educators

The practical implications of these findings can provide PETE educators and physical education teachers with the evidence-based practical recommendations on how to develop physical education learning experiences that enhance learners' intrinsic motivation producing more effort, enjoyment, interest and excitement in students, leading to greater task engagement, enhanced learning and performance of motor skills. For example, allowing pupils the freedom to explore techniques that match their unique individual characteristics (autonomy), providing learners with multiple practice option of varying complexity (competence) and working in a co-operative environment (relatedness).

Future Research

The theoretical grounding of the CLA has been supported by many empirical studies that have demonstrated performance improvement in athletes in an elite sports coaching setting and studies within this PhD programme have provided evidence to demonstrate performance and psychological enhancement in PETE students in a university setting. To date, there are no empirical studies that test the efficacy of the CLA in terms of the improvement of pupils' performance of motor skills and self-motivated engagement in the school setting. To fill this void, future practical empirical research is planned to investigate if adopting the NLP pedagogical principles in practice through the physical education teaching methodology of the CLA enhances pupils' performance of motor skills and their intrinsic or self-determined motivation in physical education lessons. These empirical research studies would involve a range of children (e.g., socio-economic backgrounds, gender, ages) in a variety of educational settings (e.g., primary, secondary, co-educational).

The planned future research aligns with suggestions made by Van den Berghe and colleagues (2014) and Sun and Chen (2010) for more intervention and experimental studies aimed at demonstrating the connection between self-determined motivation and student learning of motor skills in physical education (as proposed by Kirk 2010). Previous SDT studies that have included a motor skill outcome have used measures that reflected a students' technical performance level such as the number of successful shots in a basketball drill (Simons, Dewitte, and Lens 2003), rather than students' learning such as improvement on a complex motor task (Van den Berghe et al. 2014).

This study addressed how the CLA, informed by a sound framework of contemporary motor learning theory, could facilitate the basic psychological needs of PETE students, which has received limited attention in the extant literature. Additionally, this study revealed that it would be an ideal vehicle to research the connection between self-determined motivation and student learning of motor skills in a primary or secondary school setting. This research is important as the CLA is theoretically richer in motor learning theory and motivational theory than other alternative physical education teaching approaches and empirical data would demonstrate its benefits within the discipline of physical education. Evidence of the realisation of skill learning and psychological outcomes will help afford educational accountability to physical education and justify its place in the curriculum (Hay 2006).

Conclusion

The collective empirical findings of this PhD programme can help guide PETE educators to commence an evolution of physical education teaching practice through the introduction of an alternative pedagogy during PETE. Grounded in contemporary advancements in motor learning research, NLP offers PETE educators an empirically-verified and theoretically-rationalised alternative pedagogical framework to the dominant traditional reproductive approach. Implemented through the physical education teaching methodology of the CLA, this PhD programme has demonstrated how NLP can inform physical education learning design to effectively address the skill acquisition and motivational criticisms of the dominant traditional approach, while supporting the worldwide physical education curriculum directive of the development of skilled physical education performers. This evolution of teaching practice has the potential to result in opportunities for enhanced student learning and performance of sports skills in physical education classes.

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Appendices

Appendix A: Why the constraints-led approach is not teaching games for understanding: A clarification.

Renshaw, I., D. Araújo, C. Button, J.Y. Chow, K. Davids and **B. Moy**. 2015. Why the constraints-led approach is not teaching games for understanding: A clarification. *Physical Education and Sport Pedagogy*, DOI: 10.1080/17408989.2015.1095870.

Background: There is some apparent confusion regarding similarities and differences between two popular physical education (PE) pedagogical frameworks, i.e., the Constraints-Led Approach (CLA) and Teaching Games for Understanding (TGfU). *Purpose:* Our aim in this commentary is to detail important theoretical and pedagogical concepts that distinguish these approaches, as well as to recognise where commonalities exist.

Findings: In particular we note that TGfU had its roots in the 1960s in the absence of a substantial theoretical framework, although several attempts to retrospectively scaffold theories around TGfU have subsequently emerged in the literature. TGfU is a learner-centred approach to PE in which teachers are encouraged to design modified games to develop the learner's understanding of tactical concepts. In contrast, the CLA has arisen more recently from the umbrella of Nonlinear Pedagogy (NLP), emerging from the empirically-rich theoretical framework of ecological dynamics. The CLA adopts a 'learner-environment' scale of analysis in which practitioners are encouraged to identify and modify interacting constraints (of task, environment and learner) to facilitate the coupling of each learner's perceptual and action systems during learning. The CLA is a broader framework which has been adapted for the design of (re)learning environments in physical education, sport and movement therapy. Other key distinctions between the approaches include: the overall goals; the way in which the learner and the learning process are modelled; the use of questioning as a pedagogical tool; the focus on individual differences versus generic concepts; and how progressions and skill interjections are planned and implemented.

Conclusions: Despite such distinctions the two approaches are somewhat harmonious and key similarities include: their holistic perspective of the learner; the proposed role of the teacher; and the design characteristics of learning tasks in each. Both TGfU and the CLA have a powerful central focus on the nature of learning activities undertaken by each individual learner. This clarification of TGFU and the CLA is intended to act as a catalyst for more empirical work into the complementarity of these juxtaposed pedagogical approaches to learning design.

Key words: Learning Design, Pedagogy, Physical Education, Sport, Constraints-Led Approach, Teaching Games for Understanding

Introduction

In two recent reviews of articles in this journal we were challenged by reviewers to explain differences between the Teaching Games for Understanding (TGfU) approach and the Constraint-led Approach (CLA) since: (1) "the two approaches are the same thing, aren't they?" and (2) "The underlying basic principles [according to the reviewers of our previous work] are those of behaviourism/cognitivism (traditional approach) versus social-constructivism (CLA approach)." In our work with teachers and coaches we are finding that categorising the CLA as a games-based teaching approach is a common misapprehension, perhaps due to an early focus of CLA literature on team games (e.g., Chow et al. 2009; Renshaw, Chow, Davids, and Hammond 2010a) and published work that integrates games-centred approaches with complexity based ideas such as the CLA in education journals (e.g., Storey and Butler 2013). This may have inadvertently led to some educationists categorising the CLA as 'just another game-centred pedagogy' in line with approaches such as TGfU (Bunker and Thorpe 1982), its Southern Hemisphere derivative, Game Sense (den Duyn 1996, 1997; Thorpe 2005), Sport Education (Siedentop 2002), Play Practice (Launder 2001), Games Concept Approach (Tan, Wright, McNeill, Fry, and Tan 2002) and the Tactical Games Approach favoured by some North American pedagogues (Mitchell, Oslin, and Griffin 2012). To that end, given the view of the teachers and coaches who we work with in our teacher and coach education sessions and the comments of the academic reviewers we cite in our introductory paragraph, our aim here is to provide clarifications for physical educators and sport pedagogists on the nature of the relationship between the CLA and TGfU.

In this paper we seek to confirm that, while there may exist some similarities between the CLA and TGfU methods at an operational level, there are major differences in theoretical principles used to guide pedagogical practice and learning design. In this context, as one of the reviewers of the manuscript noted, the implementation of TGfU and the CLA (in line with other pedagogical approaches) is situated in the ambiguities, tensions, and compromises that arise when attempts are made to apply new models in practice; and which, without reflection in practitioners, may “look like the same thing” when observed in teaching and coaching contexts.

Additionally, we have argued elsewhere that some of the key principles of TGfU can be underpinned with reference to Nonlinear Pedagogy (NLP), the framework of pedagogical principles which overarches the CLA (see Chow et al. 2007; Davids, Chow, and Shuttleworth 2005; Renshaw et al. 2010; Stolz and Pill 2014). The aim of this commentary is to clarify the misconception that the CLA and

TGfU are *one and the same thing*. They are not. We also seek to demonstrate that while TGfU is essentially a games-based model, the CLA has the capacity to be more than 'just' a games-based model. While it can underpin games teaching, its concepts have also been used for understanding learning design in many other physical activities (e.g., springboard diving (Barris et al. 2013, 2014), swimming and ice climbing (Seifert 2010; Seifert et al. 2014), long jumping (Greenwood et al. 2014) and sailing (Araújo et al. 2006; 2014). TGfU has been developed as an operational model for the practice of teachers of PE, whereas the CLA is a theoretically-based approach to skill acquisition and motor learning that can be applied to developing principles of practice across the whole spectrum of exercise, health, PE, sport performance and physical activities.

Because there are a number of game-centred approaches, their advocates may consider that our comparison of the CLA with TGfU (and Game Sense as the sport coaching centred derivative of TGfU), may neglect the contribution of these 'worthy' approaches (see Stolz and Pill 2014 for a detailed discussion of the evolution of games-based models that have their roots in TGfU). TGfU has been selected for our clarification first because it is the 'founding' approach that led to the emergence of the various games-based approaches mentioned in the previous section and as such has a richer research base than other similar approaches. Secondly, previous literature has attempted to demonstrate the connections between TGfU and Non-Linear Pedagogy (e.g., Chow et al. 2007, 2009; Storey and Butler 2013). However, it is clear from our previous discussion, that despite the excellent coverage of the potential links between TGFU and NLP in previous work, practitioners (and some academics) are still unclear about the similarities and differences between the two models.

It should be clearly noted that this position paper does not constitute an attempt to discuss the relative merits of the two approaches and we will leave it to the reader to decide on the relative strengths and weaknesses of the two approaches. However, it is worth noting that the spirit and philosophy underpinning the TGfU approach is harmonious with much of the pedagogical philosophy of the authors of this clarification statement. Indeed, it inspired some of us who were lucky enough to be exposed to the teachings of Dave Bunker, Rod Thorpe, and Len Almond at Loughborough University in the 1980s. Our aim is therefore to clarify some similarities and distinctions between the two frameworks so that readers are aware of these subtleties when reading research and considering application of key ideas in their practice. To situate our discussion we will first summarise the context of the development of TGfU and consider how the zeitgeist of the times shaped the ideas and principles of the approach.

The emergence of TGfU

Whilst the first papers on TGfU were published in 1982, the roots of the approach can be traced back to the 1960s. Thorpe and Bunker noted that the likes of Allen Wade, Eric Worthington, Stan Wigmore and Jim Greenwood exerted significant early influence on the emergence of their ideas (Thorpe 2015; Thorpe and Bunker 1986). Of particular significance was their suggestion to consider the idea that “game skills should be taught through the principles of play (Thorpe and Bunker 1986, 5)”, which was formalised by Allen Wade (1967) in his seminal football coaching manual. The promotion of small-sided games as part of sessions to develop skills also emerged at this time, but still the main focus was on the 'skill' acquisition aspects of the lesson (Thorpe 2005; Thorpe and Bunker 1986).

On his return to Loughborough as a staff member, Thorpe moved away from the technique-based approach which he had been taught when he was an under-graduate at Loughborough in the early 1960s and moved towards a more cognitive orientation in his practice. This move should be seen in the context of the current trends in related fields of education and psychology at this time and alongside the development of other "cognitive-oriented learning material" like classroom studies (Pigott 1982). Even in the field of skill acquisition, the influential John Whiting was pre-eminent, publishing papers on the information processing requirements of acquiring ball skills (Savelsbergh and Davids 2002; Whiting 1969). Thorpe was heavily influenced by a wide range of pedagogical approaches, most significantly, educational gymnastics and Mauldon and Redfern's (1969) games teaching ideas. In terms of the influence of educational gymnastics, Thorpe, (2015) through an e-mail exchange with the lead author explains "Simply I was attracted by the idea of setting problems that could be answered by children at different levels of skill… [and]…perhaps the light bulb going on for me was the realisation that games set problems all the time, whereas in Educational gymnastics the teacher had to design the problem."

Thorpe was also fascinated by contemporary literature in psychology (e.g. experimental psychology) and sports coaching (e.g., the Inner Game concept presented by Gallwey 1974, 1979). Thorpe highlights that he began to teach using the TGfU approach in the early 1970s before the model was named and formalised in the early 1980s. In fact in 1969 and 1970 Thorpe supervised two final year under-graduate dissertations by Graham Stevenson (1969) and Ian Graham (1970) on modified rackets well before these became common usage. The ideas developed through a constant dialogue between Thorpe, Dave Bunker and Len Almond (see Butler 2014 for a summary of the comparative ideas of these founders in terms of the intentions, beliefs and actions they believed to be fundamental to TGfU). Significant contributions were also made by colleagues at Loughborough such as Rex Hazeldine and Jim Greenwood, as well as collaborators such as Margaret Ellis, Lynn Spackman and teachers working in schools (Thorpe 2015). The significance (and relevance for this paper) is to recognise the contribution of the knowledge gained from the very many teachers the team interacted with whilst doing in-service work. Thorpe (2015) also notes "It is also worth mentioning that some teachers came up to us and said "Thank you, I was doing something like this, but felt guilty because I did not have a framework or rationale."

It is also worth noting that, at that time, there was little to no expectation of undertaking research in British PE colleges, and it was only through the significant encouragement of Len Almond that the TGfU model was published in 1982. As Thorpe and Bunker have highlighted in their writings and many conference presentations, TGfU was proposed as a way of improving the teaching of games in schools. This proposal emerged because they believed, through their observations in schools, that many children did not understand games, or in some cases were not even playing them. What should be made clear here is that the TGfU model was designed as a *practical approach* aimed at improving the learning experiences of children and was not developed as a theoretically-based pedagogical framework;

and, incidentally, it was never intended to be (Thorpe 2015 and see Bunker 2012; Bunker and Thorpe 1982; Thorpe 2010).

However, as highlighted previously, ideas are not developed in total isolation from current trends and issues. Part of the rationale for developing TGfU was that traditional approaches seemed to contrast with some basic skill acquisition principles such as play, observational learning, high amounts of practice and the failure of 'skill' to transfer to the real game (Bunker and Thorpe 1986; Thorpe 2005; Thorpe, Bunker, and Almond 1984). As Thorpe (2005a) in his conference keynote elucidated, "Advocates of TGfU asked themselves the question, have we concentrated too much on how "we" coach, rather than how "they" learn"? This question pre-empted future trends in education, physical education and sport pedagogy, reflecting the perceived need to move from a teacher-centred approach to a learner-centred approach to teaching game skills. Accordingly, much training and assessment of teaching and coaching methods were more operationally concerned with the mechanics of teaching such as voice projection, presence, quality of demonstrations, appearance and preparation, and class management (e.g., formation of orderly queues, use of space and tidy placement and collection of equipment), rather than focusing on assessing the 'learning experience and environment'. These initial concerns are strongly in line with ideas of advocates for the CLA, who argue that central to the teaching and coaching process is the complementary need for a model of the learner and the learning process (Handford et al. 1997; Renshaw et al. 2010). A theoretical model of the learner and the learning process is needed to support pedagogical decision-making and the design of practice and training environments (Davids et al. 2015). The missing ingredient of designing motivating learning environments was also captured by the TGfU model (but also see Mauldon and Redfern 1969).

The link between motor learning, sport psychology and physical education has always been perceived as a neglected concern for contemporary pedagogists and didacticists (Abernethy 1999; Newell and Rovegno 1990; Renshaw et al. 2010) and highlights the complementary nature of experiential and empirical knowledge in sport pedagogy and physical education (Greenwood et al. 2014). It has been argued that there is a clear need for contemporary researchers and practitioners to work together when developing new pedagogical approaches (Butler 2012). In summary, "the model was developed *for* PE teachers and eventually led to changes in the UK National Curriculum and the way we sampled games – words like; target, divided and shared court, fielding, invasion games appeared as we worked from common principles – space and time" (Thorpe 2005a).

The Teaching Games for Understanding Model

The design of appropriate games to enable learners to understand key principles of games is a key feature of TGfU. Bunker and Thorpe developed a linear, yet cyclical 6-step model (see Figure 1) where the 'sequential aspects of the model are crucial' (Bunker and Thorpe 1986, 10). After deciding on *a game form* that is matched to the age and experience of the learners, and a 'close resemblance to the adult version of the game', learners move onto developing *game appreciation* and developing *tactical awareness.* These stages are all about understanding the rules of the game and determining the best tactics to exploit them. This would include awareness of the strengths and weaknesses of opponents. *Decision-making* follows based on deciding "what to do" and "how to do it". Key requirements for appropriate decision making include the need to recognise the cues and the selection of the most appropriate response from those (currently) available to the individual. This involves understanding the potential consequences and a calculation of risk and reward at any moment in time. *Skill execution* follows and reflects the actual execution of the chosen movement pattern. The quality of this movement is judged by the teacher and sits separate to the actual performance. For example, a young child may produce an excellent overarm throw with correct sequencing of body parts and an accurate throw but a lack of strength may mean the throw was not powerful enough to run out the base runner. The final stage is performance, which refers to the observed outcome and is measured against ‘criterion standards’ across learners. Players can therefore be classed as ‘good’ or ‘bad’ players, based on the effectiveness of the decisions made as well as the quality of the techniques demonstrated. At the end of the cycle, the teacher carefully evaluates each step and if necessary revises the game form to further challenge the learners. This is a key skill for teachers and coaches and requires them to identify the most important performance aspect that an individual or a team needs to work on at any specific stage of their development and then design appropriate game forms. Bunker and Thorpe (1982) suggest that the games should be implemented by using ‘modification through representation’ or by ‘modification through exaggeration’, ‘sampling’ and ‘tactical complexity’.

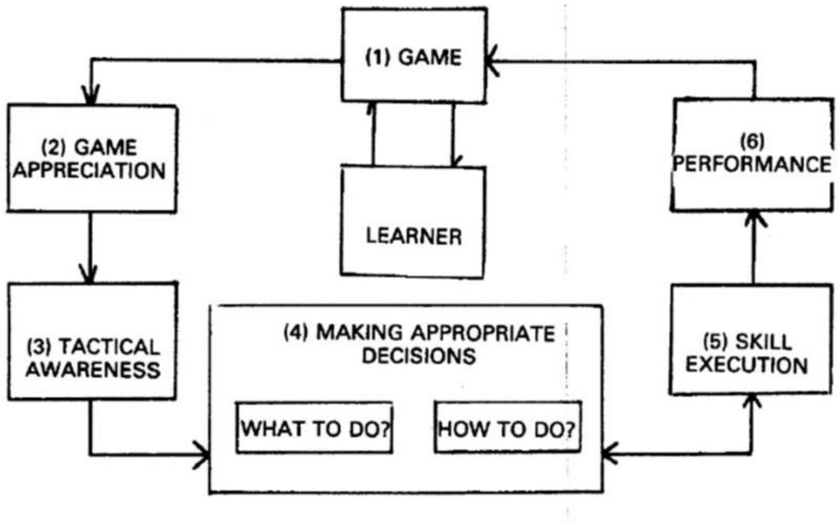

Figure 1: The TGfU Model (Bunker and Thorpe, 1982).

Theories and TGfU

As we stated in our introduction, we believe that the theoretical basis for TGfU differs significantly from that underpinning NLP, as argued by Davids et al. (2005) and Chow et al. (2007) (also see later in this paper). Core to these arguments is that TGfU, originating as a pedagogical method, was not explicitly built on a theory of motor control and learning. However, in line with the zeitgeist of the times (and Thorpe's reflections), it might be assumed that the belief that children's games playing ability could be enhanced by acquiring a greater 'understanding' of games was implicitly inspired by cognitivist (most notably constructivist) approaches to human behaviour, with a particular reference for education (see Griffin, Brooker, and Patton 2005). Pigott (1982, 17) was perhaps the first academic to argue that "the rationale behind new trends in games teaching appears to be just as valid as the psychologist awakening to the importance of cognitive constructs in motor learning." He also acknowledged that "initial thoughts on the understanding approach to teaching games might lead one to suspect that this material was based upon little more than a dissatisfaction with current traditional curricula plus a concern for the opportunities of the less able" (Pigott 1982, 20). In his article, Pigott went on to examine the "diverse literature of motor learning and cognition" proposing the possibility that Schema theory (Schmidt 1975) could best explain how TGfU was aligned with contemporary motor learning theory with the potential to support this 'new' teaching direction" (Pigott 1982, 17). He suggested that the ideas of variable practice within schema theory could enable the acquisition of motor programs needed in open skill environments while 'higher-order' centres in the CNS looked after the decision-making element in the understanding approach. Decision-making in new and different game requirements was said to be "under the control of higher order rules or 'principles' that are generalizations which can be applied to new but related tasks" (Pigott 1982, 18). In essence, therefore, in any cognitive motor learning theory, the student sits at the centre of the process, with the goal of developing cognitive processing capacities, i.e., his or her understanding through games teaching. Consequently, TGfU is a learner-centred approach where group participants make key decisions about how to solve a problem presented by a game, which is carefully designed by the teacher. By allowing children to work out their own performance solutions with focused questioning to guide their discovery, they come to understand how to play the designated game more effectively.

As highlighted earlier, the TGfU model uses 4 pedagogical principles, sampling, modification-representation, modification-exaggeration, and tactical complexity, to provide a framework to guide teachers in TGfU game design (Thorpe, Bunker, and Almond 1984). This model contains embedded assumptions about motor learning, but it does not seek to present concepts and principles, devised in detail *a priori* from a rigorous theoretical model of motor learning to empirically support the design of learning environments (Chow et al. 2007; Kirk and MacPhail 2002). In this respect, it has been argued that the major contribution of TGfU has been to define a set of *operational* principles, underpinned by practical experience and observation in physical education classes, to aid in the design of environments for games teaching (Chow et al. 2007). Indeed, empirical research explicitly attempting to provide a theoretical rationale for TGfU has not come from the originators of the model but from advocates of the approach. As such, over time a range of theories have been proposed to retrospectively explain how learning might occur in TGfU. Notable approaches include Schema theory (Pigott 1982), information processing (see Turner and Martinek 1999), situated-learning (see Kirk and MacPhail 2002) and systems theory (see Storey & Butler 2013). Additionally, in line with the original explanations as to why TGfU was needed, motivational theory (i.e., achievement goal theory) has also been proposed as a key concern (see Griffin and Patton 2005).

Regardless of these largely retro-fitted rationales, researchers have continued to express concerns about the ability of these theoretical frameworks to examine the efficacy of TGfU (e.g., Chow et al. 2007; Davids et al. 2005; Tan et al. 2011), a claim made by Rink, French, and Tjeerdsma (1996) and reiterated as recently by Stolz and Pill (2014). Most early research on TGfU was largely obsessed with the relative merits of teaching technique versus tactics, before later studies focussed more on practitioner-referenced methodologies (Stolz and Pill 2014). The research led to limited evidence to examine the claims made for TGfU and highlights the need for research to go beyond the dualist perspective to understand

and examine the learning processes underlying TGfU (Chow et al. 2007; Tan et al. 2012) to clarify the conflicting claims made on behalf of TGfU (Rink et al. 1996; Stolz and Pill 2014). Recently, the CLA approach has been proposed as_a strong contender to provide an appropriate theoretical framework to underpin TGfU (Stolz and Pill 2014) and to examine whether TGfU is able to meet its desired outcomes (Chow et al. 2007; Davids et al. 2005). Next we describe concepts and ideas from the CLA and NLP.

A Constraint-led approach in a Nonlinear Pedagogy

The CLA is an ecological model centred on the mutual relationship that emerges from interactions of each individual and a performance environment. In the CLA model, more skilful performance emerges as individuals harness inherent self-organisation processes (tendencies towards coordination of motor system components or degrees of freedom). These inherent coordination tendencies emerge under interacting constraints (see Newell, 1986) acting on individual learners, especially as they become perceptually attuned to the key information sources which can regulate their actions in specific performance environments (when performing or learning) (Chow et al. 2013, 2013a). A distinguishing feature of the CLA is that its practice design and delivery is informed by principles of a NLP, which provides a theoretical model of the learner and the processes of learning, based on the empirically-verified ideas and concepts of ecological psychology and dynamical systems theory (Chow et al. 2007, 2009, 2011; Davids et al. 2005; Renshaw, Davids, Chow, and Shuttleworth 2009; Renshaw et al. 2010, 2010a). Pedagogical principles such as information-movement couplings, representative learning design, manipulation of constraints, infusion of variability, accounting for attentional focus and attunement to affordances provides a substantial pedagogical framework for implementation of feedback, modeling, instructions, and design of practice and informational constraints (Chow 2013; Chow et al. 2015). NLP provides an empirically-verified and theoretically-rationalised description and focus for the design of learning environments in physical education and sport (Davids et al. 2005; Chow et al. 2007). This learner-environment centred pedagogy recognises the emergent, self-organising nature of learning under interacting constraints. Learners are empowered by harnessing opportunities to individually and actively explore and generate specific, functional movement solutions to satisfy the unique combination of interacting task, environment and individual constraints (or boundaries) imposed on them (for more detailed overviews see Araújo et al. 2004; Chow et al. 2006, 2007, 2009, 2013, 2013a; Davids, Button, and Bennett 2008; Davids, Chow, and Shuttleworth 2005; Handford et al. 1997; Newell 1986; Renshaw et al. 2010).

Having now summarised the key features of TGfU and the CLA, in the next two sections we will address the main thrust of our paper, consideration of some of the key similarities and differences between the TGfU and the CLA frameworks. We begin by considering the similarities.

Key Similarities between TGfU and the CLA

As mentioned earlier, there are some similarities between TGfU and the CLA. These are considered now:

Holistic skill acquisition:

1) Both approaches support a holistic approach that attempts to engage learners on physical, cognitive and emotional levels. Through designing modified games based on representativeness, teachers who adopt TGfU and the CLA approaches

use the concept of task simplification to provide emergent learning environments that guide discovery. Appropriate solutions are therefore emergent in self-organising learning systems based on the constraints (e.g., rule changes, pitch sizes) put in place by the teacher. This addition captures the discovery learning that TGfU emphasises as important in the perceptual-motor and tactical skill acquisition process of PE. However, arguably both approaches could do better in explaining why this broader form of engagement is ideal for learning movement skills and meeting the motivational needs of children in terms of competence, autonomy and relatedness (Renshaw, Oldham, and Bawden 2012). Both approaches have also been criticized and a commonly held view is that they take longer for success to be seen. While the empirical evidence is equivocal and perhaps confounded by the goals set (Stolz and Pill 2014), future research would be beneficial.

Individual differences:

2) The CLA and TGfU both focus on matching task demands to the current capabilities of the learner. According to Thorpe (2015), the originally devised aim of TGfU was to meet the needs of *all* children learning to play team games by designing modified games. Similarly, the CLA has its focus on individual differences between learners due to the emphasis on interacting constraints (personal, task and environmental) on behaviours. Both approaches are faced with the challenge of catering for all levels of ability within the same lesson. Chow et al. (2013) and Renshaw et al. (2012) provide some ideas that can be used to address these challenges. Although, the focus is on the individual learner in both approaches, it is important to mention here that as NLP is based

on ecological dynamics it is a learner-environment centred approach, not a learner-centred approach.

Role of the teacher:

3) The role of the teacher is to act as a facilitator to guide students' discovery. Answers will not simply be given, and students are encouraged to explore and take responsibility for their own learning (Butler 2014; Renshaw et al. 2010). This means that in both approaches pedagogues will adopt a more *hands-off* (Handford et al. 1997) and facilitative role during the session. In fact, Thorpe (2015) highlights that the ideal TGfU lesson would be one where the teacher says absolutely nothing and the 'game acts as the teacher'. However, important to both models is the role of the practitioner as facilitator rather than director and sometimes CLA/TGfU teachers attempt to develop awareness via discussion and questioning (Butler 2014; Storey and Butler 2013). The importance placed on the individual-environment interactions in both approaches means that teachers who wish to implement the CLA/TGfU lessons need to devote more time in designing effective self-directed/organising learning environments. This is perhaps one of the main reasons why some PE teachers may be reluctant to use TGfU and the CLA in their lessons as they simply lack the time needed to develop a deep understanding of the approach and invest further time in developing TGfU/CLA based lessons. Adopting new ideas may also threaten their current deeply engrained beliefs about what teaching PE is meant to be (see Moy et al. 2014, 2016) and because of this they might fear loss of control of the learning process. Another key barrier is that certain key performance

indictors need to be met to achieve PE syllabus learning outcomes, inhibiting the implementation of 'new' or alternative teaching approaches.

Learning design:

4) Practitioners in both approaches emphasise the design of learning tasks based on shaping the game and setting the broadest of goals to emphasise engagement for all learners irrespective of their ability level. Both approaches promote the concept of emergence through self-directed actions, providing learners with opportunities to develop appropriate perception-action couplings. That is, individuals and teams are invited to perceive similar affordances in the learning environment as are available in the performance environment. Learning tasks will, therefore, be based on the common ideas of representation (TGfU), or in CLA terms, Representative Learning Design (see Pinder et al. 2011).
5) Practitioners in both approaches will carefully design learning tasks to match the needs of individuals. Similarly, as learners demonstrate competence within the initial games, teachers will manipulate task constraints to provide new challenging games throughout the lesson and subsequent sessions.
6) The use of game forms matched to the intrinsic dynamics (inherent coordination tendencies at a specific point in time) of learners in TGfU and the CLA allows individuals the opportunity to explore and solve game-based problems. Essential to both approaches is the emergent nature of lessons with teachers prepared to take unexpected detours as learners attempt to solve game problems in unique ways. This common approach highlights the importance of variability of practice and matches the NLP-based idea of 'repetition without

repetition' (Bernstein 1967) (i.e., meeting the same task goals with different pathways of solutions).

It is clear that are key similarities between TGfU and the CLA, we now move on to consider the key differences.

Key Differences between TGfU and the CLA

In the CLA, there is an important major contrast with TGfU: From a NLP perspective, learners do not need to engage in significant amounts of 'cognitive processing' before they can discover and explore a performance solution to an activity (cf. Kirk and MacPhail 2002; Pigott 1982). Rather, theory and evidence has strongly indicated how functional behaviours can emerge from learners as they seek individualised solutions to a specific performance problem by 'acting' in a learning environment. The mantra behind this characteristic emphasis of the CLA on seeking and utilising information to regulate movements by moving to seek information is: Search, discover and exploit! (Davids et al. 2015).

The key point is that in the CLA, learners' behaviours in PE and coaching contexts need to be channelled by manipulations of interacting constraints (Araújo et al. 2004). In the CLA learners need to act in order to enhance their 'knowledge of' (and therefore understanding of) a performance environment (Araújo and Davids 2010; Gibson 1966). In the CLA, *knowledge of* a performance environment is gained through harnessing perception and action to utilise affordances or invitations to act (Handford et al. 1997). It is an important role for a pedagogist to design task constraints, which facilitate emergent knowledge of (understanding of) a performance environment through acting and perceiving (Davids et al. 2008; Renshaw et al. 2010). In contrast, in the stage like model of the TGfU approach, perception precedes decision-making, which precedes actions (Kirk and MacPhail 2002).

Understanding *before* acting may be a special case in human learning where we humans will "do things before we can do them" (Bernstein 1996). It is with no surprise that the ecological psychologist Edward Reed suggested the development of the "field of promoted action" (Reed 1996) for infants and children to learn through their daily activities. NLP, with its rich theoretical framework, conceptualises human beings as highly integrated, complex systems, which are continually adapting to surrounding constraints (both internal and external). Humans are 'open' systems, which are dynamic and constantly changing (maturing, developing, learning), adapting to all sorts of constraints (physical, psychological, social, emotional) (Davids et al. 1994). In such dynamic neurobiological systems, there is no particular component (e.g., a representation in the mind) leading/controlling the other components (the physical movement, the sport skill). The key point is that the continuous and ongoing interactions of a multitude of constraints facilitate the emergence of functional behaviours (e.g., thoughts, ideas, actions, perceptions, intentions) in each individual. The aim of a pedagogist in the CLA is to create a landscape of affordances or opportunities for action which each individual can learn to utilise to achieve their task goals.

As highlighted by Butler (2014, 467) a key difference between TGfU and the CLA, was that TGfU was "developed by practitioners for practitioners, rather than a broad, theoretically oriented teaching approach grounded in research." Thus, TGfU is directly focused on application to PE and teaching of games to children. In contrast, the CLA is based on a comprehensive theoretical framework that can explain the processes that underpin learning in humans considered as complex, adaptive, and dynamic at the level of the individual-environment system (see Renshaw et al. 2010 for detailed definitions of these underlying concepts; see also Araújo and Davids 2010; Chow et al. 2007; Davids et al. 2005; Seifert 2010; Seifert et al. 2013). The CLA is more broadly aligned to understanding movement behaviours for many different types of practitioners including those working in health, exercise, disabilities, physical activity, sport performance, training and practice (Davids, Button, and Bennett 2008). In the rest of this section we will address some of the key operational differences between TGfU and the CLA. For brevity we will provide a point-by-point discussion.

Pedagogical principles based on motor learning theory:

1) Whilst the above quote from Butler highlights that the design of TGfU was not explicitly based upon theoretically based motor learning principles. As we discuss earlier it has been retrospectively explained from a range of theoretical perspectives and the pedagogical principles put forward in the model have been tested through empirical and practitioner-referenced studies and is supported by many motor learning principles. For example, the key TGfU pedagogical principle of representation and consequently solving tactical problems within game-related contexts, is very much in line with the ideas of representative learning design, inspired in ecological psychology theorising in the 1950s (Brunswik 1956), that provides a major tenet in the CLA. In contrast to the focus on the problem of teaching games inherent in the TGfU approach, NLP key pedagogical principles based on multi-disciplinary theories (i.e., theoretical ideas and concepts from multiple disciplines in science including dynamic

systems, ecological psychology, complexity sciences, evolutionary biology, non-linear physics to name a few influences) and empirical evidence (e.g., from a significant body of motor learning and performance analysis studies providing the necessary 'muscle of skill acquisition theory' (Stolz and Pill 2014) to learning design in NLP (see work by Araújo, Davids, Seifert, Button and colleagues summarised in publications) that practitioners can adopt.

Goals:

2) According to Thorpe (2015) the goals of TGfU were twofold, with the main aim of providing opportunities to learn games that led to intrinsic motivation towards future sessions and a secondary aim of getting better at playing games. Thorpe’s view is that capturing a love for playing games was his key priority and that carefully designed games where every child could ‘succeed’ was central to this goal. Central to TGfU was therefore a focus on nurturing and development (Butler 2014) and emphasises (at least to these authors) the humanistic focus of the model founders. In terms of learning, inherent in the 6-step model are the aims of developing understanding of how to play to exploit the rules of games and the development of tactical awareness within the context of their own individual capacities. In essence, the overall goal is to develop *declarative* and *procedural* knowledge (Butler 2014) creating intelligent players who know what to do and how ‘*best*’ (our insertion) to do it. Additionally, participating in games should allow the child to appreciate what skills they need to improve to play games better. For the CLA, the aim is to achieve the task outcome goal, accepting that there may be many individualised ways of achieving the same performance outcome and many ways to enhance understanding (including

acquiring *knowledge of* a performance environment - vs. *knowledge about* a performance environment, see Araújo et al. (2009) for an application to sport of this crucial distinction proposed by Gibson (1966).

Explaining learning:

3) The implicit aim in TGfU is to improve performance by developing understanding through changing, constructing or enriching knowledge structures or cognition with understanding being located in the mind (or in the brain). In contrast, the CLA aims to change, adapt or 'attune' the nature of the emerging learner-environment system. Here, it is each individual's relationship to specific environmental properties that changes with learning. Over time this relationship can become more functional, allowing the achievement of task goals, fluently, accurately and energy efficiently. This emphasis on the quality of the individual-environment relationship is exactly why the CLA could never be included under the scope of any framework of constructivism (see Araújo and Davids 2010 for an explanation).

Use of questioning as a pedagogical tool:

4) For TGfU, whilst the optimal goal is to let the game pose the question and therefore be the teacher, as mentioned previously the questioning and the reflective activity of the student form a core part of the learning processes of the teacher (Butler 2014; Thorpe 2015). However, for the CLA, this type of verbal approach merely forms just another possibility, amongst many others, to constrain emergent learning behaviours (including no reflection at all, e.g., how much reflection does a child need in satisfying the constraints of gravity when changing from crawling to standing to bipedal walking during upright stance and

locomotion?). This issue of potential negative effects of reflection is aligned with the key insights of Bernstein (1967) who proposed ideas of how actions (in both less skilled and skilled performers) can be performed without the need to for conscious regulation of the movement form (see Davids et al. 2008).

Use of Progressions:

5) TGfU has a progressive-linear like cyclical structure within sessions, in which the complexity of the games/challenges is increased as learners develop. The key to progression is the ability of the teacher to make modifications to the starter game “leading to a careful re-appraisal of the requirements of the new game (Bunker and Thorpe 1986, 10)”. Interestingly, in their modified, more in-depth version of the original TGfU model, Kirk and MacPhail (2002) point out that whilst the model has the appearance of being a linear process, learning to play games is a complex medium and as such is not linear. The idea that ‘careful re-appraisal’ is advocated during lessons suggests (at least to us) that session structure is perhaps more emergent than linear. Perhaps, attempts to draw models on 2-dimensional papers limits appropriate representation of what operationalisation of the model looks like in practice? The CLA, inspired by Bernstein’s (1996/1950) and Newell's (1986) theorizing on motor learning and Jacobs and Michaels' (2007) work on perceptual learning, has developed a 3-stage model of learning to explain to practitioners how to deal with different perceptual-motor learning rates (Araújo et al. 2009; Davids et al. 2012). These stages are nested together, not sequentially where one comes before the other, but as concurrent processes of exploration and reinforcement (Chow et al. 2007). The stages include:

i) *Search: Exploring system degrees of freedom (i.e. huge number of components and sub-systems of the human body) to achieve a task goal*

Intentional constraints shape emergent perception-action coupling during learning. Different intentions organize perceptual-motor systems in distinct ways. Educating the intentions of learners (helping learners to specify what needs to be achieved in a performance context) might have an important influence on which particular informational variables need to be perceived by learners and when. The education of intention is not just an information-guiding process. Intention directs the attention of a learner and performer, and motivates exploratory behaviours that constrain perception, which further constrains action, and so on (Arzamarski et al. 2010). When the intentions of a performer are aligned with a task goal, learners couple their actions to key information variables in a performance environment. These couplings emerge in the continuous re-organisation of system degrees of freedom as learners (attempt to) achieve the task goals.

ii) *Discover: Exploring task solutions and strengthening them*

Throughout learning the performer identifies tentative performance solutions and attempts to stabilize them during goal-directed behaviour by re-organizing the previously exaggerated constriction of degrees of freedom (Vereijken et al. 1992). New action possibilities start to be identified (e.g. when an informational variable is not useful). In a performance environment, we are surrounded by huge amounts of potential informational variables. P*erceptual attunement* is the process of learning which sources of information to attend to in order to regulate actions, and in which situations. In this phase there is the strengthening of discovered performance solutions, as well as exploration of the limits of these solutions, and the consequent search for new information-movement couplings (Davids et al. 2012).

iii) *Exploit: Exploiting perceptual-motor degrees of freedom*

An important point at this stage is attunement to a wider range of spatial and temporal variables, and greater sensitivity to the contextual consequences of one's actions. System degeneracy, or the ability of structurally different body components to perform a similar function or yield a similar output, is available for all learners to exploit. It is an essential feature of skilled behaviour because it enhances the flexibility of athletes in competitive performance environments (Davids et al. 2006). A relevant process is that of calibration, or the scaling of the perceptual-motor system to information. Calibration establishes and updates the mapping between the units in which the relevant properties of the world are perceived, and the units in which the action is realized (Van der Kamp and Renshaw 2015).

Development of individual and group synergies:

While both TGfU and the CLA empower learners to actively explore their learning environment to generate specific individual movement solutions, the emphasis on generic tactical concepts within TGfU means that it captures this aspect of games play better than the CLA. However, the CLA can also go beyond individual learning and individual solutions and focusses on the synergies that emerge within and between individual learners, thereby helping them to come up with more functional performance solutions in sport. That is, there are functional solutions that can only emerge in groups or teams following self-organized collective exploration and discovery under task constraints, which an individual cannot achieve by him/herself. To explain further, ecological psychologists have demonstrated (see Van der Kamp and Renshaw 2015) that learning is a result of individuals attuning and calibrating their actions to key informational variables and, therefore, allows some similar solutions to emerge for a certain individuals under certain circumstances (Silva, Garganta, Araújo, Davids, and Aguiar 2013). The notion of degeneracy is relevant for understanding collective system behaviours since it signifies that there may exist several performance solutions in team games, for groups of specific individuals (the same individual in another group may not behave in the same way). A good example of this idea exists in badminton, where different opponents afford different movement possibilities, with different game play patterns emerging when challenged to compete against different opponents. The emergent pattern is not dependent just on the tactical preferences of each player but also on the behaviours of his/her opponent: an emergent person-environment relationship.

Use of skill interjections:

iv) Whilst the majority of lesson time in TGfU is spent playing carefully designed games and wherever possible technical skills would be developed in context through carefully designed game forms such as 3 vs 1 or 5 v 3. TGfU also advocates taking students out of games to develop skills (Butler 2014; Bunker and Thorpe 1986; Kirk and MacPhail 2002). This could be seen in the practice task interjected between the introductory and final games for a TGfU approach. In the CLA, the focus is on learning skills by using task simplification in environments that are representative of the performance environment. Key information that guides actions is present and the technical skills are made easier to acquire through manipulations of key task constraints such as rules, space and time, or importantly, the equipment that students can use.

Can the CLA help answer the question "does TGfU work?"

A number of articles have examined the claim that the design principles of NLP, that underpin the CLA, can provide a comprehensive, theoretical framework to support the principles of TGfU learning design (e.g., Butler, Storey and Robson 2014; Chow, 2013; Chow et al. 2007, 2009; Davids et al. 2005; Stolz and Pill, 2014; Storey and Butler 2013; Tan, Chow, and Davids 2013). Specifically, Chow (2013) illustrated how CLA describes the interactions between the different constraints (task, performer and environment). The principles described above are applied through the pedagogical channels of practice, modelling, instructions and attunement to affordances. See Figure 2.

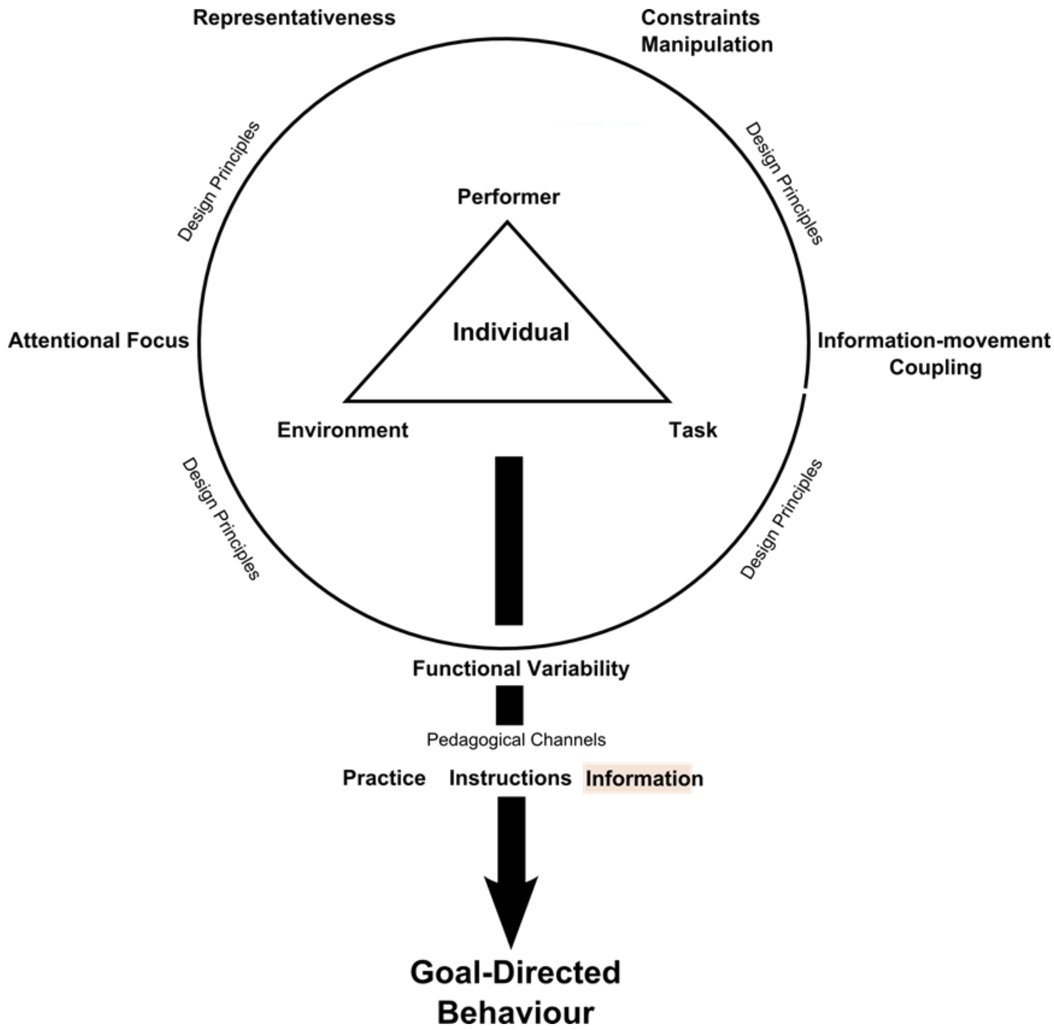

Figure 2: Figure 2. Nonlinear Pedagogy and its key pedagogical principles. CLA is embedded within the model (adapted from Chow, 2013). Design principles concerns underpinning the shaping of game forms, selecting game scenarios and creating contexts through consideration of the concepts of representativeness, attentional focus, information-moment couplings and functional variability.

In the concluding section of this commentary we consider the key issues and limitations of traditional teaching approaches as raised by Bunker and Thorpe in their 1986 article and seek to demonstrate how the CLA can inform TGfU. Earlier we highlighted that Thorpe (2015) believes that the 'perfect' TGfU lesson would not require any verbal commination to support the learning that occurs through simply playing the game. However, he adds that "in reality, our games are not well enough designed to allow this to happen and we need to supplement our teaching with questioning." To that end, we suggest that basing TGfU lesson design on the principles of NLP would potentially lead to the construction of more effective games. The bolded titles are taken directly from the work of Bunker and Thorpe.

1. **When 'can we play a game'?** The CLA and TGfU advocate the use of small-sided and conditioned games for facilitating the emergence of functional perception-action couplings in learners (Davids et al. 2012). Additionally, practising movement skills via a technical skill interjection within TGfU should also follow key learning principles commensurate with a NLP approach, through maintaining key environmental information sources in task simplified learning environments. For example, learning the technical skill of travelling with a ball in invasion games could be developed through the design of specific 1 vs. 1 games. An excellent way of designing this learning opportunity is to create 1 vs. 1 sub-phases within the context of a 4 vs. 4 team game, through the partitioning of space and use of 'artificial rules' as key task constraints (see Renshaw et al. 2012).
2. **The failure to meet and enhance 'intrinsic interest' [of children for playing games] and not exploiting [this] intrinsic motivation.** By designing small-sided and conditioned games that meet the basic psychological needs of each member of a class (i.e., competence, relatedness and autonomy), it is much more likely that class members will be intrinsically motivated, or self-determined. Recent work has outlined how applying the principles of Self Determination Theory (Deci and Ryan 2002), in conjunction with NLP, can

enhance the likelihood of learners being intrinsically motivated (Renshaw et al. 2012).

3. **[Traditional lessons are] Failing less and most able players.** In order to meet the skill acquisition needs of individual learners, game design should be matched to the intrinsic dynamics (existing dispositions and propensities) of each individual in the lesson. In recent work we have demonstrated how teachers may meet these needs by designing a rich range of tasks to match with individual learners or allowing them to self-select (Atencio et al. 2014; Renshaw et al. 2012). However, when teachers use the TGfU concepts of sampling and tactical complexity to provide simplified tasks for learners, they must be careful to ensure that the movement patterns and tactical possibilities remain representative. Adopting NLP principles can provide guidelines on how to use sampling and its impact on representativeness. For example, in line with the early work of Thorpe, the use of modified rackets by providing a greater surface area for contacting a ball may well be a useful strategy for increasing the chances of a young player achieving some success in terms of actually intercepting a ball. However, if the modified racket's new properties (e.g., mass or handle length) distort the movement information resulting in the emergence of a non-functional movement pattern, its use may lead to the emergence of (adapted) non-representative movements and tactical behaviours. These behaviours, although facilitative during PE lessons, may not transfer to sport performance environments.
4. **Missing the whole element of perception and decision-making.** By carefully sampling the constraints of specific performance environments when

designing TGfU based games, teachers can ensure that perception and action remain coupled and that functional transitions in the course of action (i.e., decisions) emerge. For example, by facing real bowlers in simulated game scenarios, cricket batters can learn to make decisions to solve game based problems using appropriate information-movement patterns rather than inappropriate ones acquired by playing against ball projection machines (Pinder et al. 2011; Renshaw et al 2007).

5. **Coach/teacher dependent**. While TGfU is viewed as a student-centred approach, we suggest that the emphasis on providing representative game forms in the approach is more in line with the CLA in terms of its adoption of an individual-environment approach. The 'hands-off' approach (de-emphasising use of direct teaching methods) advocated by both frameworks highlights that responsibility for skill learning is given back to the learner, who is empowered to be an 'active collaborator' (Thorpe 2005) during practice and learning. However, one key challenge also related to the need for the coach/ teacher is the need to be well-versed in the game that is to be taught and in particular has a good understanding of the principles of play. Manipulating appropriate constraints to channel effective exploration on the part of the learner needs to be anchored on the expertise that the coach/teacher possesses (Chow 2013).

Summary

In 2005, Rod Thorpe (2005, 243) highlighted that "Teaching Games for Understanding (and Game Sense) is being embraced, adapted and developed". While we agree with this statement which is consistent with the continued publication by academics, there is still a challenge in terms of the take up by practitioners. Indeed, Almond (2010) suggests that "…the rationale seems to have passed by practitioners without any major effect. TGfU currently thrives in only a few areas where practitioners are faithful to the original approach. (Almond 2010, vii)." To that end, providing 'game designers' responsible for implementing TGfU with a theoretical underpinning for a model of the learner and the learning process can serve to enhance the design of TGfU lessons and strengthen its usage by practitioners. As we indicated earlier, Thorpe (2015) highlights that the ideal TGfU lesson is one where the teacher is not required to say anything and the game is the teacher, but in reality we (teachers and coaches) cannot design good enough games for this to happen. We believe that the CLA may be able to help here. For example, teachers who understand the theoretical concepts of NLP can systematically manipulate key constraints to elicit changes in performance. That is, modifications should be based on an appreciation of the control parameters (variables that lead to change) acting on learners. Essentially, identifying the key rate limiters limiting current performance is a key skill for teachers and coaches to determine what aspect of performance that an individual or a team needs to work on at any specific stage of their development. Essential to this process is the need for teachers and coaches to understand the unique *intrinsic dynamics* of individuals. Intrinsic dynamics refer to the set of movement capabilities that each individual brings with him/her when learning a new skill (Thelen 1995). A detailed assessment of a performer's intrinsic dynamics should identify the emergent (contemporaneous) boundary constraints shaping current performance for each individual. Guerin and Kunkle (2004) highlight how task constraints themselves are dynamic and can emerge and decay over time and should not be viewed as permanent. Adopting these principles can underpin the design of a progressive curriculum in TGfU as "the secret to good games skills is the development of progressive games for youngsters (Thorpe 2004, 240)."

A key to the effective implementation of TGfU games underpinned by the CLA is a need for more engagement of researchers in supporting the application of theory into practice. As highlighted earlier, Joy Butler (2014) asked the originators of the model (i.e. Bunker, Thorpe and Almond) what a TGfU lesson looked like, with a similar question being asked of rugby coaches delivering Game Sense sessions (Reid and Harvey 2014); these approaches would be of value to those looking at the implementation of the CLA and other new teaching models into schools. Additionally, this type of information would be of great value for those responsible for preparing future physical education teachers by identifying the most efficacious ways to develop the knowledge and skills of pre and in-service teachers. Both TGfU and the CLA have a central focus on the nature of learning activities undertaken by each individual learner. This philosophy can be supported by ensuring that the learner is viewed within the context of his or her mutuality with a specific performance environment, a feature strongly embedded within the literature of TGfU. To date there are more empirical studies of TGfU methods published in the literature than there are investigations of the CLA. Indeed a quick Google Scholar search (1970-2014) revealed about 462,000 results for TGfU compared to 271,000 for the CLA (and see Stolz and Pill 2014). The CLA is theoretically richer in motor learning theory than the TGfU approach and it needs a deeper footprint in terms of empirical data to demonstrate its benefits. In order to increase the likelihood of the

CLA being adopted in schools (in conjunction with TGfU), more work is required by physical education specialists to ensure the utility of the model in pedagogical settings. We need to clarify that in this paper, the term 'P.E. specialists' refers to those working as researchers and practitioners in the field. In fact, we would argue that it is vitally important in terms of facilitating adoption of pedagogies that researchers and practitioners work symbiotically in embedding new thinking into practice. As highlighted by Stolz and Pill (2014), Greenwood et al. (2013), Millar et al. (2013) and Renshaw and Gorman (2015), accessing the experiential knowledge of expert pedagogues is essential to capturing expert practice in applied settings such as schools. Practitioners can provide rich data as their ideas and views have been continually tested, day in, day out, over time. Thus, a memetic approach to knowledge generation via the symbiotic relationship of practitioners and researchers is essential to develop understanding of sport pedagogy. To this end, the significant body of work found in the TGfU literature provides a good template for the CLA advocates (see Stolz and Pill 2014). Further developments should include specific applications (i.e., lesson plan templates in contrast to the broadly recognised cyclical structure proposed in the TGfU model) that teachers need (although see Moy et al. 2014, 2016, for recent exceptions).

In summary, we hope this clarification between TGFU and the CLA acts as a catalyst for more empirical work through symbiotic interactions between researchers and practitioners into these largely complementary pedagogical approaches to learning design.

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Appendix B: My Journey

Before I commenced my PhD journey I worked as a Health and Physical Education teacher for 24 years. During that time I taught over 14,000 Health and Physical Education lessons and delivered thousands of coaching sessions across rugby, soccer, cricket and track and field. I was a product of ‘physical training’ rather than traditional physical education. As a school student, the vast majority of my physical education lessons were devoted to improving my fitness through climbing hills, stepping up and down on a bench and swimming laps. Although we did occasionally play games like tunnel ball and zig-zag (primary school) and touch football (secondary school). The physical education outcome of fitness was also an emphasis throughout my professional teacher training, aligning with the Australian government programme called ‘Life. Be in it.’ which encouraged people to be more active. I was also trained to teach students using a very traditional drill-based approach within the mantra of the 3F’s of fun, fitness and fundamentals, ordered by degree of importance.

Subsequently, this socialisation process of past experiences influenced the way I taught physical education, i.e. an obsession with students being active in my classes. The traditional drill-based approach became my predominant physical education teaching approach, particularly early on in my career. However, this approach conflicted with my fitness obsession, thus, I was always on the lookout to evolve my teaching and achieve all three outcomes of fun, fitness and fundamentals. I started reading and attending professional development sessions, resulting in the use of a variety of modified learning environments, small-sided games and unbeknownst to me at the time some constraint based learning. An example of this was evident when correcting a fault with a hurdler I was coaching. Phillip was clearing the hurdle too high so I placed a matchbox on the hurdle and asked him to knock it over with his lead leg. It worked and Philip went on to win the State Title that year. I also embarked on postgraduate study involving the Australian version of TGfU, the Game Sense approach, and started to seriously experiment with this approach in my classes in the last 10 years of my teaching career. This helped me to recognise that modified games were not only useful for achieving the outcomes of fun and fitness but also for learning technique and tactics.

My PhD journey has allowed me to reflect on my physical education and sporting background, through the lens of an academic with a developing expertise in skill acquisition. This has been invaluable to me as a physical education teacher educator, as it has enabled me to use my knowledge of contemporary skill acquisition theory to explain my own skill development and give my students the opportunity to do the same. For example, like many others that grew up in Brisbane in the 1960’s, I became physically educated through semi-structured games played before school and at lunchtime in the school playground, and in the backyard and local park on weekends and school holidays. I vividly remember the lunchtime games of soccer at my primary school between the Australians and the Italians. Players with names like Becciu, Schiavon, Sciaretta, Santoro had soccer skills I had never seen before. However, over countless lunchtime games on a rock hard oval with little grass I learned and honed these skills as well as invent some of my own. I remember how hard it was to beat the Italians until a couple of students or ‘saviours’ arrived at our school from the UK. The hard fought games of backyard cricket with my friends Brian and Peter and neighbour Tony and his son Paul were also effective learning environments to develop my cricketing skills. These backyard cricket games continued until well into my 30’s, evolving into hard fought contests between teams from the Northside and Southside of the Brisbane River.

Throughout my PhD journey I have learned a significant amount about skill development and motor learning through academic readings, discussions with my supervisors and other experts, and attendance at conferences. This have given me the theoretical knowledge, understanding and appreciation and provided me with convincing evidence to explain how and why the Constraints-Led Approach works. Along the way I adopted the motor learning principles underpinning the CLA in the coaching of my daughter’s sporting teams. This was a significant and valuable experience as it allowed me to observe the efficacy of the approach. I consistently observed players as young as 9 years old improve their performance in practice and transfer what they learned to the performance environment. I also applied the principles in many hours of play with my daughter in the backyard and at the local park, for example, designing games to develop her perception and decision-making as well as her soccer dribbling skills. Over time, she implicitly developed some amazing soccer skills without me telling her what to do or how to do it. Her skill development has been recognised through selection in many State soccer teams and elite development programmes. Just like my PETE students these personal experiences have made me more receptive to the CLA.

To enhance the impact of the QUT PETE course on recruits’ custodial teaching beliefs and support their understanding and future implementation of the CLA, I have integrated the recommendations from my PhD programme into my university teaching practice. For example, as personally experiencing and observing skill development was an important mediator of PETE students receptiveness to the CLA, students are given more opportunity to experience a sport as a novice. Hurdling has been incorporated into a second CLA that integrates the key principles of contemporary theories of skill acquisition, educational psychology and human intrinsic motivation with physical activity performance environments. As many students have little experience in hurdling relative to team games, they have a greater capacity to improve their performance. Anecdotal evidence from students reflecting on their hurdling experiences has confirmed student experiences of the CLA 'working'.

To develop a clearer understanding and appreciation of the motor learning theory underpinning the CLA, also an important mediator of receptiveness, the supporting theory lectures of the game-based CLA unit have been modified. Rather than purely theory presentation, students are challenged in lectures to solve problems that require an application of the key pedagogical principles of NLP, such as the analysis and evaluation of traditional practice environments and the proposal of justified improvements. To provide a more convincing rationale for the effectiveness of each pedagogical principle of NLP, lectures present not only the theoretically informed research evidence, but also many sports specific empirical studies that can demonstrate their effectiveness in performance enhancement, as well as specific practical implications for physical education teachers. An assessment task has been incorporated into the games-based unit to allow PETE students the opportunity to gain some experiential knowledge and practical understanding of the emergent learning process within the nonlinear CLA, and also to develop their observational and analytical skills. These skills were identified as major challenges facing PETE students when implementing a NLP. Also, student quotes from this PhD programme are used in lectures to give personal examples of powerful and meaningful learning experiences such as this reflection from a female participant after playing a 1 v 1 soccer/football dribbling game:

> *I have never really had the chance to play soccer until today. Today my skills improved in a way that I didn't think possible in such a short amount of time and this was because I was given a chance to play and make mistakes. 10 minutes in – I had a busted lip and had been knocked over twice because I was too focused on the ball-so I learned to LOOK UP! As I watched other players I found myself using my body more to 'block' my opponent and would look for an opportunity to play the ball backwards or turn it away from them on their weaker side. I wasn't criticised by focusing on HOW to perform; in the end I just did. My body was starting to make decisions for me because I was learning implicitly from my mistakes. (Reflection, Bella, state representative in softball)*

My journey has also involved the sharing of what I have learned with others. I have presented many practical and theory sessions to my former peers at schools, sporting clubs, and Health and Physical Education related conferences. I believe that my PhD journey has given me the tools, motivation and opportunity to make a real difference in the teaching of physical education and ultimately student learning.