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

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

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.

Keywords: self-determination theory; intrinsic motivation; physical education; nonlinear pedagogy; constraints-led approach

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 behaviors 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. 2015). 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. 2015). 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 behavior 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 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 1 near here)

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 2.

(Figures 1a, 1b near here)

(Table 2 near here)

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. 2015), 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!

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Table 1. Questionnaire reliability analysis (Cronbach's Alpha 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 Alpha
		M	SD	M	SD	α
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

Table 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) (2-tailed)	d
1	Competence Mean Scores (CLA) - Competence Mean Scores (Traditional)	1	1.33	6.17	26	.000	1.38
		2	0.85	3.41	26	.002	0.74
2	Relatedness Mean Scores (CLA) - Relatedness Mean Scores (Traditional)	1	1.25	5.53	26	.000	1.02
		2	2.27	7.26	26	.000	2.17
3	Autonomy Mean Scores (CLA) – Autonomy Mean Scores (Traditional)	1	2.27	6.11	26	.000	1.73
		2	3.10	11.74	26	.000	3.20
4	Enjoyment Mean Scores (CLA) - Enjoyment Mean Scores (Traditional)	1	1.81	5.49	26	.000	1.34
		2	2.73	11.10	26	.000	2.67
5	Effort Mean Scores (CLA) – Effort Mean Scores (Traditional)	1	1.03	3.51	26	.002	0.80
		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}).

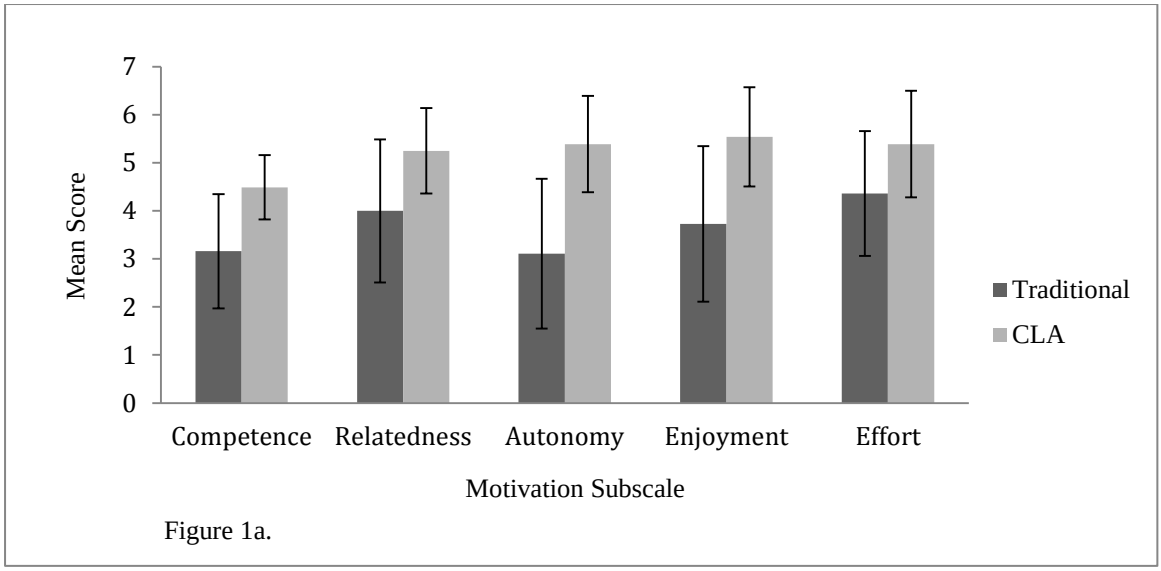

Figure 1a.

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

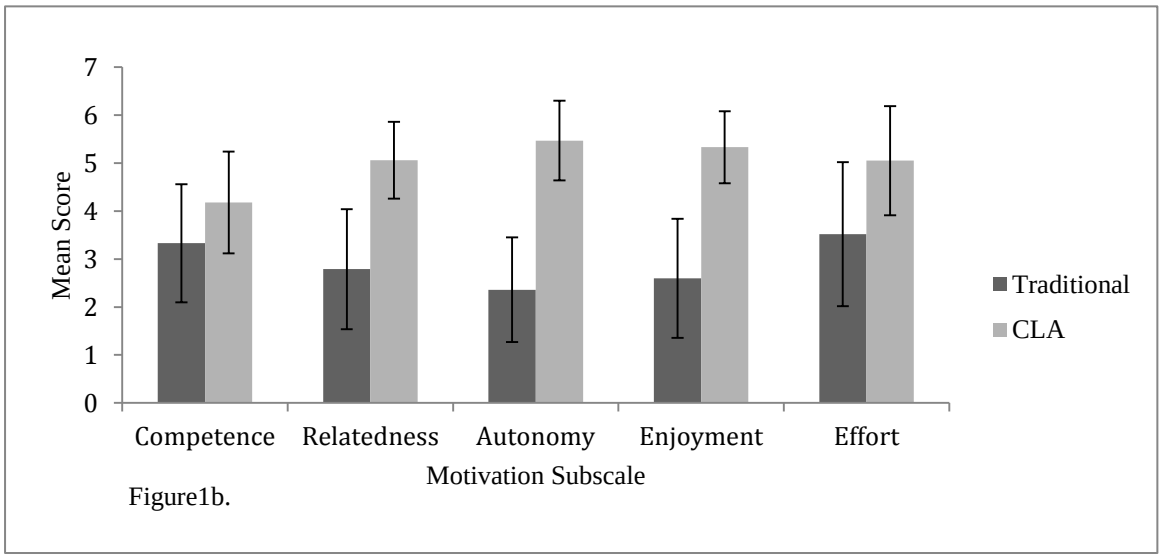

Figure1b. Comparison between traditional approach and CLA motivational subscale mean scores for Group 2 (Order: CLA, Traditional)**.**