Why the Constraints-led Approach is not Teaching Games for Understanding: A Clarification

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Abstract

There is some apparent confusion regarding similarities and differences between two popular physical education pedagogical approaches, i.e., the Constraints-Led Approach (CLA) and Teaching Games for Understanding (TGfU). Our aim in this commentary is to detail important theoretical and pedagogical concepts that distinguish the approaches, as well as to recognise where commonalities exist. In particular we note that TGfU emerged in the 1960s in the absence of a substantial theoretical framework, although several attempts to scaffold theories around TGfU have occurred subsequently. 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, CLA has arisen more recently from the umbrella of Nonlinear Pedagogy based on powerful empirically-verified theoretical frameworks of ecological psychology and dynamical systems theory. CLA creates a 'learner-environment' centred approach in which practitioners are encouraged to identify and modify interacting constraints to facilitate emergence of perception-action couplings. CLA is a broader approach 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; focus on individual differences versus generic concepts; and how progressions and skill interjections are planned and implemented. Despite such distinctions the two approaches are somewhat harmonious and key similarities include: their holistic perspective; the proposed role of the teacher; and the learning tasks that are designed by each. Both TGfU and CLA have a powerful central focus on the nature of learning activities undertaken by each individual learner. This

clarification of TGFU and 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

Shortened PE teachers abstract (150 words max)

Our aim in this commentary is to detail important theoretical and pedagogical concepts that distinguish the approaches, as well as to recognise where commonalities exist. We observe that TGfU emerged in the absence of a theoretical framework, although several attempts to scaffold theories around TGfU have occurred retrospectively. 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, CLA has arisen more recently from the umbrella of Nonlinear Pedagogy based on the empirically-verified ideas and concepts of ecological psychology and dynamical systems theory. CLA is a 'learner-environment' centred approach in which practitioners are encouraged to identify and modify constraints to develop perception-action couplings. Although there are several other distinctions, importantly both TGfU and CLA have a powerful central focus on the nature of learning activities undertaken by each individual learner.

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 [in the different approaches] are those of behaviourism /cognitivist (traditional approach) versus social-constructivism (CLA approach)." In our work with teachers and coaches we are finding that the categorisation of CLA as a games-based teaching approach is a common misapprehension, perhaps due to an early focus of CLA on team games (e.g., Chow et al., 2009; Renshaw, Davids, Shuttleworth & Hammond, 2010). Our published work in education journals has led to some educationists categorising CLA as 'just another game-centred pedagogy' in line with approaches such as TGfU (Bunker, Thorpe & Almond, 1982), its Southern Hemisphere derivative, Game Sense (Thorpe, 2005), Sport Education (Siedentop, 2002), Play Practice (Launder & Pilz, 2012), Games Concept Approach (Tan, Wright, McNeill, Fry & Tan, 2002) and the Tactical Games Approach favoured by some North American pedagogues (Mitchell, Oslin & Griffin, 2012). Here we provide some further clarifications for physical educators and sport pedagogists on the nature of the relationship between CLA and TGfU. In this paper we seek to confirm that, while there may exist some similarities between CLA and TGfU methods at an operational level, there are major differences in theoretical principles that can guide pedagogical practice and learning design. Additionally, some of the key principles of TGfU can be underpinned with reference to Nonlinear Pedagogy, the framework of pedagogical principles which overarches CLA. The aim of this commentary is to

clarify the misconception that CLA and TGfU are *one and the same thing*. They are not. We also seek to demonstrate why CLA is much more than 'just' a games-based model, and can be used for learning design in many other physical activities (e.g., springboard diving (Barris et al., 2013, 2014), swimming and ice climbing (Seifert et al., 2013; Seifert et al., 2012), rowing (Shuttleworth et al., 2010) and sailing (Araujo et al, 2006)). TGfU has developed as an operational model for teachers of P.E, whereas CLA is a theoretically-based approach to skill acquisition and motor learning that can be applied to the whole spectrum of exercise, health, P.E., sport performance and physical activities.

Because there are a number of game-centred approaches, their advocates may consider that our comparison of CLA with TGfU (and Game Sense as the sport coaching centred derivative of TGfU), may neglect the contribution of these 'worthy' approaches. We would like to note that TGfU has been selected for our clarification because it is the predominant games-based approach with status as a Special Interest group in AISEP (International Association for Physical Education in Higher Education), and because TGfU has a dedicated biennial international conference. It should also be noted that this discussion paper does not constitute an attempt to discuss the relative merits of the two approaches by arguing that one is *better* than the other. In fact, the spirit and philosophy underpinning the TGfU approach is harmonious with 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. 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

TGfU emerged in the 1960s at a time when there was a ground swell of interest amongst those involved in the teaching of games, not the least of which included the ground breaking ideas of Allen Wade (1967) in football. The promotion of small-sided games as part of sessions to develop skills also emerged during this time, but still the main focus was on the 'skill' acquisition aspects of the lesson (Thorpe, 2005). It is worth noting that, at the time, there was little to no expectation of undertaking research in British P.E. 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 (see Thorpe, 2010; Bunker, 2012). However, ideas are not developed in total isolation from current trends and issues and as discussed above, 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, Thorpe & Almond, 1982; Bunker and Thorpe, 1986; Thorpe, 2005). As Thorpe (2005) 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 reflected the perceived need to move from a teacher-centred approach to a student-centred approach concerning how game skills were taught. Accordingly, much training and assessment of teaching and coaching methods were more 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 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., 2014). The missing ingredient of designing motivating learning environments was also captured by the TGfU model. The link between motor learning, sport psychology and physical education has always been perceived as a neglected concern for contemporary pedagogists and didacticists (Newell & Rovegno, 1990; Abernethy, 1999; Renshaw et al., 2010). 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, 2005).

Theories and TGfU

As we stated in our introduction, we believe that the theoretical basis for TGfU differs vastly from that of Nonlinear Pedagogy, 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, 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, it might be assumed that the belief that children's games playing ability could be enhanced by acquiring a greater 'understanding' of games was subconsciously inspired by cognitivist (most notably constructivist) approaches to human behaviour, with a particular reference for education (see Griffin, Brooker & Patton, 2005). In this approach, 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. 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, they come to understand how to play the designated game more effectively.

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 learning, but it does not seek to present concepts and principles, devised in detail from a rigorous theoretical framework and research, to empirically support the design of the learning process (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

did not come from the originators of the model but much later from advocates of the approach. As such, information processing (see Turner & Martinek, 1999) and situated-learning (see Kirk & MacPhail, 2002) have been proposed as viable theories to retrospectively explain how learning might occur in TGfU. Additionally, in line with the original explanations why TGfU was needed, motivational theory (i.e., achievement goal theory) has also been proposed as a key concern (see Griffin & Patton, 2005).

Regardless of these retro-fitted rationales, researchers have continued to express concerns about the ability of these theoretical frameworks to examine the efficacy of TGfU (e.g., Davids et al., 2005; Chow et al., 2007; Tan et al., 2012). In fact, most research on TGfU has largely tended to be concerned with the relative merits of teaching technique versus tactics. This narrow focus has 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). Only then can Bunker and Thorpe's question "does TGfU work?" be answered with theoretical arguments, rather than observations and anecdotal experiences from the classroom. We have previously argued that the CLA approach is a strong contender to provide an appropriate theoretical framework to examine whether TGfU is able to meet its desired outcomes (Davids et al., 2005; Chow et al., 2007). Next we consider how concepts and ideas from CLA and Nonlinear Pedagogy may underpin learning processes identified in studies of TGfU.

A Constraint-led approach in a Nonlinear Pedagogy

In contrast to TGfU, which is focused on the learner, 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 through self-organisation under constraints as individuals become perceptually attuned to the key information sources which can regulate their actions in specific performance environments (when performing or learning) (Chow, 2013). A distinguishing feature of the CLA is that its practice design and delivery is informed by principles of a Nonlinear Pedagogy (NLP), which provides a powerful 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 (Davids et al., 2005; Chow et al. 2007, 2009, 2011; Renshaw, Davids, Chow & Shuttleworth. 2009; Renshaw et al., 2010). The provision of pedagogical principles (such as information-movement couplings, representative learning design, manipulation of constraints, infusion of variability, accounting for attentional focus and attunement to affordances) supports the pedagogical channels of modeling, instructions, and design of practice and informational constraints (Chow, 2013). Nonlinear Pedagogy 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 student-environment centred pedagogy recognises the emergent, self-organising nature of learning under interacting constraints. It empowers learners 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 Handford et al., 1997; Chow et al., 2007; Chow et al. 2009; Chow et al. 2006, 2013; Davids, Button, and Bennett, 2008;

Davids, Chow, and Shuttleworth 2005; Renshaw et al. 2010; Araújo, Davids, Bennett, Button & Chapman, 2004). In CLA, there is an important major contrast with TGfU: Learners do not need to engage in significant amounts of 'cognitive processing' before they can discover and explore a performance solution to an activity. Rather, theory and evidence has strongly indicated how functional behaviours can emerge from students as solutions to a specific performance problem as they 'act' in a learning environment. The key point is that their learning behaviours in physical education and coaching contexts need to be channelled by manipulations of interacting constraints (Araújo et al., 2004). In CLA learners need to act in order to enhance their 'knowledge of' (and therefore understanding of) a performance environment (Gibson, 1966; Araújo & Davids, 2010). In CLA, *knowledge of* a performance environment is gained through perception and action (Handford et al., 1997). It is an important role for a pedagogists 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). 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 biological 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, percepts, intentions) in each individual. While TGfU is directly focused on application to physical education and teaching of children, 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. Due to its wider application than TGfU, CLA requires more work by physical education specialists to further develop 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, for a recent exception). In the rest of this section we will address some of the key operational differences between TGfU and CLA. For brevity we will provide a point by point discussion:

Pedagogical principles based on motor learning theory:

1) Nonlinear pedagogy provides key pedagogical principles, based on multi-disciplinary theory and empirical evidence that practitioners can adopt. Whilst the design of TGfU was not based upon these pedagogical principles it is fair to say that it is supported by many of them. For example, the key 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. CLA, on the other hand, is a comprehensive framework that can explain the processes that underpin learning in humans considered as complex, adaptive, dynamic systems including self-organisation under constraints, phase transitions and degeneracy, and ecological psychology ideas such as perception-action

coupling, and learning by exploration to enable perceptual attunement to affordances available in the environment (see Renshaw et al, 2010 for detailed definitions of these underlying concepts; see also Davids et al., 2005; Chow et al., 2007; Seifert et al., 2013, Seifert et al., 2014).

Goals:

2) The goal of TGfU is to enhance understanding. For example, in order to develop tactical awareness the assumption is that the learner should (explicitly) understand in order to perform the skill adequately (somehow understanding is needed to construct the program (Schmidt & Lee, 2013), the schema, the knowledge structures (Piaget, 1972). For 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 aim in TGfU is to change, construct or enrich knowledge structures or cognition with understanding being located in the mind (or in the brain). In contrast, 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 person-environment relationship is exactly why CLA could never be included under the

scope of any framework of constructivism (see Araújo & Davids, 2010 for an explanation).

Use of questioning as a pedagogical tool:

4) For TGfU, questioning and the reflective activity of the student form a core part of the learning processes. For 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 progression-like structure in which the complexity of the games/challenges is increased as learners develop. Whilst CLA, inspired by Bernstein's (1996/1950) and Newell's (1985) 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) 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. 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 system degrees of freedom as learners (attempt to) achieve the task goals.

ii) *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. 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 e exploration of the limits of these solutions, and the consequent search for new information-action couplings.

iii) *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.

Individual differences:

iv) CLA is also more focused (than TGfU) on individual differences between learners due to the emphasis on interacting constraints (personal, task and environmental) on behaviours. For this reason, it is important to note that NLP is a *learner-environment* centred approach, not a learner-centred approach.

Development of individual and group synergies:

While both TGfU and 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 CLA. However, 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 collective exploration and discovery, which an individual cannot achieve by him/herself. To explain further, ecological psychologists have demonstrated (see Van der Kamp & 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, & 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:*

v) TGfU advocates isolated drills and instructions common to more traditional approaches to address poor technical skill execution within the game (Bunker and Thorpe 1986; Kirk & MacPhail 2002). This could be seen in the practice task interjected between the introductory and final games for a TGfU approach. Whereas in CLA, the focus is on task simplification where the 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.

Key Similarities between TGfU and CLA

As mentioned earlier, there are some similarities between TGfU (like 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 – but 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 & Bawden, 2012).

Role of the teacher:

2) The role of the teacher is to act as a facilitator to guide students' discovery. Answers will not simply be given, and learners are encouraged to explore movements to find their own performance solutions. This means that in both approaches pedagogues will adopt a more *hands-off* (Handford et al., 1997) and facilitative role during the session. However, the importance placed on the individual-environment interactions means that more time needs to be spent in designing effective learning environments. This is perhaps one of the main reasons why some PE teachers may be reluctant to use CLA ideas in their lessons as they simply lack the time needed to develop a deep understanding of the approach and invest further time in developing CLA based lessons. Adopting new ideas may also threaten their current deeply engrained beliefs about what teaching P.E. is meant to be (see Moy et al, 2014) and because of this they might fear loss of control of the learning process. Another key barrier would be that certain key performance indictors need to be met for the PE syllabus, inhibiting the implementation of new teaching approaches.

Learning design:

3) Practitioners design learning tasks that provide 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.
4) 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.
5) The use of game forms matched to the intrinsic dynamics (inherent coordination tendencies at a specific point in time) of learners in TGfU and CLA allows individuals the opportunity to explore and solve game-based problems. 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).

Can we answer the question "does TGfU work?"

In a number of articles we 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., Davids, et al., 2005; Chow, 2013; Chow et al., 2007; Chow et al., 2009; Tan, Chow, and Davids 2013). Specifically, Chow (2013) illustrated how CLA describes the interactions between the different constraints (task, performer and environment).

Specifically, the principles described above are applied through the pedagogical channels of practice, modeling, instructions and attunement to affordances. See Figure 1.

In the concluding section of this commentary we seek to demonstrate how CLA can help TGfU address the key issues and limitations of traditional teaching approaches raised by Bunker and Thorpe in their 1986 article. The bolded titles are taken directly from the work of Bunker and Thorpe.

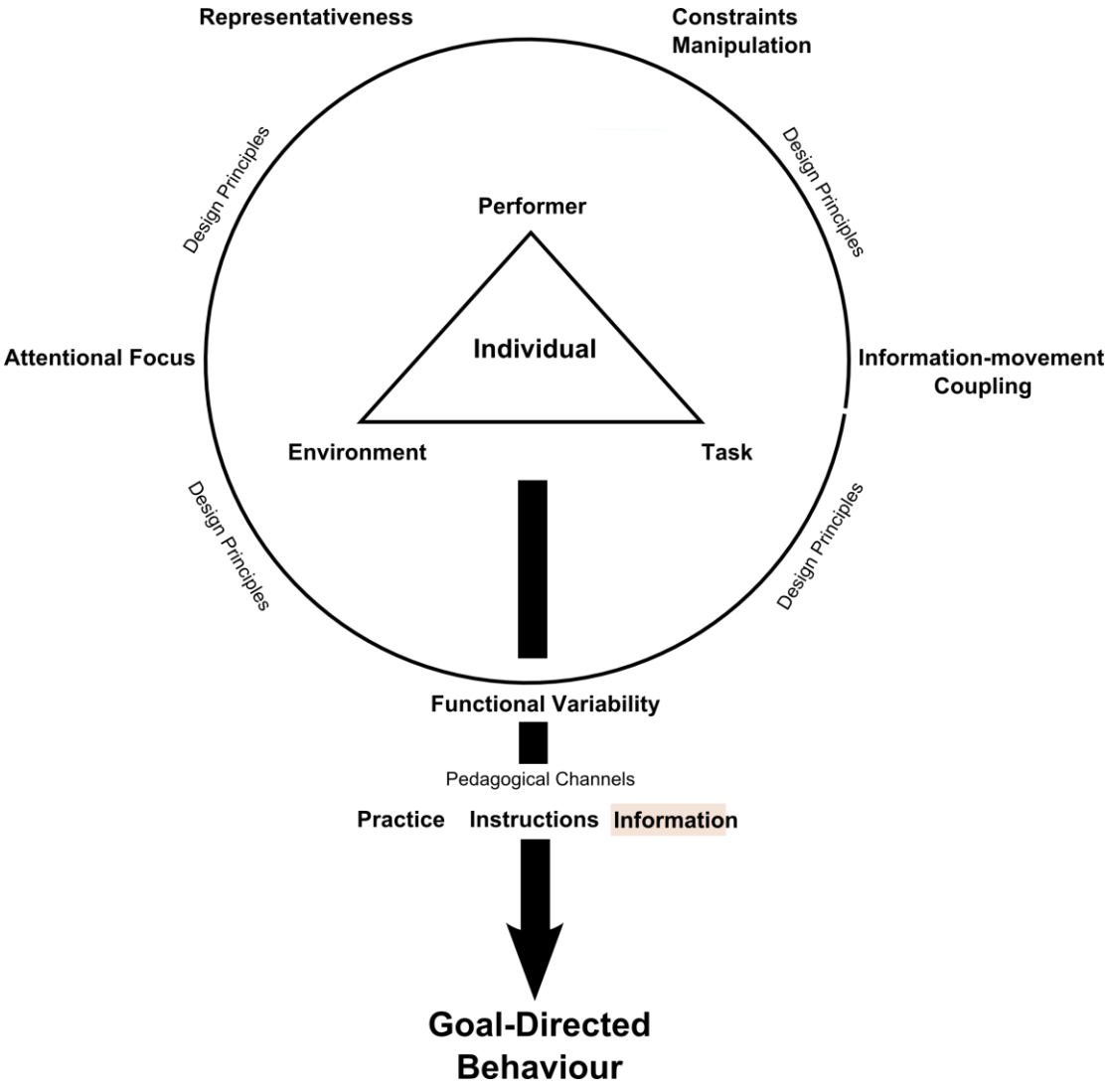

Figure 1. Nonlinear Pedagogy and its key pedagogical principles. CLA is embedded within the model. (adapted from Chow, 2013)

1. **When 'can we play a game'?** 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., 2013). Additionally, practising movement skills via a 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 to travel 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. In recent work, we have outlined how applying the principles of Self Determination Theory (Deci & 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 (Renshaw et al., 2012; Atencio, Chow, Tan & Lee, 2014). However, if 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, 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 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 (Renshaw, Oldham, Davids & Gold, 2007; Pinder et al., 2011).

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 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 to be well-versed in the game that is to be taught. 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

Rod Thorpe (2005, p243) highlighted that "Teaching Games for Understanding (and Game Sense) is being embraced, adapted and developed". 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. Both TGfU and CLA have a powerful 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 embedded with the ideas of TGfU. To date there are more empirical studies of TGfU methods published in the literature than there are investigations of CLA. Indeed a quick Google Scholar search (1970-2014) revealed about 462,000 results for TGfU compared to 271,000 for CLA. The CLA is

theoretically richer than the TGfU approach and it needs a deeper footprint in terms of empirical data to demonstrate its benefits. We hope this clarification between TGFU and CLA acts as a catalyst for more empirical work into these largely complementary pedagogical approaches to learning design.

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