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Teaching Games for Understanding: What does it look like and how does it influence student skill learning and game performance?

Abstract

Teaching games for understanding (TGfU) is understood as problem-based approach to games teaching where the play of a game is taught to situated skill development. The TGfU approach has encouraged debate on games teaching which until recently has often polarized into skills v tactics arguments. In reality it is impossible to separate skills from tactics, the tactical use of skills is the essence of effective game playing. Based on Author's (2002) meaning matrix the TGfU approach will be analyzed from skill-progression and tactical progression perspectives. From this understanding the paper will draw on skill acquisition theories of information processing and dynamic systems to show how tactical and skill focused approaches influence student learning. The paper will conclude with recommendations for games teaching framed in an integration of skills and tactics in a TGfU approach.

Key Words: Tactical Approach, Skill acquisition, Instructional/Curricular practices

Introduction: What is TGfU?

For the last two decades the teaching games for understanding (TGfU) approach has caused considerable debate in games teaching. The TGfU focuses upon teaching students tactical understanding before dealing with the performance of skills, as such the TGfU offers a tactical approach to games teaching emphasizing game performance before skill performance (Griffin, Mitchell, & Oslin, 1997; Werner, 1989). As such game

performance is understood as tactical awareness leading to effective skill selection and skill execution. Conversely, a "technique" approach focuses first on teaching students the skills to play the game then introducing tactical understanding once a skill base has been developed. The TGfU approach has stimulated research comparing technique v tactic approaches to games teaching (Alison & Thorpe, 1997; Rink, 1996; Turner & Martinek, 1992), however no clear benefits from a tactical or skill learning perspective have been shown. Though the results of these studies were inconclusive due to factors such as length of studies and problematic indicators of success, it was noted that children in a tactical approach model indicated more enjoyment when learning and did not show any less significant skill improvement. Indeed, Strean & Holt's (2000) research highlight that children, coaches and parents all acknowledge that games and game-like situations were more fun that technically oriented drills. Rink, French, & Graham (1996) commented that a key problem of the research into TGfU was discerning between a technique approach and a tactical approach. This concern highlights the problem of trying to separate technical skill learning from tactical learning. Effective games teaching from a TGfU perspective is about combining the teaching of tactical understanding *with* skill development, rather than focusing on one aspect or the other. This idea implies a game play experience for a tactic-to-skill approach to games teaching. Griffin et al., (1997) in their book devoted to an integrated tactical/skill approach for teaching games, state that "a tactical approach…lets your students experience the excitement of actual play before they begin practicing specific skills…When they understand why each skill is important, students can apply the skills effectively during game play" (p. 1).

We find that to understand a tactical approach to teaching games it is necessary to realize that the debate is not about a skill approach v tactic approach, rather it is about how to combine the two. In other words, should games teaching be skill-to-tactic or tactic-to-skill. To help answer this question this paper has two purposes:

1. To draw on the original TGfU work of Bunker and Thorpe (1986a) we clarify the TGfU approach by examining how to teach games based on an analysis of a "technique" perspective and a "tactical" perspective, and
2. To infer how students learn in a techniques approach and tactical approach by drawing on current skill acquisition theories, in particular information processing and dynamic systems theory.

In conclusion will make connections on recent work suggesting a situated learning perspective to games teaching (Kirk & MacPhail, 2002; Rovegno, Nevett, & Babiarz, 2001). Finally we conclude with support for more recent research on TGfU focused on examining student learning when tactics and skill learning are integrated

Background to the TGfU approach

The TGfU phrase was first coined in the United Kingdom in the early 1980s. The ideas were spawned by Thorpe, Bunker, & Almond (1986) and drew on the earlier work of Mauldon & Redfern (1981). The TGfU approach was proposed as an alternative to the technique approach because it was noted that techniques practiced in isolation did not transfer to the game. In addition Bunker & Thorpe (1986a) observed, and we believe this is still the same today, that "games teaching shows at best, a series of highly structured lessons leaning heavily on the teaching of techniques, or at worst lessons which rely on the children themselves to sustain interest in the game" (p. 7).

The TGfU approach was proposed as a way of putting the WHY of a game before the HOW. (Bunker & Thorpe, 1986a) suggested a six-stage model. A key focus of this model is that learners have to make decisions about "what to do" to play a game successfully, then "how to do" what they have realized they need. Based on this decision making learners are sensitized to their need to practice the necessary skills or way of playing to improve game performance (Griffin et. al., 1997). However, researchers such as Asquith (1989) and Laws (1994) have noted that in practice the TGfU has not necessary resulted in teachers being able "to stand back" and react to the tactical problems of game play. A tactical lesson can still involve teacher led questioning focused on one ability level where students are exposed to tactical problems they are ill equipped to solve. In this way tactics can be taught in a similar imposed manner to techniques without the necessary game modification to create students decision making based on their individual needs. To clarify what TGfU looks like we draw on Author's (2002) meaning matrix shown in Figure 1.

Games teaching matrix: Comparing technique perspective to a tactical perspective

In Figure 1 the matrix indicates how a "technique" approach relates to a "tactical" approach by highlighting how common misinterpretations of the two approaches often confuses understanding. The matrix is divided into four quadrants. On one side of the diagram is the traditional technique perspective to teaching games, on the other a tactical perspective to game playing. The top half of the diagram is games teaching with a student emphasis, on the bottom half of the diagram is games teaching with a content emphasis.

Insert Figure 1 about here

Focusing on a "technique" dominated approach, (Bunker & Thorpe, 1986c) argue that "often the teacher sees the teaching of techniques as the critical part of the lesson, indeed lists of skills are presented, week by week, to be ticked off and assessed in an evaluation of the children's performance" (p. 11). In Figure 1 this description would refer to the bottom left of the diagram. We have called this an “isolated skill focus” approach where covering content is emphasized over student learning. Though it appears that a progression of skills are being learned, in reality a progression of skills are covered but learned only by the most able, or those with previous ability. This problem is used by Bunker & Thorpe (1986c) to justify the need for a TGfU approach. Though we agree with their observation of the worst type of games teaching, often this critique obscures the need for skill progression. This critique alienates effective game teachers who work from a technique focus in their games teaching and offer a progression of skills based on the needs of learners who understand tactical play. Examples of this are skill development advocated by coaches of teams where children have been selected by ability to play on a team.

Bunker & Thorpe (1986c) noted "many teachers have realized that for many children the techniques are of little value and have let children get on with the game, only to realize that they seem to enjoy themselves more with less interference from the teacher" (p. 11). From this scenario a teacher can be left wondering what to teach. In the worst-case scenario this can lead to “‘the’ game focus” approach noted in the bottom right of the diagram. Here students may be playing "the" game of, say, soccer or baseball with the teacher emphasizing the content of the rules of the game and telling students where to position themselves in the game, but there is a lack of learning progression in the students' understanding of how to play tactically. In this situation the teacher is satisfied

with the students being occupied in an organized recess type lesson. The problem with this approach is that the majority of students are over-whelmed by the complexity of the game and eventually the novelty of the game wears off, with even the more capable students becoming bored or frustrated with the game. Though organized recess has its place in a school PE program, as advocated in a Sport Education model (Siedentop & Tannehill, 2000), the concern is that this type of games lesson may not relate to the diverse abilities students. When a teacher simply lets the children play "the" game without allowance made for difference in learners' abilities and social inequalities, the lesson cannot be seen as a tactical lesson because it is missing the complexity of developmentally teaching tactics for evolving game structures.

The tactical perspective to games teaching located in the top right-hand side of the diagram has a student emphasis on learning and a tactical focus on game play. "Tactical focus" is a progression of strategic principles that are taught in relation to a gradually more increasing challenging environment. Strategic understanding refers to ways of playing like being consistent in badminton, or keeping possession of the ball in soccer, where students can practice without an opponent trying to beat them. Tactics refers to ways of playing (strategies) expressively selected in order to gain an advantage over an opponent. Once a tactical awareness is realized it can be practiced as a strategy to be used in a competitive game. Tactical understanding is complex and, as argued by Griffin et al., 1997, Mitchell et al. (1994), Author (1998) and Author & Another (2000), has to be taught in progressive elements related to the development and experience of the students. However, the TGfU approach draws on this tactical perspective to teach skills so that we teach from a game form where we play games to create the need for skills.

The technique perspective to games teaching located in the top left-hand side of the diagram has a student emphasis on learning and a technique focus to game play. A "technique" focus is a progression of skills taught in relation to a gradually more increasing challenging environment. Movement approaches to teaching games such as those discussed by Wall & Murray (1994) focus on developing skillful players. In this approach skill refinements related to movement concepts are taught that enable students to move from an elementary movement pattern to a mature movement pattern (Gallahue, 1996). In such an approach a student is given a broad open task such as "Selecting a ball of your own choice show me how you can keep the ball in the air after one bounce." As students attempt to keep the ball going the teacher can work on refinements such as more height for more time, bend your knees as you prepare to hit, keep the racquet head flat and beneath the ball. Some students can be guided to catch and send the ball if this task is too difficult or to change the ball to a slower bouncing ball. Others students can be encouraged to hit the ball without a catch. Students could then be asked to hit the ball over a line or to a target as the teacher refines their skill further. Eventually this task will be applied to an application game like the castle game discussed in the tactical approach. In this way the application game gives purpose to hitting the ball up in the air.

As Berkowitz (1996) explains "technical skill work still has its place, but never in isolation -- always as it would be in the game and mostly as a means to accomplish the tactical problem" (p. 45). She emphasizes that skills cannot be taught without tactical awareness. To combine skills and tactics a teacher needs to understand the developmental needs of the learner. In other words, what tactical awareness can learners comprehend and what level of skillfulness can they achieve. Skill progression implies a back and forth marriage with tactical awareness, where skill performance is realized

through tactical application. However, can skill performance be learned before tactical awareness?

This synthesis of technique and tactical perspectives to teaching games emphasizes how tactics and skills need to be taught together, based on the needs of learners. TGfU, seen as an alternative to a traditional technique approach, does not minimize a teaching focus on the development of technical skills, as the tactical v technique dichotomy would imply, but rather incorporates the teaching of technical skills with tactical understanding developed from a modified game. As shown in Figure 1, the TGfU approach draws together the tactical perspective and the techniques perspective to create an improved game performance. As such, the TGfU approach is not really an alternative to teaching technique, but an approach to games teaching based on the game playing needs of a learner. From playing a game a learner has a tactical awareness to perceive cues of what they should do in a game and what skill they need to improve their game performance.

Combine technique and tactical learning - finding the right game structure.

To effectively teach a student a game the teacher needs to teach a progression of skills needed to play the game (i.e. catching, kicking, striking), while at the same time introducing a progression of tactical awareness to play effectively (i.e. anticipate where the ball will travel, aim for the spaces).

In a “technique” approach, learners practice a skill in a space on their own or in pairs, possibly with simplified equipment and objects, with successful repetition as their goal. For example, in a tennis lesson a teacher could start by asking students, "How long can you keep the ball going in a rally with your partner throw feeding the ball?" The teacher could then emphasize the following technical points: (1) get racket back before the ball bounces, (2) hit a falling ball, (3) hit the ball high, and (4) follow through in the direction

of your hit. In a way this is like a very simple modified game with a problem to solve. Too often it is perceived that a technique perspective to teaching games implies "telling" students how to do a skill. This is just one strategy to teaching that on its own does not enable meaningful learning. The whole array of teaching styles described by Mosston and Ashworth (1996) can be applied to any technique being learned.

In a “tactical” approach to games teaching this means involving learners in modified games. Games can be modified by simplifying game structures such as reducing the area of play, playing with fewer players, adapting rules to players needs, using lighter, smaller equipment, and using objects that move more slowly. Whilst playing modified forms of a game, students are asked to solve problems related to the game. For example, in a modified tennis game played in a tennis service box, a problem set by the teacher at the beginning of the lesson could be, "where should you go after hitting a ball into an opponent's court?" In this case, the location affording the greatest advantage is in the centre of the opponent's target area, an area that changes depending on where the ball is hit in an opponent's court. Understanding this positioning principle creates the opportunities to play a shot to become more consistent at hitting the ball and leads to the situation where the skill of accuracy is needed. With consistency the player then needs to know how to strike a ball so that it gets to the desired area.

For teaching games, the difference between a technical and tactical approach boils down to what constitutes a game. A game depends on the age of the learner, and the type of skill learned depends on the physical development and ability of the learner. In other words, to a young child hitting the ball against a wall and fetching it before it stops bouncing is a game, however to an older child this may seem pointless and become a boring skill practice. The TGfU model asks the teacher to discern which game structure

will enable the student to play with improved game performance. As Kirk & MacPhail, (2002) highlight to improve skill use within a game a student needs a tactical awareness that comes from an emerging understanding of playing a game.

To emphasize why we feel tactical understanding should be taught first, the next section of this paper will consider current theories for student learning in sport. Drawing on the sport of tennis the next section will describe, from the perspective of skill acquisition theories, how students learn in a games lesson when technique is emphasized first (skill-to-tactic) compared to when tactics are emphasized first (tactic-to-skill).

Skill acquisition and game play

In tennis, becoming skilled is a gradual process that involves learning to implement the most appropriate movement pattern for situations that arise in game play. The problem that novice tennis players face is multifaceted; they need to learn which environmental cues are important and which are redundant in order to selectively attend to only the most essential information (Abernethy, 1987). Based on this information players need to select tactics that will allow them the best opportunity to score a point, and they need to precisely coordinate patterns of movement that will effectively accomplish the tactics they select.

The two dominant theoretical frameworks guiding the understanding of motor learning and control have been broadly categorized as the information processing approach, and the ecological/dynamical systems approach (van Wieringen, 1988; William, Davids, Burwitz, & Williams, 1992; William, Davids, & Williams, 1999; Wulf, McNevin, Shea, & Wright, 1999). Each of these will be briefly described, following which we will present arguments assessing the effectiveness of the skill-to-tactic

approach and a tactic-to-skill approach to improving game performance. Implications for applied practice will also be discussed.

Information Processing Approach: Introduction

The information processing approach is a cognitive approach that views the human player as a communication channel that processes incoming information through a series of hypothetical stages in order to produce a movement output (Schmidt & Wrisberg, 2000; Williams et al., 1992). It is commonly accepted that these stages include *stimulus identification*, which involves the assembly, recognition, and identification of environmental information, *response selection*, which involves deciding on whether a response will be made, and which response will be selected, and *response programming*, which involves organizing and executing movement (Schmidt & Wrisberg, 2000). The processing of information is assumed to require attention resources, which are limited in supply (for a review of models of limited attention capacity, see Williams et al., 1999). Subsequently, human players are only capable of processing a limited amount of information at any time, and at a limited rate (Fitts, 1954; Hick, 1952; Hyman, 1953).

Novice players and Expert players

Learning allows the human player to develop strategies to overcome these attention limitations (Salthouse, 1991). For example, one way more expert players overcome the limitations of attention capacity and processing rate is to become "perceptually efficient." That is, rather than taking in all the visual information in a scenario, they selectively attend to the information that is most relevant (Abernethy, 1993; Williams, Davids & Williams, 1999). More expert players can also execute skills more automatically than novice players, reducing the amount of attention that needs to be dedicated to programming a response. Thus, the advantage that experts gain through practice and

experience is that they require fewer attention resources at each of the series of information processing stages.

The concepts of learning, attention, and expertise are linked within the information processing approach (Magill, 1998; Schmidt & Wrisberg, 2000; Williams et al., 1999). Learning is viewed as a stage-like process of gaining expertise where characterized by a gradual reduction in the need for attention to produce motor skills (e.g. Fitts & Posner, 1967; Gentile, 1972; Newell, 1986). For example, in the Fitts and Posner model, the earliest stage of learning is identified as the verbal/cognitive stage. It is characterized by the need to gain a basic understanding of the fundamentals of the game, including the rules, tactics, and basic movements, as well as to begin to distinguish between information that is critical and non-critical in producing a response. This stage relies heavily on conscious and verbal cognitive activity as learners think and talk their way through various tasks (Schmidt & Wrisberg, 2000). Once these basics are understood, learners progress to the associative stage where they can begin to refine their movements and strategies until, after much practice, they may achieve the autonomous stage, where their implementation becomes nearly automatic.

In assessing the attention demands of tennis, there is a lot of information available for processing. In the stimulus identification stage, perceptual demands are made by environmental information, which includes the on-coming speed, direction, and spin of the ball, the direction, speed of motion, and on-court position of one's opponent, weather conditions, and so forth. In the response selection stage, previous information must be considered in light of the player's knowledge of their own strengths, weaknesses, and preferences, the strengths, weaknesses, and preferences of their opponent, the stage of the game, fatigue, etc., in order to come to a decision regarding the most appropriate tactic to

employ. The response programming stage involves the organization, coordination and precise timing of muscular contractions in order to produce a movement that successfully completes the selected tactic. The ability for a novice to handle all of this information within the limited time available during game play is overwhelming if not impossible. Thus, the key for instructors in the earliest stages of learning is to reduce the attention demands on learners to a level that they can reasonably handle.

Part practice

Part practice is a frequently used strategy to reduce attention demands, and is defined as "practice on some set of components of the whole task as a prelude to performance of the whole task" (Wightman & Lintern, 1985, p. 280). Segmentation, fractionation, and simplification are part practice procedures available to instructors (Wightman & Lintern, 1985; see also in texts by Kluka, 1999; Magill, 1998; Schmidt & Wrisberg, 2000). Segmentation involves partitioning a whole task based on its spatial or temporal dimensions, practicing one part, and progressively adding more parts until the whole is achieved. In tennis this can be achieved at both the tactical and/or technical levels, but typically involves practicing the fundamental technical skills outside of the whole game context, and gradually incorporating restricted game situations into drills. Fractionation involves partitioning two or more subtasks that are normally executed together (e.g. separating tactical decisions from technical execution, or upper from lower body movements) and practicing them in isolation before combining them again. Simplification involves making a difficult task easier by adjusting one or more of its features (e.g. providing more time, equipment modifications, easing accuracy requirements) and gradually incorporating more of the characteristics of the whole task as learners demonstrate their capabilities.

Implications for technique and tactic approaches

Instructors who adhere to the technique approach (skill-to-tactic progression) frequently reduce attention demands for their learners through fractionation—separating technical and tactical practice (e.g. groundstrokes, serve), and segmentation—practicing component parts of skills (e.g. the toss, arm action, and follow-through of a serve). The purpose of these part practice procedures is to allow the learner's attention capacity to match the attention demands of the task. Once learners show improvement and some degree of automaticity has been achieved, attention can be directed towards higher order activities, such as more complicated technique, tactics, and eventually the full game environment. Thus the normal progression of learners implicitly advocated by the information processing approach is from skills, to tactics, to a full game. Indeed, many motor learning texts state that once the attention demands of response programming diminish, attention can be directed towards higher-level activities, such as tactics and strategy (Kluka, 1999; Magill, 1998; Schmidt & Lee, 2000; Schmidt, 1991; Schmidt & Wrisberg, 2000). However, this type of repetition is very boring to the learner, especially if they have not experienced the excitement of playing the game for which the skill is needed.

Tactical approach (tactic-to-skill) also represents an approach to reducing the attention demands on learners. However this is accomplished by the simplification part practice procedure. Tactical approach uses modified games, which simplify both tactics and technique by reducing space, increasing time, and using modified equipment to introduce the major principles of the whole game to learners. Once basic decision-making rules are understood and can be implemented in the simplest modified game, it can be altered to incorporate more of the features found in the whole game. By adjusting

modified games, more of the technical form and tactics of the full game can be incorporated into practice until learners find themselves performing in a whole game environment. The key difference between the tactic-to-skill and the skill-to-tactic approaches to games teaching is the part practice procedure that is used. Fractionation emphasizes technique over tactics, while simplification emphasizes tactical understanding as the primary goal with technical development as a secondary goal at the novice stage of learning.

The part practice procedure adopted by each approach effectively reduces attention demands on novice learners by manipulating the task until a reasonable degree of mastery has been achieved. Then learners are challenged by gradually increasing the demands of the task until they resemble those of the full game. This way, learners' ability to cope with task demands is never completely overloaded. From the perspective of creating a learning environment where the processing limitations of learners' are taken into account, each approach is successful. However, each approach must also be assessed with regards to how effectively learning transfers to the criterion situation, which is the game. Ideally, the information processing requirements of practice should prepare learners for what they will face in a game so that the adaptations they make during practice can transfer to games (Lee, 1988).

As explained above, the information-processing model is serial in nature, with the response selection stage following the stimulus identification stage, and the response programming stage following the response selection stage. The skill-to-tactic approach to games teaching minimizes decision-making (response selection) early in learning, while emphasizing technical mastery. One problem with adopting this approach is that with few decisions to make during practice, the response selection stage can be by-

passed. As a result, information can be processed in the response programming stage immediately following stimulus identification. For clarity of argument, we'll label the three stages of information processing A (stimulus identification), B (response selection), and C (response programming). In the skill-to-tactic approach, drills typically foster a consistent A-C mapping. A game, however, is dynamic requiring players to continuously sample the environment and make decisions based on the information they perceive. Learners encounter many situations in games whose solutions are not always as neat and clear cut as they are in practice drills. Thus, the information processing demands of a game (A-B-C) are different than those of practice (A-C). Owing to a lack of practice in processing information at the response selection stage (deciding what to do), learners may respond by implementing a technique without a purpose (e.g. hit a forehand drive over the net), or may become overloaded and confused by the demands of what amounts to a novel situation.

In the skill-to-tactic approach it is argued that once technical skills have been automated to a reasonable level, attention can be gradually and progressively directed towards tactics and strategy. However, consistently mapping A-C, over time, leads to the formation of habitual, automatic ways of responding (Schmidt & Bjork, 1992); learners will habitually implement a technique without due consideration of strategy, since that is what they have practiced. For a learner to consider tactical demands what is required is more than simply directing attention to this aspect of the game, it requires them to replace one habitual pattern of responding with another. In essence, trying to squeeze decision-making between perception and response programming requires learners' un-learn one habit (A-C) and replace it with another (A-B-C), which takes time and effort. The danger of this approach is that in stressful game situations when arousal levels increase, players

are likely to regress to their most dominant habit (Fuchs, 1962; Schmidt & Wrisberg, 2000). Applied to tennis, when faced with a ball coming to the forehand side, the goal of players may be simply to hit it back over the net, rather than hitting it to a particular target location for a particular strategic purpose. By working to automate response programming first, learners develop decent skills, but when it comes to games they are more likely to fit learned skills into a situation rather than assess the situation and use the appropriate skills to achieve a particular tactical goal.

The tactic-to-skill approach can be thought of as a principle-based approach. Similar to the skill-to-tactic approach, the demands for attention are reduced early in learning. However this is achieved through simplification rather than fractionation and segmentation part practice procedures. Simplification is achieved through the use of modified games designed to incorporate critical response selection principles but reduced response programming demands. This way, learners must continually decide "what to do" as they practice, and are able to discover the range of movement capable of achieving their tactical goal. Once initial response selection and response programming processes become more automated, the simplified games can be altered to incorporate more of the complexities of the full game. The advantage of skills practice in the tactical approach is that it is done from within a context, which produces learners who learn to solve problems (Higgins, 1991). In this sense, practice within the tactical approach facilitates transfer to games since, from the start, learners' process information during practice in relation to the way they are required to process information in the game. In practices, as in games, learners assess the game environment in order to select an appropriate strategy, following which they implement a pattern of movement that will achieve their tactical

goal (A-B-C). Emerging tactical understanding is needed to facilitate skill development leading to improved game performance.

Dynamical Systems Approach: Introduction

A more recent approach to understanding motor behavior is the dynamical systems approach. In the dynamical systems approach movement is viewed as an emergent property of a self-organizing system (Walter, Lee & Sternad, 1998; Wulf, McNevin, Shea & Wright, 1999). In the game of tennis, for example, players are faced with a variety of situations in which the overall goal is similar—keep the ball in play. In each of these situations, there are a variety of tactics that can be applied, and for any given tactic there are a variety of ways to coordinate movement to achieve the tactical goal. The learner's job is to figure out how to best coordinate their many moving parts to successfully achieve these tactical goals (Hodges, McGarry & Franks, 1998). Thus, the form of technique per se is secondary. Achieving the tactical goal by any means possible is what drives movement. Although this view of motor coordination affords the motor system incredible freedom to generate patterns of movement, some patterns of movement are simply more effective and efficient than others.

Movement patterns

As noted by Van der Kamp, Vereijken and Savelsbergh (1996), in dynamic systems theory the movement pattern that eventually emerges forms spontaneously as a function of physical and informational constraints. These include the structural characteristics of the player's body, their personal characteristics, the objects and motion in the environment, and the rules of the game (Clark, 1995; Newell, 1986; Temprado & Laurent, 2000; Vereijken, 1999). Each of these restrictions limits how players' movements can be coordinated (Corbetta & Vereijken, 1999). Furthermore, Davids and

Button (2000), Temprado and Laurent, (2000) and Wulf et al. (1999) have proposed that intention should been considered as a constraint. This means that players' intentions should also be viewed as a constraint, reflecting the influence of knowledge on the form that movement ultimately takes.

Constraints from all sources place limits on the range of movements that can effectively accomplish a task goal. The neuromuscular system works within these confines to organize a pattern of muscle activity around joints that allows the player's body to act as a single unit (Clark, 1995; Higgins, 1985; Turvey, 1990). Turvey (1990) refers to this temporary assembly of united joint action as a coordinative structure

Although the coordinative structure that emerges in similar situations can be variable, it tends to stabilize over time. A stabilized movement pattern is known as an attractor (Clark, 1995). The assumption is that the goal of the motor system is to settle into an attractor state. In sport, it is further assumed that, for each individual, there is an optimal coordination pattern for any given task based on the interaction of each individual's unique physical constraints, and the informational constraints present in the environment. The challenge for all learners is to find this optimal coordination pattern (Wulf et al., 1999). This discovery process may be more or less difficult depending on the existing coordination preferences of the individual. An individual's intrinsic dynamics refers to attractor states that represent their preferred modes of coordination (Clark, 1995; Corbetta & Vereijken, 1999). Learning a new coordination pattern involves competition between an individual's intrinsic dynamics and the optimal movement pattern (Davids & Button, 2000; Lee, 1998). With practice, learners can modify intrinsic dynamics to produce the optimal coordinative structure demanded by the new task (Corbetta & Vereijken, 1999). To do this, learners must destabilize intrinsic dynamics, and search for the optimal

coordination pattern. The degree of similarity between an optimal movement pattern and intrinsic dynamics provides a clue as to how quickly and how much practice will be needed for the optimal pattern to become the preferred attractor state.

Implications for tactical and technique approaches

In tennis, there are many constraints. However, regardless of the situation, the player's goal is to match the spatial features of the racquet with the spatial and temporal features of the ball such that the ball travels over the net and lands within the boundaries of the court, preferably where one's opponent will have the most difficulty returning it. Quite a set of constraints! But there is more. To achieve this tactical goal, the racquet face must be held at a specific orientation when it contacts the ball. Movements that place the racquet at the appropriate orientation must accomplish this at the appropriate time, and are further constrained by the properties of the racquet itself (size, weight) as well as the flight path, spin, and speed of the ball. Furthermore, the movement path of the racquet head once a stroke has been initiated is constrained by the style of grip adopted by the player, while tactical considerations constrain preparatory off-the-ball movements (e.g. footwork and body orientation) so that the player may hit the ball to a particular location in the opposite court. These constraints also interact with movement limitations caused by the player's physique (structural constraints) as well as their preferred pattern of movement (intrinsic dynamics). These constraints converge to severely restrict the movement pattern that will successfully accomplish the player's tactical goal. Assessed from the dynamical systems approach, the only difference between the skill-to-tactic and tactic-to-skill approaches to games teaching is the presence or absence of tactical constraints.

In the tactical approach, the combination of tactical learning and reduced technical requirements through the use of modified games, allows learners to set tactical goals for action based on the information at hand. By necessity, the tactical goals that learners determine constrain the movements that will achieve them. What learners learn under the tactical approach is to generate tactical action goals based on dynamic informational constraints (position and motion of the opponent, etc), and generate appropriate off-the-ball movements in order to assume a court position that will allow them to hit the ball to a particular location. As learners develop more effective tactical goals, they also develop new skills and further refine previously learned skills in order to achieve them.

The skill-to-tactic approach also appears to make good use of dynamical systems principles in the development of technique. Intrinsic dynamics must be destabilized, and new dynamics discovered and practiced in order to establish an appropriate attractor state. However, in the absence of tactical goals, an important constraint is released, which allows more room for movement variability. That is, if a player wants to place the ball in the far left corner, her movement must be more precise than if her goal is simply to get the ball over the net. Once the new attractor has sufficient strength, it seems a short step to add tactical constraints. However, the addition of tactical constraints, which depend on players' knowledge (an intentional constraint), requires destabilizing the old attractor, since the optimal movement pattern must be modified. This is where the classic problem of skills not transferring into the game is witnessed, and links back to the concerns highlight by Bunker and Thorpe when they suggested the TGfU approach.

Conclusion

Figure 1 highlights how a "technique" focus and a "tactical" focus for games teaching are linked as two essential components. The teacher of games must have knowledge of

both skill progressions and tactical progressions. The ability to shift between the two perspectives means that game teachers transform the content knowledge into forms that are pedagogically powerful, yet adaptive to the variations in ability and background presented by students (Griffin, Dodds, & Rovengo, 1996). Emphasizing either perspective at the expense of the other results in a mis-interpretation of how to teach students to play games. The arrows in Figure 1 highlight how the movement in games teaching is aimed at the gray shaped area between "technique" and "tactical" perspectives, the TGfU game performance domain. The TGfU approach strives for this domain by focusing on game-like games that the student can play. Support from the information processing and dynamic system theories show that the key to learning games is that the TGfU promotes games by using the self-propelling motivation of games to foster increased skillfulness. The teacher has to meet the challenge of developing game-like games dependent on the age and prior experience of each student.

We recommend that when teaching games practitioners should use Figure 1 as a guide. As the arrows indicate the teacher should adapt the lesson to try to shift learning into the play rich area of the TGfU domain. When teaching games it is too easy to focus on content, believing you are teaching tactics or techniques, when in reality you are covering material but not engaging the learner. Instead, what is needed is a modified game framed with a tactical awareness problem associated with the "Tactical progression" for the learners' abilities. If the game is too complex, or students do not realize the tactical needs of the game the teaching episode has slipped into a content focus in "'the' game focus". In this situation the teacher must adapt game structures, with the goal of making the game play. Based on students' awareness of the situation the teacher may simply repeat a familiar skill to automate it for use in the game ("skill

learning progression"), before return back to the modified game. If skill practice lacks a tactical frame then it can sink into the "Isolated skill focus" where students practice but without meaning with a limited chance for the skill transferring into the play of the game. At this point a modified game is needed to reframe the learning process. This process of games adapted to players needs and skill progressions develops student meaningful skill improvement, leading to students' shaping their own practice, and in time learning to modify games to suit each others playing abilities.

Initial interest in the TGfU approach started in the UK with teachers researching their own practice in an attempt to improve games teaching (Almond, 1986; Burrows & Abbey, 1986; Jackson, 1986). Experimental design research comparing skill-based lessons to tactical based lessons has tried to inform our knowledge of teaching games. However this separating of the approaches is questionable and artificially simplifies the complexity of games teaching (Rink et al., 1996). More recent work by (Kirk & MacPhail, 2002) offers a rethinking of the TGfU model from a situated learning perspective. Their article focuses learning theory more on the active engagement of the learner with the environment, and through perception and decision-making how the learner adapts new knowledge to fit what they already know. This leads the teacher to focus more on the prior knowledge of individuals, such as TV viewing and related sports, to frame learning experiences. The Griffin & Placek (2001) monograph reports research focused on how TGfU affects student learning. Such a publication offers promising insights from collaborative research between researchers from motor learning and sport pedagogy. This research emphasized the interplay between individuals, their prior knowledge and environment created by the teacher. The research agenda needs to develop further to describe and document the ongoing learning experiences of teachers,

children and collaborating teacher educators in TGfU programs of instruction developed over a sustained period. We need PE teachers willing to take the challenge of committing to a TGfU approach in their games curriculum with the goal of assessing long term cognitive, social and physical learning outcomes for students. We hope this paper will encourage PE teachers to take on the challenge.

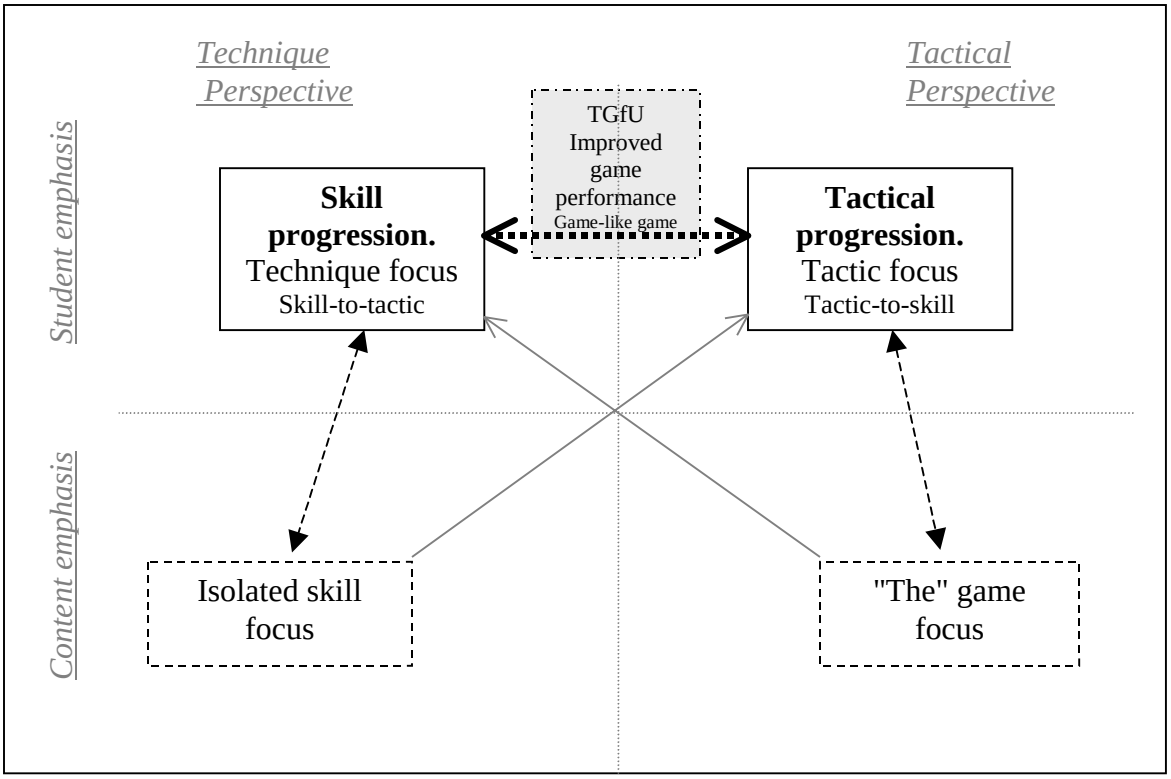

Figure 1 – Games teaching meaning matrix: Contrasting learning in a technique focus and a tactical focus

References

Abernethy, B. (1987). Anticipation in sport: A review. Physical Education Review, 10(1), 5-16.

Abernethy, B. (1993). Searching for the minimal essential information for skilled perception and action. Psychological Research, 55, 131-138.

Abernethy, B. (1994). The nature of expertise in sport. In S. Serpa, J. Alves, & V. Pataco (Eds.), International perspectives on sport and exercise psychology (pp. 57-68). Morgantown, WV: Fitness Information Technology, Inc.

Alison, S., & Thorpe, R. (1997). A comparison of the effectiveness of two approaches to teaching games within physical education. A skills approach versus a games for understanding approach. The British Journal of Physical Education, 28(3), 9-13.

Almond, L. (1986). Asking teachers to research. In R. Thorpe, D. Bunker, & L. Almond (Eds.), Rethinking games teaching (pp. 35-44). Loughborough: University of Loughborough, Nene Litho.

Asquith, A. (1989). Teaching games for understanding. In A. Williams (Ed.), Issues in physical education for the primary years (pp. 76-90). London: The Falmer Press.

Berkowitz, R. (1996). A practitioner's journey: From skill to tactics. JOPERD, 67(4).

Berkowitz, R. (1996). A practitioner's journey: From skill to tactics. JOPERD, 67(4).

Broadbent, D. A. (1975). The magical number seven after fifteen years. In A. Kennedy & A. Wilkes (Eds.), Studies in long-term memory (pp. 3-18). New York: John Wiley & Sons.

Bunker, B., & Thorpe, R. (1986). The curriculum model. In R. Thorpe, Bunker, D., & Almond, L (Ed.), Rethinking games teaching (pp. 7-10). Loughborough: University of Technology, Loughborough.

Bunker, D., & Thorpe, R. (1986a). Is there a need to reflect? In R. Thorpe, D. Bunker, & L. Almond (Eds.), Rethinking games teaching (pp. 25-34). Loughborough: University of Technology, Loughborough.

Bunker, D., & Thorpe, R. (1986b). From theory to practice. In R. Thorpe, D. Bunker, & L. Almond (Eds.), Rethinking games teaching (pp. 11-14). Loughborough: University of Technology, Loughborough.

Bunker, D., & Thorpe, R. (1986c). Is there a need to reflect? In R. Thorpe, D. Bunker, & L. Almond (Eds.), Rethinking games teaching (pp. 25-34). Loughborough: University of Technology, Loughborough.

Burrows, L., & Abbey, W. (1986). A teacher's reactions. In R. Thorpe, D. Bunker, & L. Almond (Eds.), Rethinking games teaching (pp. 45-51). Loughborough: University of Technology, Loughborough.

Chandler, T. (1996). Teaching games for understanding: Reflections and further questions. JOPERD, 67(4), 49-51.

Chase, W. G., & Ericsson, K. A. (1982). Skill and working memory. The psychology of learning and motivation, 16, 1-58.

Clark, J. E. (1995). On becoming skillful: Patterns and constraints. Research Quarterly for Exercise and Sport, 66(3), 173-183.

Corbetta, D., & Vereijken, B. (1999). Understanding development and learning of motor coordination in sport: The contribution of dynamic systems theory. International Journal of Sport Psychology, 30, 507-530.

Davids, K., & Button, C. (2000). The cognition-dynamics interface and performance in sport. International Journal of Sport Psychology, 31, 515-521.

Ericsson, K. A., Chase, W. G., & Faloon, S. (1980). Acquisition of a memory skill. Science, 208, 1181-1182.
Fitts, P. M. (1954). The information capacity of the human motor system in controlling the amplitude of movement. Journal of Experimental Psychology, 47, 381-391.
Fitts, P. M., & Posner, M. I. (1967). Human performance. Belmont, CA: Brooks/Cole.
Fuchs, A. H. (1962). The progression-regression hypotheses in perceptual-motor skill learning. Journal of Experimental Psychology, 63(2), 177-182.
Gallahue, D. L. (1996). Developmental physical education for today's children (3rd ed.). Madison: Brown & Benchmark.
Gentile, A. M. (1972). A working model of skill acquisition with application to teaching. Quest, Monograph XVII, 3-23.
Griffin, L. L., Mitchell, S. A., & Oslin, J. L. (1997). Teaching sport concepts and skills: A tactical games approach. Champaign, IL: Human Kinetics.
Griffin, L., & Placek, J. (2001). The understanding and development of learners' domain-specific knowledge. Journal o f Teaching Physical Education [monograph], 20(4), 299-422.
Griffin, L., Dodds, P., & Rovengo, I. (1996). Pedagogical content knowledge for teachers: Integrate everything you know to help students learn. JOPERD, 67(9), 58-61.
Hick, W. E. (1952). On the rate of gain of information. Quarterly Journal of Experimental Psychology, 4, 11-26.
Higgins, S. (1985). Movement as an emergent form: Its structural limits. Human Movement Science, 4, 119-148.
Higgins, S. (1991). Motor skill acquisition. Physical Therapy, 71(2), 123-139.
Hodges, N. J., McGarry, T., & Franks, I. M. (1998). A dynamical system's approach to the examination of sport behaviour. Avante, 4(3), 16-38.

Hyman, R. (1953). Stimulus information as a determinant of reaction time. Journal of Experimental Psychology, 45, 188-196.
Jackson, S. (1986). Teaching for understanding in games - A working curriculum 11-16. Bulletin of Physical Education, 22(2), 27-30.
Kirk, D., & MacPhail, A. (2002). Teaching games for understanding and situated learning: Rethinking the Bunker-Thorpe model. Journal of Teaching in Physical Education, 21, 177-192.
Kluka, D. A. (1999). Motor behavior: From learning to performance. Englewood, CO: Morton.
Laws, C. (1994). Rhetorical justification for new approaches to teaching games - Are physical education teachers deluding themselves? Paper presented at the Proceedings for the 10th Commonwealth & International Scientific Congress, Victoria, British Columbia.
Lee, T. D. (1988). Transfer-appropriate processing: A framework for conceptualizing practice effects in motor learning. In O. G. Meijer & K. Roth (Eds.), Complex movement behaviour: 'The' motor-action controversy (pp. 201-215). Amsterdam: Elsevier Science.
Lee, T. D. (1998). On the dynamics of motor learning research. Research Quarterly for Exercise and Sport, 69(4), 334-337.

Magill, R. A. (1998). Motor learning: Concepts and applications (5 ed.). Dubuque, IA: WCB McGraw-Hill.
Mauldon, E., & Redfern, H. (1981). Games Teaching. London: Macdonald and Evans.
Mitchell, S., Griffin, L., & Oslin, J. (1994). Tactical awareness as a developmentally appropriate focus for the teaching of games in elementary. Physical Educator, 51(1), p. 8-29.
Newell, K. M. (1986). Constraints on the development of coordination. In M. G. Wade & H. T. A. Whiting (Eds.), Motor development in children: Aspects of coordination and control (pp. 341-360). Dordrecht: Martinus Nijhoff Publishers.
Rink, J. (1996). Tactical and skill approaches to teaching sport and games: Introduction. Journal of teaching in physical education, 15, 397-398.
Rink, J., French, K., & Graham, K. (1996). Implications for practice and research. Journal of Teaching in Physical Education, 15, 490-502.
Rovegno, I., Nevett, M., & Babiarz, M. (2001). Chapter 5. Learning and teaching invasion-game tactics in 4th grade: Introduction and theoretical perspective. Journal of teaching in physical education [Monograph], 20, 341-351.
Salthouse, T. A. (1991). Expertise as the circumvention of human processing limitations. In K. A. Ericsson & J. Smith (Eds.), Toward a general theory of expertise: Prospects and limits (pp. 286-300). New York: Cambridge University Press.
Schmidt, R. A., & Bjork, R. A. (1992). New conceptualizations of practice: common principles in three paradigms suggest new concept for training. Psychological Science, 3(4), 207-217.
Schmidt, R. A., & Lee, T. D. (2000). Motor control and learning: A behavioral emphasis (3 ed.). Champaign, IL: Human Kinetics.
Schmidt, R. A., & Wrisberg, C. A. (2000). Motor learning and performance: A problem-based learning approach (2 ed.). Champaign, IL: Human Kinetics.
Siedentop, D., & Tannehill, D. (2000). Developing teaching skill in physical education. Cakifornia: Mayfield publishing company.
Silverman, S. (1997). Is the tactical approach to teaching games better than a skills approach? JOPERD, 68(7), 5.
Starkes, J. L. (1987). Skill in field hockey: The nature of the cognitive advantage. Journal of Sport Psychology, 9, 146-160.
Strean, W., & Holt, N. (2000). Players', coaches', and parents' perceptions of fun in youth sport. AVANTE, 6, 84-98.
Temprado, J. J., & Laurent, M. (2000). Cognition in action: A dynamical approach to intentional control of coordination. International Journal of Sport Psychology, 31, 522-529.
Thorpe, R., & Bunker, D. (1989). A changing focus in games teaching. In L. Almond (Ed.), The place of physical education in schools (pp. 42-71). London: Kogan/Page.
Thorpe, R., Bunker, D., & Almond, L. (Eds.). (1986). Rethinking games teaching. Loughborough: University of Technology, Loughborough.
Turner, A., & Martinek, J. (1995). Teaching for understanding: A model for improving decision making during game play. QUEST, 47, 44-63.
Turner, A., & Martinek, T. (1992). A comparative analysis of two models for teaching games (technique approach and game centered (tactical focus) approach). International Journal of Physical Education, XXIX, 131-152.

van der Kamp, J., Vereijken, B., & Savelsbergh, G. (1996). Physical and informational constraints in the coordination and control of human movement. Corpus, Psyche et Societas, 3(2), 102-118.
van Wieringen, P. C. W. (1988). Kinds and levels of explanation: Implications for the motor systems versus action systems controversy. In O. G. Meijer & K. Roth (Eds.), Complex movement behavior: 'The' motor-action controversy . Amsterdam: Elsevier Science Publishers.
Vereijken, B. (1997). Dynamics in development. Corpus, Psyche et Societas, 4(1), 14-26.
Vereijken, B. (1999). Changing perspective on motor control and coordination. Corpus, Psyche et Societas, 6(2), 112-122.
Vereijken, B., & Whiting, H. T. A. (1990). In defense of discovery learning. Canadian Journal of Sport Science, 15(2), 99-106.
Vereijken, B., Van Emmerik, R. E. A., Bongaardt, R., Beek, W. J., & Newell, K. M. (1997). Changing coordinative structures in complex skill acquisition. Human Movement Science, 16, 823-844.
Wall, J., & Murray, N. (1994). Children and movement. Dubuque, IA: Wm. C. Brow Publishers.
Walter, C. (1998). An alternative view of dynamical systems concepts in motor control and learning. Research Quarterly for Exercise and Sport, 69(4), 326-333.
Walter, C., Lee, T. D., & Sternad, D. (1998). The dynamic systems approach to motor control and learning: Promises, potential limitations, and future directions. Research Quarterly for Exercise and Sport, 69(4), 316-318.
Werner, P. (1989). Teaching games: A tactical perspective. JOPERD, 60(3), 97-101.
Whiting, H. T. A., & Vereijken, B. (1993). The acquisition of coordination in skill learning. International Journal of Sport Psychology, 24, 343-357.
Wightman, D. C., & Lintern, G. (1985). Part-task training for tracking and manual control. Human Factors, 27(3), 267-283.
Williams, A. M., Davids, K., & Williams, J. G. (1999). Visual perception and action in sport. London: E & FN Spon.
Williams, A. M., Davids, K., Burwitz, L., & Williams, J. G. (1992). Perception and action in sport. Journal of Human Movement Studies, 22, 147-204.
Wulf, G., NcNevin, N., Shea, C. H., & Wright, D. L. (1999). Learning phenomena: Future challenges for the dynamical systems approach to understanding the learning of complex motor skills. International Journal of Sport Psychology, 30, 531-557.