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Original Article

Effects of teaching games for understanding on tactical knowledge development in middle school physical education

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Abstract:
In contrast to the traditional direct instruction pedagogical model, the teaching games for understanding (TGfU) model emphasizes the development of cognitive factors (i.e. tactical knowledge and decision-making) in the development of sport expertise. However, despite some TGfU-focused investigations demonstrating some positive learning outcomes for students, especially in terms of developing their tactical knowledge, more empirical support for TGfU is warranted. Consequently, the purpose of the study was to examine the effects of a TGfU soccerunit on the tactical knowledge developmentof middle school physical education (PE) students. Participants were 12 sixth grade students (n = 6 female) selected from four middle school PE classeswho participated in a TGfU soccer unit taught by the lead authorand teacher fidelity was established.A pre-test/middle-test/post-test quasi-experimental design was employed. A verbal protocol analysis (VPA) technique was applied to assess potential developments in students' tactical knowledge across the duration of the unit and was undertaken by participants acting like an ESPN sports announcer, providing live in-situ commentary on the activities of one player as they participated in the game. The interview commentaries were transcribed and coded using established protocolsat three levels of analysis: conceptual content, conceptual sophistication, and conceptual structure. The Wilcoxon signed-rank test was applied to contrast the differences between the measurements conducted (pre-mid-post). Findings confirmed the effectiveness of the TGfU unit in developing adaptations to long-term memory that improved the quality of the students' tactical knowledge at all three levels of analysis (conceptualcontent, sophistication, and structure). Given our results, we emphasize the need to use pedagogical models such as TGfU to increase students' capacity to evaluate game situations and develop their tactical reasoning.
Key Words: **Pedagogical models, cognitive expertise, verbal reports, soccer**

Introduction

In sports like soccer, tactical and decision-making skills are extremelyimportant in becoming a successful player in addition to technical skills (Lex, Essing, Knoblauch, & Schack, 2015). Different studies have highlighted the importance of the cognitive factors (i.e. tactical knowledge and decision-making) in the development of sport expertise (Moran, 2012). From a cognitive psychology perspective, the level of sport expertise depends on the mental representations and cognitive processes that appear betweenthe interpretation of the stimulus and action selection (Hodges, Starkes, &MacMahon, 2006).

Based on this perspective, the players' tactical knowledge is developed in contextualized situations based on individualplayers' interaction with the task and the environment (Newell, 1986). Thus, the knowledge structures stored in the memory affect the decision-making processes (MacMahon& McPherson, 2009) in such a way that the greater and more varied the tactical knowledge is, the better players can perceptually select the relevant cues from the environment while are ignoring the other information (McPherson, 2008). Consequently, instructional processes should specifically target the decision-making aspects of play, such as tactical knowledge, which will enable to take more appropriate deliberate decisions to be taken in a specific situation (Vickers, 2007).

In a physical education (PE) context, sport teaching has traditionally been undertaken using a direct instruction pedagogical model. This model has been described as physical-education-as-sport-techniques(Kirk, 2010)because of its skills first orientation where students are assumed to develop a certain level of technical skill proficiencybefore game play can occur(Oslin& Mitchell, 2006). Consequently, this model has been strongly criticized as it decontextualizes sport teaching to the extent thatmost students obtain limitedgame understanding and,

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consequently, possess inflexible techniques and poor cognitive expertise (Gray & Sproule, 2011; Light, Harvey, &Mouchet, 2014; Stoltz & Pill, 2014).

The teaching games for understanding (TGfU) model is one of several second-generation pedagogical models that shift the focus on learning beyond solely the psychomotor domain. With its emphasis on promoting skillful and intelligent performance, learning in the cognitive domain isprioritized in the TGfU model (Metzler, 2011). Students learn game appreciation and tactical awareness from the outset(Kinnerk, Harvey, MacDonncha, & Lyons, 2018) through playing developmentally appropriate small-sided and/or modified/conditioned versions of the game (Harvey & Jarrett, 2014; Harvey, Pill, &Almond, 2017). This facilitates the development of game play strategy and tactical decision-making related to both the on-and off-the-ball concepts required for effective game play (Turner &Martinek, 1999). Although the cognitive domain is prioritized when teachers use TGfU, psychomotor development is not neglected. The PE teacher can choose to develop technical skills in one of two ways. First, technical skills can be integrated into game play through using specific game conditions/modifications (i.e., multiple goal games in soccer to encourage turning and dribbling skills). Second, when needed, the teacher can bring students out of the game to give them the opportunity to perform a skill drill or practice task focused on technical skill development. Both these options allow students the opportunityto further their game performance development (Bunker & Thorpe, 1982; Miller, 2015; Mitchell, Oslin, & Griffin, 2013).

In the last decade, TGfU has received much support from practitioners and the research community alike, analyzing how this pedagogical model can influence on different learning outcomes such as game performance (Arias-Estero, Jaquero, Martínez-López, & Morales-Belando, 2020; Dania & Harvey, 2020; Harvey, Cushion, Wegis, & Massa-Gonzalez, 2010; Morales-Belando& Arias-Estero, 2017; Morales-Belando, Calderón, & Arias-Estero, 2018), physical literacy (Mandigo, Lodewyk, & Tredway, 2019; Nathan, 2015), psycho-social variables (Bracco, Lodewyk, & Morrison, 2019; Harvey, Gil-Arias, Smith, & Smith, 2017; Hortigüela& Hernando, 2017), and physical activity levels (Harvey & García-López, 2017; Wang & Wang, 2018). However, Rink, French, and Tjeerdsma, (1996) arguedthat, despite some TGfU-focused investigations demonstratingsome positive learning outcomes for students, especially in terms of developing their tactical knowledge, more empirical support for TGfU is warranted.

The main sources thatresearchers use to collect data on students' cognitive development in PE has been the use of written knowledge tests (Gil-Arias et al., 2013) and video-based knowledge tests supported by structured written questions (VandeBroek, Boen, Claessens, Feys, &Ceux, 2011). However, these sources of data collection offer limited information on students' cognitive development because it is not possible to know if the knowledge analyzed by these tests is used by the player during a sporting action (Salmon, Stanton, Gibbon, Jenkins, & Walker, 2009).

Moreover, Gréhaigne, Godbout, and Bouthier (2001) argued that verbal protocol analysis (VPA) is another means of collecting information about cognitive processes, and that overt verbalization (including VPA techniques) can be used as, (a) a method to collect information about students thought processes, and, (b) a tool for eliciting reflection and critical thinking about performance to bring transformation to action play. Thus, the VPA applied during matches provides the teacher (and researcher) with relevant information about the cognitive processes that the students develop from within a real in-situ game situation that requires not only response selection, but also a response (motor) execution (McPherson &Kernodle, 2007). The VPA technique has been applied in two previous TGfU studies in PE within a high school badminton context (French, Werner, Rink, Taylor, & Hussey, 1996; French, Werner, Taylor, Hussey, & Jones, 1996). Findings from these studies revealed that none of the 48 students thought in advanced ways about their game play and/or used condition-action statements in the three-week study, although some students did demonstrate some tactical reasoning in game play (French, Werner, Rink et al, 1996). In the second, longer, six-week study, only two of 52 players stated plans with condition-action linkages (French, Werner, Taylor et al., 1996). Since these two studies, the use of VPA technique has been limited in TGfU research.

However, VPA has been used widely to assess problem representations of sports performers whilst in the act of competing in high strategy sports (McPherson &Kernodle, 2007). As this procedure was originally devised for tennis, it has been used with various populations within this sport (García-González, Moreno, Moreno, Iglesias, & Del Villar, 2012; McPherson &Kernodle, 2007). It has also been used in research insoccer (Evans, Whipp, & Lay, 2012), baseball (e.g., Nevett& French, 1997), and volleyball (Afonso, Garganta, Mcrobert, Williams, & Mesquita, 2012a; 2012b; Gil-Arias, Del Villar, García-González, Moreno, & Moreno, 2015) contexts. These studies found expert performers used a greater variety and higher level of sophistication than novices/beginners when talking about the game. Furthermore, adults, college-aged players, and even high school players used greater levels of sophistication when compared to youth players.

To glean more information about students' cognitive processes and provide more insight into the effectiveness of the TGfU model in PE settings, Turner (2003) suggested using the VPA technique, which has had limited use in studies on invasion type games where game play is more dynamic and less predictable in nature than net/wall and striking and fielding games. Given the need to develop more studies to assess developments in students' tactical knowledge when being taught with TGfU in PE, the main purpose of the current study was to examine the effects of a TGfU soccer unit on the tactical knowledge development of middle school physical educationPE students. Wehypothesized that the sixth-grade students who participated in the study would significantly improve their tactical knowledge in terms of content, sophistication, and conceptual structure from pre-to-mid-to-post-test.

Material & methods

Design

This study followed a pre-test/mid-test/post-test quasi-experimental design without control group (Harvey et al., 2010). Pre-tests on tactical knowledge took place before the TGfU unit began, while the mid-test took place when the students had completed half of the TGfU unit lessons and the post-tests wereconducted following completion of TGfU unit.

Participants and setting

A purposive sampling method was employed to recruit participants for this study (Creswell, 2014). Participants were 12 sixth grade students (n = 6 female) selected from four PE classes at an urban middle school in the Pacific North Western United States. PE classes met daily with total teaching time available for class instruction being approximately 35 minutes. The school where the TGfU unit delivery was conducted was chosen because its students had previously had little exposure to the TGfU model, either in their present, or in previous grade levels. The resident PE teacher also viewed this as a professional development opportunity by "seeing TGfU in action".

All study participants were students selected from four PE classes that received the TGfU unit. Three participants from each of the four classes (a higher-, moderate- and lower-skilled student) were randomly selected from the available students to be part of the final data analysis (see Table 1). Students in each class had equal chance of selection for the final data analysis, and no participant ever knew they were going to be a subject or not. Due to the fact that class membership far exceeded the number of subjects needed for the final data analysis, the criteria for selecting participants used in the final data analysis were,(a) attendance and participation in 100% of TGfU sessions; (b) attendance and participation at all assessment sessions; (c) completion of assent/informed consent documentation. The resident PE teacher chose names from a hat by skill level that included names of all students who met these criteria. The demographics of the final participants (names are pseudonyms) their class, skill level, previous soccer experience and the amount of soccer they played during the TGfU unit can be seen in Table 2.

Table I

Class Numbers and lesson time in school day, boys/girls in class, and total numbers (and percentages) of Informed Consent/Assent forms received from members of classes A – D used in the study

Class	N	Girls	Boys	IC (%)	Number of participants available after sessions	Final participant group per class (n)
A	23	9	14	14 (61)	8	3
B	36	20	16	28 (78)	7	3
C	26	12	14	14 (54)	6	3
D	42	22	20	21 (50)	10	3
Total	127	63	64	76 (61)	31	12

Notes: IC = Informed Consent

Table II

Participant demographics

Participant Pseudonym	Class	Skill Level	Years of Soccer Playing Experience Before study	Types of Soccer Playing Experience Before Study	Outside Soccer Play During Study (hrs)
Neal	A	H	7	Recreational Soccer/Youth Group, School PE/Club	0
Nancy	B	H	6	Recreational Soccer/Youth Group/Club	5.5
Lane	C	H	5	Recreational Soccer/Youth Group	0
Harry	D	H	7	School PE/Other	1
Abby	A	M	2	Recreational Soccer/Youth Group	0
Lisa	B	M	2	Youth Groups/School PE	0
Mike	C	M	4	Recreational Soccer/Youth Group/ School PE	0
Tiffany	D	M	3	Recreational Soccer/ School PE	0
Evelyn	A	L	2	Recreational Soccer/Youth Group	0
Steve	B	L	0	None	0
Naomi	C	L	2	Recreational Soccer/Youth Group	0
Wade	D	L	3	Club	0

Notes: H = High Skill, M = Moderate Skill, L = Low Skill

The lead author served as the teacher of the TGfU soccer unit. The unit teacher had extensive previous experience implementing the TGfU model in both coaching and teaching settings in both the USA and England, thus, this gave a potential to see the effects of a TGfU unit in its fullest sense. Informed consent was received from participants using standardized procedures after they had been approved by the Institutional Review Board for the protection of human subjects. Permission was also gained from the school principal and resident PE teacher to use the schools PE classes for the study.

The TGfU unit

The TGfU unit consisted of a series of eleven (classes A and C) or thirteen (classes B and D) 'teaching sessions' that employed a game-based approach (TGfU) to instruction(see Table 1). Each teaching session in the TGfU unit comprised of small-sided game (SSG) type practices, some used regular goals; other modified goals and rules (see Table 3 for a breakdown of each teaching session and how these were integrated with assessment sessions). Teaching sessions focused specifically on *off-the-ball skills*, such as playing in a 'diamond formation' or in 'triangles' in order to pass and move quickly, opening spaces when a team possessed the ball, and/or covering players and/or spaces when the opposite team had the ball possession.

Table III
Assessment and Teaching Sessions for Class A

Assessment/Teaching Session Number	Session Content
Familiarization Session 1	Familiarization to Assessment Game
Assessment 1	Baseline Assessments
Teaching 1	Handball Game
Teaching 2	Zones Game
Teaching 3	Types of Defense
Teaching 4	Four Goals Game
Teaching 5	Two Wide Goals Game
Teaching 6	Target Player Game
Assessment 2	Mid Assessments
Teaching 7	Handball Game
Teaching 8	Zones Game
Teaching 9	Two Diagonal Goals Game
Teaching 10	Two vs. One Goal Game
Teaching 11	Tournament
Assessment 3	Final Assessments

The TGfU unit was centered on increasing participants' tactical knowledge *within the game* or the 'what to do' and 'when' and 'how to do it associated with the TGfU model (see Table 3). Practice of isolated techniques were kept to a minimum and used only when the unit teacher felt it was essential in order to help the participants become more aware of certain concepts within game play (Bunker & Thorpe, 1982).

The unit teacher used various techniques to engage the participants, including the principle of exaggerating games (by modifying rules, controlling the size and form of the playing areas, limiting players to certain zones of the field, modulating the number and size of the objectives used etc.), as well as the three pedagogical principles outlined by Launder (2001): a) shaping play, b) focusing play, and c) enhancing play, and, using "questioning" as a form of instruction, "coach as a player" and "freeze replays" (Práxedes, Moreno, Sevil, García-González, & Del Villar, 2016).

The general format for each of the teaching sessions followed closely the one outlined by Metzler (2001):

a) Introduction to 'tactical problem' and 'initial game form': Make suggestions to, and ask participants 'why' they think the tactical problem is important to them being able to successfully play the game;
b) Use of effective communication skills to outline the situation to be practiced and the major tactical problem/decisions that are being focused on;
c) Instruction: Use of effective instructional techniques during game play. Unit teacher thinks about 'when to ask' and 'when to tell'; 'where and when' to introduce skill practice; 'when' to stop the whole group or small groups for instruction; 'how' to modify games such as the 'initial game form' by shaping, focusing or enhancing play (Launder, 2001).
d) Review of lesson content and 'tactical problem' with questions and provide an introduction to the next session.

Although each class, A through D, received similar content (see Table 3), the content was controlled slightly because of the different characteristics of each classroom, class size, facilities available and initial ability levels.

Fidelity of TGfU instruction

To ensure treatment integrity and procedural reliability and control for treatment drift throughout the course of the TGfU unit, as well as ensure that using TGfU in this research was being undertakenwith fidelity(Metzler, 2011), the unit teacher was observed at each session by a minimum of one independent observer at each teaching session using the validation protocol set out by Turner and Martinek (1992, 1999;see Table 4). Results of the training

of observers in using this protocol indicated all observers were able to distinguish between the teachers' use of TGfU teaching and 'traditional' technique-orientated instruction.

Table IV

ESPN Announcer Task

Your task is to watch your assigned peer and, pretending that you are broadcaster/announcer for ESPN. Use your previous experience of playing the game of soccer to commentate on his/her performance in game that you are currently watching. Whilst watching and commentating you will answer the following questions.

Preliminary Questions:

a) Please state your **Name** and **Assigned Jersey/Pinnie number**:

b) Please state the **Class Period** you are in:

c) Please state on the tape the format number of the laminated sheet you have in front of you (this is circled in red in the top right-hand corner of the laminated sheet):

Main Questions:

1) What things does your player do to **help him/her *keep* personal possession** of the ball?

2) Describe how your player tries to stay **involved** in the game?

3) What things does your player do to **communicate** with team mates?

4) What things does your player try and do to **guard players** from the other team?

5) Describe, general how well you think/feel the player you are watching is playing.

6) What things does your player seem to **anticipate** happening?

7) What things does your player do to help **his/her *team* keep possession** of the ball?

8) How does your player **help his/her *team* regain possession** of the ball?

NOTE: Press the STOP button on your SMALL cassette recorder and place it down next to you. Now STOP and REWIND the cassette tape in the LARGE cassette recorder.

If you have any questions, please do not hesitate to ask your teacher.

For 42% of the teaching sessions, two observers validated the use of appropriate TGfU instruction. Inter-Observer Agreement (IOA) levels between these two observers were 100%. In addition, for the other 58% of teaching sessions, one observer validated the TGfU model was being utilized 100% of the time.

Measurement

A VPA technique was used in the current study to assess the impact of the TGfUsoccerunit on students' tactical knowledge development. Participants spoke into mini Radio Shack 33-3013 microphones that were attached to an Olympus Pearlcorder J300 micro cassette recorder whilst they were prompted to answer a series of eight pre-recorded questions. Verbal records were created by placing tape recorders at stations at safe locations around the periphery of the game play areas. Participants sat and watched a player play a 4 vs. 4 small-sided soccer game at baseline, mid, and final assessment points of the study. This task was couched in the format of them acting like an ESPN sports announcer, commenting on the play as it happened. Participants were provided with verbal prompts by listening to a previously constructed structured interview cassette tape with pre-recorded questions (see Table 5). Questions related to both on and off-the-ball aspects of game play (see Table 4). Before conducting each of their three VPA trails, information on the procedures of the task was provided to the, with, with researchers further noting to each of them that they all they had to do was answer the questions they were promoted to answer as accurately as possible. To ensure reliability of the data collection process questions posed to the study participants were the same at each assessment time point. However, the order of the questions was varied at each of the eight data collection points to reduce the risk of the participants answering questions from memory. The lead authoralso listened to each recording after each assessment day to ensure the audio records clarity for subsequent transcription. Ecological validity of the data registration was established due to participants completing this tactical knowledge assessment task during a real in-situ game situation (Marasso et al., 2014; Travassos et al., 2013).

Table V

Teaching Validation Protocol (Turner &Martinek, 1999)

Coder makes judgments based on:	0 = not occurring 1 = if occurring
a) The student spent most of the lesson in games or game-based practices.	
b) The students spent the lesson learning specific skills taught by the teacher before playing the game.	
c) The teacher started the lesson with skill instruction.	
d) The teacher intervened in game play or in game-play situations to discuss strategies to students.	
e) The teacher based his teaching on observations of an initial game or game-related situation (e.g., 3 versus 1, 3 versus 3).	
f) The major emphasis of the lesson was skill teaching.	
g) The major emphasis of the lesson was tactical instruction in games or game like practices.	

Coding should therefore be 1 for items a, d, e and g and 0 for items b, c and f.

Coding system

The interviews were transcribed and later, within the coding process, they were firstly divided into concepts or information units and coded by means of a system of categories into three levels of analysis. The first level of analysis was *conceptual content* where each information unit was assigned to a main conceptual category. The main conceptual categories were the following: goal, condition, action, do, regulatory, affective statements and prediction or probability comments. Goal concepts reflect the purpose of a selected action or the way a game or score was won; condition concepts specify under what circumstances to apply an action or pattern of actions; action concepts refer to the action selected or pattern of actions selected; regulatory concepts specify how an action was conducted; do concepts reflect how to perform an action; affective statement specify emotional responses during game play; and prediction statements reflect predict future actions or patterns of actions within the game context.

The second level of analysis was *conceptual sophistication*, which refers to the quality level of the concepts mentioned in the first level and was only applied to the conceptual concepts of goal, condition, and action. For goals, four hierarchical levels were applied: (a) hierarchical level 0, concepts related to skill and oneself; (b) hierarchical level 1, concepts related to oneself and the team members; (c) hierarchical level 2, concepts related to oneself and opponents; (d) hierarchical level 3, concepts related to win attributes (score or match). The conceptual sophistication for condition and action concepts were classified by quality of sophistication: (a)quality level 0,inappropriate or weak concept; (b)quality level 1, appropriate concept without any details or features; (c)quality level 2, appropriate concept with one detail or feature; (d)quality level 3, appropriate concept with two or more features.

The third level of analysis was *conceptual structure*, which refers to the total number of linkages between concepts of one same sentence related to the number of goals, conditions and actions, classifying phrases into three different levels: (a) single concept (one concept), (b) double-concept linkages (two connected concepts), and (c) triple-concept linkages (three or more linked concepts) (McPherson, 2000; McPherson, &Kernodle, 2007).

Coding reliability

Coding reliability was carried out by the third author, who underwent a period of training from the second author. The third author possessesa PhD in sports science and specific training in coding transcripts from similar projects previously development. The interviews used during the training represented 17.58% of the total data corpus, higher than the 12.5% recommended by Tabachnick and Fidell (2007). To obtain the required coding reliability, three training sessions were held sequentially with the coder and at different moments in time. Reliability between coders (researcher-coder) was obtainedusing Cohen's Kappa coefficient, with values over .81, thus ensuring acceptablereliability (Fleiss, Levin, & Paik, 2003). Temporal reliability was achieved by coding thesame interviews after aten-day periodandthe test-retest reliability valueswere above.80, again demonstrating acceptable levels of reliability(Altman, 1991).

Data analysis

Version 24.0 of the Statistical Packagefor Social Sciences(SPSS; IBM Corporation, 2016) was used for the data analysis. Results of the Shapiro-Wilks test (for studies with less than 50 individuals) revealed not normally distributed data ($p < .05$), that led to non-parametric statistics. The Wilcoxon signed-rank test was applied to contrast the differences between the measurements conducted (pre-mid-post). The statistical significance level for the assessment of differences between time-points was established at an alpha of .05, with a 95% confidence interval. The effect size (ES) was calculated separately for each sub-variable of tactical knowledge, using the formula: $r = Z/\sqrt{N}$ (Rosenthal &DiMatteo, 2001).

Results

A significant increase was found in conceptual content from pre-test to mid-test in total concepts ($p = .032$; ES = .61), total goals ($p = .044$; ES = .58), and total conditions ($p = .007$; ES = .77). Likewise, total prediction significantly increased from mid-test to post-test ($p = .025$; ES = .64). A significant increase was also found from pre-test to post-test in total concepts ($p = .005$; ES = .80), total goals ($p = .045$; ES = .57), total conditions ($p = .032$; ES = .62) and total prediction ($p = .008$; ES = .76) (see Table 6).

In conceptual sophistication, goals hierarchical level 3 (win attributes) significantly increased from pre-test to mid-test ($p = .045$; ES = .49). A significant increase was also found from mid-test to post-test in actions of quality level 2 ($p = .041$; ES = .51). Similarly, a significant increase was found from pre-test to post-test in goals hierarchical level 1 ($p = .014$; ES = .70) and conditions of quality level 3 ($p = .045$; ES = .57) (see Table 6).

In conceptual structure, number linkages ($p = .012$; ES = .72) and triple-concept linkages ($p = .018$; ES = .68) significantly increased from pre-test to mid-test. A significant decrease was found from mid-test to post-test in the variable single-concept linkages ($p = .043$; ES = .54), while double-concept linkages ($p = .011$; ES = .73) significantly increased from mid-test to post-test. Likewise, the variables number linkages ($p = .012$; ES = .78), single-concept linkages ($p = .012$; ES = .72) and triple-concept linkages ($p = .046$; ES = .57) significantly increased from pre-test to post-test (see Table 6).

Table VI
Means, standard deviation and analysis of differences between different measurements

Variables	Pre-test		Middle-test		Re-test		*Dif.*
	M	SD	M	SD	M	SD	
Concept Content							
Total Concepts	16.83	8.67	22.58	7.03	25.00	6.57	**a, c**
Total Goals	3.33	1.55	6.08	4.44	5.58	2.53	**a, c**
Total Conditions	3.33	2.14	5.83	3.92	5.91	3.55	**a, c**
Total Actions	5.83	3.56	5.58	2.50	6.91	3.17	nd
Total do	.66	1.61	.50	1.44	.41	.90	nd
Total Regulatory	4.33	3.28	4.00	2.62	5.33	3.84	nd
Total Affective	.50	.90	.25	.45	.08	.28	nd
Total Prediction	.16	.38	.33	.49	.75	.62	**b, c**
Concept Sophistication							
Goal Hierarchies							
0-Skill-Themselves	2.25	7.79	.08	.28	.00	.00	nd
1-Mate-Themselves	1.50	1.08	3.33	3.65	3.50	1.83	**c**
2-Opponent-Themselves	1.50	1.62	1.75	1.48	1.83	1.74	nd
3-Win attributes	.33	.49	1.05	1.16	.25	.45	**a**
Condition Qualities							
0- Weak / Inappropriate	.08	.28	.00	.00	.00	.00	nd
1- Apropiate without features	.00	.00	.08	.28	.16	.57	nd
2-Apropiate-one features	.50	1.00	.33	.49	.50	1.44	nd
3-Apropiate-two or more features	3.58	2.77	5.41	3.98	5.25	2.26	**c**
Action Qualities							
0- Weak / Inappropriate	.25	.62	.16	.38	.16	.38	nd
1- Apropiate without features	1.50	2.54	1.25	1.48	1.08	.90	nd
2-Apropiate-one features	2.00	1.95	2.16	1.11	3.08	1.97	**b**
3-Apropiate-two or more features	2.41	2.42	1.91	1.16	2.72	1.62	nd
Concept Structure							
Number linkages	11.08	5.68	15.25	7.49	16.91	6.15	**a, c**
Singles	2.00	1.12	1.50	.79	.87	.58	**b, c**
Double-concept linkages	2.75	1.76	1.50	1.31	3.25	1.81	**b**
Triple-concept linkages	1.75	.96	3.41	1.83	3.25	2.13	**a, c**

Dif. = differences; a = differences between pre-test and middle-test; b = differences between middle-test and re-test; c = differences between pre-test and re-test; nd = no differences between any phase or test time.
Note: all differences expressed are $p < .05$.

Discussion

The main purpose of the current study was to examine the effects of a TGfU soccer unit on the tactical knowledge development of middle schoolPE students. We hypothesized that the sixth-grade students who participated in the study would significantly improve their tactical knowledge in terms of content, sophistication, and conceptual structure from pre-to-mid-to-post-test.

By the endof the TGfUsoccerunit, students modified the conceptual content of their tactical knowledge, as significant increases in their scores in all concepts, goals, conditions and predictions were observed. This increase in all concepts allowed students to have a greater capacity to reflect upon on executed actions and its influence on future actions (Evans et al., 2012). Moreover, a significant increase in conditions is important, because this shows that students generated specific advanced conditions to adapt and modify their interpretations of every game action over the course of the TGfU unit. Thus, students displayed a more in-depth tactical approach to the game situations they observed, continuously representing relevant information, which allowed them to explain how the players they observed would choose relevant skills to be executed (i.e. *"if he cannot find one, he passes to his teammates or he just passes it off the wall"*; *"he charges for the ball when he has the chance to"*) (McPherson &Kernodle, 2007). Likewise, these changes demonstrate that the students were more competent in modifyingtheir interpretations of the game actions during each game play episode they observed, updating their action plan profiles (tactical action modelsfaced with explicit conditions) and current event profiles (tactical condition prototypes used to take decisions),

and referring to these profiles with an increasing level of complexity (McPherson, 2008; McPherson &MacMahon, 2008). These changes in conceptual content lead to greater cognitive flexibility and greater capacity for participants to predict possible game events (i.e. *"he knows when passes are going to be made to the other team"*; *"she anticipates that the other teammates is going to go into the direction towards their goals"*) that would help them select an effective response during game play (McPherson &Kernodle, 2007).

In terms of conceptual sophistication, the TGfU unit provoked participants to refer to a significantly greater number of conditions with two or more features. This greater quality in condition concepts allows players a greater capacity to represent the game situations in a more complex way(Afonso et al., 2012a; Gil-Arias et al., 2015). Therefore, participants changed from a superficial processing of the environment (related to lower levels of expertise) towards a deeper level of tactical knowledge processing (McPherson &Kernodle, 2007). The greater sophistication of condition concepts further suggests that the study participants focused more on the most relevant characteristics of the game context during their observations (i.e. *"he watches the person he is guarding and if there is an open pass to him then he goes up on him"*; *"he tries to get open when people are guarding him by faking them out"*). Thus, by updating the action plan profiles, players listed (in a more or less complex and sophisticated manner, depending on the game situation) contextualized, relevant, and very specific meaningful questions about the game situation, leaving out details that had no interest or were irrelevant for performance development (Calmeiro& Tenenbaum, 2011; McPherson, 2000).

Within the conceptual structure, similar changes to those previously identified were achieved, as the number linkages and triple-concept linkages were significantly higher once students has been participating in the TGfU unit (i.e. *"she tackles the ball and tries to get* [Goal hierarchical level 1], *and gets in between the other teams passing lanes* [Action quality level 3] *like she gets between the other teams passing lanes, so that she can steal the ball* [Condition quality level 3]"). These findings indicate a greater interrelationship of different concepts and with a more hierarchically structured organization, which permits participants access to knowledge structures much more quickly (MacMahon& McPherson, 2009). This higher interrelationship of different concepts allowed students to generate more variety of responses and increased the connection of condition-action concepts (McPherson &Kernodle, 2007). Likewise, this greater structuring of knowledge shows how concepts unite to form more complex profiles that are developed in the LTM, which are required to facilitate better decision-making (García-González, Moreno, Moreno, Gil-Arias, & Del Villar, 2013; McPherson, 2008). More specifically, connecting a larger number of different concepts in one same sentence entails a selective, global, and in-depth analysis of the situation, which may additionally generate ahuge variety of specific responses to a specific situation (McPherson &Kernodle, 2007).

Our results also show how the tactical knowledge base of the students who participated in TGfU unit evolved to show characteristics associated with higher levels of expertise, where global approaches to sporting situations turn into tactical approaches with the presence of relevant information; and where the superficial processing of events of the environment is replaced by a deep processing of information (Afonso et al., 2012b; MacMahon& McPherson, 2009; McPherson, 2008). This improvement in tactical knowledge is assumed to be represented by specific structures in LTM (action plan profiles and current event profiles) responsible for encoding, updating, and modifying the condition profiles required to select appropriate responses (McPherson &Kernodle, 2007). The results of this current study suggest that while the development of these adaptations in LTM require several years of experience (McPherson, 2008), formative strategies such as participating in PE lessons taught through the TGfU pedagogical model, can potentially help these adaptations to be developed faster and more effectively. The development of these adaptations in the LTM also explains improvements in other cognitive skills required for successful game play performance (i.e. decision-making). Therefore, the improvements of tactical knowledge achieved through the TGfUsoccerunit applied in this current study will permit the enhancement of decision-making skills because knowledge guides the response selection process (López, Práxedes, & Del Villar, 2017; MacMahon& McPherson, 2009).

We can point toseveral strengths of the current study. First, teacher fidelity to TGfUwas measured and reported. Thus, we can report that contamination effects were not presentin the study results. Second, the utilization of the VPA methodology enabled the study researchers to conduct an in-depth and detailed analysis of the students' development in tactical knowledge, through the collection of information about their thought processes, reflection, and critical thinking about game performance. Third, a pre-test/mid-test/post-test quasi-experimental design was used where we examined changes in tactical knowledge over the course of an 11-13-lesson TGfU unit, in contrast to previous studies where only two measurements were conducted (Gray & Sproule, 2011).

Despite the aforementioned strengths, several limitations and future research directions should be considered. First, the small number of participants limits the capacity to generalize the results. Consequently, future research can extend the current sample by, for example, increasing the number of students who complete the VPA task in each class, and/or by using more PE classes/PE teachers at the same/different schools. Second, researchers did not include a control group to test the differences between groups. Therefore, it is not possible to guarantee that significant changes in tactical knowledge were a sole consequence of the TGfU unit. Third, only one TGfU unit has been developed in the current study. Consequently, it would be valuable to replicate this study and examine the effect on tactical knowledge over a more longitudinal time frame with the application of consecutive TGfU units in different team sports. Finally, future research could capture game performance data to link these data to student tactical knowledge development.

Conclusions

It is significant that PE teacher uses the design features of TGfU to deliver learning tasks that were meaningful and authentic to the reality of the game. The teacher additionally promoted reflection and thinking through open-ended questioning to stimulate the students' capacity for analysis. Within this TGfUsoccerunit, the design of small-sided modified/conditioned games is key because it allows for the simplification of the demands of a sport to favor the identification of more relevant tactical and game stimuli, so students increased their capacity to evaluate the game situation and develop greater tactical reasoning during game play. Thus, students attended tothe key information of the game context, anticipated game events, and accessed and selected the best response from their LTM (McPherson &Kernodle, 2007).

Conflicts of interest: The authors declare that there is no conflict of interest.

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