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Enhancing Students' Metacognitive Knowledge, Metacognitive Regulation and Performance in Physical Education via TGFU

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Abstract This study aimed to examine the effectiveness of the TGfU (Teaching Games for Understanding) tactical-game approach in promoting metacognitive knowledge (declarative knowledge, procedural knowledge, conditional knowledge, information management), metacognitive regulation (planning, monitoring, problem solving strategies, evaluation, imagery) and game- play performance in physical education. An experimental intervention study in basketball was conducted with pre- and post- intervention measures. The participants were forty-one, seventh grade, students who came from two classes of a Senior High School from a rural area of Southern Greece. The classes were randomly labelled as experimental group (8 boys, 12 girls), which was taught basketball by the TGfU, or control group (10 boys, 11 girls), which was taught basketball by the technical skill-based approach. Both participating groups of students were taught ten lessons in respective ten weeks, each of which lasted forty-five minutes. Students' metacognition was assessed pre- and post- intervention using self-report questionnaire, and their basketball game performance was estimated by two experts in both conditions. The main results showed that (a) after the completion of the intervention, the TGfU group of students, compared to technical teaching group of students, reported higher metacognition in perceptual knowledge, information management, conditional knowledge, problem solving strategies and evaluation, and performed better in games, and (b) in the post- vs pre- teaching condition, the technical teaching group only referred to higher using of declarative knowledge, whereas the TGfU teaching group achieved higher performance in games, and it referred to more frequent use of metacognitive knowledge of declarative, perceptual, information management and conditional, and of metacognitive regulation of planning, problem solving strategies and evaluation. Overall, the tactical-game approach of TGfU proved effective in improving both metacognition and performance in physical education classes. The results are discussed for their applications into effective learning and future research.

Keywords: *metacognition, tactical-game approach, physical education*

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1. Introduction

1.1. Metacognition and Teaching Approach

Metacognition was introduced by [1], and it is "thinking about thinking" or "cognition about cognition". Researches, despite their theoretical differences, define two main dimensions of metacognition; metacognitive knowledge and metacognitive regulation which are mainly operationalized into monitoring [metacognitive knowledge and metacognitive experience] and regulatory [goals and activation of strategies] functions [2-12]. Metacognitive knowledge or metacognitive awareness concerns individuals' knowledge of their own cognitive and affective processes, it may vary between tasks, strategies, goals and other relevant to achievement of a pursuit goal information, and it consists of declarative (knowing that), procedural (knowing how) and conditional (when, where, why) knowledge [5,9,12,13,14]. Metacognitive regulation refers to the actual activities that 'help control one's thinking or learning" [[11], p. 354], that is, the implementation of metacognitive knowledge in the process of self-regulated learning [15-20]. It contains the three main components of planning which is about relevant background knowledge, goal setting, time and effort allocation and selecting the appropriate strategy, monitoring which refers to self- testing and assessment skills necessary to control the learning process, and evaluating that involves a student's appraisal of learning processes and learning itself [3,9,16,21,22,23,24].

During the last three decades, research has consistently supported critical contribution of metacognition in

self-regulated learning and successful learning in various domains and across curriculum, including physical education [8,25-35]. Students, who are high in metacognitive knowledge and metacognitive regulatory skills and who use metacognition, usually excel [13,15,31,36-42]. As Price, Collins, Stoszkowski and Pill [2019] point out, across curricular evidence is significant because sport and games operate within distinctly different boundaries to typical classroom subjects, such as math and science. Further, students in games which are open and complex systems, are needed to use all metacognitive components in dynamic contexts where no conditions are ever the same, and the solutions that students-players apply in arisen problems within these open systems could be considered as probabilities but cannot be pre-determined by the teacher or the coach [43,44].

Most past studies have examined metacognition in science learning and problem solving [45,46], while a limited number of studies have focused on the full range of academic domains [31,32]. Precisely, there is still a dearth of investigations examining students' development of metacognition in physical education classes [47,48,49]. Therefore, this study focuses on metacognition in physical education.

Research has indicated that changes in metacognitive abilities come from both development [50,51] and instruction [10,14,52-57]. Furthermore, metacognitively trained students function effectively within school subjects, since they improve their both metacognitive abilities and academic achievement [54,55,58,59,60,61].

Teaching methods that facilitate and sustain students to become active and self-regulative learners seem to be functional to the development of metacognition [10,24,61-66]. In physical education, specifically, a positive influential teaching method of metacognition is "Teaching Games for Understanding" (TGfU) [47,48,67,68,69,70] which was developed by [71], and it is well applied into game categories of invasion, such as basketball, net /wall, such as tennis and squash, striking / fielding, like as baseball and softball, and target, such as golf [72].

In applying TGfU, students become active participants in the learning process and they construct their own learning through answering questions rather than direct delivery of information [73-78]. Student are involved in a game situation where tactics, decision making and problem solving (e.g., when, what and how to apply certain skills, or how to create enough space to shoot the ball) are very important [47,79,80,81,82], resulting in higher order thinking [83]. As [84] mention, the underlying theme of TGfU is to shift the focus of learning games from solely technical instruction to include affective and cognitive aspects within games. Also, TGfU instruction includes the use of developmentally appropriate, modified games to facilitate maximal participation, interaction and understanding [85]. Precisely, the teacher modifies the game by reducing the number of team members, and utilizes questions to stimulate student's' thinking [73]. While variations on the original TGfU approach have been developed, common key is the 'game based approach to stimulate thinking and tactical awareness' [72,75,86,87].

The traditional technique-based approach has been widely used in teaching sports in physical education across various countries, including Greece [76,88,89]. This teaching approach emphasizes the technique or (and) skills of a game, out of the context of the game, through demonstration and imitation. Specifically, first, the teacher introduces basic skills through advanced activities and training, while she/he corrects the students whenever they execute the technical skills incorrectly, and, then, the students play in small games [90,91]. Further, according to Forrest et al. [2006], this teaching approach supports that once the basic skills are mastered, students will be able to play the game in a meaningful way. However, although students master the basic skills and techniques of a game well, they are not effectively engaged in the game, as previous studies have shown [92,93,94]. This is because they do not know when and what skill should be applied during the game and what to do when they do not possess the ball [95]. Furthermore, technical method of teaching does not emphasize or ignore [96] the reasoning aspect of games which involves decision making and problem solving [97]. As Salimin, Noruzzaman, Shahril, Taff et al. (2018) point out, teachers should implement teaching methods that are more mind-challenging so that students are able to apply strategy planning, tactics, and decisions making, such as the delivering direction, best movement to earn points, and the best position to receive the ball, can help players perform effectively in games.

TGfU and technical models are two different approaches, and they are used in achieving teaching objectives for games in psychical education. Certainly, skills can help students understanding a game comprehensively, but students need to formulate and apply of their own ideas through reasoning to solve game problems [98,99]. Of significant importance of learning within TGfU is the notion of 'getting the game right' so that students 'think more about, and within, the game' [[100], p. 7]. This, then, can enhance psychomotor, cognitive, affective and social skills relevant to game play [101]. In addition, TGfU facilitates metacognition, as instruction is embedded into an authentic learning context of the game, and presented concurrently with course content [20,102] or, in other words 'metacognitive game skills occur during game play itself' [43].

Despite the limited empirical research on the association of TGFU with metacognition, it evident the effectiveness of the tactical-game approach, compared to technical approach, in improving performance, knowledge and metacognitive- related factors. For example, it has been reported enhancement of declarative knowledge and decision making related to performance in field hockey [103], tennis [104], volleyball [105] and soccer [106]. Also, studies evident development in enjoyment and game-understanding in team games, such as field hockey and basketball [107,108,109,110]. Similarly, Harvey, Wegis, Beets, Bryan, Massa-Gonzalez, and van der Mars (2009) found that implementing the TGfU model in handball unit for grade six students yielded "significant changes in student perception of learning and effort regardless of skill level…" (p. 111), indicating that the TGfU enable students to feel like they are learning and participating more than was typical in their PE classes. Yet, there was performance enhancement in invasion games regarding "off-the-ball" movement [93,111]. Further, Chatzipanteli, Digelidis, Karatzoglidis and Dean

(2014) revealed the critical contribution of TGFU into promoting metacognitive behavior in volleyball among primary school students, and, in a similar study, in 2015, they showed the positive effect of TGFU on students' metacognitive behavior in basketball. Similar were the findings in [112]'s study, evidencing the promoting of metacognitive activity in eleven year- old students in basketaball. Also, Jamon and Lusung-Oyzon (2019), although quantitative data showed no difference between the metacognition of students exposed to the TGFU and to the skills- based approach, performing qualitative data analysis, suggest that the three grade students taught with the TGFU improved in all the metacognition phases and the level of their discussion of concepts and game strategies had moved beyond surface understanding.

Other researches, however, comparing the effects of tactical approach vs technical approach on learning and performance, do not support the superiority of the first compared to the latter. For example, in hockey and volleyball, both teaching approaches proved positive contributors into development of motor and cognitive skills, with no differences in metacognition [113]. Also, there was no difference between the two teaching approaches in declarative and procedural knowledge in field hockey [114] and badminton [115], although the TGfU group acquired a better understanding of game tactics and strategies.

It could be argued that past studies are favoring for TGFU than technical teaching approach, despite some mixed findings. The mixed findings could be understood due to the fact that studies varied considerably in many factors, such as the game chosen, the length and nature of the intervention, the variables examined, and the ways in which these variables were measured [48,101,116,117]. Kirk and MacPhail (2000), additively, argue that a such difficulty 'may be located in the traditional dualistic divide in physical education between cognition and physical performance, and in the constructs used to theorize this relationship' (p. 181). TGfU, specifically, aims to balance this disproportionate emphasis as it develops students' thinking [87].

As it is evident, a very limited number of researches have focus on the role of TGfU in metacognition in invasion games in physical education. Taking into consideration that the participants in the studies utilizing TGFU were tertiary students or elementary and middle graders, it could be interesting to examine if such an approach affects students' metacognition in the transaction from elementary to junior high school.

1.2. Aim and Hypotheses of the Study

This study mainly aimed at examining the effectiveness of the TGfU (Teaching Games for Understanding) tactical-game approach in enhancing students' metacognitive knowledge (declarative knowledge, procedural knowledge, conditional knowledge, information management) metacognitive regulation (planning, monitoring, problem solving strategies, evaluation, imagery) in basketball in physical education classes. This study also examined the role of TGfU in game-play performance in the same classes.

The Hypotheses of the study are the following.

The students, who taught basketball unit with the TGfU, compared to students, who taught basketball with the traditional technique-based approach, will report greater metacognitive knowledge and metacognitive regulation across all the components (Hypothesis 1a). In the experimental group of students, all the components of both metacognitive knowledge and metacognitive regulation will be higher in the post- than in the pre-intervention condition (Hypothesis 1b), while no specific hypothesis is applied into control group of students (Hypothesis 1c).

There will be difference in effects of TGfU and the technical approach on game performance. Specifically, the students taught by the TGfU will show better game performance in basketball than students taught by the technical approach (Hypothesis 2a). The learners taught by TGfU will be able to play basketball better after the completion of the intervention than before of it (Hypothesis 2b), while no specific hypothesis is applied into students taught basketball with the technique-based approach (Hypothesis 2c).

2. Method

2.1. Participants

The sample consisted of forty-one, seventh grade, students who came from two classes of one Senior High School from a rural area of Southern Greece. The one class from the school was the experimental group (8 boys, 12 girls) which was taught basketball by TGfU, while the other class was treated as the control group (10 boys, 11 girls) which was taught basketball by a technical approach. The classes were randomly labelled as control or experimental group, since there was not any difference between them in physical education performance. In addition, none of the students had formal exposure to basketball and none of them was a member of any professional athletic basketball club. Consequently, the participants were novices.

2.2. Measurements

Metacognition. Metacognition was examined via the 'Metacognitive Process in Physical Education Questionnaire' (MPIPEQ) which, based on [3] conceptualization, was developed by [33]. The questionnaire includes 52 items that are categorized into four subscales of metacognitive knowledge: Declarative knowledge (e.g., I understand which exercises I can perform properly), procedural knowledge (e.g., I have a clear view of how to put in practice a learning method that I have been taught), conditional knowledge (e.g., when I want to grow better in a game, I put into practice a learning strategy") and information management (e.g., I think if the game I play is similar to others), and into five subscales of metacognitive regulation: Planning (e.g., I know exactly what I want to learn), monitoring (e.g., The moment I perform an exercise, I check if I actually learn it right), problem solving strategies (e.g., When I am confused I stop to see again the whole thing from the beginning), evaluation (e.g., Since I have learned an

exercise I compare the way I learned it with other ways) and imagery (e.g., Before I perform an exercise I imagine myself to perform it). Responses ranged from 1= strongly disagree to 5 = strongly agree.

This questionnaire is a reliable and valid measure in assessing metacognition in physical education and sports (see 19;56). In this study, Cronbach alpha value was acceptable in each of the subscales as follow: Declarative knowledge = .69, conditional knowledge= .63 procedural knowledge= .69, information management= .63, planning= .71, self-monitoring= .68, problem solving strategies= .68, evaluation= .61 and imaginery= .74.

Game performance. Game performance was estimated 5-5 basketball by coding players' behavior in both conditions before after the intervention. The 5- point scoring system of Game Performance Assessment Instrument (Mitchell - Oslin, 1999) was used to assess that performance. More accurately, each student's game performance was evaluated by two trained physical education teachers as a very week=1, week = 2, average= 3, good= 4 or very good= 5, based on the components/criteria (a) skill execution: pass / shoot / dribble options in game of expertise, (b) support: the player tries to be in a position to receive a pass from a teammate, (c) decision-making: the participant makes appropriate choices among pass or shoot or dribble options and (d) marking: the player marks an opponent player when opposing team has possession.

Demographical and personal factors. A short set of questions were about the participants' personal and demographical factors, such as gender, age and past experience in basketball.

2.3. Construction of the Intervention Program, and the Content of the Motor-skills Acquisition

The intervention program was based on [75]'s framework, since it has proved useful in examining the effectiveness of TGfU in game learning and performance. For example, Gutiérrez, Fisette, García-López and Contreras (2014) used such lesson plans in handball, [90] applied it in football, [98] in their research on knowledge transfer to football handball and hockey. Especially in basketball, such lesson plans have been used in previous studies [47,93,112] and they proved effective in basketball game learning.

Due to students' certain basketball level, the first ten lessons of [75]'s framework were applied. Various tactics within the game, such as 'finding space', 'creating space to attack', 'defending space and playing with width' and "making two consecutive passes and bringing the ball back to the target player", were the focus of each lesson. More accurately, the first six lessons focused on tactical attack, the next three lessons concerned the tactical defense and the tenth referred again to the tactical attack.

Each lesson, in accordance to the TGfU model, included the six stages in TGfU: Game, Game Appreciation, Tactical Awareness, Making Appropriate Decisions, Skill Execution and Performance. The lesson begun with a modified game (e.g., game 2 vs 2 or 3 vs 3), in order to establish the framework within which the tactical problems will be addressed. The last modified game of teach lesson was almost identical to the first one or a little more complex. In the tactical awareness session as well as at appropriate points, after the teacher stopped the game, students were asked questions relevant to the purpose of the game and the appropriate skill for each phase. Thus, the learners had the opportunity to monitor, evaluate and reflect on their ideas, and to discover and decide what to do in various situations in the game.

In the first lesson, the aim was to teach students to maintain possession and keeping the ball by making quick and accurate passes, receiving the ball correctly and learning the options available in the triple threat, that is, shots, passes and throws.

In the second lesson, students learnt to attack via doing quick passes and pretenses, and shooting as often as possible. All the players in the game tried to shoot.

In the third lesson, the participants were asked to maintain possession of the ball and create corridors so that the teammate with the ball has options. The students were also required to make at least three passes and then shoot immediately.

The fourth lesson focused on creating space and corridors to attack, by using L or V to clear the defender.

The fifth lesson aimed to help the student to estimate whether or not there is an open corridor to penetrate towards the basket. All shoots, almost, were required after penetration.

In the sixth lesson, the use of the dribble becomes more intense, making the student understand that she/he must place her/his body between the ball and the opponent. They were told that if there is an opportunity for shooting or passing the ball, to do so. Dribble was only used when a student could neither shoot nor pass.

In the seventh lesson, the defensive tactic begun. It focused on the players' defensive positions either mark the opponent who holds the ball or mark other players of the offensive team. The defenders' goal was to get the ball and attack again.

In the eighth lesson, the defense got tougher. The defenders' goal was to prevent the attacking team of passing the ball and scoring. To do so, the defenders applied a stifling tough mark. In the modified game, if the team prevents the opponents to make three passes it gets one point, while if the team steals it without foul it gets two points.

The ninth lesson focused on how to defend after a shot. Students were required to block out (that is, put their body in front of the opponent in relation to the ball and the basket, in order to have the advantage of getting the ball in the case of unsuccessful shot), in order to get the rebound and attack again.

In tenth lesson, the offensive tactic was again taught. The goal was to attack towards the basket by applying the "give and go" movement which allows the offensive player to unravel and get the ball for a shot.

In the control group of students, in consistency with the Physical Education school Curriculum, the ten lessons aimed at motor-skills acquisition. Specifically, four lessons focused on passing and catching (basic positions - movements, type of pass, pass in movement), two lessons were about dribbling (dribble, stops-pivot, dribble - stop -pass), three lessons focused on shooting (shoot, layup shoot, jump shoot) and the last lesson combined the above skills in a game 5 vs 5. Each lesson consisted of an introductory activity, a skill practice section and a 10-minute game.

2.4. Procedure and Research Design

Prior to addressing of the scales, permission was sought, and granted, from the administration of the participating school and the Physical education teacher. Additionally, a letter of invitation containing information about the study and an informed consent form was sent to the students' parents. None of the parents denied her/his child participation in the investigation. Following this, participating classes were informed about the aim of the study, the voluntary nature and the procedure. All of the above were assured of anonymity and confidentiality.

The students responded to personal /demographical scale before the start of the intervention program, while they filled in the metacognition scale pre- and post-intervention. The scales were completed during regular school hours in front of one of the researchers.

The participants' basketball game performance was assessed by two experts before and after the completion of the program.

The two participating classes of students were randomly assigned as control group and experimental group. The experimental group was taught a basketball unit with the TGfU, while the control group was taught the same unit with the technical teaching method. Both participating groups of students were taught ten lessons in respective ten weeks, each of which lasted forty-five minutes, by the same physical education teacher who was expert in TGfU and had long teaching experience.

3. Results

3.1. The Role of Teaching Approach (Technical vs TGfU) in Metacognition

In order to examine whether the experimental group differs from the control group in metacognition due to the type of teaching approach (technical vs TGfU) and whether metacognition differs between pre- and post-teaching experience, two separate Manovas for metacognitive knowledge and metacognitive regulation were performed with the components of metacognition as depend variables and the type of teaching (technical vs TGfU) and the teaching experience (pre- and- post condition) as independent variables.

The results regarding metacognitive knowledge showed significant effects of teaching approach, $F = 4.87$, $p < .05$, $n^2 = .059$, teaching experience, $F = 18.46$, $p = < .01$, $n^2 = .19$, and interaction of teaching experience with teaching approach, $F = 4.00$, $p< .05$, $n^2 = .48$. The findings with respect to metacognitive regulation revealed significant effects of teaching approach, $F = 7.90$, $p < .01$, $n^2 = 0.92$, and teaching experience, $F = 4.82$, $p < .05$, $n^2 = .058$, while the interaction of teaching approach with teaching experience had no significant effect on it, $F = 2.50$, $p > .05$.

To clarify the above findings, one-way ANOVAs, one for each of the components of metacognition in both pre- and post- teaching condition, with teaching approach as between-subjects factor, and repeated measures Anovas, one for each of the components of metacognition, with the pre- and post- teaching condition as within-subjects factor, were performed.

The observed descriptive statistics and results from the one-way Anovas on Table 1 indicate that, in the post- teaching condition, the TGfU group of students, in comparison to technical teaching group of students, reported significantly higher perceptual knowledge, information management, conditional knowledge, problem solving strategies and evaluation, while there were no significant differences between the two groups of students in the rest of the components of metacognition. As for the pre-teaching condition, there was no significant difference between the TGfU group and the technical teaching group across the components of metacognition.

Table 1 Descriptive statistics and results from Anovas for the differences between the experimental group of students taught by the TGfU teaching approach and the control group of students taught by the technical-teaching approach in the components of metacognition in both pre- and post- teaching conditions

	Pre- teaching						Post- teaching					
	Control group		Experimental group				Control group		Experimental group			
Components metacognition	Mean	SD	Mean	SD	F	n^2	Mean	SD	Mean	SD	F	n^2
Metacognitive knowledge												
Declarative	3.86	.72	4.00	.64	.44	.01	4.52	.81	4.70	.47	.40	.01
Procedural	3.81	.92	3.65	.83	.34	.008	3.71	.90	4.10	.44	3.95	.08
Conditional	3.38	.86	3.60	.86	1.39	.03	3.38	.97	4.60	.50	25.00	.40
Information management	2.19	.92	2.35	1.08	.25	.00	2.52	1.25	3.40	1.27	4.95	.11
Metacognitive regulation												
Planning	3.95	1.02	3.95	.68	.00	.00	3.90	1.22	4.35	.81	1.87	.04
Monitoring	3.52	1.16	3.65	.72	1.44	.03	3.81	.87	3.95	.71	1.34	.00
Problem sol-ving strategies	3.57	1.20	3.60	1.23	.00	.00	3.38	1.35	4.35	.74	7.90	.16
Evaluation	2.29	1.14	2.55	.94	.64	.01	2.67	1.23	3.65	1.13	7.00	.15
Imagery	3.24	1.57	3.10	1.11	.01	.00	3.67	1.46	3.85	1.34	.17	.00

Note: $F \geq 7.00$, $p < .01$, $F \leq 1.87$, $p > .05$, $F < 7.00$, $p < .05$.

In addition, the results from the repeated measures ANOVAs (Table 2) and the presented descriptive statistic on Table 1 show significant effect of teaching experience. Specifically, the participants in the group that was taught with the TGfU approach reported more frequent use of metacognitive knowledge: declarative, perceptual, information management and conditional, and metacognitive regulation: planning, problem solving strategies and evaluation in the post-teaching condition than in the pre- teaching condition. In contrast, the participants in the technical teaching group, only referred to higher using of declarative knowledge in the post- vs pre- teaching experience condition.

The above findings totally and partly confirm Hypothesis 1a regarding metacognitive knowledge and metacognitive regulation respectively. These findings also in the most confirmed Hypotheses 1b and 1c.

Table 2. Results from repeated measures ANOVAs for the differences between the pre- and the post- teaching experience in the components of metacognition within the experimental group of students taught by the TGfU and the control group of students taught by the technical-teaching approach

	Control group		Experimental group	
Components of metacognition	F	n^2	F	n^2
Metacognitive knowledge				
Declarative	10.00	.16	13.10	.28
Procedural	.11	.00	3.67	.11
Conditional	.00	.00	15.54	.29
Information management	1.43	.01	10.25	.17
Metacognitive regulation				
Planning	.02	.00	2.45	.06
Monitoring	.83	.00	.48	.00
Problem solving strategies	.29	.00	6.33	.12
Evaluation	1.56	.00	38.90	.22
Imagery	1.70	.02	5.37	.09

Note: $F \geq 6.32$, $p < .01$, $F \leq 1.70$, $p > .05$, $F < 6.33$, $p < .05$.

3.2. The Role of Teaching Approach (Technical vs TGfU) in Game Performance

The results from repeated measures Manova with the game performance in pre- and post- intervention as within-subjects factor and teaching approach as between-subjects factor revealed a significant interaction of teaching experience and teaching approach, $F(1, 39)= 8.00$, $p < .01$, $n^2= .10$, a main effect of teaching experience $F(1, 40)= 25.72$, $p < .01$, $n^2= .20$, and a significant effect of teaching approach, $F(1, 40)= 7.00$, $p < .01$, $n^2= .16$. The mean scores and post hoc pairwise comparisons indicated that TGfU was significantly more effective compared with technique teaching among learners in basketball in 5-v-5 game play. Specifically, the experimental group of students that was taught with the TGfU approach (Mean= 3.55, SD= .65), compared with the group taught the traditional technique-based approach (Mean=2.70, SD= .72), achieved higher performance in the post-intervention game play, $F(1, 40)= 6.50$, $n^2= .13$, while the former group (Mean= 2.20, SD= .45) did not differ from the latter (Mean = 2.28, SD= .38) in the pre- intervention game play, $F(1, 40)= .30$, $n^2= .00$. Also, while both groups of students enhanced basketball game performance, it was found statistical significance only in the experimental group, $F= 18.10$, $p < 0.01$, $n^2= .32$.

Hypotheses 2a, 2b and 2c were confirmed by the above findings.

4. Discussion

This research examined the role of the TGfU approach in promoting metacognitive knowledge (declarative knowledge, procedural knowledge, conditional knowledge, information management), metacognitive regulation (planning, monitoring, problem-solving strategies, imagery and evaluation) and game performance through the implementation of intervention program in basketball, in physical education classes.

The findings were in the most as expected, thus confirming previous research that has supported the positive role of the TGfU approach in metacognition and game performance.

Specifically, in line with studies in team games, such as basketball [47], volleyball [68,105] and field hockey [103], in the post- teaching experience condition, higher declarative knowledge [what to do], procedural knowledge [how to do it] and conditional knowledge [when to use a strategy and why it should be used] and information management [effective use of the information] were reported for the students who experienced the TGfU approach than for the students who experienced the technical teaching approach. Also, in consistency with empirical evidence, highlighting the crucial role of TGFU in increasing declarative and procedural knowledge [111,118,119], but, in contrast to some other researches, reporting none positive effect of tactical approach on procedural [114] or declarative knowledge [78], the students from the experimental group improved their metacognitive knowledge across all the components, whereas in the control group of students only the declarative knowledge enhanced. These findings suggest that, in the group of TGfU approach, the learners, via the tactical problems which hold in the modified games and via answering questions regarding offense or defense or the goals of the game, acquired global view of the task, became energetically involved in monitoring and evaluating the alternative movements, and, consequently, improved knowledge of how to react, how to create and or cover open space, how to pass the ball effectively, and determine where other players were positioned. On the other hand, the improvement of declarative knowledge in the control group of students could be partly explained by the fact that in sport games it is concerned to the rules of the game and is developed early in the learning process [43,48], and by the novice level of the participant. This finding is also partly in agreement with [117]'s suggestion that TGfU and technique-based approaches should be seen as alternative forms of practice, and [71] claimant that teaching for understanding must also include technique development.

The TGfU approach proved also beneficiary for metacognitive regulation. More precisely, confirming our hypotheses and other findings [67], in the post- teaching experience condition, students who were taught basketball with the TGfU, compared to students who were taught the

same unit with the skills- based approach, reported higher in using appropriate strategies to solve tactical problems within a game, and in evaluating the way they learn. Also, complimenting existence literature [93,120,121], in the experimental group, the students in the post- than in the pre- teaching condition referred to more frequent use of appropriate strategies of solving problems, planning the movements in a game, visualizing how to perform a move, and evaluating the actions in a game play. Probably the TGfU method, through the tactical problems which are posed in the modified games as well as the questions that the teacher and students ask, enabled students to think about what to do, how to plan an action, what strategy to follow and how to achieve the pursuit goal. Additionally, as in TGfU questioning and discussion are the main focus, and, as it is a game-centered method [122,123,124], the students, perhaps, had their own ideas and solutions to tactical problem, made plan and took decisions how to solve the arrive problem, reflected on their own actions, and imagery the next movement within the game. The broad knowledge of the participant physical education teacher may be an additive explanatory factor to the predominant enhancement of problem solving strategies, as compared to the other components of metacognitive regulation, since, as Kandel (2002) supports, teachers with rich subject matter knowledge tend to emphasize conceptual, problem solving and inquiry aspects of the task teaching. This argument is relevant to [91]'s notice that deep understanding of games both within and across categories is essential for teachers' development.

Unexpectedly, monitoring remained unchanged among students in both groups, and the intervention did not result in comprehension monitoring. This specific finding might suggest that students are needed more active individualized reflection to promote monitoring their actions and the ways to learn something properly. It could be also argued that this result underlines the high complexity of this certain component of metacognitive, since the students/ players, in order to control their own movements in a game, consciously get involved into when and why to combine knowledge of playing the game (e.g., the strategic-tactical-skill-technical elements of the game, score line, time remaining, rules) with knowledge of the opponent and/or team mates (e.g., players' strengths, weaknesses, behaviors and characteristics), in order to have an impact [43,44].

As expected, the findings, complimenting previous researches [47,93,120], revealed enhancement of basketball game performance in favoring the TGfU. More accurately, the students who were taught basketball with the TGfU performed better in basketball game than the students who were taught with the technical- based approach. In addition, in the experimental group, the students achieved higher game performance in the post- than in the pre- teaching experience condition, while this was not the case in the control group of students. It could be argued that the TGfU approach, students through the tactical problems which were posed in the modified games and the questions that the teacher asked enabled them to achieve the pursuit goal, since under such conditions students report higher in monitoring ways to learn properly [93,99,101], in problem solving [74,80,81], in learning transfer across situations -games- [125,126,127], and in evaluating the way they learn. These findings also support [128] who suggested that playing games is about solving tactical problems; skills are used to overcome these problems. TGfU is a pedagogical approach where the 'why' is first taught and then the 'how' to play game with the use of tactical problems and solutions [129]. In addition, the novice level of the participants might be a contributor factor into lack of the improvement of game performance in the control group of students, since skill practice is advocated but only when the learner is motivated to learn based on game play and then within a game-like practice [123]. Further, as past researches point out investigation needs on how learning occurs within the combined processes [75,116], and on the moderator factors, such as skill level and past knowledge, that might affect the learning process.

Limitations, and Implications of the Findings for Education practice and Future research

The narrow number of the participants and the self-reported measures of metacognition are limitations in this study. In addition, the findings were associated with the students' novice level. Therefore, for more generalizable findings, a larger and more diverse sample should be studied as well as objective measures of metacognition should be included. Also, this research solely examined the differences in students' performance and metacognition after receiving basketball tuition within the tactical game approach, as opposed to a tactical game approach. Future research needs to examine the effect of the combination of the two teaching approaches in student learning, and whether there is transfer of metacognition from this specific task to other tasks in physical education.

Despite the above limitations, this study contributes to and expands the extant literature by underlying the way by which TGfU affects learning in physical education, and it may help inform physical educators in their practice. The findings suggest that active individualized reflection is beneficial to metacognition. Further, TGfU helps students to construct metacognitive knowledge, metacognitive regulation and skills, increasing their ability to recognize game play actions and make more appropriate choices during game play. TGfU allows not only for progressive development of metacognition but also for enhancing learning motivation based on game play. Both components are essential to self-regulatory learning which is a key element for school success. Overall, the findings from this study indicate the importance of examining TGfU approach in teaching in physical education.

Conflict of Interest

All the authors declare no conflict of interest.

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