An Investigation of Pupil's Levels of MVPA and VPA During Physical Education Units Focused on Direct Instruction and Tactical Games Models

Abstract

This study investigated the moderate-to-vigorous physical activity (MVPA) and vigorous physical activity (VPA) levels of pupils during co-educational physical education units focused on direct instruction and tactical games models (TGM). 32 children (11-12 years; 17 girls) were randomly assigned to either a direct instruction (control) or TGM (intervention) group. Children wore RT3® triaxial accelerometers over six physical education lessons focused on field hockey to objectively measure time spent in MVPA and VPA. The System for Observing Fitness Instruction Time (SOFIT) was also used during each lesson to examine pupil physical activity, lesson context and teacher behaviors. Results from accelerometry showed that both MVPA and VPA were significantly higher in the TGM class when compared to the class taught using direct instruction. SOFIT lesson context data showed that the TGM teacher spent less time managing and more time in both skill practice and game play. The results of this study suggest that a shift in games pedagogy to TGM, where the central aspect is participation in modified/conditioned games is more likely to provide pupils the opportunity to achieve current physical activity guidelines stipulated by the Department of Health (2011) and the Institute of Medicine (2013).

Keywords: Tactical Games Model, direct instruction, vigorous physical activity, accelerometers, SOFIT, physical education

Introduction

In physical education programs there is a current over-reliance on a direct instruction model (Metzler, 2011) where constituent parts of sports and games are broken down and techniques are practiced in isolated, decontextualized conditions where practice is unlikely to generalize to actual game conditions (Roberts & Fairclough, 2011). This approach has been criticized on a number of levels, which include; a lack of opportunity for learner empowerment and creativity (Butler & McCahan, 2005), and its non-situated nature that fails to appropriately prepare learners for the complexities of games (Kirk & MacDonald, 1998). Further criticisms lie in the role the teacher adopts within this approach, as they are the primary decision maker (Light, 2013).

As a way of expanding the focus of physical education and its goals and purposes beyond a skills first direct instruction model, Metzler (2011) proposed seven alternative pedagogical models that included the Tactical Games Model (TGM). The TGM is an Americanized derivative of Teaching Games for Understanding (TGfU; Bunker & Thorpe, 1982). Game-centered approaches (GCAs) such as TGfU and TGM begin the lesson by locating learning within modified games or game-like activities and present the game first and introduce skill practice second and when needed. GCAs such as TGM therefore refute the notion that quality game play cannot emerge until the core techniques are mastered a priori (Oslin & Mitchell, 2006), instead, offering a way of linking techniques and tactics with the aim of promoting skillful and intelligent performance. These situated learning contexts further enable the teacher to step back, observe and, critically, 'emphasize questioning to stimulate thinking and interaction' (Light & Mooney, 2014, p. 2) so as to guide the pupils about the various ways of overcoming the tactical problem set by the game, and understand why certain skills are needed to elevate game performance.

Previous studies have suggested that given the focus of GCAs such as TGM on locating learning within small-sided and conditioned/modified games (Light & Mooney, 2014), this model of teaching physical education may aid pupils in reaching current physical activity (PA) goals within physical education lessons (McKenzie, 2012; Roberts & Fairclough, 2011; Van Acker, Carreiro Da Costa, De Bourdeaudhuij, Cardon, & Haerens, 2010). Current goals outlined by the Institute of Medicine (IOM, 2013) in the United States suggest that pupils should engage in moderate-to-vigorous physical activity (MVPA) for at least 50% of the physical education lesson, a figure that is not regularly met in most lessons, especially when games are not used as the organizing center for learning (Yelling, Penney, & Swaine et al., 2000). For example, Roberts and Fairclough (2011) found that English physical education lessons centered on the direct instruction model resulted in high levels of pupil inactivity. In addition, these authors noted high levels of teacher management time, time centered on skill and drill practice, and a focus on full-sided versions of games (i.e. 11 vs. 11 soccer) where some pupils were left to 'sit out' on the sidelines. Roberts and Fairclough suggested that involvement in small-sided modified/conditioned games, a staple feature of GCAs such as the TGM (Mitchell, Oslin, & Griffin, 2006), could potentially increase pupils' levels of PA.

Of particular significance in this current study is that current physical activity guidelines for children in countries such as the United Kingdom (UK) have been recently updated to emphasize the importance of including vigorous physical activity (VPA) on at least 3 days a week, in the context of a daily 60 minutes MVPA target (Department of Health, 2011). An additional accumulation of higher intensity physical activity (VPA and above) components during physical education is highly significant given that VPA (or higher) is a stronger predictor of cardiorespiratory fitness, (Aires, Silva, Silva, Santos, Ribeiro, & Mota, 2010; Dencker, Thorsson, Karlsson, Linden, Wollmer, & Andersen, 2008; Gutin, Yin, Humphries, & Batbeau, 2005) body fatness (Abbott & Davies, 2004; Parikh & Stratton, 2011;

Ruiz, Rizzo, Hurtig-Wennlof, Ortega, Wanberg, & Sjostrom, 2006) and vascular function (Hopkins et al., 2009) in children compared to moderate intensity physical activity.

What This Study Adds

Given the growing concerns regarding low PA levels amongst children (Trost et al., 2002) more research is required into whether GCAs such as TGM, if taught appropriately, can realize the potential of aiding pupils in reaching current PA goals within physical education (IOM, 2013; Van Acker et al., 2010; Yelling et al., 2000), especially when compared to the direct instruction model. In addition, there is scope to examine how lessons taught using TGM affect levels of VPA. It was the purpose of the study to investigate the MVPA and VPA levels of pupils during physical education units focused on direct instruction and TGM. It was hypothesized that pupils would gain greater levels of both MVPA and VPA during the TGM unit when compared to direct instruction.

Methods

Participants and Setting

This study was conducted in one co-educational state middle school in the East of England. A total of 32 students from two classes in the year seven age group (aged 11-12yrs) participated in the study (n = 17 girls). Free school meal (FSM) eligibility was stated as 21.5% for the school, which is above the national average of 12.1 % (Department for Education and Skills, 2005). In total, 543 students were enrolled at the school with 78.6% of students ethnicity stated as White British. All research procedures received approval from the University Research Committee, head teachers and physical education teachers from the schools who were involved in the study. Informed consent was obtained from parents/guardians as well as pupil assent using approved University and school system protocols.

Research Design

The aim of this study was to investigate the MVPA and VPA levels of pupils during physical education units focused on direct instruction and TGM, using a quasi-experimental pretest-posttest design. Harvey and Jarrett (2014) noted that 10 of the 44 GCA studies published since 2006 utilized this same quasi-experimental comparative approach demonstrating that it is a popular research design in this specific area of research (e.g. Gray & Sproule, 2011).

Two co-educational classes from the school participated in the study; each class was randomly selected to be taught using the TGM intervention (n = 16; 8 girls) and one acting as a control class that were taught through the direct instruction model (n = 16; 9 girls). One male and one female teacher taught the control and intervention classes, respectively. Different teachers taught the control and TGM classes to avoid contamination of the data (i.e. aspects of the TGM intervention filtering into the control sessions). A total of twelve field hockey lessons were observed over a 3-week period (6 control, 6 intervention).

Prior to data collection, a meeting was held with the teachers selected to plan lessons using either the Mitchell, Oslin, and Griffin's (2006) TGM and/or the direct instructional model, as well as to overview model benchmarks (Metzler, 2011). The TGM teacher had experience of TGM as they had previously attended a University based training course focused on TGM. The control group teacher was familiar with the direct instruction model and reported at this meeting that the direct instruction model mirrored their current approach to teaching games. Teachers were not aware, however, of the specific aims of the study. Additional descriptions of the direct instruction and TGM model sessions are provided in the next section.

Intervention

The weekly control and TGM sessions ran in parallel at the school. Teachers adapted their lesson objectives and delivery according to whether the session used the TGM or the direct instruction model. For the direct instruction model, teachers followed a 'traditional' lesson structure outlined by Blomqvist, Luhthaten, and Laakso (2001) where an introductory activity was followed by a skills phase focusing on developing and improving skill technique and this was then progressed into a game in the latter part of the lesson. For example, in the hockey lesson (attacking play and maintain possession) the teacher sent the pupils on a warm-up. They were then split into pairs and asked to make two lines. The task was to pass the hockey ball back and forth in pairs across the width of the hockey field in their pairs, finishing the drill with a shot on goal. A defender was then added to increase the difficulty of the attacking play and maintaining possession to develop this drill further. After a brief discussion about the drill, the teacher then placed the pupils in a game situation (11 vs. 11). The units of work were organized in such a way that the teacher centered learning in each lesson on one major technique/skill with a subsequent game situation.

The TGM teacher followed a three-part lesson recommended by Mitchell et al. (2006) which focused on an introductory modified (representative and exaggerated) game, followed by a skills phase before returning to the initial modified game form. For example, in the third hockey session, the lesson focused on 'attacking play and maintaining possession of the ball'. The teacher sent the pupils on a warm-up and provided some general knowledge about attacking play. The teacher then set up a 3 vs. 3 game with the condition that there was no tackling and if the team missed a shot that possession would go to the opposing team. Pupils were then taken out of the game and a 'dodging' practice was then set up to enhance the skill of getting away from your marker. Before, during and after the 'dodging' practice, the teacher asked guided questions in line with guidelines outlined by Mitchell et al. (2006) to aid learning, e.g., 'How were you able to get closer to the goal?' 'What dodges can you use to get away from your marker?' 'What should other players on your team do when their teammate

has the ball?'. The final part of the lesson involved the same conditioned game, this time, with the additional condition that each team could shoot from anywhere within the attacking half of the pitch.

Fidelity of Intervention

The TGM and control lessons were assessed using benchmarks to ensure that both approaches were implemented correctly and were not detrimental to learning outcomes (Metzler, 2011). A researcher and assistant were present at each physical education lesson (control and TGM) to assess the teachers fidelity to model benchmarks. Lesson plans for both models were obtained prior to lesson implementation to ensure lessons followed the characteristics of each pedagogical model. For example, in the TGM condition, lesson plans were checked for deductive questions and that the teacher planned to begin each lesson with a game form to assess pupil knowledge. Where necessary, the lead researcher provided any feedback on the teacher's plans for both models.

Data Collection

RT3® triaxial accelerometry. The RT3® accelerometer measures acceleration of movement across three axes (x, y and z) and this data is subsequently converted to activity counts that have been successfully validated in a laboratory setting against oxygen uptake relative to body mass ($R = 0.87$, $p < 0.01$ level; see Rowlands, Thomas, Eston, & Topping, 2004). RT3 activity counts for each lesson were converted to metabolic equivalents using the cut off points outlined by Rowlands et al. (2004). Frequencies were then calculated to establish time spent in MVPA. Activity thresholds (counts/min) were as follows; sedentary <288 (<1.5 METs), light 288-969 (1.5 METs), moderate 970-2332 (3 METs) and vigorous >2333 (6 METs) activity (Rowlands et al., 2004). These were then reintegrated to match the 1 second epoch setting used for this study in order to minimize underestimation of any short bouts of high intensity exercise that may occur with longer duration epochs (Rowlands, 2007).

All children were assigned a specific number by the research staff. Body mass and stature were measured using Tanita bioelectrical impedance Scales (BC-418MA) and a portable Leicester height stand, respectively prior to pupils being issued an accelerometer that had been programmed with the specific details of each pupil. Accelerometers were placed in a clear, plastic bag with the pupil's assigned number written on it. Whilst in the changing rooms prior to each physical education lesson pupils located the bag with their assigned number, took the accelerometer that was connected to a waistband out of the bag and placed it around their waist with the accelerometer on the right hip (Rowlands et al., 2004), wearing it for the duration of the lesson.

System for observing fitness instruction time. The system for observing fitness instruction time (SOFIT) is described as 'a momentary time sampling and interval recording system designed specifically to quantify factors believed to promote health-related PA' (McKenzie, Sallis, & Nader, 1991, p. 196). While SOFIT additionally provided an additional measurement of PA levels alongside accelerometers, SOFIT was also deemed useful as it provided important lesson information that helped link lesson contextual factors and teacher behavior to PA levels (Fairclough & Stratton, 2005a; Scruggs, Beveridge, & Clocksin, 2005). SOFIT is split into three phases (McKenzie et al., 1991).

The first phase involves the observation of pupils' PA levels. The activity level is coded against numbers 1-5, with 1 = lying down, 2 = sitting, 3 = standing, 4 = walking and 5 = very active. The second coding phase involves coding the context of the lesson. Lesson context codes are as follows; M = general content (transition, break, management), P = knowledge content (physical fitness), K = general knowledge (rules, strategy, social behavior, technique), F = motor content fitness, S = skill practice and G = game play. The final phase involves the coding of teacher behavior; P = promotes fitness, D = demonstrates fitness, I = instructs generally, M = manages, O = observes, T = off task.

The second author and an assistant were present for all observed SOFIT data collection (SOFIT data was collected for each lesson within the study). As per the SOFIT training manual (McKenzie, 2012), the PA levels of four randomly selected pupils (different each lesson) were observed on a rotational basis as well as the lesson contexts in which they occurred and teacher behaviors. These three elements were coded every 20s using momentary time sampling as per standard SOFIT protocols (McKenzie, 2012).

Observer Reliability

Each lesson was analyzed using SOFIT, following an intensive training period. This consisted of the second author and research assistant coding protocols, and analyzing other physical education lessons with an experienced SOFIT observer. Observer agreements were calculated following the training and observer agreements in excess of 85% were achieved for both observers with the 'expert' before the study lessons were coded (van der Mars, 1989). Inter-observer reliability checks were calculated for 20% of the lessons (randomly selected) and greater than levels recommended in the SOFIT training manual (McKenzie, 2012). Interval-by-interval agreement between observers were 88% for activity level, 91% for lesson context and 89% for teacher behavior, which exceeded both the minimum levels of agreement suggested by van der Mars (1989) and the minimum levels of reliability for SOFIT (McKenzie, 2012).

Data Analyses

RT3® triaxial accelerometryRT3® data for each child was downloaded after every lesson. RT3s ® that did not contain any data either due to absence or neglecting to wear the device were excluded. Mean percentage of time spent in MVPA and VPA during physical education over the 6 lessons overall and according to condition were calculated. Levene's tests were employed to establish if the parametric assumptions were met (Field, 2009). MVPA and VPA physical education data for all schools met the assumptions of a parametric

test. Data were therefore analyzed using an independent samples t-test. Effects of gender were assessed using a 2 x 2 between groups ANOVA. All data were analyzed using SPSS version 19.0 (SPSS, Chicago, IL).

System for observing fitness instruction time. SOFIT data were analyzed using the methods outlined in the SOFIT training manual (McKenzie, 2012). For example, time spent in MVPA and VPA was aggregated into percentages for each lesson, before mean percentages for the 6 lessons were calculated according to condition. Independent sample t-tests were employed to establish any significant differences between conditions and bonferroni correction factors were employed to each section of the analysis. For example, two behaviors were tested in the pupil PA level section, so the alpha level = 0.05/2 = 0.025. In the lesson context and teacher behavior sections, the alpha level was set at 0.01 due to the multiple behaviors being analyzed.

Results

In this section we overview, in turn, the results from each of the data collection methods. The section begins with reference to data generated from the accelerometer data before outlining results from the various aspects of the SOFIT analysis.

RT3® Triaxial Accelerometry

MVPA according to the RT3 accelerometry data was significantly higher in the intervention class (see Table 1), which related to 10.25±3.40 and 18.49±7.10 minutes of MVPA for the control and intervention class, respectively. In addition, the VPA data was also significantly higher in intervention class when compared to the controls (see Table 2). This was despite the large variation in MVPA and VPA, particularly within the intervention groups. Analysis revealed no significant effects of gender for MVPA (p=0.81) or VPA (p=0.48) between groups indicating that gender is of no further theoretical interest.

System for Observing Fitness Instruction Time

Pupil physical activity level. Table 3 represents the average percentages of lesson time spent in MVPA and VPA and in different lesson contexts according to the SOFIT data. This analysis also demonstrated that MVPA and VPA were higher in the intervention class, although this was non-significant (see Table 3). There was, however, greater variation in the SOFIT data in the TGM intervention group when compared to the control.

Lesson context. Lesson length was $M = 36.09$, $SD = 3.14$ minutes versus $M = 38.79$, $SD = 2.32$ minutes for control and intervention classes, respectively. There were no significant differences between the control and intervention lessons in any of the lesson context variables. Having said that, the teacher of the control group spent more time in management and other (i.e., free play), as well as less time in skill practice than the intervention teacher who also spent more time in game play.

Teacher behavior. There were no significant differences between the control and intervention lessons in any of the teacher behavior variables. Having said that, management (see above), demonstrating fitness and observation was slightly higher in the control group. Higher levels of instruction were noted in the TGM group as well as the percentage time spent by the teacher on other tasks such as 'attending to events not related to his/her responsibilities to the class at hand' (McKenzie, 2012, p. 12). This was due to the TGM teacher being a member of the school senior management team and, thus, they were sometimes distracted away from the class for short periods of time to deal with specific incidents.

Discussion

The purpose of the study was to investigate the MVPA and VPA levels of pupils during co-educational physical education units focused on of direct instruction and TGM. It

was hypothesized that pupils would gain greater levels of both MVPA and VPA during TGM classes when compared to those taught using direct instruction.

One major finding of this study was the contribution of physical education lesson focused on TGM to the amount of time spent in VPA. On average, physical education lessons focused on TGM provided over ten minutes of VPA according to the accelerometer data, which was significantly higher in the TGM group when compared to the direct instruction group (see Table 2). This suggests that pupil's in the TGM groups were more likely to achieve current physical activity guidelines that emphasize the importance of including VPA on at least 3 days a week, in the context of a daily 60 minutes MVPA (Department of Health, 2011). In addition, the levels of VPA observed in the TGM group were higher than those reported in previous studies reporting amounts of VPA during physical education of 4.5 and 3.3 minutes highlighted by Fairclough & Stratton (2005a). Fairclough and Stratton (2005a) outlined that a reason for larger contributions of VPA in lessons focusing on team games is the requirement to sustain large muscle groups engaged in PA for large proportions of time and hence its impact on the heart to beat faster to satisfy oxygen demand. Clearly, the lessons focused on the TGM provided lesson contexts within which pupils were provided with opportunities for these high levels of VPA to occur (i.e., high levels of both game play and skill practice than was observed in the control group).

In addition to increasing levels of VPA, this study found higher levels of accelerometer-based MVPA in the TGM condition when compared to the control group supporting previous research findings (e.g., Fairclough, 2003; Fairclough & Stratton, 2005b) that have shown team games activities to be one of the highest contributors to MVPA levels. These findings also replicate those of Yelling et al. (2000) who found that pupils in skill dominated lessons gained lower levels of MVPA when compared to game-focused lessons. Having said that, MVPA levels in the current study were slightly below the 50%

recommendation of the IOM (2013) and were lower than MVPA levels reported by Van Acker et al. (2010) where pupils exceeded the 50% criterion in games-based lessons focused on korfball. Differences between the current study and that of Van Acker et al. (2010) may be a reason for these differences. First, Van Acker et al. (2010) focused on korfball whereas the game in this current study was field hockey. Second, Van Acker et al. (2010) observed only one lesson while this current study examined PA levels over multiple sessions, albeit we observed a smaller number of participants. Third, Van Acker et al. (2010) used heart telemetry while accelerometers and SOFIT were used to examine PA levels in the current study. Fairclough and Stratton (2005c) outlined that heart rate telemetry can be inaccurate due to increased heart rate from other variables such as stress. Consequently, future studies should consider using devices such as accelerometers as they measure actual PA participation and continue to measure PA over multiple lessons.

On a related note, the current study found that the observational PA assessment through SOFIT did not highlight any significant differences in VPA or MVPA between the control and intervention classes, a finding that is contradictory to the objective accelerometry data. Fairclough and Stratton (2005c) have outlined that SOFIT may provide different results to objectively measured PA due to the different dimensions of activity that each method measures (i.e., RT3 accelerometry = movement and SOFIT = behavior). An additional suggestion for this difference may be that, while SOFIT is a valid and reliable instrument, it may underestimate actual PA levels because it is based on a momentary time sampling method which captures only the final second of a pupil's movement every 20 seconds McKenzie, 2012). Moreover, it is also largely dependent on the pupils that are monitored as only four pupils are monitored per class period, whereas all/most pupils within a class/group can be individually monitored using accelerometers.

It is our opinion that SOFIT was a useful data generation tool in this study as it provided important lesson information that linked lesson contextual and teacher behavior to VPA and MVPA levels (Fairclough & Stratton, 2005c; Scruggs et al., 2005). For example, the use of SOFIT demonstrated that the TGM teacher spent more time in both game play *and* skill practice and much less time in management and other lesson contexts (i.e. free play) than the control group. From the review of these data it could be suggested that the greater amount of time in motor content therefore afforded the opportunity for a greater amount of VPA and MVPA and, arguably, the game-skill-game lesson structure of the TGM provided a more coherent lesson structure for the teacher of that unit. It is our contention that this, alongside the small sample size within this current study that would be sensitive to individual variation, may explain why there was a larger variation in VPA and MVPA scores in the TGM group when compared to the control group because the TGM group spent a greater amount of game play and skill learning time (approximately 55% of the lesson; see Table 3), and thus had more opportunities to 'move and learn'. In contrast, the control group spent more time being managed by the teacher as a whole group (nearly 46% of the lesson; see Table 3), with all pupils therefore spending more time doing the same thing, i.e. being inactive while listening to the teacher, thus not displaying the variation in scores of the TGM group. A previous study by Roberts and Fairclough (2011) noted a high level of inactivity was associated with lessons focused on the direct instruction model, largely due to high levels of management and instruction, as well as full-sided games. In contrast, previous research by McNeill and colleagues (2008) has shown how the use of the Games Concept Approach, a Singaporean derivative of TGfU, afforded pupils more time in game play in secondary school classes.

Capturing the teacher behavior data in the current study was also important. It served to demonstrate the active supervision techniques of the TGM teacher when compared to the direction instruction teacher. For example, the TGM teacher spent more time instructing and less time observing as the environment of the TGM lesson meant that the TGM teacher was

freed up to be able to give feedback and ask questions by moving from game to game and practice to practice, thus reducing the time needed for knowledge and pupil management.

Notwithstanding this larger variation in VPA and MVPA scores for the TGM intervention group, it is promising that physical education lessons focused on TGM, where the central aspect is participation in modified/conditioned games, accumulated over ten minutes of VPA thus not necessitating alternative 'prescribed' interventions (Basquet, Berthoin, & Van Praagh, 2002). Basquet and colleagues designed a specific intervention to enhance cardiorespiratory fitness during physical education lessons that tended to lack an appreciation and value for the activities in and of themselves as they potentially lack 'spontaneity and freshness' (Dewey, 1910, p. 217). In contrast, modified/conditioned games offer an opportunity for playfulness and the 'unfolding of the subject on its own account' (Dewey, 1910, p. 219), thus making physical education content, arguably, more meaningful and purposeful (Light, 2013).

There were some limitations to the current study that could be addressed in future research. First, a both a greater sample size and a longer unit of both TGM and direct instruction units would permit an answer to the question regarding the sustainability of the levels of MVPA and VPA within the TGM and/or would enable greater demarcation in MVPA and VPA between specific individuals the two models. Clearly, the small sample size observed in this current study is susceptible to greater variation from the mean, and a greater sample size in particular would ensure that results were not influenced (either positive or negatively) by a small number of individual pupils. Second, although the effects of TGM on boys and girls were not significant in this current study, previous research such as the study by Van Acker et al. (2010) suggested there might be differences. Further research may therefore examine differences between boys and girls taught in both co-educational and single-sex cohorts as only co-educational cohorts were examined in this current study. Third,

it may also be advisable to investigate the effects of different team and individual sport activities on MVPA and VPA levels (Fairclough & Stratton, 2005a) as most of the previous research, including this current study has focused on team games being taught with TGM. Fourth, it would be of interest in future research to examine the effects of pupil motivation on the pupils propensity to engage in higher levels of MVPA and VPA and investigate which particular motivational constructs in particular demarcate pupils taught by TGM and direct instructional models (Gray, Sproule & Wang, 2008), as well as for which categories of games (i.e. net/wall, invasion) and which activities within these categories (see Mandigo, Holt, Anderson, & Sheppard, 2008). Finally, future studies may attempt to demarcate teacher behavior more specifically using the System for Observing the Teaching of Games in Physical Education (SOTG-PE; Roberts & Fairclough, 2012). This newly validated system was adapted from SOFIT and additionally considers game-specific teacher interaction behaviors such as whether interactions were technically or tactically orientated and whether they were verbal or non-verbal. Using this system would therefore give more insight into the differences in teacher behaviors and provide researchers with more detailed data upon which to link changes in PA levels to the pedagogies associated with TGM that was not uncovered by using SOFIT in this current study.

Conclusion – What This Study Adds

This study has provided much needed research to demonstrate the likely benefits of lessons focused on TGM to MVPA and, in particular, to VPA. Pupils in the TGM group had significantly higher MVPA and VPA levels when compared to the control group, as measured by accelerometry and were therefore more likely to meet current physical activity goals for MVPA and VPA stipulated by both the Department of Health (2011) and the IOM (2013). This was, arguably, due to the greater amount time the pupils were engaged in both game play and skill practice when compared to lessons focused on direct instruction where higher levels

of management were observed. Despite these positive findings, these results were subject to a large variation between participants and not corroborated by direct observation of PA through SOFIT, which found there were no significant differences between treatments.

Future research should attempt to corroborate these findings over longer units in different games, especially with a greater sample of pupils (e.g., from multiple classes/schools), in both co-educational and single-sex contexts. Future research can additionally investigate pupil's motivation (see Mandigo et al., 2008) as a possible mediating factor in the links between teacher pedagogy and pupil's levels of PA with TGM units.

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Table 1: *Descriptive Statistics: Overall percent MVPA (mean ± SD) according to condition*

Activity	Condition	*n*	% MVPA (Mean ± SD)	t	Sig.
Hockey	CON	16	31.89 ± 9.82	-2.94	.006*
	INT	16	47.08 ± 18.19		

Note. *denotes significance at the p<0.01 level

Table 2: *Descriptive Statistics: Overall percent VPA (mean ± SD) according to condition*

Activity	Condition	*n*	% VPA (Mean ± SD)	t	Sig.
Hockey	CON	16	15.40 ± 7.03	-2.77	.009*
	INT	16	27.19 ± 15.47		

Note. *denotes significance at the p<0.01 level

549 Table 3: *Percent mean (± SD) of SOFIT analyses by condition*

	CON	INT	t	Sig
Student behavior (% lesson time)				
MVPA	21.5 ± 5.7	33.9 ± 10.2	-2.08	0.09
VPA	4.1 ± 5.4	10.9 ± 9.6	-1.23	0.28
Lesson Context (% lesson time)				
Management	45.8 ± 9.4	31.3 ± 3.5	2.49	0.05
General Knowledge	12.2 ± 4.40	10.4 ± 6.2	0.45	0.66
Physical Fitness	0	0	0	0
Fitness Activity	3.4 ± 2.8	2.5 ± 4.1	0.32	0.76
Skill Practice	15.9 ± 15.3	26.6 ± 18.8	-0.84	0.44
Game Play	16.9 ± 21.8	29.5 ± 14.3	-0.86	0.43
Other	7.4 ± 10.1	0	1.25	0.27
Teacher behavior (% lesson context)				
Promotes Fitness	0	0	0	0
Demonstrates Fitness	3.2 ± 2.6	0	2.08	0.09
General Instruction	31.5 ± 10.6	39.0 ± 13.9	-0.60	0.57
Manages	32.5 ± 11.9	26.2 ± 2.1	0.86	0.43
Observes	31.5 ± 7.2	25.9 ± 5.6	1.51	0.19
Other Task	1.7 ± 2.2	8.9 ± 6.2	-2.21	0.08

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