

Accepted author manuscript version reprinted, by permission, from Journal of Teaching  
in Physical Education, volume 35, no. 4, pp: 349-357,

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1 Gender and school-level differences in students' moderate and vigorous physical activity  
2 levels when taught basketball through the Tactical Games Model

3 Abstract

4 The Tactical Games Model (TGM) prefaces the cognitive components of physical  
5 education (PE), which has implications for physical activity (PA) accumulation. PA  
6 recommendations suggest students reach 50% moderate-vigorous physical activity  
7 (MVPA). However, this criterion does not indicate the contribution from vigorous  
8 physical activity (VPA). Consequently, this study investigated: a) the effects of TGM  
9 delivery on MVPA/VPA and, b) gender/school level differences. Participants were 78  
10 seventh and 96 fourth/fifth grade co-educational PE students from two different schools.  
11 Two teachers taught 24 (middle) and 30 (elementary) level one TGM basketball lessons.  
12 Students wore ActigraphGT3X® triaxial accelerometers. Data were analyzed using four  
13 one-way ANOVAs. Middle school boys had significantly higher MVPA/VPA  
14 (33.34/21.80%) than girls (24.90/15.32%). Elementary school boys had significantly  
15 higher MVPA/VPA (29.73/18.33%) than girls (23.03/14.33%). While TGM lessons  
16 provide a context where students can accumulate VPA consistent with national PA  
17 recommendations, teachers need to modify lesson activities to enable equitable PA  
18 participation.

19 *Keywords:* models-based practice; physical activity; accelerometers

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**Introduction**

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Models-Based Practice (MBP) has been suggested as a means of overcoming limitations of traditional physical education (PE) curricula (Kirk, 2013), which has been chastised for being ‘a mile wide and an inch deep’. MBP offers teachers and other stakeholders the opportunity to “limiting the range of learning outcomes, subject matter and teaching strategies appropriate to each pedagogical model and thus the arguments that can be used for educational value” (p. 972). Kirk’s main justification for a move towards MBP is that educational value can be developed in MBP because it centers on affirming the notion that PE has the potential to contribute to a wide range of beneficial outcomes across an array of domains. This is in contrast to a traditional ‘one-size fits all’, physical-education-as-sports-techniques (Kirk, 2010), multi-activity curricula (Kirk, 2013). In this model students often practice in isolated, decontextualized conditions that are unlikely to generalize to game conditions, spend much of their lesson time inactive, and have little opportunity for empowerment and creativity (Kirk & MacDonald, 1998).

Kirk’s argument, and those before him (Jewett, Bain, & Ennis, 1995; Metzler, 2011), for centering the development of PE curricula using MBP, is justified by an emerging literature base on second generation models (cooperative learning, sport education, and the Tactical Games Model) underpinned by constructivist learning theory (Kirk & MacDonald, 1998). For example, in Game-Centered Approaches (GCAs) such as the Tactical Games Model (TGM), the teacher utilizes a game-skill-game format to promote the links between tactics and technique with the aim of promoting skillful and intelligent performance. For example, an initial game form is introduced first (i.e., a 3 vs. 3 game to one basket in basketball), with skill practice introduced second (i.e., creating

44 passing lanes off the ball), before returning to the 3 vs. 3 game form. As Mitchell, Griffin  
45 and Oslin (2006) note, the *what* therefore comes before the *how* in the TGM, refuting the  
46 notion that quality game play cannot emerge until the core techniques are mastered a  
47 priori (Oslin and Mitchell, 2006, p. 627).

48 Research on GCAs such as the TGM provide evidence for the development of  
49 cognitive outcomes (i.e., tactical; Vande Broek, Boen, Claessens, Feys, & Ceux, 2011),  
50 affective outcomes (i.e., student motivation; Gray, Sproule, & Morgan, 2009) and  
51 psychomotor outcomes, particularly off-the-ball movement (Lee & Ward, 2009). More  
52 recently, however, a limited number of studies (Harvey, Smith, Fairclough, Savory, &  
53 Kerr, 2015; Harvey, Song, Baek & van der Mars, 2015; Miller et al., 2015, 2016; Smith  
54 et al., 2015; Van Acker et al., 2010; Yelling et al., 2000) have begun to provide evidence  
55 that teachers' use of a GCA can afford students opportunities to engage in moderate-  
56 vigorous physical activity (MVPA) for at least 50% of the lesson time, consistent with  
57 national recommendations (Association for Physical Education, AfPE, 2008; Institute of  
58 Medicine, IOM, 2013). This is particularly significant as it has been well documented  
59 that regular physical activity (PA) of at least a moderate intensity is related to an overall  
60 improvement in health and wellbeing along with a reduced risk of chronic diseases in  
61 children and young people (e.g. Andersen et al., 2006).

62 Recently, Brusseau and Burns (2015) published a compendium of PA in a range  
63 of middle school physical education activities measured using pedometers, which  
64 included the activity chosen for this current study, basketball. These authors noted that  
65 across invasion games, skill-focused lessons yielded between 37-40 (basketball, floor  
66 hockey) and 61 steps per minute (soccer), which resulted in MVPA of 17.5% and 35%,

67 respectively. Skill focused lessons were described as those involving “a warm-up, skill  
68 development through individual and small group static practice and small-sided skill  
69 games” (p. 647). Game-focused invasion game lessons yielded between 47 (tchoukball,  
70 floor hockey) and 85 steps per minute (flag football), which resulted in 22.5% and 52.5%  
71 MVPA, respectively. The authors defined these lessons as those that “consisted primarily  
72 of a warm-up activity and multiple game playing opportunities” (p. 647). Flag football  
73 was the only activity where students attained higher than 50% MVPA, and this was  
74 during lessons focused on game play. In basketball, the game chosen for this current  
75 study, skill-focused basketball lessons yielded 37 steps per minute (17.5% MVPA) and  
76 55 steps per minute (28% MVPA) for game-focused lessons. These data are useful in the  
77 context of the current study, given its focus on PA levels, and teachers utilization of a  
78 different instructional model to those described in the Brusseau and Burns’ study.

79         In addition, more recent studies (e.g. Harvey et al., 2015a; Smith et al., 2015)  
80 have shown that teachers use of a GCA can provide opportunities to engage in PA of a  
81 vigorous intensity. For example, Harvey et al. (2015a) have reported VPA data  
82 demonstrating that a GCA-focused TGM unit of field hockey afforded students  
83 opportunities to accumulate vigorous physical activity (VPA) above and beyond that  
84 previously reported in the literature. The limitation of this study was its focus on only  
85 two middle school-aged classes, and therefore its low sample size. Nevertheless, this is  
86 significant given that national recommendations, both in the US and United Kingdom  
87 (UK), are emphasizing the importance of VPA on at least three days per week (Centers  
88 for Disease Control, CDC, 2008 Department of Health, DoH, 2011). Providing children  
89 with more opportunity to engage in VPA is of particular significance given its positive

90 association with cardiorespiratory fitness (e.g. Denton et al., 2013), vascular function  
91 (e.g. Hopkins et al., 2009) and body fat (e.g. Ruiz et al., 2006).

92 This body of emerging research into PA in GCAs is therefore promising.

93 However, a limited number of GCA studies to date have examined differences in PA  
94 between boys and girls whilst participating in the same GCA activity, particularly for  
95 more than one individual lesson (Van Acker et al., 2010). Gutierrez and Garcia-Lopez  
96 (2012) found significant differences in boys and girls game behavior in a modified  
97 invasion game, with boys handling the ball more and girls spending more time as a  
98 spectator-player, suggesting that PA levels could also be impacted. Knowing the impact  
99 of GCA's such as TGM on PA levels could aid teachers in selecting balanced teams and  
100 designing appropriate game forms that promote equitable participation to meet  
101 skill/psychomotor and PA goals in PE. Second, none of the GCA-focused PA studies to  
102 date have included reports of PA data from both elementary and middle school contexts  
103 in the same study. While trends suggest higher PA participation in PE as students become  
104 older (Fairclough & Stratton, 2005, 2006), this affect could be mediated by the type of  
105 instructional model chosen by the teacher, and the content taught within this model.  
106 Third, given the growing focus in PA recommendations on the need to participate in VPA  
107 on three days of the week (CDC, 2008; DoH, 2011), greater attention can be afforded to  
108 research studies in reporting VPA data, particularly where the content chosen may result  
109 in significant accumulation of VPA.

110 This current study is therefore a timely addition to the growing literature base on  
111 PA within GCAs given its inclusion of data from boys and girls from both elementary  
112 and middle school levels as they participated in multiple lessons where teachers

113 employed the TGM. Moreover, it additionally reports the contribution of MVPA/VPA.  
114 Consequently, the purposes of this study were to investigate: a) the effects of TGM  
115 delivery on MVPA/VPA and, b) gender/school level differences.

## 116 **Method**

### 117 **Participants & Settings**

118 **Students.** Participants were 174 students (79 girls), 78 middle school (40 girls)  
119 and 96 (39 girls) elementary school students from four seventh and five fourth/fifth grade  
120 co-educational classes at two schools in the Eastern United States, respectively. These  
121 schools were chosen because their teachers and students had no previous exposure to  
122 GCAs such as TGM, either in their present schools, or in previous grade levels. Informed  
123 consent was received from participants using standardized procedures after approval from  
124 the Institutional Review Board for the protection of human subjects at a large Mid-  
125 Western United States University. Permission was also gained from the County School  
126 Board, school principals and the resident PE teachers who signed an informed consent.

127 **Teachers.** There were two teachers in this study, one middle school teacher and  
128 one elementary school teacher, both male. Both teachers had over 20 years of teaching  
129 experience. Both had or were currently coaching interscholastic basketball teams within  
130 the same school district where they taught PE, but not within the same school they taught  
131 at. As the teachers had no previous experience teaching using TGM, the use of basketball  
132 therefore gave the opportunity to ease the transition of the teachers to the TGM (Griffin,  
133 1996). TGM lessons were taught in an indoor gymnasium of 40 x 30 yards and had six  
134 baskets available at both schools. Lessons covered were a replication of the level one

135 TGM basketball lessons from the *Teaching sports concepts and skills: A tactical games*  
136 *approach* text (Mitchell, Oslin, & Griffin, 2006).

137         **Settings.** The middle school students had daily PE and lesson periods were  
138 between 43-47 minutes' bell to bell, which included dressing out time. However, for  
139 observed sessions, actual lesson instructional time averaged  $M_{\text{length}} = 35\text{mins } 53\text{ secs}$  and  
140  $M_{\text{length}} = 27\text{mins } 37\text{ secs}$  for the middle school and elementary schools, respectively.  
141 Lesson length at the elementary school was slightly shorter to the middle school because  
142 of slightly shorter class periods, but also because some lessons were shortened due to  
143 assembly (2 lessons) and 2-hour delays on days where there was inclement (wintery)  
144 weather where lessons were reduced by 10-minutes (3 lessons).

145         In total, the middle school teacher taught a total of 24 lessons (four per day)  
146 during the month of November. The elementary school students only had one PE lesson  
147 per week and lesson periods were 40 minutes' bell to bell, which included the teacher  
148 needing to collect classes from their classroom and bring them to the gym. The  
149 elementary teacher taught the TGM lesson once a week from January to March.

150         The middle school had an enrollment of approximately 500 students, with 29.5%  
151 of students receiving free or reduced lunch. According to school demographic  
152 information, 74.2% of the school population are white, 12% Asian/Pacific Islander, 9.1%  
153 Black/African American, 1.9% Hispanic, 0.8% Alaskan/American Indian, with the  
154 remaining 1.2% of mixed races. The elementary school had an enrollment of  
155 approximately 500 students, with 40% of students receiving free or reduced lunch.  
156 According to school demographic information, 90% of the school population are white,



157 8% Black/African American, with the remaining 2% other races (i.e., Latino/Hispanic,  
158 Alaskan/American Indian, Asian/Pacific Islander).

### 159 **Research Design**

160 This project used a non-experimental observational design. One main advantage  
161 cited for this type of study is that it gets “close to social practices and everyday  
162 situations” to see “what occurs when people act in a context” (Ohman & Qunnerstedt,  
163 2012, p. 190). Hastie (2015) recently made a call for less comparative studies of different  
164 ‘models’ of teaching and additional examination of the micro-pedagogies of practice  
165 within each of the ‘models’. Moreover, Kirk (2005) outlined how the ‘practice-referenced  
166 approach’ can serve as an alternative to traditional instructional method studies which  
167 compare alternative approaches such as a GCA, typically to direct instruction (Miller et  
168 al., 2015; Smith et al., 2015). Kirk (2005) noted the practice-referenced approach “is  
169 concerned with making judgments about the usefulness of TGfU [TGM] for achieving  
170 learning appropriate to the model itself and to the circumstances in which it has been  
171 applied” (p. 218). In this current study, the practice-referenced approach enabled the  
172 specific investigation of PA levels (AfPE, 2008; CDC, 2008; DoH, 2011; IOM, 2013)  
173 and how this was influenced by gender and school level when teachers taught TGM-  
174 focused lessons to multiple classes within two school contexts (Harvey et al., 2015b).

### 175 **The Unit**

176 **Pre-study training of teachers.** Teachers were supported in learning about and  
177 using the TGM via the lead researcher. Initially, the lead researcher met with the two  
178 teachers individually and overviewed the tenets of the TGM, concluding this meeting by  
179 asking if they would be able to participate in the study. After this initial meeting, the lead

180 researcher provided the two teachers with copies of the first three chapters of Mitchell et  
181 al. (2006) and chapter 14 from *Instructional Models in Physical Education* (Metzler,  
182 2011). They were additionally provided with a copy of chapter 5 from Mitchell et al.,  
183 which outlined the lesson content for basketball. Once the teachers had read this material,  
184 the lead researcher conducted a second individual meeting with each of the teachers to  
185 discuss the content covered in chapter 5 (Mitchell et al., 2006) and review model  
186 benchmarks from chapter 14 (Metzler, 2011), and address any questions and/or concerns.

187 **TGM lesson delivery.** Students were arranged into mixed ability teams of three  
188 by each of the two teachers using their previous knowledge of the students. Before each  
189 lesson the first author met both teachers individually and reviewed lesson content, which  
190 included the three lesson sections (game-skill-game) and transitions between the three, as  
191 well as the teachers' deductive questions from the Mitchell et al. (2006) lesson plans (e.g.  
192 'When you receive the ball, what are your three options?'). The first author also provided  
193 the teachers with suggestions on how games or skills drills could be simplified to make  
194 games more developmentally appropriate (e.g., both hands behind back defense) but still  
195 meet model benchmarks (Metzler, 2011)<sup>1</sup>.

196 **Post-lesson teacher feedback.** Researcher/teacher post-lesson discussions  
197 occurred between taught sessions so that the teacher could ensure that they continued to  
198 meet model benchmarks controlling for possible teacher drift over the course of the  
199 study. For example, the first author overviewed the game-skill-game lesson format, the

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<sup>1</sup> In lesson 5 (tactical problem of attacking the basket) the teacher started with a 3 vs. 3 game with the condition of no dribbling unless to drive to the basket. The teacher would stop this initial game, gather the class around one basket and asked deductive questions in line with those outlined by Mitchell et al. (2006) to aid learning. The teacher then demonstrated with students how to set up the skill drill practice. This practice involved three players. One player would defend with arms behind their back (an additional modification to ease the initial task complexity), a second player, on receipt of a pass from a third player, would ball fake, juke or jab step, and drive to basket, making a jump stop to shoot the ball. The final part of the lesson involved the same 3 vs. 3 conditioned game, this time, with the additional condition that each team must dribble and drive to basket as often as possible.

200 utilization of deductive questions, game modifications and skill drills, as well as  
201 adherence to model benchmarks (Metzler, 2011).

202 Please note that while the teachers were aware that the researchers were  
203 examining PA levels in the context of the study, at no point were teachers given feedback  
204 relative to the amount of PA gained by the students in any of the classes. Moreover, no  
205 specific strategies to encourage higher levels of PA were given to the two teachers (i.e.,  
206 asking students to conduct walk and talks to consider an answer to a teacher question).

### 207 **Instruments and Data Generation**

208 The lead researcher and at least two other members of the research team were  
209 present at each PE lesson to distribute/collect accelerometers, conduct lesson context  
210 analyses and assess the two teacher's fidelity to model benchmarks.

211 **Actigraph GT3X® triaxial accelerometry.** PA levels during each lesson were  
212 measured using ActigraphGT3X® triaxial accelerometers (Pensecola, FL). The GT3X®  
213 measures acceleration of movement across three axes (x, y and z) and these data are  
214 subsequently converted to activity counts. The GT3X® activity counts for moderate and  
215 vigorous have been validated through indirect calorimetry (Evenson, Catellier, Gill,  
216 Ondrak, & McMurray, 2008; Trost, Loprinzi, Moore, & Pfeiffer, 2010). The thresholds  
217 (counts/min) of Evenson et al., (2008) were used in this study: moderate 2296-4010 (3  
218 METs) and vigorous >4011 (6 METs).

219 Each participant was assigned a specific identification (ID) number by the first  
220 author. Accelerometers with these corresponding numbers were pre-programmed by a  
221 member of the study team for the individual specifications of each participant (i.e.,  
222 height, weight, date of birth). Stature and body mass were measured using standardized

223 procedures (CDC, 2011)<sup>2</sup> and date of birth information was gained from school records  
224 with parental and school consent and approval by the Institutional Review Board.

225 On data collection days, accelerometers were placed in a clear bag. Immediately  
226 on entering the gymnasium prior to the start of each PE lesson all participants placed  
227 their accelerometer onto their waistband with the assistance of members of the study  
228 team where needed. This procedure was pilot-tested with all classes in a PE lesson at both  
229 the middle and elementary schools prior to the start of the study.

230 Once each lesson was completed, the devices were returned into the correct clear  
231 plastic bags, collected and placed into a box and taken back to the first authors office.  
232 Here the devices were connected to a personal password protected computer and the  
233 information downloaded via the Actigraph software. The utilization of the Actigraph  
234 software permitted GT3X® activity counts for each lesson at a 1-second epoch. Data  
235 were extracted by applying a filter with the specific times of the lesson, which had  
236 previously been noted during data collection at the school. This enabled the mean  
237 percentage of time spent in MVPA and VPA to be calculated using the previously cited  
238 Evenson et al. (2008) cut off points. These data were then exported from the Actigraph  
239 software to Microsoft Excel™ for subsequent data management before being imported  
240 into Version 21 of SPSS (SPSS Inc, Chicago, IL) for statistical analyses.

241 **Lesson context.** Lesson context was coded using definitions from the System for  
242 Observing Fitness Instruction Time (SOFIT) training manual (McKenzie, 2012). This  
243 involves coding the context of the lesson every 20 seconds (McKenzie, 2012). Lesson  
244 context codes were recorded as follows; M = general content (transition, break,  
245 management), P = knowledge content (physical fitness), K = general knowledge (rules,

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<sup>2</sup> Stature and body mass (calibrated Tanita BF-682 scales; Tanita Corp, Tokyo) were measured to the nearest 0.1cm and 0.1kg.

246 strategy, social behavior, technique), F = motor content fitness, S = skill practice and G =  
247 game play. The first, second and third author as well as one additional coder conducted  
248 all four parts of the SOFIT training included in the SOFIT manual and reached the  
249 acceptable levels of Inter Observer Agreement (IOA) with the gold standard within the  
250 lesson context section. When acceptable IOA levels (i.e. 80%) were reached (McKenzie,  
251 2012), observers undertook live coding on at least two occasions alongside the first  
252 author. On each occasion acceptable IOA levels were reached (McKenzie, 2012).

253         **Model benchmarks.** The TGM lessons were assessed using benchmarks to  
254 ensure that lessons were implemented correctly and not detrimental to learning outcomes  
255 (Metzler, 2011). While benchmarks offer key criteria to determine if the teacher is ‘doing  
256 the model’ it has been suggested that not all benchmarks need to be met when using  
257 curriculum models. For this study, we followed the lead of Gurvitch, Blankenship,  
258 Metzler, & Lund (2008) in selecting four key ‘non-negotiable’ teacher benchmarks,  
259 which included: teacher uses tactical problems as the organizing center for the learning  
260 tasks, teacher begins each lesson with a game form to assess students’ knowledge,  
261 teacher uses deductive questions to get students to solve tactical problems, teacher uses  
262 high rates of guides and feedback during situated learning tasks. ‘Non-negotiable’ student  
263 benchmarks utilized for model fidelity were: students are given them time to think about  
264 deductive questions regarding the technical problem, students understand how to set up  
265 situated learning tasks, students are making situated tactical decisions, game  
266 modifications developmentally appropriate (for a complete list of model benchmarks, see  
267 Metzler, 2011).

268 Prior to the study the first and fourth authors observed videotaped records of three  
269 invasion game TGM lessons not part of the current study using the same 3-point scale as  
270 Gurvitch et al., (2008) of ‘not at all’, ‘ok’, and ‘very well’. This same protocol was used  
271 during the actual study data collection. Due to the small number of items and choice of  
272 three alternatives, inter-observer agreement was set at 70% following guidelines from  
273 Osborne (2008, p. 48).

274 **Observer reliability.** Inter-observer reliability checks for lesson context data  
275 were completed for 18.52% (10) of the 54 lessons (randomly selected based on observer  
276 availability and training; McKenzie, 2012). Interval-by-interval agreement between  
277 observers was 95-100% for lesson context, which exceeded minimum levels of  
278 agreement (McKenzie, 2012). Scores from the lead observer were used for data analysis  
279 (McKenzie, 2012). For model benchmarks prior to the study, IOA for the three observed  
280 sessions was 100%, 88%, and 100%, thus averaging 96%. Model benchmark IOA during  
281 the study was conducted on 24% (13) of the total sessions (randomly selected based on  
282 observer availability and training; McKenzie, 2012). IOA levels averaged 78.84%, with  
283 scores ranging from 62.50% (one session), 75% (eight sessions), 82.50% (three sessions)  
284 to 100% (one session).

#### 285 **Data Analysis**

286 **Accelerometry.** Once accelerometry data for each child had been downloaded for  
287 each lesson by two members of the study team and exported to SPSS, this enabled  
288 computation of mean scores for MVPA and VPA over the six lessons. Accelerometers  
289 that did not contain any data either due to absence or neglecting to wear the device were  
290 excluded (5.77% and 6.94% – 27 of 468 and 40 of 576 observations – at the middle and



314 At the middle school, boys had significantly higher MVPA ( $F(1, 76) = 36.24, p =$   
315  $.000, \eta p^2 = .32$ ) and VPA ( $F(1, 76) = 29.37, p = .000, \eta p^2 = .28$ ) than girls (see Table 1).  
316 The same results were found from the elementary school data, with boys accumulating  
317 significantly higher MVPA ( $F(1, 94) = 23.66, p = .000, \eta p^2 = .20$ ) and VPA ( $F(1, 94) =$   
318  $11.90, p = .001, \eta p^2 = .11$ ) than girls (see Table 1).

### 319 Lesson Context Data

320 At the middle school, 44.68% ( $SD=7.30$ ) of lesson time was game play, 25.03%  
321 ( $SD=4.72$ ) skill practice, with the remaining time comprised of 15.75% ( $SD=4.80$ )  
322 management and 14.53% ( $SD=4.80$ ) knowledge. At the elementary school, slightly less  
323 lesson time, 42.22% ( $SD=4.91$ ), was game play, with 22.25% ( $SD=5.18$ ) skill practice,  
324 16.77% ( $SD=4.29$ ) management time and 18.76% ( $SD=5.15$ ) knowledge (see Table 2).

### 325 Discussion

326 Results of this study indicate that when two teachers implemented basketball  
327 lessons using the TGM, students fell short of the national PA recommendations (i.e., 50%  
328 of lesson time spent in MVPA). This is commensurate with MVPA data from previous  
329 research on basketball lessons in PE measured using pedometers, particularly for game-  
330 focused lessons where students' MVPA was 28% (Brusseau & Burns, 2015). In skill-  
331 focused lessons, students only gained 17.5% MVPA, suggesting that lessons with greater  
332 lesson time attributed to game play, such as the 42-45% observed in this study, can assist  
333 students in meeting national recommendations for MVPA. However, previous research  
334 by Smith et al., (2015) and Harvey et al, (2015b) also using accelerometry indicated that  
335 male and female middle school-aged students taught via TGM in soccer and rugby  
336 (Smith et al., 2015) and field hockey (Harvey et al., 2015a) contexts may, indeed, meet



337 these recommendations. There may be a number of reasons for these disparities. First, the  
338 type of accelerometer used in Smith et al., (2015) differed from this current study.  
339 Moreover, the cut off points utilized in that study differed from those in the current study,  
340 and it has been well reported that caution should be applied to interpretations between  
341 cut-points employed and accelerometer brands. For example, Welk et al., (2012)  
342 demonstrate the difference between accelerations and activity counts from the Actigraph  
343 and RT3 accelerometer devices due to filtering and scaling of acceleration signals used  
344 by the different manufacturers. Furthermore, the nature of the game was different. In this  
345 study we utilized basketball, and, in particular, a modified version of basketball where the  
346 main game form was a half-court game, which did not involve a transition where, we  
347 would argue, students could have possibly accrued higher levels of PA. Research with  
348 elite junior male players, also using accelerometers, has shown that greater PA from  
349 engaging in a 5 vs. 5 full-court game when compared to a 5 vs. 5 game which took place  
350 on a half court (Mongomery, Pyne, & Minahan, 2010).

351 In addition, results of the current study are commensurate with time motion  
352 analysis of men's basketball games, which also demonstrate that 60% and 15% of time is  
353 spent in low-intensity activity and high intensity activity (McIness, Carlson, Jones, &  
354 McKenna, 1995). In contrast, research in PE settings using heart rate monitoring by  
355 Slingerland et al. (2014) found that periods of game-based activity without active  
356 supervision or teacher intervention yield approximately 70% MVPA for the participants.  
357 However, these authors noted the likely ceiling effect of continuous game play on  
358 MVPA, suggesting it would be difficult to attain 100% MVPA. Moreover, while simply  
359 playing games could potentially increase PA, this would likely not result in student

360 learning. Striking a balance between productive PA and student learning when utilizing a  
361 GCA such as the TGM is therefore needed (Harvey et al., 2015b; Miller et al., 2015,  
362 2016). While the inherent nature of the TGM focuses on learning in small-sided  
363 conditioned games and skill drills in small groups, planning lessons with MVPA  
364 objectives alongside other PE learning outcomes is necessary for teachers (Fairclough  
365 and Stratton, 2005). Within TGM lessons, short 30-second small-group discussions using  
366 pre-planned questions (which can also be conducted while transitioning to play other  
367 teams), making activities fun, and planning for individual differences such as organizing  
368 games by gender and/or ability level (Van Acker, et al., 2010), etc. may assist teachers in  
369 attaining PA recommendations while maintaining the focus on the achievement of other  
370 student learning outcomes (Miller et al., 2015, 2016), particularly if equitable  
371 participation is to be encouraged.

372 Findings in the current study did, in fact, show an inequitable participation  
373 pattern, with boys having significantly more activity time than girls. This was in contrast  
374 to the recent GCA study of Van Acker et al., (2010) who showed that girls were more  
375 active than boys in korfbal, a modified version of basketball. However, these authors  
376 used heart rate monitoring, where girls typically show higher levels of PA due to having  
377 slower heart rate recovery (Smith et al., 2015). Notwithstanding measurement issues, one  
378 strategy for teachers to utilize in order to encourage greater equitable participation may  
379 be using additional game modifications. A further suggestion may be to allow the  
380 students themselves to self-select into their own teams for game play at the beginning of  
381 the unit. This is suggested as an alternative to girl-only games, as Slingerland et al.,  
382 (2014) previously noted that girls' activity patterns did not differ when girls played in

383 both co-educational or single-gender games. Whatever the modifications, the teachers  
384 need to be purposeful with that modification or strategy and emphasize its importance,  
385 thus attempting to decrease the gap between boys' and girls' activity levels.

386 In addition to difference in activity patterns between genders, we also noted  
387 differences in activity by school level. This may not be surprising given that both groups  
388 were taught the same lessons from Mitchell et al., (2006), although modifications were  
389 made to ensure that content was more developmentally appropriate for the elementary  
390 students. Notwithstanding this fact, the maturation levels of the middle school students  
391 may have contributed to their ability to assimilate the content presented to them even  
392 though it was both groups of students first exposure to the TGM. In addition, the fact that  
393 the elementary school teacher had to deal with school delays that shortened some of the  
394 lessons may also have been a factor in these findings as the teacher still worked through  
395 the normal game-skill-game lesson structure but still had to manage transitions between  
396 these and explain and demonstrate the skills drill for that day to students.

397 One positive finding from this study was that a large proportion of the MVPA  
398 gained by students was in the form of VPA (Harvey et al., 2015). Indeed, we noted that  
399 up to two-thirds of the MVPA gained by students, both boys and girls and in both  
400 elementary and middle school contexts, was in the form of VPA. In consideration of the  
401 lesson time, these results indicate that the students spent between 5 and 7 minutes of  
402 lesson time in VPA. In the context of this current study, for the middle schoolers, the  
403 TGM basketball sessions could provide between 25-35 minutes of that activity over the  
404 course of one week. The importance of vigorous activity has been somewhat ignored in  
405 the context of PA recommendations in PE, although other guidelines, such as those from

406 the CDC (2008) and UK DoH (2011) indicate the significance of VPA. It is our  
407 contention that these high levels of VPA were a consequence of the context of the games  
408 and skill drills within the TGM unit that focused primarily on ‘the game’, and actions  
409 required in the game, such as cutting to open space, dribbling, passing and shooting, all  
410 of which require the utilization of large muscle groups (Fairclough & Stratton, 2005;  
411 Harvey et al., 2015a).

412         Notwithstanding this positive finding, we acknowledged that a lot of lesson time  
413 was not spent in MVPA although students were active in learning content for the majority  
414 of the lesson. The lesson context data revealed that while 42-45% of time was spent in  
415 game play and between 22-25% in skill drills, between 30-35% of lesson time was spent  
416 managing or providing knowledge to the class. This was despite the utilization of  
417 management routines, such as home courts and teams. Although the skills drills were  
418 complex to explain, setting up one group as the demonstration group ahead of time and  
419 then using a 30-second show and go would have been helpful in reducing this time in  
420 large group instruction. Thus, when utilizing a new model such as the TGM, teachers  
421 must plan knowledge and management time so that time in games and skill drills can be  
422 maximized and students gain enough time to learn content and be physically active.

423         We can point to several strengths of the current study. First, an objective measure  
424 of PA was utilized alongside the inclusion of lesson context variables. Second, we  
425 examined VPA as well as MVPA, while also comparing responses from boys and girls  
426 and students from different school levels, previously not seen in the GCA literature on  
427 PA. A final strength was that no specific PA targets and tactics to increase PA were  
428 provided to the teachers.

429           This study had limitations that should be addressed in future research. First, while  
430 the sample size in the current study was an improvement on that seen in the previous  
431 GCA research on PA, further increases are required to be able to generalize the current  
432 findings. Second, it utilized a non-experimental design, which has been a common trend  
433 in research focused on the impact of national PA guidelines (Li et al., 2016). Li and  
434 colleagues suggest that even with a small number of classes such as in this study,  
435 researchers would be able to utilize experimental designs to detect differences between  
436 groups. In the case of the current study, for example, some groups may have followed  
437 their normal unit of basketball but with a different teacher to the experimental classes to  
438 act as a comparison group to classes where the teacher employed the TGM. Moreover,  
439 this study did not examine whether students improved their psychomotor skills and/or  
440 game performance while meeting the 50% goal, and the likely trade-offs that may occur  
441 due to the emphasis on time spent in skills drills/game play within TGM lessons (Li et al.,  
442 2016; Miller et al., 2016). In addition, utilization of subjective measures such as  
443 motivation surveys alongside objective measures may also move this research forward  
444 (Smith et al., 2015).

445

### **Conclusions**

446           TGM lessons provide a context where students can accumulate VPA consistent  
447 with national PA recommendations. More delineation between MVPA and VPA should  
448 be present in the PE literature. However, teachers must continue to lesson activities such  
449 as modified games and skill practices to enable equitable PA participation. Future  
450 research may also consider employing an experimental design alongside additional  
451 dependent measures to show the development in psychomotor skills, game performances,

452 and/or motivational profiles to complement the examination of PA. These studies would  
453 provide much needed evidence that skill/game learning goals and public health goals are  
454 two sides of the same coin and need not be mutually exclusive when a teacher employs a  
455 specific model such as the TGM (Harvey et al., 2015b).

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584 *Table 1: Overall percentage MVPA and VPA (Mean  $\pm$  SD) according to school level and*  
 585 *gender*

School	Gender	% MVPA M ( $\pm$ SD)	CI (95%)	% VPA M ( $\pm$ SD)	CI (95%)
Middle	Girls	25.14 ( $\pm$ 6.16)	23.19-27.08	15.47 ( $\pm$ 5.10)	13.79-17.14
	Boys	34.04 ( $\pm$ 6.88)	31.83-36.26	22.37 ( $\pm$ 6.14)	20.46-24.27
Elementary	Girls	23.03 ( $\pm$ 6.76)	20.93-25.14	14.33 ( $\pm$ 5.59)	12.55-16.10
	Boys	29.73 ( $\pm$ 6.53)	29.99-31.47	18.33 ( $\pm$ 5.58)	16.86-19.80

586  
 587

588 *Table 2: Lesson Contexts (Mean  $\pm$  SD) according to school level*

Lesson Context	Middle School M ( $\pm$ SD)	Elementary School M ( $\pm$ SD)
Management	15.75 ( $\pm$ 4.80)	16.77 ( $\pm$ 4.29)
Knowledge	14.53 ( $\pm$ 3.96)	18.76 ( $\pm$ 5.15)
Skill practice	25.03 ( $\pm$ 4.72)	22.25 ( $\pm$ 5.18)
Game play	44.68 ( $\pm$ 7.30)	42.22 ( $\pm$ 4.91)

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