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PEDAGOGY

Tactical Games Model and Its Effects on Student Physical Activity and Gameplay Performance in Secondary Physical Education

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Abstract

Many have examined game-based instructional models, though few have examined the effects of the Tactical Games Model (TGM) on secondary-aged students. Therefore, this study examined the effects TGM has on secondary students' physical activity (PA) and gameplay performance (GPP) in three secondary schools. Physical education teachers (N = 3) were trained extensively on the TGM; they then implemented 10 TGM lessons derived from the Tactical Games Approach textbook (Mitchell, Oslin, & Griffin, 2013) to secondary students (N = 123). Pedometers and Team Sports Assessment Procedure (TSAP) were used to measure students' PA levels and pre- and post-GPP, respectively. Fidelity was determined by Metzler's (2005) benchmarks for TGM and measured that teachers implemented TGM the majority of the time (93.5%). A one-way ANOVA and subsequent post hoc analysis found a significant difference between the average number of steps students took across all lessons for Teacher 1 (soccer; M = 60.7, SD = 17.5) and Teacher 2 (football; M = 55.8, SD = 20.0); Teacher 3 (handball) was not sig-

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nificantly different (M = 55.2, SD = 20.0). An independent t test examined step counts between gender, and repeated measures t tests examined GPP pre- and posttest scores. Secondary-aged females averaged significantly higher steps (M = 61.3, SD = 14.1) than secondary-aged males (M = 51.6, SD = 11.1). All GPP pre- and postmeasures were significantly different ($p < 0.01$) and indicated a significant improvement in GPP. TGM generated positive physical effects on secondary students. Although students were slightly missing the recommended 50% of class time in moderate to vigorous PA, the quality of moderate to vigorous PA or physical education learning indices should be considered.

Physical education (PE) is taught in many forms and variations. Some educators use curriculum or instructional models to aid instruction. Typically, these models are comprehensive and contain a theoretical foundation revolving around national standards. Researchers claim that when teachers utilize a standards and research–based model their overall teacher effectiveness and ability to reach content standards are more easily established (Metzler, 2005). However, many are simply teaching with a direct style or traditional method to teaching (Hastie, 2003). This approach, described as the technical skill-based approach, begins the lesson with a teacher-oriented demonstration and explanation of the skill taught that lesson, followed by teacher-led drills, and closing with a game offering students an opportunity to apply the skill learned. Bunker and Thorpe (1982) found students were unsuccessfully transferring skills taught during the drill segment and subsequently into gameplay. They also discovered that underperforming students were more likely to demonstrate hesitation in game activities if demonstrating poor performance in the drills. As a result, Bunker and Thorpe created Teaching Games for Understanding (TGfU), aiming to increase students' understanding of the game, tactical awareness, and development of game appreciation.

The TGfU instructional model offers freedom for the teacher during instruction and facilitated student learning. Researchers have explained, "The task of the teacher in TGfU is to present a game which children can enter with some of the skills already developed and that improvement can be achieved through understanding what the game is about" (Werner, Thorpe, & Bunker, 1996, p. 31).

This model, TGfU, made a pathway for other game-based instructional models to be developed. These are the Sport Education model (Siedentop, 1994) and the Tactical Games Model (TGM; Mitchell, Oslin, & Griffin, 2013).

The TGM (Mitchell et al., 2013) is a simplified version of TGfU utilizing modified gameplay and authentic skill practices to teach sport skills. Although the TGM instructional approach differs slightly from that of TGfU, the overall goal remains the same: to facilitate the development of game sense by placing students within modified gameplay and small-sided teams. As a result, students gain an opportunity to collectively and publicly share ideas, solve authentic problems (e.g., deciding where to send a birdie in badminton based on the position of their opponent), and possibly further increase their learning of the game.

A tremendous amount of research has been conducted on TGM among PE students. In the elementary setting, Nevett, Rovegno, Babiarz, and McCaughtry (2001) found offensive skills in students to improve significantly when teachers use the TGM instructional model. Empirical findings have also indicated TGM to increase students' perceptions on PE engagement and increase their enjoyment levels (Alison & Thorpe, 1997; Berkowitz, 1996; Wright, McNeill, & Fry, 2009) compared to a traditional approach. Additionally, Smith et al. (2015) found that elementary teachers using TGM significantly improved their students' overall physical activity (PA) levels. However, there is limited empirical evidence of the effects of TGM on secondary PE students. One study examined ninth grade PE students' perceptions of TGM and discovered students to be favorable toward TGM and learning sports skills during a PE lesson (Tjeerdsma, Rink, & Graham, 1996). Lee and Ward (2009) found tactical-focused instruction, as compared to traditional instruction, to improve supporting movements significantly in low-skilled female and male students and to improve supporting movements in average-skilled female students. Most recently, Harvey, Song, Baek, and van der Mars (2016) discovered that middle school students' PA activity levels were surpassing the suggested level of activity, that is, 50% of class time in moderate to vigorous PA (MVPA; Institute of Medicine, 2013). Qualitative studies conducted with college-aged students have documented teacher candidates to hold favorable perceptions of TGM (Gubacs-Collins, 2007).

TGM researchers have used a variety of methods to assess their participants. Many have developed their own assessment tools, facilitating an authentic evalution of students' gameplay performance (GPP) in a variety of sports (Blomqvist, Vänttinen, & Luhtanen, 2005; Gréhaigne, Godbout, & Bouthier, 1997; Gufierrez, Fisette, García-López, & Contreras, 2014; Nevett et al., 2001; Tallir, Musch, Lannoo, & Voorde, 2003; Oslin et al., 1998). The most common tools found in TGM literature are the Team Sport Assessment Procedure (TSAP; Gréhaigne et al., 1997) and the Game Performance Assessment Instrument (GPAI; Oslin et al., 1998). TSAP assesses GPP based on a tally system by examining students' on-the-ball movements (i.e., received ball, lost ball, successful shots). GPAI evaluates game performance behaviors that demonstrate students' tactical understanding, including decisions made, skill execution, and support. According to Memmert and Harvey (2008), a number of limitations exist for the use of the GPAI in evalutions of student performance, the most notable being the lack of description GPAI provides the observer for identifying off-the-ball movement and the disparity the observer experiences when deciphering an appropriate or inappropriate off-the-ball action (Memmert & Harvey, 2008).

Some believe a curricular model is only effective if it promotes high PA levels among the other aforementioned PE-related learnings. Pangrazi, Beighle, and Sidman (2003) suggest 1,200 to 2,000 steps is a reasonable number for an active 30-min PE class. Others have indicated this to be a requirement for a lesson to be dignified as a quality PE lesson (Corbin & Pangrazi, 1998; Fairclough & Stratton, 2005; Simons-Morton, 1994). According to Scruggs (2007) and Scruggs, Mungen, and Oh (2010), reaching 50% of MVPA for secondary students is equivalent to 82 to 88 steps/min (seventh to eighth grade) and 82 to 83 steps/min (ninth to 12th grades), respectively. If a model can only raise PA without offering or satisfying other PE standards, the PE program may be considered no better than free play, which reduces its legitimacy as a well-rounded subject area. Therefore, TGM and the effects on learning (e.g., cognitive or psychomotor improvements) and student PA should be examined conjointly. This offers teachers and administrators viable information on the effectiveness of the model. To date, only Smith et al. (2015), Miller et al. (2016), and Harvey et al. (2016) have examined

the effects that TGM has on students' PA. These researchers used accelerometry and the System for Observing Fitness and Instruction Time (SOFIT; McKenzie, Sallis, & Nader, 1991) to examine PA levels. However, only Miller et al. examined effects of the TGM on promoting PA and another PE learning index.

The purpose of this study was to examine the effects of TGM on secondary students' PA and GPP across various schools, units, and age ranges. This unique approach aims to offer a realization of effects absent of contextual factors. The outcome of this study will offer administrators and curriculum developers further evidence on game-based approaches, more specifically TGM and its effects on secondary students' PA and GPP.

Method

Procedures

Teachers were asked to implement 10 sequential TGM lessons into their PE classes. Specific lessons were selected from the TGM textbook (Mitchell et al., 2013) and provided to teachers prior to commencement. The team handball unit lessons were modified following the soccer chapter, as team handball is not located in the text. This was an adequate unit selection with both being invasion games with similar tactics and design. All lessons followed Metzler's benchmarks: (a) modified gameplay with small-sided teams (3 vs. 3 and 4 vs. 4), (b) authentic practicing using passive defenders and minimal lines, and (c) critical thinking period using the guided discovery teaching style.

One day of training was provided to teachers before the study. The teachers had marginal experience and knowledge with the TGM before this study and training period. During the training period, researchers explained and described the model, demonstrated quality lessons, and provided video-recorded examples to the teachers. They also answered the teachers' questions and offered them additional support throughout the study. The researchers answered teachers' questions via e-mail or in person and provided them with visual demonstrations to clarify drills, which sometimes occurred on-site before each implemented lesson.

This study was approved by the institution's institutional review board and the participating school district, before the study. Parents'

and teachers' informed consent for their participation was also provided and collected before the start of the study. Names of school, teachers, and students were kept anonymous to protect their identity.

Participants and Settings

Teachers. Participating teachers (N = 3) were recruited and selected based on availability, in three northeastern United States school districts. Teachers' teaching experience averaged 13.01 (SD = 10.70) years. Teacher 1 (soccer) and Teacher 3 (team handball) had access to either a large field outside or a full indoor basketball court. Teacher 2 (football) had access to a full indoor basketball court. Class periods lasted between 48 and 51 min including time allotted for dressing into PE-appropriate attire. Each teacher taught a warm-up prior to implementing the TGM lesson. Units selected were based on the teachers' predesigned sequenced curricular plan.

Students. One hundred twenty-three students participated in this study. Teacher 1 selected two classes (n = 49), Teacher 3 selected two classes (n = 54), and Teacher 2 selected one class (n = 20) in which to implement the 10 sequential TGM lessons. Among the five PE classes, students identified their ethnicity as Caucasian (56.1%), Asian (17.1%), Hispanic (17.1%), Arab American (8.1%), and African American (1.6%). Students' ages ranged from 13 to 18 years old with an average of 15.3 (SD = 1.5) years old. Teacher 1 used 12th graders, Teacher 3 used ninth graders, and Teacher 3 used eighth graders. Prior sports experiences and skills varied among students, and the invasion game units selected were not taught that current academic year.

Assessments

Gameplay performance. The TSAP by Gréhaigne et al. (1997) assesses individual performance in team sports. In this study, this tool assessed students' pre- and post-GPP. The TSAP is based on a tally system and examines students' on-the-ball movements. The assessment has the following categories: (a) conquered balls (CB), whereby a player intercepted a pass, stole from an opponent, or recaptured the ball after an unsuccessful shot; (b) received balls (RB), whereby the player received the ball from a partner; (c) lost balls (LB), whereby the player is considered having lost the ball when an opponent steals or intercepts the ball; (d) neutral balls (NB), a routine ball to a part-

ner whereby the player passed the ball to a partner but did not truly put pressure on the other team; (e) pass (P), whereby the player displaces the ball toward the opposing team's goal; and (f) successful shot (SS), whereby the player makes a shot. From these variables, students' Volume of Play (VP) = CB + RB, Efficiency Index (EI) = (CB + P + SS) / (10 + LB), and Performance Score (PS) = (VP/2) + (EI x 10) were calculated based on the procedures from the TSAP (Gréhaigne et al., 1997).

Video recordings of pre- and post-GPP were taken to offer researchers an opportunity to document GPP accurately. Pre-gameplay assessment occurred 1 day before the 10 sequential lessons, and postassessment occurred immediately after completion of all lessons. During pre- and postassessment, video recordings occurred that captured students playing in modified games following TGM characteristics (i.e., small-sided games, modify rules, etc.).

Pedometers. Yamax Digi-walker DW-200 pedometers were used to record student PA. This assessment method was selected due to the accessibility of these devices as well as objectivity to assess students' PA for each lesson. Pedometers have been identified as a valid tool for evaluating children's step counts in PE (Sinard & Pate, 2001).

At the beginning of the study, students were assigned a specific pedometer and offered instruction on how to wear it. Multiple practice lessons occurred before the TGM lessons so the students and teachers could familiarize themselves with the process of using the pedometers.

Students were asked to calibrate their assigned pedometer after the warm-up, that is, to strap on the pedometer to their waistband in line with their knee, clear the pedometer, and take 20 steps. If the pedometer did not read 20 steps, students were instructed to situate the pedometer on the waistband, clear the device, and try again until 20 steps were recorded. After each lesson, a researcher collected and documented each student's steps.

Teacher fidelity. A research team member was trained and collected teacher fidelity to the TGM and pedometer data every lesson. The fidelity checklist was based on Metzler's (2005) benchmarks for faithful implementation of the TGM. An example of one instruction question includes, "Students are given time to think about deductive questions regarding the tactical problem" (Metzler, 2005, p. 423). All

lessons were observed, and the researchers found that teachers were implementing the TGM successfully and reaching all benchmarks the majority of the time (93.5%).

Interobserver reliability. Training and practice of TGM evaluation occurred among coresearchers before the study. Researchers observed TGM lessons and independently recorded teachers' fidelity and then compared results. Interobserver agreement (IOA) reached above 90%, surpassing minimum levels of agreement (van der Mars, 1989).

Data Analysis

Data reduction was performed in SPSS (Version 23, Chicago, IL). Initial descriptive statistics of means, standard deviation, and individual *z* scores were performed on students' PA and GPP data. A one-way analysis of variance (ANOVA) with Tukey post hoc was performed to determine any significant differences in the average number of steps taken by the students between the three sports lessons/teachers (soccer, football, handball). In addition, an independent samples *t* test was performed and examined whether there was a significant difference between female and male students on the average number of steps taken. These first two analyses examined the effects of the TGM on students' PA. In all cases, alpha was set at 0.05.

For this study, evaluation of PA levels using pedometers was quantified into MVPA, which was compared to previous research. Therefore, based on Scruggs et al.'s (2010) validation cut-point scale for pedometer steps to MVPA, approximately 82 to 88 steps/min would reach the MVPA guideline of 50% of class time.

To determine the effects of the TGM on GPP, the researchers performed three repeated measures *t* tests between pre- and postinterventions on Volume of Play (VP), Efficiency Index (EI), and Performance Score (PS). A one-tailed test was used, as it was expected that the the posttest measures would yield greater outcomes. Alpha was set at 0.05.

Results

Five PE classes with three teachers, each from a different school district, were included in the study. Three students' data were removed from the analysis for various reasons; one participant had

an extreme score on the number of steps per minute (z = -3.1), another attended only three of the 10 sessions, and the third did not attend any sessions.

Physical Activity

On average, TGM lessons from the three teachers lasted approximately 31 min. The average steps per minute for all students was 59.8 (SD = 13.7). Of the three groups, the students of Teacher 1 (soccer) had the highest average steps per minute (M = 60.7, SD = 17.5), with the teacher teaching TGM for approximately 34 min; the classes of Teacher 2 (football) had an average 55.8 (SD = 20.0) steps/min, with the teacher teaching approximately 32 min of TGM; and the students of Teacher 3 (team handball) had an average of 55.2 (SD = 20.0) steps/min, with the teacher teaching 31 min of TGM (Figure 1).

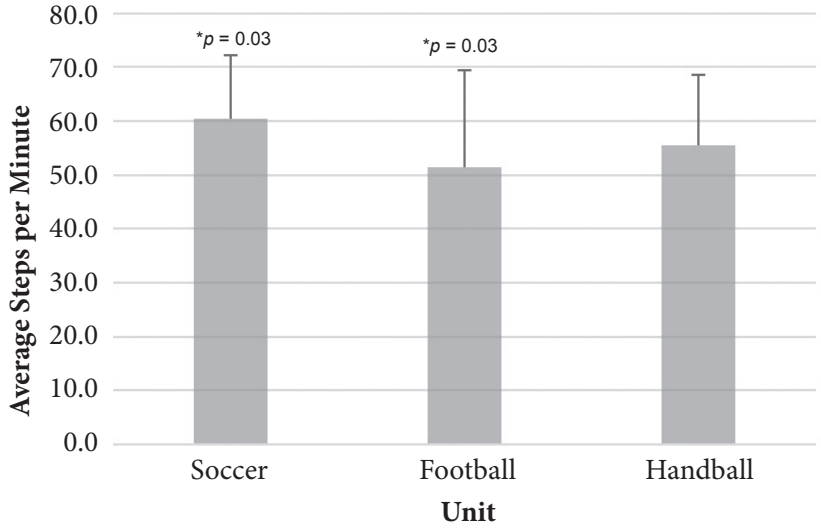

Figure 1. Average steps per minute for three groups.

A significant difference was found following ANOVA calculations between teachers on the average number of steps, $F(2, 118) = 3.61$, $p = 0.03$. Tukey post hoc analysis indicated a significant difference ($p < .05$) only between Teacher 1 (soccer) and Teacher 2 (football). Specifically, the average number of steps for students with Teacher 1 (soccer) was significantly greater than the average for students with Teacher 2 (football) by approximately 9.0 steps/min.

The average number of steps for all females (N = 66) was 61.3 (SD = 14.1) compared to all males (N = 55) with an average number of steps of 51.6 (SD = 11.1). An independent t test indicated that the females had a significantly higher average number of steps per minute than the males by 10.3, $t(119) = 4.14$, $p < 0.01$.

Gameplay Performance

The repeated measures t test comparing average pre- and post-VP measures found a significantly greater VP after the intervention, $t(23) = 5.1$, $p < 0.01$. The average VP score increased from 4.96 (SD = 1.85) preintervention to 7.32 (SD = 3.20) postintervention, for an increase of 2.37. The average EI score also significantly increased, $t(23) = 2.04$, $p = 0.02$, from 0.48 (SD = 0.21) premeasures to 0.59 (SD = 0.27) postmeasures; postmeasures on EI were on average 0.11 greater. Finally, the PS pre- and postmeasures were significantly different, $t(23) = 3.5$, $p < 0.01$. The average posttest performance score of 9.63 (SD = 4.08) was 2.43 greater than the pretest score of 7.20 (SD = 2.65).

Discussion

In this study, students reached an average count of 59.82 (SD = 19.18) steps/min and significantly improved their GPP in all three categories (VP, EI, PS). According to the U.S. (Institute of Medicine, 2013) recommendation for student PA in PE, students should reach at least 50% of class time engaged in MVPA. Students missed the recommended guideline for PE by approximately 23 steps/min, but a growing number of studies on game-based models have documented better success (Miller et al., 2016; Smith et al., 2015; Yelling, Penney, & Swaine, 2000), which signals inconsistent findings. In this section, we attempt to explain our findings and raise the notion that PE instruction should focus not only on PA but also on the attainment of other PE learning aspects concurrently.

Some believe an instructional model should not only promote PA but also help students to obtain additional standards-based learning areas in PE. For example, Fairclough (2003) explained that the criteria to judge the effectiveness of a program must exceed the notion of getting students active. If researchers or PE teachers solely focus on attainment of high PA, the field may revert once again to the findings by Placek (1983), who found that teachers perceive

quality PE as nothing more than organizing recess. In this study, students significantly increased their GPP in all areas (VP, EI, PS), satisfying the learning component found in national standards (i.e., SHAPE America National Standard 1: The physically literate individual demonstrates competency in a variety of motor skills and movement patterns). Students commonly miss the suggested MVPA guideline, regardless of the model implemented, according to the related literature. Kahn et al. (2002) performed a systematic review of all intervention studies during 1980–2000 and concluded that in the majority of interventions students were below the cut point of 50% class time in MVPA. However, many interventions found in this review (Kahn et al., 2002) demonstrated significant improvement in other PE-related outcomes (i.e., knowledge and skill development). Therefore, it may be concluded that these students were conducting quality PA during PE class time, rather than playing a game or recreational activity (e.g., capture the flag) that yields high PA with limited learning potential.

Recent studies have examined TGM specifically on the promotion of PA and found it to surpass the MVPA guidelines. United Kingdom- and Australia-based studies examined TGM effects on elementary students' PA levels (Miller et al., 2016; Smith et al., 2015). Conflicting results are documented in comparison to this study. Smith et al. (2015) discovered that 11–12-year-old boys had significantly higher MVPA than the condition group and reached the 50% criterion. However, girls' MVPA levels based on accelerometry were significantly lower than the level for the control and missed the 50% mark. No additional learning measures were taken to verify the models full capability (Smith et al., 2015). This study used pedometers and witnessed the opposite effects: Secondary-aged females engaged in more PA than secondary-aged males. The researchers recommend further examination on TGM and the effects on secondary students' PA based on students' gender for future research to find more conclusive outcomes. In a study among elementary students, Miller et al. (2016) documented similar results using SOFIT to evaluate PA; students improved gameplay decision making and support performance while reaching 50% of class time in MVPA.

Only Harvey et al. (2016) evaluated the effects of the TGM on the PA of secondary-aged students. They evaluated students from

one class during an eight-lesson soccer unit using McKenzie et al.'s (1991) SOFIT. Harvey et al. discovered that students were surpassing the 50% MVPA cut point; however, they did not assess additional learning outcomes. This, then, leaves questions regarding the quality of PA. From the Harvey et al. study, this study extends these results and offers evidence that TGM significantly increases GPP in all areas and promotes a moderate level of PA (59.82 steps/min). Past research documents that an active 30-min lesson should offer 1,200 to 2,000 steps (Pangrazi et al., 2003). Based on this notion, the overall step results in this study reached an active level, with approximately 1,794.6 steps/30-min lesson.

The lesson-by-lesson results (Table 1) show that a few lessons limited steps or PA compared to others. Teacher 1 (soccer) offered elevated steps for students in all but two lessons, Lesson 3 and Lesson 8, which both yielded 1,405 (41 steps/min) and 1,503 (44 steps/min), respectively. After reviewing these lessons and concepts taught, the researchers believe the limited steps may be from the introduction of novel tactics of the sport. The lower step count for these lessons dropped the overall average. Perhaps the teachers' limited content knowledge or unfamiliarity with TGM resulted in more time talking, demonstrating, or offering poorly constructed drills not conducive to high activity or repetitions. Additional scrutiny on specific lessons and construction of more active lessons should be considered.

Perhaps another factor that may have provoked limited PA for students overall is the lack of space or facilities for Teacher 2 (football). Teacher 2 (football) taught football indoors, in one gymnasium with a full-size basketball court. Despite the teacher designing small-sided games and authentic practice segments, space may have limited students' level of activity. This has been found to hold true; Bevan, Fitzpatrick, Sanchez, Riley, and Forrest (2010) found that when PE teachers have access to adequate equipment and facilities, students' PA levels significantly increase. Teacher 2 (football) obtained the active mark in five of the 10 lessons, but access to equipment and facilities is a common issue for urban schools that researchers should consider when evaluating any instructional model. Although no models apply to all settings, understanding the effects from the TGM instructional model based on contextual factors offers more useful information for curriculum developers, dis-

Table 1
Student Step Count per Lesson by Teacher

Lesson	Teacher 1 (Soccer) 34-min lessons[a] *M* (*SD*)	Teacher 2 (Football) 31-min lessons[a] *M* (*SD*)	Teacher 3 (Team Handball) 32-min lessons[a] *M* (*SD*)
1	2400.60 (491.91)	1181.36 (569.25)	946.30 (271.15)
2	1972.97 (523.10)	1522.29 (715.60)	2008.77 (623.25)
3	1503.68 (330.59)	1792.47 (424.42)	1903.95 (718.27)
4	2152.41 (522.03)	1813.19 (565.60)	2025.28 (528.11)
5	2119.19 (546.50)	2063.20 (958.80)	1689.34 (704.32)
6	2174.53 (536.11)	2097.50 (849.73)	1348.16 (477.09)
7	1874.39 (532.78)	1542.55 (561.82)	2138.16 (754.01)
8	1405.49 (426.02)	1332.00 (493.02)	1994.24 (914.74)
9	2420.97 (767.24)	1372.56 (591.65)	1797.64 (561.66)
10	2621.63 (751.01)	2589.83 (475.28)	1829.48 (858.50)
Total	**2064.58 (542.73)**	**1730.64 (620.52)**	**1768.13**
Steps/min	**60.72 (17.51)**	**55.83 (20.02)**	**55.25 (20.03)**

[a]*M* (*SD*).

trict administrators, and classroom teachers. Therefore, based on the findings in this study, TGM appears to be promising to help teacher maintain an active class while providing an educational (learning) aspect, despite the many factors and variations of teaching environments (i.e., different units, facilities, teacher teaching experience and experience with the TGM).

Conclusions

Based on the current study findings, TGM seems to provide a significant positive effect on GPP among secondary students. Although TGM facilitates an active level of PA, students missed the national recommendations for PA (Institute of Medicine, 2013). It is important to note that students were actively learning and developing GPP. PE teachers must maintain and reach dual objectives in PE rather than focus independently on either getting their students highly active or having their students learn at the sacrifice of activity. Further examination on secondary students in different units,

teachers' experience, and gender of the students, together with PA levels, may help determine the effectiveness of TGM on secondary students' learning outcomes.

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