Can physical education and physical activity outcomes be developed simultaneously using a game-centered approach?

Article

Can physical education and physical activity outcomes be developed simultaneously using a game centered approach?

Andrew Miller

(School of Education) University of Newcastle, Australia

Erin M Christensen

(School of Education) University of Newcastle, Australia

Narelle Eather

(School of Education) University of Newcastle, Australia

Shirley Gray

(Moray House School of Education) University of Edinburgh, United Kingdom

John Sproule

(Moray House School of Education) University of Edinburgh, United Kingdom

Jeanne Keay

University of the West of Scotland, United Kingdom

David R Lubans

(School of Education) University of Newcastle, Australia

Conflict of interest:

The authors declare that there is no conflict of interest.

Acknowledgements:

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

The PLUNGE research group acknowledges Dr Wendy Miller for her contribution to all of our lives. RIP Wendy.

Corresponding author:
Andrew Miller**,** School of Education,
University of Newcastle, Australia, EN 205, 10 Chittaway Rd, OURIMBAH, NSW, 2258.
Email: Andrew.miller@newcastle.edu.au

Abstract

The primary objective of this study was to evaluate the efficacy of a pilot intervention using a game centered approach for improvement of physical activity (PA) and physical education (PE) outcomes simultaneously, and if this had an impact on enjoyment of PE. A group-randomized controlled trial with a 7-week wait-list control group was conducted in one primary school in the Hunter Region, NSW, Australia. Participants (n = 107 students; mean age = 10.7 years, SD 0.87) were randomized by class group into the Professional Learning for Understanding Games Education (PLUNGE) pilot intervention (n = 52 students) or the control (n = 55) conditions. PLUNGE involved 6 × 60 min PE lessons based on Game Centered curriculum delivered via an in-class teacher mentoring program. Students were assessed at baseline and 7-week follow-up for fundamental movement skills (FMS) of throw and catch, game play abilities of decision making, support and skill performance; in-class PA; and enjoyment of PA. Linear mixed models revealed significant group-by-time intervention effects (p<0.05) for throw (effect size: d=0.9) and catch (d=0.4) FMS, decision making (d=0.7) and support (d=0.9) during game play, and in-class PA (d=1.6). No significant intervention effects (p>0.05) were observed for skills outcome during game play (d=-0.2) or student enjoyment (d=0.1). Game Centered pedagogy delivered via a teacher professional learning program was efficacious in simultaneously improving students' FMS skills, in-class PA and their decision making and support skills in game play.

Keywords:
Physical activity, physical education, fundamental movement skills, professional development, motor skills, game centered, non-linear pedagogy, primary school

Introduction

Physical activity (PA) research within the physical learning domain of the primary school setting has been influential in moving physical education (PE) practice towards health related outcomes (Kirk and Haerens, 2014). Teachers are encouraged to keep classes highly physically active due to the physical (Janssen and LeBlanc, 2010), psychological (Eime et al., 2013) and academic (Singh et al., 2012) benefits of adequate amounts of moderate-to-vigorous physical activity (MVPA). A focus on the development of motor skills is also promoted due to evidence from cross-sectional studies of a positive association between fundamental movement skill (FMS) competency and PA levels (including MVPA) in children and adolescents (Lubans et al., 2010; Barnett et al., 2011).

Due to this research, school based PA interventions within PE classes often emphasize the improvement of motor skill competency (Dudley et al., 2011), which is generally performed through direct instruction of motor skills (in isolation) before integration of skills into game play (Rink et al., 1996). Atencio et al (2014) speculated whether such a linear and reductionist approach was useful for young learners, and Sproule et al (2011) have advocated moving classroom achievement beyond simply the body's capacity to move in 'correct' ways. As this approach often produces classes low in MVPA (Fairclough and Stratton, 2005), a common intervention strategy is to add physical fitness

activities for the improvement of MVPA within lessons (Lonsdale et al., 2013), a practice which may further limit student learning in favor of immediate cardio respiratory outcomes.

Physical education and sport pedagogy (PESP) research, whilst increasing in volume recently, has focused on learners and learning, and teachers and teaching within the physical domain (Kirk and Haerens, 2014). Outcomes from this research have rightly focused on areas of learning embedded within many PE syllabus documents, for example: Technical skills (Turner, 1996; Nathan and Haynes, 2013), game knowledge (Tallir et al., 2005; Nathan and Haynes, 2013), game performance (Gray and Sproule, 2011; Harvey et al., 2010), and affective outcomes (Gray and Sproule, 2011; Jones et al., 2010). Whilst the volume of research has increased in this field, the traction (application to teaching practice) gained within a school setting has been limited (Kirk and Haerens, 2014), with narrow acceptance more broadly of pedagogical models other than direct instruction within schools (Tinning, 2015; Larsson and Karlefors, 2015).

There has been a call recently for PESP research to take an interdisciplinary path to further legitimize the field of PESP (Kirk and Haerens, 2014). There are only two studies having investigated the use of an alternate pedagogical approach for the improvement of in-class MVPA (Smith et al., 2014; Miller et al., 2015), and there is no research investigating whether PE associated outcomes can be achieved simultaneously with PA outcomes using

an alternate pedagogical approach. This study contributes to work within PESP and PA simultaneously by investigating the effect of a student-centered games based approach to teaching games and sports upon outcomes associated with PE and PA research domains. As such this study provides a start to the conversation into the contribution that student centered pedagogies (rather than a reductionist approach of providing activity and skills) can make towards the health outcomes of students through PE.

A game centered approach (GCA) situates learning within game play (Kirk and MacPhail, 2002), the goal of which is to better connect the learners and their skills (both physical and cognitive) to the demands of the game. This approach asks learners to interact with the individual (physical attributes, functional characteristics), environmental (physical and social conditions), and task (rules, equipment) constraints placed upon them (Chow et al., 2007). Each individual can/may react differently to the constraints placed upon them, thus this pedagogical approach is said to be non-linear (Atencio et al., 2014).

The traditional paradigm within teaching has been concerned with the linear transmission and acquisition of knowledge and skills (Biesta, 2010). Students exposed to non-linear pedagogy are viewed as emerging ‘in and through’ learning processes ‘in unique and unpredictable ways’ rather than in predictable linear progression (Biesta, 2010: 6). Responding to the constraints within game play requires the learner to process information

(perception) and provide movement responses (action), forming a perception-action coupling (Gibson, 1979). This process contextualizes learning of skills within the games they will be played in, with skills learnt more likely to be transferrable to actual game performance situations (Chow and Atencio, 2012).

This approach stems from pedagogical practice that challenges the sport-as-technique model of teaching game and sports (Kirk, 2010), and stems from approaches such as Teaching Games for Understanding (Bunker and Thorpe, 1982), Game Sense (den Duyn, 1997) and the Tactical-decision learning model (Gréhaigne et al., 2005). Each of these models, whilst nuanced, is based on the premise that game understanding and decision making is not dependent on the prior development of sport specific movement techniques (Stolz and Pill, 2014). Additionally, and importantly for potential PA outcomes within a games and sports PE context, the active nature of game play used within these approaches can provide pupils with short bouts of intermittent activity that can stimulate physiological changes that benefit children's health (Ratel et al., 2004; Coyle, 2005).

The ability to improve outcomes associated with PE and PA domains through the use of a GCA is of great interest, and there is a lack of previous investigation of outcomes related to PA research (FMS and in-class PA levels) within the GCA field. The Professional Learning for Understanding Games Education (PLUNGE) pilot intervention

was developed to improve the FMS (throwing & catching), game skills (decision making, support and skill outcome), and in-class PA of participants through exposure to GCA curriculum. PLUNGE was facilitated through a professional learning process involving teacher education and mentoring within the teachers' PE classes.

The aim of this research was to evaluate the efficacy of the PLUNGE 6-week pilot intervention for the simultaneous improvement of PA related outcomes (FMS of throw and catch, and in-class PA) and PE related outcomes (decision making, support and skill outcomes during game play). Additionally, as enjoyment has been identified as a possible mediator for PA (Salmon et al., 2009), the impact of PLUNGE in influencing enjoyment during PE classes was included. PLUNGE was evaluated using a group randomized control trial (RCT) with a 7-week wait-list control group.

While the professional development programme itself is of great interest and relevance as generalist teachers (non PE specialists responsible for all student content) report low levels of teaching efficacy and describe PE programs as inadequate for achieving outcomes (Morgan and Hansen, 2008), this article focuses on the intervention and its efficacy. We hypothesized that participants in the PLUNGE intervention, compared to those in the control group, would display more favourable changes in FMS, game play abilities, in-class PA and higher PE enjoyment levels over the 7-week study period.

Methods

Study design

The study was a two-armed group RCT. Class units (teacher and their students) were randomly allocated to one of two groups: the PLUNGE 6-week pilot intervention (treatment) or a wait-list control group. Outcome measures were obtained from all participants at baseline and 7-weeks (post-test). Measurements were taken during school hours by trained staff, using the same instruments at each time point. Participants and assessors were blind to group allocation at baseline assessment. The wait-list control group received no information or intervention before attending the follow-up assessments. The design, implementation and reporting of the PLUNGE study conform to the Consolidated Standards of Reporting Trials (CONSORT) guidelines for randomized trials (Moher et al., 2010). Ethics approval for this study was obtained from the University of Newcastle and the Diocese of Maitland-Newcastle Catholic Schools Office ethics' committees. All participants provided written informed consent and the study was conducted from September to December 2012.

Recruitment and Participants

One primary school from the Newcastle Maitland Catholic Diocese, NSW Australia, was

invited to participate in the study. Four teachers of Stage 2 or 3 classes (9 – 12 years of age) from the school were invited to participate in the study. To maintain generalizability of results to the majority of generalist primary school teachers, a teacher was excluded from the study if they: i) held an external sports coaching qualification, or ii) held a tertiary PE teaching qualification. All students from the classes of consenting teachers were invited to participate. Only students consenting to involvement in the study were involved in assessment sessions. All students in the intervention group participated in that group's PE classes regardless of consent as they were considered part of the normal school PE schedule.

Intervention

The goal of the PLUNGE program was to improve the FMS (throwing & catching), game skills (decision making, support and skill outcome), in-class MVPA, and enjoyment of physical activity of the participants through exposure to GCA curriculum. A short intervention period was chosen due to the pilot nature of the program, with lesson content for the 6-week intervention period (1 hour per week) developed by the research team.

In line with design recommendations for non-linear pedagogy (Tan et al., 2011), the complexity of game based activities increased progressively across the intervention period to ensure the tactical complexity of activities was not above the ability levels of

participants. Initial activities were focused on target activities in pairs, with movement into small and large group invasion game structures throughout the intervention. Table 1 outlines the focus and overviews the content of the designed curriculum.

The curriculum was delivered as part of a professional learning program involving a 2.5 hour information session for the participating teacher, followed by in-class mentoring in which the lead researcher assisted the teacher in delivery of content for the first four weeks of the six week intervention period. The mentor had greater involvement in the first two lessons, demonstrating the setup, management and teaching components of several activities in the first lesson to provide a model of practice for the classroom teacher. The mentor progressively withdrew instructional assistance of the class across the four sessions, providing only instructional/teaching suggestions and feedback to the teacher in the final two sessions.

Professional learning was a combination of a training model (Kennedy, 2005) for standardized content delivery, followed by a mentoring model (Kennedy, 2005; Rhodes and Beneicke, 2003) which is underpinned by situated learning theory (Lave and Wenger, 1991) and moves to contextualize the theoretical content presented to teachers. Table 2 outlines the content delivered to teachers and the focus of in-class mentoring / student learning throughout the intervention period.

The development of PE and PA outcomes during intervention activities was addressed via three areas of focus: i) how to move, with FMS used as a framework for development of movement patterns during activities, ii) how to play, focusing on space, support, decision making and tactical development to achieve success within a game, and iii) how we play, focusing on a definition of a successful activity involving team-work, contributions by all players, reduction of over competitive behaviors and support for team mates regardless of performance outcomes.

Control condition

Teachers in the control condition were asked to teach from the Games and Sports strand of the syllabus (Board of Studies NSW, 2007) from baseline to follow-up assessment to match the strand of the intervention curriculum. Teachers were also asked to focus on the throw and catch FMS in their planned activities. There was no specification given as to the pedagogical approach used by the control teachers as this group gave an indication of standard practice among these teachers.

Measures

Outcome measures were obtained from all participants at baseline and 7-weeks (post-test). The primary outcome was object control proficiency (throw and catch) at 7-week follow-

up, with a range of secondary measures also assessed.

Fundamental movement skills. Object control was specifically targeted in the PLUNGE intervention as these skills are more strongly associated with adolescent physical activity levels (Cohen et al., 2014; Barnett et al., 2009). Object control skills were measured using selected scales from the Test of Gross Motor Development, Second Edition (TGMD-2) (Ulrich, 2000). Skills were filmed for evaluation, and one assessor evaluated all skills. Assessor training included rating of children performing each FMS on a video previously rated by a panel of experts (>95% agreement rate required). Five percent of the sample at each assessment time point was repeat rated for intra-rater reliability (99% and 98% agreement respectively), and against ratings from a member of the research team for quality control purposes (Kappa = 0.98; 95% CI - 0.97 to 0.99).

Enjoyment. Enjoyment was measured using a modified version of the Factors Influencing the Enjoyment of Physical Education questionnaire (Motl et al., 2001). The questionnaire consisted of 10 statements that begin with the stem "When I am in PE class".....with a following statement: e.g. "Learning new skills is something that I". Students were asked to select their relevant feeling about PE classes by circling the relevant response on a 5-point likert-type scale (1 = "Dislike a lot" to 5 = "Enjoy a lot"). A score was computed by summing the score of the 10 items. Two items were excluded from the original

questionnaire. These items referred to students getting changed prior to and showering after PE lessons, which was not applicable in the studied setting.

In-class physical activity. Student in-class activity patterns were measured during two lessons per assessment period using the System for Observation of Fitness Instruction Time (SOFIT) (Pope et al., 2002). The PA levels of four randomly selected students, the lesson context, and teacher behavior were coded every 20 seconds throughout entire lessons. The SOFIT measure provided a simultaneous record of: i) student activity levels, ii) lesson context in which they occurred, and iii) teacher behavior. Detailed description of the procedure for this instrument and the validity of student activity level coding have previously been published (McKenzie et al., 1992; Honas et al., 2008; Pope et al., 2002). The percentage of class time spent in MVPA was used for analysis. One trained staff member conducted all observations. Initial training included classroom lectures and discussion, videotape assessment, and field practice. During training, the observer became certified by reaching an inter-observer agreement criterion of 85% on all variables on pre-coded "gold-standard" videotaped lessons, as described by McKenzie et al (2004). SOFIT observation was chosen over the use of ambulatory recording devices (accelerometer or pedometer) due to the pilot nature of this investigation and a lack of access to these devices.

Game play skills. Student game play ability was measured on a random sample of students

(n = 32) using modified game performance coding scales (Gray and Sproule, 2011) during small sided invasion games. Eight pupils from each class were recorded on video playing a 4-minute 4v4 invasion game (2 x female; 2 x male participants) at both pre and post intervention assessment periods. With the exception of one of the students from each study group, who were absent for the post assessment game, and were replaced by another student (same gender) from the same class, the players in each team were the same for both games and each team played against the same opposition.

The invasion game used for assessment was a modified version of netball. The aim of the game was to move the ball across the space (1/2 basketball court) to a team mate within a 1 meter end-zone. A team had to complete five passes prior to any/or all team mates moving to the end-zone space to receive a scoring pass. Players could not run with the ball or pass back to the player they received the ball from. Possession would change if the ball was dropped, intercepted, interrupted by the defense or was thrown or caught out of bounds. A 15cm dimpled ball was used, and teams were separated by the use of singlet style fluorescent bibs, which were numbered 1-8 for the purpose of analysis.

Measurement scales for game play decision making and skill performance are outlined in Table 3 and 4 respectively. All of the players involved were coded for the full game period. An individual player was observed from start to finish of the game, and their

off-ball (support) or on-ball (decision and skill) performance was coded for each game segment (the period from when a player received the ball, to when the ball has reached its target, been intercepted, been interrupted, hit the ground or gone out of bounds). The game play file was paused at the beginning of a game segment to observe the context of the game, and the support or decision and skill performance evaluated as positive (good) or negative (poor) for that segment.

A percentage of positive performance was used to determine the quality of each student's involvement in each of the game assessment periods for decision, support and skill categories (e.g. good decisions / (good decisions + poor decisions) x 100). All players scored within each of the positive and negative game categories during each of the assessment periods, avoiding the problem of a 0 or 100% index during analysis as addressed by Memmert and Harvey (2008).

One researcher performed assessment of game performance videos. Reliability was assessed by recoding a random selection of 20% of student game play video (10% of control and intervention groups) from pre and post assessment periods one week after the initial coding took place. Consistent with the procedures adopted by Blomqvist, Vanttiinen, and Luhtanen (2005), a percent agreement reliability test was used (number of agreements/number of agreements + number of disagreements). Intra-rater reliability of

game coding displayed similar levels to those previously reported for similar game play assessment instruments (Blomqvist et al., 2005; Gray and Sproule, 2011), with all agreement levels above 90%. Agreement of decision making coding was 95% and 91% for baseline and follow-up time points respectively, and agreement of skill performance coding was 95% at baseline and 92% for follow-up time points.

Instruction classification and intervention fidelity. Inadequate description of intervention procedures (van Sluijs et al., 2008) and intervention fidelity (Harvey and Jarrett, 2013) have been identified as issues in quality reporting of intervention effects. Evaluation of the style of instruction used by the teachers in both the intervention and control condition was performed using lesson observation scales (Turner and Martinek, 1992). Two PE lessons per teacher were observed by the lead researcher prior to and at the end of the intervention period (weeks 5 and 6). The lesson was judged against three skill based format statements and four game based format statements to obtain the percentage of agreement for each of these sets of statements (e.g. lesson agreement with one of four game based statements and two of three skill statements = 25% game agreement and 66% skills agreement, indicating a greater skills based lesson focus). These agreement values were used to indicate: i) if the style of instruction undertaken at each time period was in line with a skill based or game centered approach, and ii) if the fidelity of the instruction undertaken by the intervention

group teachers was in line with the true nature of the intervention.

Sample size

Calculation of sample size was based on a change in FMS performance. As this was the first intervention focused on improving FMS using GCA-based pedagogy, our power calculation was based on a previous FMS intervention targeting motivational climate in the primary school setting (Martin et al., 2009). Martin and colleagues reported a moderate effect size for their intervention on object control motor skill proficiency using the Test of Gross Motor Development II (TGMD-2). Using an alpha of 0.05 and power of 80%, it was determined that a sample size of approximately 104 was needed to detect a between group difference of 1 unit (SD = 1.8) for the TGMD-2 throw skill test.

Randomization

Randomization by class was performed after baseline assessments, with two classes allocated to the intervention conditions and two classes randomized to the control (7-week wait-list) condition. Randomization was performed by an independent 3rd party using a coin toss, with all assessors being blinded to treatment conditions at baseline and post-test assessments.

Analysis

Statistical analyses were completed using PASW Statistics 21 (SPSS Inc.Chicago, IL) software and alpha levels were set at $p < 0.05$. All variables were checked for normality and satisfied the criteria. Independent samples t-tests were used to compare differences between intervention and control groups at baseline. Linear mixed models were fitted to compare intervention and control groups for continuous variables. Mixed models were used to assess primary outcomes for the impact of group (intervention or control), time (treated as categorical with levels baseline and follow-up) and the group by-time interaction. Potential gender effects were explored using a group-by-time-by-gender interaction term in the mixed model. However, as there were no significant interactions for any of the outcomes, this term was removed from the final models. A repetition variable was included in the model assessing in-class activity to determine if there was a difference in the lessons between first and second delivery. Differences of means and 95% confidence intervals (CIs) were determined using the linear mixed models. Analyses included all randomized participants. Cohen (1988)'s *d* was used to determine effect sizes ($d = (M1 – M2) / \sigma$ pooled).

Results

Overview

The flow of participants through the study process is reported in Fig. 1. The study sample included 107 students from four classes at one primary school. There were no significant differences between control and intervention groups at baseline for age, gender (%), FMS (throw or catch), enjoyment of physical activity, in-class activity (% MVPA & time management) or for any of the game assessment indices (decision, support or skills) (Table 5). The mean age of participants was 10.7 (SD 0.9) years and all participants were born in Australia and spoke English at home.

Intervention fidelity

Pre intervention coding of lesson observation scales displayed identical code agreement among intervention and control groups (13% game / 92% direct), indicating that the observed lessons were in greater agreement with the coding of scales seen for skills based lesson instruction. Coding of lessons at the end of the intervention period displayed 19% game / 42% direct agreement for the control group and 88% game / 0% direct agreement for the intervention group, indicating that the control group lessons remained in greater agreement of skills lesson coding, and intervention group lessons had shifted to greater

agreement with Game Centered instruction, in line with the intention of the intervention.

Outcome effects

There was a significant treatment effect for change in object control FMS at 7-week follow-up for the throw ($p < 0.001$, $d = 1.0$) and the catch ($p = 0.028$, $d = 0.4$) (Table 6). The intervention group displayed a mean increase of 1.46 (95% CI = 0.98 – 1.95) units for the throw, and an increase of 0.61 (95% CI = 0.18 – 1.04) units for the catch. For in-class activity patterns, significant beneficial treatment effects were found from baseline to follow-up for MVPA ($p = 0.001$, $d = 1.6$). The intervention group increased lesson MVPA by 26.3% (95% CI: 16.7 – 35.8), for a total MVPA of 50% (95% CI: 59.63 – 40.37) during post-intervention observation.

For game play outcomes, significant beneficial treatment effects were found from baseline to follow-up for decision making ($p = 0.039$, $d = 0.7$) and support ($p = 0.010$, $d = 0.9$) outcomes, however there were no between group differences for the skills outcome ($p = 0.624$, $d = -0.2$). For the enjoyment outcome, there were no significant group-by-time interaction effects ($p = 0.635$, $d = 0.1$).

Discussion

The aim of this research was to investigate if PA related outcomes (FMS of throw and

catch, and in-class PA) and PE related outcomes (decision making, support and skill outcomes during game play) could be improved simultaneously using a GCA, and if this had an impact on enjoyment of PE. The PLUNGE intervention resulted in a significant beneficial intervention effect for throw and catch FMS, game play outcomes of decision making and support and in-class PA, but there was no significant change in the enjoyment or game play skill performance outcomes over the study period.

The novel aspect of the PLUNGE intervention was that a focus on effective pedagogical practice using a game based curriculum produced simultaneous development of FMS, game play outcomes and improved levels of in-class physical activity. This study, and a subsequent trial (Miller et al., 2015) are the only studies to investigate the concurrent effects achieved in PA and PE fields through a focus on quality pedagogical practice, and curriculum concerned with more than just development of motor skills and activity levels. As such, this study provides a starting point of evidence for the legitimacy of PESP in the improvement of future health outcomes for young people. This is not to say that studies in PESP have not previously contributed to the PA and health outcomes of students, just that outcomes in domains other than PESP have not been investigated to date.

Motor and game skill outcomes

The improvement in FMS observed in this investigation was in line with previous school

based interventions (van Beurden et al., 2003; Martin et al., 2009). The PLUNGE intervention produced improvements in FMS in a relatively short time frame, supporting findings that improvements in FMS are not necessarily dependent on intervention volume (Morgan et al., 2013).

Current research suggests strong FMS performance as the foundation for a physically active lifestyle (Barnett et al., 2009; Cohen et al., 2014; Lubans et al., 2010). It must be recognized however that good sports performance requires strong cognitive and decision making skills (Nevett et al., 2001a), with expert performers developing more effective recognition and response to game situations (Janelle and Hillman, 2003). Activities within the PLUNGE intervention were designed to promote variability of movement in authentic learning contexts to maintain a perception-action coupling (Gibson, 1979). These activities produced improvements in FMS without isolation of these movement skills from the activities they are to be used in, promoting a more contextual learning experience.

For game play outcomes, the increase in positive support play observed is supported by previous GCA research findings (Chatzopoulos et al., 2006; Gray and Sproule, 2011; Harvey et al., 2010). Likewise, the improvement of decision making during an invasion

game is supported by previous investigations utilizing a GCA (Chatzopoulos et al., 2006; Gray and Sproule, 2011; Nevett et al., 2001b; Tallir et al., 2007).

The lack of improvement in the skill performance outcome replicates findings from Gray and Sproule (2011). Skills indices of 67% and 69% at baseline for control and intervention groups respectively indicates that skill performance outcomes were relatively high initially in this group (near 7/10 effective), producing a possible ceiling effect (Stone et al., 1998). Most likely, as identified in a review released after this study was undertaken (Miller, 2015), and given the pilot nature of this program, this result appears common in intervention volumes lower than eight hours (Gray and Sproule, 2011; Harvey et al., 2010; Turner and Martinek, 1992). Greater intervention volumes are recommended for future interventions, particularly given the positive effect on support play and decision making within game assessment observed in this study.

In-class physical activity

Only two studies have previously reported on efforts to simultaneously improve motor skills and in-class physical activity: Sports, Play, and Active Recreation for Kids (SPARK) (McKenzie et al., 1998; Sallis et al., 1997), and Move it, Groove it (MIGI) (van Beurden et al., 2003). Both reported motor skill and in-class physical activity improvements. The improvement in MVPA (26.3%; 95% CI: 16.7 – 35.8), and the follow-up result (50%; 95%

CI: 40.37 – 59.63) is consistent with intervention based studies of similar age groups, using the SOFIT measure for MVPA analysis (McKenzie et al., 2004; Sallis et al., 1997; Verstraete et al., 2007).

Previous school based interventions (McKenzie et al., 2004; Sallis et al., 1997; Verstraete et al., 2007) have used a mix of fitness integration and modified teaching strategy (e.g. shorter instruction times, reduced management etc.) to improve MVPA levels. Integration of fitness activities into PE lessons displays the greatest increase in MVPA undertaken in PE lessons (Lonsdale et al., 2013), however whilst this practice has immediate health benefits, fitness based activities have little influence on the development of motor skills (particularly object manipulation skills) or the cognitive abilities needed to be a skilled sports performer (Nevett et al., 2001a; Janelle and Hillman, 2003). The novel aspect of the PLUNGE intervention was that a focus on effective pedagogical practice and student involvement in active game play produced improved levels of in-class physical activity and FMS development whilst improving cognition during game play.

Enjoyment

There was no significant change in the enjoyment outcome in this investigation. Only two previous investigations have measured changes in enjoyment using a GCA, with one reporting a positive effect (Chatzopoulos et al., 2006), the other not (Tjeerdsma et al.,

1996). Mean scores at baseline for this measure were high among both groups (means scores: both groups > 42/50) and may have resulted in the creation of a ceiling effect (Stone et al., 1998). The high scores indicate that the students in this study enjoyed doing PE (regardless of the curriculum or pedagogical style), limiting the scope of the intervention to improve this construct, particularly during the short time frame undertaken. Furthermore, the enjoyment scale used in the student questionnaire (adapted version of the 12-item Factors Influencing the Enjoyment of Physical Education Questionnaire) (Moore et al., 2009) did not specifically target the types of physical activity that the students were involved in, and as a result may not be sensitive enough to detect true intervention effects in this study.

Professional learning

Physical education continuing professional development has typically been characterized by fragmentation (Armour and Duncombe, 2004). The goal of the PLUNGE intervention was to align theoretical content with practical delivery through a process that involved the teachers as a learner and a teacher (Darling-Hammond and McLaughlin, 1995). It is beyond the scope of this article to focus heavily on the professional development component, however the fidelity and in-class PA results indicate that teachers were able to: i) present the GCA curriculum in the intended way after the mentoring process, and ii) teach GCA

based lessons that were more active than their baseline lessons from the same syllabus strand. It must be acknowledged that lesson coding scales only indicate that teachers made a shift away from skills based instruction and do not indicate the degree to which intervention teachers focused on motor skills, game skills or sociocultural aspects within the activities undertaken. Longer term follow-up is required to evaluate longer term changes to teaching practice, and effects on student outcomes.

With regard to sustainability, whilst initially very intensive (one half day and four in-class sessions), the PLUNGE model could be implemented via a trained mentor working with several schools, with ongoing support reduced dramatically after the initial mentoring of teachers. This process would promote longer term PE quality and PA outcomes through ongoing teacher support (Armour and Duncombe, 2004), and may be viable as an isolated intervention, or as part of a multi-component school program.

Strengths and Limitations

The PLUNGE intervention represents a novel method of exposing students to quality PE using a game centered pedagogical approach. Previous GCA investigations have reported positive effects on student outcomes, however there have been no studies reporting on the efficacy of non-linear pedagogy for improvements in both PA and PE outcomes

simultaneously. With the positive results observed from this investigation, the use of non-linear GCA curriculum is considered viable in the delivery of quality PE in primary schools, as is professional learning for delivery of this pedagogy among primary school teachers.

Despite the novelty of this study, there are some limitations that should be noted. First, this was a pilot investigation, and thus the intervention period was relatively short and the sample size relatively small. Second, due to budget constraints, in-class PA was not measured across all lessons during the study period. Finally, quantitative process evaluation was not undertaken to report the feasibility of the program from the teacher's perspective.

Future research

The simultaneous development of FMS and game play skills in this study offers further opportunity for PESP research to contribute to the improvement of health outcomes for children. There is a positive association between FMS competency and PA levels in children and adolescents (Lubans et al., 2010; Barnett et al., 2011), however effective sports performance involves more than just motor movement skills (Janelle and Hillman, 2003). The association between the abilities of students to play games (game play skills) and PA levels (current and future) is of interest.

In addition, perceived sports competence is considered as a mediator of the relationship between FMS competency and PA in young people (Barnett et al., 2008; Barnett et al., 2011), and interventions targeting both perceived and actual FMS competency are recommended in preventing the PA decline typically observed during adolescence (Morgan et al., 2013). Holt's (2002) assertions that mastery of less complex versions of adult games using a GCA may provide positive affective experiences and feelings of competence should be investigated further for the relationship with PA levels. As actual competence is said to precede perceived competence (Harter, 1978; White, 1959), the ability to improve both FMS and game skills demonstrated by the current investigation provides a starting point for the potential development of perceived sports competence and physical activity levels in young people through exposure to a GCA.

Conclusion

A non-linear GCA intervention simultaneously produced significant PA and PE outcomes. Intervention efficacy was produced through professional learning involving education and mentoring of primary school teachers during delivery of the intervention to students. This investigation begins to provide a rationale for PESP to contribute effectively to the health outcomes of young people through: i) promoting effective pedagogical practice and ii)

using curriculum that is focused on the learning of movement skills other than motor movement patterns.

It is suggested that the longer term sustainability of the positive efficacy observed should be tested with future investigations of a larger scale for longer periods. With the positive link between physical self-perception and improved long term physical activity outcomes in children and adolescents (Barnett et al., 2008; Lubans et al., 2010), measurement of the effects of GCA based interventions on physical self-perception and PA levels should be undertaken.

References

Armour KM and Duncombe R. (2004) Teachers' continuing professional development in primary physical education: lessons from present and past to inform the future. *Physical Education and Sport Pedagogy* 9: 3-21.

Atencio M, Yi CJ, Clara TWK, et al. (2014) Using a complex and nonlinear pedagogical approach to design practical primary physical education lessons. *European Physical Education Review* 20: 244-263.

Barnett LM, Morgan PJ, Van Beurden E, et al. (2011) A reverse pathway? Actual and perceived skill proficiency and physical activity. *Medicine and Science in Sports and Exercise* 43: 898-904.

Barnett LM, Morgan PJ, van Beurden E, et al. (2008) Perceived sports competence mediates the relationship between childhood motor skill proficiency and adolescent physical activity and fitness: A longitudinal assessment. *International Journal of Behavioral Nutrition & Physical Activity* 5: 1-12.

Barnett LM, Van Beurden E, Morgan P, et al. (2009) Childhood Motor Skill Proficiency as a Predictor of Adolescent Physical Activity. *Journal of Adolescent Health* 44: 252-259.

Biesta G. (2010) Five theses on complexity reduction and its politics. In: Osberg D and Biesta G (eds) *Complexity Theory and the Politics of Education.* Rotterdam: Sense Publishers, 5-14.

Blomqvist M, Vanttiinen T and Luhtanen P. (2005) Assessment of secondary school students' decision-making and game play ability in soccer. *Physical Education and Sport Pedagogy* 10: 107 - 119.

Board of Studies NSW. (2007) *Personal Development Health and Physical Education Years K to 6 Syllabus,* Sydney: Board of Studies NSW.

Bunker D and Thorpe R. (1982) A model for the teaching of games in secondary schools. *Bulletin of Physical Education* 18: 5-8.

Chatzopoulos D, Drakou A, Kotzamanidou M, et al. (2006) Girls' soccer performance and motivation: Games vs technique approach. *Perceptual & Motor Skills* 103: 463-470.

Chow J, Davids K, Button C, et al. (2007) The role of Nonlinear pedagogy in physical education. *Review of Educational Research* 77: 251-278.

Chow JY and Atencio M. (2012) Complex and nonlinear pedagogy and the implications for physical education. *Sport, Education and Society*: 1-21.

Cohen K, Morgan PJ, Plotnikoff RC, et al. (2014) Fundamental movement skills and physical activity among children living in low-income communities: a cross-sectional study. *International Journal of Behavioral Nutrition and Physical Activity* 11: 49.

Coyle EF. (2005) Very intense exercise-training is extremely potent and time efficient: a reminder. *Journal of Applied Physiology* 98: 1983-1984.

Darling-Hammond L and McLaughlin MW. (1995) Policies that support professional development in an era of reform. *Phi Delta Kappan* 76: 597.

den Duyn N. (1997) Game Sense - Developing Thinking Players Workbook. Canberra, ACT: Australian Sports Commission.

Dudley D, Okely A, Pearson P, et al. (2011) A systematic review of the effectiveness of physical education and school sport interventions targeting physical activity, movement skills and enjoyment of physical activity. *European Physical Education Review* 17: 353-378.

Eime RM, Young JA, Harvey JT, et al. (2013) A systematic review of the psychological and social benefits of participation in sport for children and adolescents: informing development of a conceptual model of health through sport. *International Journal of Behavioral Nutrition & Physical Activity* 10: 98-118.

Fairclough S and Stratton G. (2005) Physical activity levels in middle and high school physical education: a review. *Pediatr Exerc Sci* 17: 217 - 236.

Gibson JJ. (1979) *An ecological approach to visual perception,* Boston, MA: Houghton-Mifflin.

Gray S and Sproule J. (2011) Developing pupils' performance in team invasion games. *Physical Education and Sport Pedagogy* 16: 15-32.

Gréhaigne J, Wallian N and Godbout P. (2005) Tactical-decision learning model and students' practices. *Physical Education & Sport Pedagogy* 10: 255-269.

Harter S. (1978) Effectance motivation reconsidered: Toward a developmental model. *Human Development* 21: 34-64.

Harvey S, Cushion CJ, Wegis HM, et al. (2010) Teaching games for understanding in American high-school soccer: a quantitative data analysis using the game performance assessment instrument. *Physical Education and Sport Pedagogy* 15: 29-54.

Harvey S and Jarrett K. (2013) A review of the game-centred approaches to teaching and coaching literature since 2006. *Physical Education and Sport Pedagogy*: 1-23.

Holt NL, Strean WB and Bengoechea EG. (2002) Expanding the teaching games for understanding model: New avenues for future research and practice. *Journal of Teaching in Physical Education* 21: 162-176.

Honas JJ, Washburn RA, Smith BK, et al. (2008) The system for observing fitness instruction time (sofit) as a measure of energy expenditure during classroom-based physical activity. *Pediatric Exercise Science* 20: 439-445.

Janelle CM and Hillman CH. (2003) Expert performance in sport: current perspectives and critical issues. In: Starkes JL and Ericson KA (eds) *Expert performance in sports.* Champaign, IL: Human Kinetics, 19-49.

Janssen I and LeBlanc AG. (2010) Systematic review of the health benefits of physical activity and fitness in school-aged children and youth. *International Journal of Behavioral Nutrition & Physical Activity* 7: 40-55.

Jones R, Marshall S and Peters D. (2010) Can We Play a Game Now? The Intrinsic Benefits of TGfU. *European Journal of Physical and Health Education* 42: 57-63.

Kennedy A. (2005) Models of continuing professional development: A framework for analysis. *Journal of In-Service Education* 31: 235-250.

Kirk D. (2010) *Physical Education Futures,* England: Routledge.

Kirk D and Haerens L. (2014) New research programmes in physical education and sport pedagogy. *Sport, Education and Society*: 1-13.

Kirk D and MacPhail A. (2002) Teaching games for understanding and situated learning: Rethinking the bunker-thorpe model. *Journal of Teaching in Physical Education* 21: 177-192.

Larsson H and Karlefors I. (2015) Physical education cultures in Sweden: fitness, sports, dancing … learning? *Sport, Education and Society*: 1-15.

Lave J and Wenger E. (1991) *Situated learning: legitimate peripheral participation,* Cambridge: Cambridge University Press

Lonsdale C, Rosenkranz RR, Peralta LR, et al. (2013) A systematic review and meta-analysis of interventions designed to increase moderate-to-vigorous physical activity in school physical education lessons. *Preventive Medicine* 56: 152-161.

Lubans DR, Morgan PJ, Cliff DP, et al. (2010) Fundamental movement skills in children and adolescents review of associated health benefits. *Sports Medicine* 40: 1019-1035.

Martin EH, Rudisill ME and Hastie PA. (2009) Motivational climate and fundamental motor skill performance in a naturalistic physical education setting. *Physical Education and Sport Pedagogy* 14: 227-240.

McKenzie TL, Alcaraz JE, Sallis JF, et al. (1998) Effects of a physical education program on children's manipulative skills. *Journal of Teaching in Physical Education* 17: 327-341.

McKenzie TL, Sallis JF and Nader PR. (1992) Sofit: System for observing fitness instruction time. *Journal of Teaching in Physical Education* 11: 195-205.

McKenzie TL, Sallis JF, Prochaska JJ, et al. (2004) Evaluation of a two-year middle-school physical education intervention: M-SPAN. *Medicine and Science in Sports and Exercise* 36: 1382-1388.

Memmert D and Harvey S. (2008) The Game Performance Assessment Instrument (GPAI): Some Concerns and Solutions for Further Development. *Journal of Teaching in Physical Education* 27: 220-240.

Miller A. (2015) Games Centered Approaches in Teaching Children & Adolescents: Systematic Review of Associated Student Outcomes. *Journal of Teaching in Physical Education* 34: 36-58.

Miller A, Christensen EM, Eather N, et al. (2015) The PLUNGE randomized controlled trial: Evaluation of a games-based physical activity professional learning program in primary school physical education. *Preventive Medicine* 74: 1-8.

Moher D, Hopewell S, Schulz KF, et al. (2010) CONSORT 2010 explanation and elaboration: Updated guidelines for reporting parallel group randomised trials. *BMJ* 340.

Moore JB, Yin Z, Hanes J, et al. (2009) Measuring Enjoyment of Physical Activity in Children: Validation of the Physical Activity Enjoyment Scale. *Journal of Applied Sport Psychology* 21: S116-S129.

Morgan PJ, Barnett LM, Cliff DP, et al. (2013) Fundamental Movement Skill Interventions in Youth: A Systematic Review and Meta-analysis. *Pediatrics* 132: e1361-e1383.

Morgan PJ and Hansen V. (2008) Classroom Teachers' Perceptions of the Impact of Barriers to Teaching Physical Education on the Quality of Physical Education Programs. *Research Quarterly for Exercise and Sport* 79: 506.

Motl RW, Dishman RK, Saunders R, et al. (2001) Measuring enjoyment of physical activity in adolescent girls. *American Journal of Preventive Medicine* 21: 110-117.

Nathan S and Haynes J. (2013) A move to an innovative games teaching model: Style E Tactical (SET). *Asia-Pacific Journal of Health, Sport & Physical Education* 4: 287-302.

Nevett M, Rovegno I and Babiarz M. (2001a) Chapter 8. Fourth-grade children's knowledge of cutting, passing and tactics in invasion games after a 12-lesson unit of instruction. *Journal of Teaching in Physical Education* 20: 389-401.

Nevett M, Rovegno I, Babiarz M, et al. (2001b) Chapter 6. Changes in Basic Tactics and Motor Skills in an Invasion-Type Game After a 12-Lesson Unit of Instruction. *Journal of Teaching in Physical Education* 20: 353.

Pope RP, Coleman KJ, Gonzalez EC, et al. (2002) Validity of a revised system for observing fitness instruction time. (SOFIT) *Pediatric Exercise Science* 14: 135-146.

Ratel S, Lazaar N, Dore E, et al. (2004) High-intensity intermittent activities at school: controversies and facts. *Journal of Sports Medicine and Physical Fitness* 44: 272-280.
Rhodes C and Beneicke S. (2003) Professional development support for poorly performing teachers: challenges and opportunities for school managers in addressing teacher learning needs. *Journal of In-Service Education* 29: 123-140.
Rink JE, French KnE and Tjeerdsma BL. (1996) Foundations for the learning and instruction of sport and games. *Journal of Teaching in Physical Education* 15: 399-417.
Sallis JF, McKenzie TL, Alcaraz JE, et al. (1997) The effects of a 2-year physical education program (SPARK) on physical activity and fitness in elementary school students. Sports, Play and Active Recreation for Kids. *American Journal of Public Health* 87: 1328-1334.
Salmon J, Brown H and Hume C. (2009) Effects of strategies to promote children's physical activity on potential mediators. *International Journal of Obesity* 33: S66-S73.
Singh A, Uijtdewilligen L, Twisk JR, et al. (2012) Physical activity and performance at school: A systematic review of the literature including a methodological quality assessment *Archives of Pediatrics & Adolescent Medicine* 166: 49-55.
Smith L, Harvey S, Savory L, et al. (2014) Physical activity levels and motivational responses of boys and girls: a comparison of direct instruction and tactical games models of games teaching in physical education. *European Physical Education Review* 21.
Sproule J, Ollis S, Gray S, et al. (2011) Promoting perseverance and challenge in physical education: the missing ingredient for improved games teaching. *Sport, Education & Society* 16: 665-684.
Stolz S and Pill S. (2014) Teaching games and sport for understanding: Exploring and reconsidering its relevance in physical education. *European Physical Education Review* 20: 36-71.
Stone EJ, McKenzie TsL, Welk GJ, et al. (1998) Effects of physical activity interventions in youth: Review and synthesis. *American Journal of Preventive Medicine* 15: 298-315.
Tallir IB, Lenoir M, Valcke M, et al. (2007) Do alternative instructional approaches result in different game performance learning outcomes? Authentic assessment in varying game conditions. *International Journal of Sport Psychology* 38: 263-282.
Tallir IB, Musch E, Valcke M, et al. (2005) Effects of two instructional approaches for basketball on decision-making and recognition ability. *International Journal of Sport Psychology* 36: 107-126.
Tan CWK, Chow JY and Davids K. (2011) 'How does TGfU work?': examining the relationship between learning design in TGfU and a nonlinear pedagogy. *Physical Education and Sport Pedagogy* 17: 331-348.
Tinning R. (2015) Commentary on research into learning in physical education: towards a mature field of knowledge. *Sport, Education and Society*: 1-15.
Tjeerdsma BL, Rink JE and Graham KC. (1996) Student perceptions, values, and beliefs prior to, during, and after badminton instruction. *Journal of Teaching in Physical Education* 15: 464-476.
Turner A. (1996) Myth or reality? *Journal of Physical Education, Recreation & Dance* 67: 46-55.
Turner A and Martinek TJ. (1992) A comparative analysis of two models for teaching games (Technique Approach and Game-Centered (Tactical Focus) Approach). *International Journal of Physical Education* 29: 15-31.
Ulrich DA. (2000) *Test of Gross Motor Development Examiner's Manual,* Austin, Texas: Pro.Ed.

van Beurden E, Barnett LM, Zask A, et al. (2003) Can we skill and activate children through primary school physical education lessons? "Move it Groove it" - a collaborative health promotion intervention. *Preventive Medicine* 36: 493-501.

van Sluijs EMF, McMinn AM and Griffin SJ. (2008) Effectiveness of interventions to promote physical activity in children and adolescents: systemic review of controlled trials. *British Journal of Sports Medicine* 42: 653-657.

Verstraete SJM, Cardon GM, De Clercq DLR, et al. (2007) Effectiveness of a two-year health-related physical education intervention in elementary schools. *Journal of Teaching in Physical Education* 26: 20-34.

White RW. (1959) Motivation reconsidered: The concept of competence. *Psychology Review* 66: 297-333.