ANGLIA RUSKIN UNIVERSITY

FACULTY OF SCIENCE AND ENGINEERING

Do Secondary Sector Physical Education Lessons Support UK Public Health Physical Activity Targets?

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A thesis in partial fulfilment of the requirements of Anglia Ruskin University for the degree of Master of Philosophy (MPhil)

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ABSTRACT

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Abstract

The purpose of this study was to establish the effectiveness of secondary school physical education (PE) lessons, in supporting UK public-health physical activity (PA) recommendations for children and young people. It has been identified that PE as a subject has great potential to support PA targets across whole populations, and the present study aimed to establish how active students are within secondary school PE lessons utilising two methods of PA measurement. The aims of the study were to identify the contribution of PE lessons to daily MVPA attainment across a normal school week, and to analyse MVPA levels within PE lessons to identify how active students are and the influence a number of factors might have on MVPA.

The study recruited 32 female and 30 male participants within year 7 at two state-funded secondary schools within Cambridgeshire, and all were fitted with an ActiGraph accelerometer across 5 school days to monitor daily levels of PA. The System for Observing Fitness Instruction Time (SOFIT) protocol was also used to provide more contextualised PE lesson information. Moderate-to-vigorous physical activity (MVPA) was measured using accelerometers across each day, and then analysed to provide a comparison for PE and non-PE days. In addition, the amounts of MVPA within PE lessons were calculated to establish the contribution of PE to daily MVPA levels, and thus PA targets.

Students engaged in 20.86 minutes more MVPA on PE days (mean 82.57 $\pm$ 27.53 minutes) compared to non-PE days (61.71 $\pm$ 25.80 minutes; p=<0.05). Accelerometer data identified that students were engaged in MVPA within PE lessons for on average 19.34 minutes per lesson ($\pm$ 16.94), and that this represented 32.23% of PE lesson time. PE lesson PA analysis via SOFIT identified an average MVPA level of 17.89 minutes ($\pm$ 7.77) per lesson at 42.65% of the observation period. Analysis via SOFIT also identified a spectrum of MVPA levels

based on different observed PE activities / lessons, and these ranged from a low of 7.27 minutes of student MVPA up to 29.75 minutes.

The data presented within this study highlights the important role that regular PE lessons can have on children's attainment of daily minimum health-based PA targets. Whilst PE lessons within this study positively contributed to the levels of daily MVPA, it is also recognised that the levels of MVPA per PE lesson were below the levels recommended by various vocational bodies. Recommendations are made in order to encourage PE practitioners and school leaders to consider further their curriculum design and implementation methods, in order to maximise PA alongside subject-based learning outcomes.

Key Words: Physical Education, Physical Activity, Moderate-to-vigorous physical activity, Accelerometer, System for Observing Fitness Instruction Time.

Abbreviations: Physical Education (PE), Physical Activity (PA), Moderate-to-vigorous physical activity (MVPA), System for Observing Fitness Instruction Time (SOFIT).

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Introduction

1. Physical activity and health

Physical activity (PA) has been identified as a critical element in ensuring health and well-being across the population, and a clear research focus has developed investigating the role of PA on the health and well-being of children and young people. The Department of Health in the UK identify that within this context the term 'children and young people' refers to individuals who are within the age range of 5 – 18 years (DHSC, 2011). Previous research has identified that a lack of PA amongst this group is a key contributory factor in the development of a several health conditions, including for example the onset of type 2 diabetes, and an increased likelihood of weight gain potentially leading to obesity (Naylor and McKay, 2009). It has been identified that the incidence of non-communicable diseases such as obesity amongst children and adolescents has increased significantly (Abarca-Gomez, et al., 2017), and that physical inactivity (defined as not meeting recommended PA targets) amongst this population is a prime contributory factor (Janssen, et al., 2005). The development of obesity is influenced by genetic factors, alongside behavioural choices that dictate energy intake and expenditure ratios (Romieu, et al., 2017). Obesity has been found to have a significant negative impact on the development of a range of health issues, including increasing the risk of developing type 2 diabetes, cancers, and cardiovascular disease (Hardman and Stensel, 2009).

Previous research has investigated how PA behaviours change over time, from early childhood through adolescence and into adulthood, and established the associated health implications and key influences on such behaviours. Evidence identifies that levels of PA tend to decline throughout childhood years, and this affects both boys and girls (Farooq, et al., 2018). As a result, it is clear that addressing the reduction of PA amongst children and young people has become a key public health target. Furthermore, Telema, et al. (2005) identified that 'PA from age 9 – 18 significantly predicted adult PA, and continuous PA at school age considerably increased the probability of being active in adulthood' (p. 271). Therefore, success in engaging children and young people in regular PA over formative years has the potential to span across a lifetime, thus affording those engaged in such positive behaviours the associated benefits in terms of improved health and well-being.

2. Physical activity - children and young people

The impact of increased PA on the health and well-being of children and young people has been well documented, and is widely acknowledged (PHE, 2015). Through engagement in regular PA children and young people are able to maintain and improve a range of physical indicators, including their lung and heart condition, bone health, muscular fitness, and cardiovascular health markers (WHO, 2014). Furthermore, those young people completing at least the recommended 60 minutes of daily MVPA report having higher levels of cardiorespiratory fitness, muscular endurance, strength, and reduced body fat when compared to inactive peers (WHO, 2014).

A growing body of research has also identified the positive relationship that exists between PA and a range of cognitive functioning constructs, thus supporting the potential of PA to positively influence academic achievement in children and young people. Sibley and Etnier (2003) conducted a meta-analysis of the literature in this area, and the results of their analyses led them to suggest that 'physical activity may actually be related to improved cognitive performance and academic achievement' (p. 253). More recently, McPherson, et al. (2018) conducted a cross-sectional study that supports this viewpoint, identifying a direct and significant association between PA and academic performance. Research conducted by Bangsbo, et al. (2016) provides a consensus that further supports the link between PA and academic performance, stating that PA is beneficial to brain function, structure, and cognition. The authors also provide further applied evidence that includes support for promoting PA bouts before, during, and after-school to develop academic performance in children, and outline that the allocation of additional PA time at the expense of traditional 'academic' lessons does not impede the educational outcomes of students.

In their report 'Global Recommendations on PA for Health' the World Health Organisation reviewed a broad range of available literature, and formulated a range of key recommendations to help countries develop PA related targets for different populations (WHO, 2010). In relation to children and young people, the report identifies that 'an overall evaluation of the evidence suggests that important health benefits can be expected to accrue in most children and youth who accumulate 60 or more minutes of moderate to vigorous physical activity daily' (WHO, 2010 p. 19). In accordance with this recommendation, current UK guidance stipulates that children and young people should engage in at least 60 minutes of MVPA every day (DHSC,2011).

However, research indicates that many children and young people are not achieving the minimum amount every day, and that 81% of adolescents aged 11-17 years were insufficiently active in 2010 (Van Sluijs, et al., 2008; WHO, 2014). Furthermore, Cooper, et al. (2015) identified that across countries only a low percentage of study participants met the 60 minutes daily MVPA recommendation. More specifically, results identified that just 9% of boys and 1.9% of girls achieved this target figure on every day of data recording, and that ≥ 60 minutes MVPA was recorded on just 46% of days for boys and 22% for girls. Evidence from a range of studies also provides consistent support that PA levels decline as the population ages from childhood into adolescence (Hardman and Stensel, 2009). For example, Ortega, et al. (2013) identified that levels of MVPA observed in their study reduced significantly from childhood into adolescence, and also from adolescence into young adulthood. The identification of such trends provides a powerful framework to design appropriate health-related PA interventions across the lifespan, to engage the population in lifestyles and behaviours that support key public health outcomes and priorities.

Several self-report surveys have been completed across the UK aiming to establish current activity patterns amongst children and young people. Sport England have produced the 'Active Lives Children and Young People Survey (CYPS, 2018), which presents data for children and young people (ages 5-16) in England. This report identifies that only 17.5% of respondents complete the recommended minimum of 60 minutes MVPA every day. The CYPS (2018) also indicates that children within school years 5 and 6 have the highest percentage of people achieving the 60 minutes MVPA level recommendations (22%), and that the number reduces as children get older (20% in years 7 and 8, reducing to 14% in years 9-11).

Previous research has investigated sex differences in PA, as well as the influence of ethnicity on PA characteristics (Belcher, et al., 2010). Various studies have identified that participants from minority ethnic groups often engage in lower levels of PA, and are therefore potentially more at risk of developing negative health markers. For example, Eyre, et al. (2013) identified that South Asian children (ages 8-9) attending primary school in the UK engaged in significantly less PA when compared to the majority White European ethnic group. Furthermore, Smith, Aggio, and Hamer (2018) also found that ethnic grouping had an influence on factors including levels of MVPA experienced, and also the amount of sedentary behaviours students were engaged in. The authors highlight that these sedentary habits and

behaviours, particularly when established early in life, may have major implications for future health outcomes in at risk minority groups. Conversely, other research studies have not identified PA related differences across ethnic groups. For example, Kaczynski, et al. (2013) identified that there was no significant difference in PA levels amongst youth participants (2-20 years) when analysed based on different race/ethnicity based groups.

According to the WHO (2014) report adolescent girls tend to be less active when compared to their male peers, a viewpoint supported by several research studies. For example, Armstrong and Welsman (2006) established a consistent finding that boys tend to experience higher levels of PA compared to girls at all ages from 7-18 years, and that these PA levels decrease in both girls and boys as they age. Furthermore, Guthold, et al. (2010) found that 24% of boys met a statutory minimum guideline of 60 minutes of MVPA per day, compared to just 15% of girls. The apparent decline in levels of PA across both sexes as children age has been found in numerous studies (Marques, and Gasper De Matos, 2014).

3. Physical education

The UK government recognises that schools play an important role in providing opportunities for young people to take part in PA, and make a significant contribution to the achievement of recommended activity levels (PHE, 2015). Within schools PE is a subject that is ideally placed in order to help develop levels of PA across the school ages, and is 'unique in the school curriculum as it offers the greatest opportunity for PA and development in the psychomotor domain' (Stratton and Draper, 2019. p.374). According to the Association for Physical Education (AfPE) PE can be defined as 'the planned, progressive learning that takes place in school curriculum timetabled time and which is delivered to all pupils' (AfPE, 2015. p. 2).

The educational aims of the National Curriculum for PE are broad, offering students the opportunity to develop knowledge, understanding, and skills in a range of activities. Key aims of the program include ensuring that pupils are able to develop the competencies needed to excel, engaging students in a range of competitive sports, and to ensure that students are encouraged to lead healthy and active lives (DofE, 2014). Furthermore, Whitehead (2015) also emphasises that PE as a subject has a range of key aims, including skill-focused outcomes that enable pupils to be 'competent, confident, and expert in their techniques, and apply these across difference sports and physical activities' (p. 22). More recently an

increasing focus of the PE agenda in schools has been on developing strategies to promote the health and well-being aspects of PE, recognising how the subject can play a key role in developing student's physical, mental, and social well-being. As such, a priority aspect of the modern PE curriculum is to effectively promote student health and well-being across the school population, alongside the more skill-based outcomes often considered one of the core elements of the subject (Whitehead, 2010).

Despite the established benefits of increased PA on pupil mental and physical well-being, and the relationship between PA and positive learning and attainment outcomes, many secondary schools within the UK have reduced the number of curriculum hours dedicated to sport and PE lessons. In their report 'PE provision in secondary schools 2018', the Youth Sport Trust (YST) identify some key data that helps outline the extent of the issue. The key findings from this report are:

- The average number of timetabled curriculum PE minutes per week reduces as pupils progress through the school years (21% reduction from key stage 3* to key stage 4** on average).
- Over the last 5 years, there has been a significant drop in the number of allocated PE curriculum minutes delivered across the age range (key stage 3 minutes reduced by 20%, and key stage 4 reduced by 38%).
- Within the last academic year 24% of schools report to have seen a reduction in the number of minutes for timetabled core PE at key stage 4, and 10% of schools report a reduction in core PE minutes for key stage 3 students (YST, 2018).

* Key stage 3 relates to pupil ages 11-14, representing school years 7-9

** Key stage 4 relates to pupil ages 14-16, representing school years 10 and 11 (DofE, 2014)

The YST report that 38% of teachers identify the main reason for such reductions are that the core academic subjects (English, Maths, Sciences) have been prioritised, and subsequently allocated additional curriculum time. Moreover, 33% identify that the pressures involved with performance measures such as Progress 8 also heavily influenced decision making in schools, specifically related to the number of hours allocated to core PE lessons. Within secondary education a school's performance is measured by a Progress 8 score, which 'aims to capture the progress that pupils in a school make from the end of primary school to the end

of key stage 4' (DfE, 2020. p. 9). This score is a key factor in school inspection data and the focus of senior management and school leaders on prioritising academic results, due largely to the inspection framework in which they are functioning, means that the reduction of core PE curriculum hours continues to be a very real concern for PE and well-being practitioners.

The National Assembly for Wales through their Health, Social Care, and Sport Committee have also identified the apparent diminished importance placed on PE lessons within some school curriculums (HSCSC, 2019). Within the report 'Physical Activity of Children and Young People' the committee identified that 'PE and activity opportunities are generally not receiving sufficient priority in schools, and are being squeezed out of the school timetable due to other curriculum pressures' (HSCSC, 2019, p. 36). Furthermore, Penney and Evans (1999) expand this theme by stating that historically 'PE is a subject often regarded as of less value than other 'more academic' subjects', and that this process results in a hierarchy that has often promoted 'intellectual labour over practical and vocational endeavour' (p. 93). This historical context that seemingly promotes academia over physical and practical learning, provides an opportunity for school leaders to devise a modern curriculum that supports both academic and physical development in more equal terms.

The UK government through the Department of Education (DofE) states that PE as a subject is compulsory within all schools at ages 4 – 16 years, and that it is at the school's discretion how much curriculum time is allocated to PE. When discussing curriculum requirements and design, specifically relating to PE, the 'gold standard' current UK recommendation is that schools should provide 120 minutes of PE per week as a minimum. The DofE advise schools that it is ***recommended*** that all students receive this minimum allocation of curriculum PE per week within their timetable, although this is not currently a statutory requirement (DofE). Furthermore, the PE and Sport Strategy for Young People (PESSYP, 2008) not only stipulated the importance of access to at least 2 hours of high-quality PE at school each week, but also promoted the concept of the '5-hour offer' through additional opportunities for participation via school, voluntary, and community providers.

Despite the guidance being set by the UK government, and recommendations made by other industry bodies, it is evident that some schools are increasingly reducing the amount of time allocated to curriculum PE delivery. The HSCSC (2019) report identifies that only four out of ten schools were meeting the current UK guidance, and the committee makes specific

recommendations regarding the implementation of the baseline allocation of PE time. They propose to make schools and school leaders more accountable for the physical well-being of their students, through enforcing the 120-minute allowance as a statutory minimum requirement. It is hoped that this accountability will help to ensure that schools are providing students with the required opportunities to be physically active within their education.
The HSCSC (2019) also recognise the need for a revised modern school curriculum to be developed, and that the implementation of this new curriculum could be an opportunity to raise the profile of PE as a core subject. The committee recommends that a key aspect of this enhanced curriculum model should be to ensure that PE has a greater importance placed upon it, including within school inspection criteria. It is hoped that with the quality of PE provision being a core aspect of a school's inspection outcome, school leaders will place greater importance on students mental and physical development through engagement in a highly effective PE curriculum. In addition, Harris (2018) identifies that the inclusion of PE as a core subject has the potential to 'stimulate significant health and educational attainment benefits and ensure greater connectivity between physical education and other curriculum subjects', and that such a move would also stimulate a greater proportion of time being allocated to PE within the school curriculum (p. 5).

4. Physical activity and physical education

With PE being identified as a vital opportunity for schools to positively influence and support PA levels amongst young people, research has identified the extent to which students are physically active within PE lessons. Previous research has investigated PA levels within PE lessons in secondary education (Hollis, et al. 2017). Other research has investigated the contribution of sports clubs and coach behaviour in helping young people to meet PA guidelines (Guagliano, Rosenkranz, and Kolt, 2013). Studies such as that conducted by Fairclough and Stratton (2005) have identified that students engaged in a range of MVPA levels across PE lessons – within this study the MVPA levels accrued ranged from 27 to 47% of PE lesson time. The Association for PE, a recognised representative subject association within the UK, subsequently stated that PE lessons should engage participants in MVPA for a minimum of 50% of the lesson time (AfPE, 2013).

Hollis, et al. (2017) conducted a systematic review and meta-analysis on existing literature relating to PA levels within secondary school PE lessons. From their analyses, it was established that the average time spent in MVPA within secondary school settings was

40.5%. Moreover, when focused on high school students (ages 12-18) this figure reduced to 35.9% of PE lesson time being spent in MVPA. These findings highlight that many PE lessons within schools are not consistently achieving the recommended level of MVPA as outlined by organisations such as the AfPE. Therefore, the present study aims to extend this previous body of literature by focusing on secondary school age PE lessons within the Cambridgeshire region, an area where there appears a paucity of previous research into activity levels within the PE setting alongside PA data obtained via contextualised observational protocols. It was hoped that the inclusion of the SOFIT protocol as an observation-based PA assessment tool would provide strong evidence for its potential usage by PE professionals, due to its high level of accessibility, affordability, and practicality for the on-going analysis of PA levels within PE lessons.

Further anecdotal evidence has also highlighted concerns regarding PA levels within PE lesson in the UK. The Office for Standards in Education, Children's Services and Skills (OFSTED) has identified that in PE lessons students are sometimes 'not fully challenged to work hard', and that learning activities were often completed 'at the expense of high-intensity, sustained physical activity' (OFSTED, 2013. p. 6-7). Furthermore, OFSTED also identified that schools with highly effective teaching of PE delivered lessons that were physically active for extended periods of time leading to an increase in fitness, and provided extended periods allocated to actually practicing and refining skills (OFSTED, 2013). Whilst these comments from OFSTED offer an observation-based insight into current practice within schools, it does appear to reinforce research evidence suggesting that students are not sufficiently active within some PE lessons.

Ethnic background has been found to have a key relationship with the levels of PA experienced in population samples. For example, Brodersen, Steptoe, Boniface, and Wardle (2007) found that ethnic and socio-economic factors influenced PA engagement, with students from an Asian background and black girls being less active than white participants. Reasons for this apparent negative association amongst young people are complex, but possible reasons include a lack of parental awareness of PA recommendations and the existence of cultural and religious barriers making engagement challenging (Trigwell, et al. 2015). In terms of ethnicity based PA research within the PE domain, previous studies have investigated the MVPA levels of students from different ethnic backgrounds. Zhou and Wang (2019) found that students from a white ethnic background were consistently more active

than black students in PE lessons, highlighting that the reasoning behind this remained unclear. There appears a relative paucity of research directly investigating the activity levels of students from different ethnic groups within PE lessons, and therefore it is hoped the present study will contribute valuable evidence in this area.

An important aspect of the research literature in the field of PE has investigated the impact of gender on the levels of MVPA attained within PE lessons, and the contextual factors that may influence PA. Studies such as that conducted by Smith, Lounsbery, and McKenzie (2014) have identified that differences in activity levels within PE lessons can be evident based on gender. More specifically, within this study the authors found that boys were engaged in significantly greater levels of both MVPA and vigorous PA (VPA) when compared to girls. Furthermore, Singerland, Oomen, and Borghouts (2011) established that when comparing boys and girls MVPA levels within PE lessons, a significant difference exists with boys being engaged in significantly more MVPA than girls in secondary education settings (43.2% of lesson time for boys, compared to 36.6% for girls). In addition, this study based in the Netherlands also found that PE intensity levels for girls reduced significantly at the start of secondary school education. The apparent discrepancy between PA levels accrued within PE based on gender is therefore of key importance, and the present study is designed to investigate and analyse data to identify any gender-related differences in MVPA levels within UK-based secondary education PE lessons.

The System for Observing Fitness Instruction Time (SOFIT) tool was originally developed by McKenzie, Sallis, and Nader (1991) as a method of assessing PA levels during PE lessons, alongside teacher behaviour and lesson context variables. This protocol provides a well-researched and cost-effective method of analysing PA levels in the educational setting, with statistical comparisons identifying that results are valid when analysed against data derived from objective measures such as accelerometers and heart rate monitors (McKenzie, Sallis, and Armstrong, 1994; Row, Schuldheisz, and Van Der Mars, 1997). Within the present study the SOFIT protocol was deemed appropriate as an additional PA assessment method, to enable the researcher to gain further insight into the contextual factors that may influence the PA response. In addition, the accessibility and cost-effectiveness of such a protocol provides the potential to support PE professionals in establishing the levels of MVPA attainment in PE lessons within their own settings. Therefore, it was felt that the inclusion of SOFIT within the present study had the potential to provide greater contextual

insight and PA data, and also the findings could further raise awareness of the potential benefits of utilising this protocol across the PE profession.

A number of previous studies have utilised the SOFIT protocol as a means of quantifying PA levels within PE lessons. For example, Sutherland, et al. (2016) identified that students spent 39% of PE lesson time engaged in MVPA, with 10% in vigorous PA. A review of previous studies that used the SOFIT protocol has been conducted by Smith, McKenzie, and Hammons (2019), and this study identified that the percentage of lesson time spent in MVPA ranges between research projects. More specifically, this report highlighted that the percentage of lesson time spent in MVPA ranged from a low of 20.9% to a high of 58.2%, with the median figure across twelve studies being 41.9%. This study re-iterated that the median figure remained below the recommended minimum MVPA target level of 50%, raising legitimate concerns regarding the levels to which students are physically active within some PE lessons.

Previous SOFIT studies have also investigated teacher behaviour, and lesson context, and related these to the levels of PA experienced within the PE setting. For example, Mersh and Fairclough (2010) found that the dominant teacher behaviour within PE lessons was observation, accounting for 34.2% of lesson time. In relation to lesson context, the same authors also identified that 22% of lesson time was devoted to general knowledge instruction, and 14.9% to fitness activity contexts. Through identifying both teacher behaviour and lesson context variables within the applied setting, appropriate key recommendations for PE professionals can be made to support the development of provision that ensures highly effective learning alongside maximising PA levels.

Previous research within the PE setting has also investigated differences in MVPA based on the curriculum activity being undertaken, and this is an important factor in curriculum design and delivery in order to support PA recommendations. For example, Fairclough and Stratton (2005a) identified that students were engaged in the highest levels of MVPA during PE lessons that focused on ‘team games’ (for example football and hockey ‘invasion’ games). Conversely, the least MVPA was recorded during PE lessons that focused on movement activities (examples of movement activities included gymnastics and dance). Moreover, studies such as that conducted by Song, et al. (2018) have also found significant differences in MVPA based on the type of activity being completed, in this case specifically that soccer

classes elicited significantly more MVPA than badminton classes. The authors conclude that 'PE and sport practitioners should find the most parsimonious balance between MVPA and motivation through adjusting games to ensure they meet the developmental needs to their students' (p. 19). This statement helps to support the notion that a school PE curriculum needs to be carefully developed, employing a multi-faceted approach. This approach should consider the learning needs of the students and their stage of development within each activity, alongside promoting engagement and enjoyment that supports the development of improved MVPA levels.

5. Summary

According to Lee and Ellingson (2019) there is clear evidence that 'we now have two strong independent weapons to fight preventable chronic diseases: reduce sitting time and promoting PA' (p.59). This statement applies to the population as a whole, but also specifically to PA levels of children and young people within the UK education system. Therefore, this study is designed to provide an insight in to the daily MVPA patterns of children across a normal school week, to help establish how active our young students are. In particular, the focus will be on establishing the contribution that PE lessons make to student PA levels, and analysing the effectiveness of current PE practice in supporting attainment relating to daily MVPA targets. The study will identify and evaluate the impact of different PE curriculum activities on the levels of MVPA attained, and therefore it is envisaged that key recommendations regarding curriculum design and implementation will emerge. It is hoped that through analysis of the activity data from this study, recommendations for schools can be made in terms of increasing the opportunities for students to be active across the learning day and developing PA within PE lessons. Furthermore, the overall achievement (or otherwise) of daily UK public health PA targets will provide highly relevant data to help create a holistic PA approach that engages all key stakeholders, to help develop children that are physically active across all life settings. The present study will provide a valuable insight into student activity levels, and the teachers influence in determining how active PE lessons are. The research could support the development of teaching strategies that effectively increase PA within PE, thus increasing young people's achievement of PA goals.

6. Aims and hypotheses

The research aims and hypotheses, alongside the key research questions to be explored within the study, are set out below.

Aim A. To identify the contribution of PE lessons to daily MVPA attainment, providing comparisons between PE days and non-PE days

Research Question A. What is the contribution of UK-based PE lessons toward the achievement of daily UK public health minimum PA guidelines for children and young people?

H_0 A= There will be no significant difference in the levels of MVPA experienced on PE days when compared to non-PE days

H_1 A = Participants will engage in significantly greater levels of MVPA on PE days when compared to non-PE days

Aim B. To identify potential differences in MVPA attainment within PE lessons based on sex

Research Question B. Do PE lessons within the Eastern region of the UK enable both boys and girls to attain similar levels of MVPA, or are there clear discrepancies across sexes?

H_0 B = There will be no significant difference in the levels of MVPA experienced during PE lessons based on sex

H_1 B = There will be a significant difference in the levels of MVPA experienced during PE lessons based on sex

Aim C. To identify potential differences in MVPA attainment within PE lessons based on ethnicity

Research Question C. Does the ethnic background of children and young people have an impact on the levels of MVPA experienced during PE lessons in the UK?

H_0 C = There will be no significant difference in the levels of MVPA experienced during PE lessons based on ethnicity

H_1 C = There will be a significant difference in the levels of MVPA experienced during PE lessons based on ethnicity

Method

1. Study design

A quantitative cross-sectional observational study design was utilised. Cross-sectional studies 'describe the prevalence of a health-related outcome in representative samples and relate this to personal or demographic characteristics' (Hardman and Stensel, 2009. p. 18), and is therefore deemed applicable to the current project design.

This study received ethical approval from the Anglia Ruskin University Faculty of Science and Engineering Research Ethics Panel (FST/FREP/18/797).

2. Recruitment

Schools were recruited using a convenience sampling approach, which has been defined as 'a sampling strategy where participants are selected based on their accessibility and/or proximity to the research' (Bornstein, Jager, and Putnick, 2013. p. 361). The advantages of utilising such an approach include that it can be more effective in terms of the time-scale required for recruitment and data collection, and also may require comparatively less financial resources when compared to alternative sampling strategies. Therefore, it was deemed appropriate to base recruitment of schools within the current MPhil study on such an approach, through identifying schools within a reasonable geographical area to enhance access opportunities. However, to ensure impartiality across the study, the researcher targeted state secondary schools across Cambridgeshire where no personal or professional relationships existed. With the key focus on MVPA within PE across the project, the researcher contacted PE leads in secondary schools within the target catchment area. Further meetings were held with those schools expressing an interest in the research, where supplementary details about the project were discussed.

The PE leads were asked to confirm their interest in the schools becoming part of the research project at the end of the introductory meetings, this was confirmed by all staff at this stage. Having received verbal confirmation from the PE leads further contact was then made with the school Headteacher. This referred to the meeting held with the PE lead and provided a letter of introduction, further written details of the project, and the offer of a meeting to discuss the implications for the school should this be of interest. Alongside this, the researcher provided a gatekeeper consent letter, for the Headteacher to consider, sign,

and return on headed paper should they consent to the project being delivered at their school. Following the school recruitment process, two state secondary schools within Cambridgeshire were successfully recruited. Gatekeeper letters were received from both Headteachers, granting access to the schools for research purposes.

Year 7 was selected in order to identify PA levels at an age (11-12 years) where PA often starts to decrease (Marques, and Gaspar De Matos, 2014), and the project recruited 62 participants including both boys and girls from the two different schools (boys n = 30, girls n = 32). Previous studies, such as Fairclough and Stratton (2005a), have used relatively equal male / female participant numbers, in order to facilitate appropriate comparison data based on gender. The sample size was similar to other previous studies in this domain (e.g. Fairclough and Stratton, 2005b), and it was felt this is a feasible sample size within the MPhil project timeline. The majority of subjects were classified as either White British or White European (n=56), with 6 students classifying their ethnic background as either Asian or Black African. This enabled further analysis of PA trends amongst participants from different ethnic backgrounds.

This was a preliminary study that aimed to provide the basis for wider research to be developed, and therefore a sample size calculation was deemed not appropriate. Indeed, the data collected from the present study will be used to derive effect sizes that can be utilised in power calculations to inform future larger studies. By recruiting a sample size of 62 participants it was envisaged that the research outcomes and conclusions would provide the requisite rigour in terms of informing future research and practice.

Within this study the majority of subjects were classified as either White British or White European (n=56), with 6 students classifying their ethnic background as Asian or Black African. This enabled further analysis of PA trends amongst participants from different ethnic backgrounds.

All year 7 pupils attending participating schools were provided with the required information sheets for parents/carers, and for the participants themselves. All information sheets contained the lead researcher's email contact, as a further means of raising any concerns or questions regarding the study. Participants within the study were made aware on several occasions that they can withdraw from the study at any time (via informed

consent/assent, information sheets, assemblies, at the start of data collection) without giving a specific reason, and that doing so will have no negative consequence.

All necessary permissions were obtained prior to data collection, and copies of the relevant documents are contained within the appendix section at the locations listed below in parentheses. The researcher provided the following information sheets and consent / assent forms:

- Information sheet for Headteachers (appendices 1 and 2)
- Headteacher gatekeeper letter (appendices 1 and 2)
- Parent/carer information sheet (appendices 3 and 4)
- Parent/carer consent form (appendix 5)
- Participant information sheet (appendix 6)
- Participant assent form (appendix 7)

In addition, the researcher offered recruited schools the use of materials to raise awareness of the project. This may be through the researcher delivering a year group assembly, providing tutor time activities for year 7 tutor groups, or other opportunities dependent on individual school preference. Finally, an information evening was offered for the researcher to deliver a presentation about the project, and to answer any additional questions from parents/carers and participants.

3. Collation of consent/assent forms

The researcher discussed the process of distribution and collection of the relevant consent forms directly with the PE lead at each school. The aim of this discussion was to ascertain the institutions preferred process for disseminating information to parents/carers, and also for collating returns. For example, some schools make use of electronic communications systems, such as parent mail, to send communications to parents/carers. Other institutions may utilise jotform, or similar on-line form systems, to receive permissions.

For each institution both hard and electronic copies of the information sheets, and consent/assent forms were provided and discussed. The schools assumed responsibility for sending the relevant forms to parents/carers, and to participants. This was managed within the PE department at each school, with regular updates being received regarding the stage of the

process. All consent and assent reply forms were to be collated by identified qualified staff within the school's PE department, with the forms being stored securely at the school site. Prior to data collection starting the lead researcher arranged to obtain copies of the consent and assent forms from the school. Copies of all informed consent and assent forms were stored securely within a lockable filing cabinet at Compass House Annex, Anglia Ruskin University. This annex is also a secure building accessible only to authorised personnel.

4. Pre-project questionnaires

Prior to data collection all assenting participants were asked to complete a short questionnaire (a blank copy of the pre-data collection questionnaire can be found within appendix 8). These questionnaires were completed within the school setting, with the lead researcher and staff from the school available to support pupils if required. The questionnaire was used to identify basic demographic data – age, gender, and ethnicity. This enabled the accelerometer data collected to be analysed and cross referenced to identify key trends across both gender, and ethnic background.

The questionnaire also requested basic medical information about the participant, specifically asking for details of any potential medical issue that may exclude them from taking part in their ***normal*** activities and their ***normal*** PE lessons. Year 7 students who presented with an injury or illness that precludes their usual active participation in PE lessons were excluded from the data collection. All students who provided the necessary consent and assent forms, and were able to take their usual active part in their PE lessons, were included within the sample.

Research sites compiled a list of students where both parental consent and participant assent forms had been returned, thereby meeting eligibility criteria to be included in the data collection. Where potential participants had returned only one of the required permission documents, or were missing the required signatures, follow up meetings took place to ensure all documentation was completed appropriately. All participants remained anonymous throughout the data collection and analysis procedures within this project. The participant lists created for both research sites were stored securely on a password protected spreadsheet, which was only accessible to the lead researcher. Student names were allocated a unique participant ID number, to ensure anonymity throughout the research process.

5. Measurement

The project utilised two key assessment procedures to provide the required data on PA levels amongst participants. Firstly, objective activity monitoring was conducted through participants wearing accelerometers. In addition, live observational analysis within the PE setting allowed the researcher to establish further data on the PA levels of participants, and also how the actions of teachers and the lesson context influenced activity levels.

Within both recruited institutions all year 7 participants received two 1-hour timetabled PE lessons per week, meaning that two sets of MVPA data for PE lessons were obtained for each participant through accelerometry over the week-long recording period. Therefore, over the duration of the study accelerometer derived MVPA levels within PE lessons provided 124 sets of data (two PE assessments per study participant). In addition, 10 SOFIT observations were also carried out to provide further PA assessment alongside lesson-based contextual factors.

6. Accelerometers

Actigraph accelerometers have been used extensively within the research setting to identify levels of PA amongst various cohorts. These devices are acknowledged to be a valid and reliable measure for recording PA levels (Sirard, Melanson, and Freedson, 2000), and have been widely used to provide an objective PA measurement in studies with children and young people (McCann, et al., 2016).

Accelerometers provide a continuous time-stamped method of recording human movement, via the measurement of raw accelerations that are created by subjects (Fairclough, Noonan, and Curry, 2019). The use of wearable accelerometers has a number of benefits when researching PA levels amongst different populations, including the relatively unobtrusive nature of the device which therefore limits direct influence on normal movement patterns within the applied environment. Within the present study the observation of participants engaged in their normal movement patterns within the PE setting was of paramount importance, and therefore the inclusion of accelerometers to record MVPA levels was deemed an appropriate PA monitoring method. Whilst recognising that accelerometers possess a number of benefits when monitoring PA levels in research studies, potential drawbacks associated with using such devices were also considered. Some of the issues relating to the use of accelerometers include the expensive nature of the devices being a

limiting factor, and that the wear location of the device can influence the data obtained (Fairclough, Noonan, and Curry, 2019). The specific protocols and research design utilised in this study included key measures to limit the influence of such factors, in an attempt to ensure validity of the research outcomes.

The use of wearable technology, such as accelerometers, enables researchers to monitor movement patterns over an extended period of time. The ActiGraph accelerometer provides an objective measure of movement across three axes, specifically identifying direction and intensity of accelerations, and the present study employed the GT3X and GT3X+ devices (ActiGraph Corp. Pensacola, FL). These activity monitors were utilised as they do not overly burden participants with excessive equipment, and therefore do not have a significant impact on 'normal' PA patterns.

In terms of the duration of the accelerometer monitoring, Hilderbrand and Ekelund (2017) identify that activity monitors should be worn for 3-7 continuous days, including both weekends and weekdays, in order to help account for day-to-day variations. Furthermore, Trost, McIver, and Pate (2005) provide recommendations regarding the duration of accelerometer recording, identifying that 7 consecutive days provides a reliable measure of normal PA behaviours in children. In line with these recommendations, participants in this study wore the accelerometers on a belt secured to the waist over 7 consecutive days, including weekends. Participants were encouraged to wear the accelerometer every day over the 1-week period, removing the device at night and re-fitting the belt upon waking. Participants were asked not to wear the monitors during any water-based activities (including swimming, bathing etc.), or contact sport situations (within this study this related specifically to full-contact rugby lessons), to ensure both the safety of the participant and maintain optimum condition of the device. The term 'contact sports' could be deemed to include a wide range of curriculum PE activities where contact may be initiated in the normal course of play (such as football, hockey etc.). However, such incidences of potential contact were deemed acceptable as a permissible risk within this project, and no additional curriculum activities were therefore excluded from the study.

The lead researcher attended the research sites at the start of each data collection cycle, in order to provide detailed guidance on the accelerometer protocols employed within the study. This consisted of the lead researcher meeting with participants in an open classroom

area alongside a member of school staff, issuing the devices and belts, and supporting the process of fitting the devices ensuring correct placement in line with manufacturer guidance. All participants were provided with an activity log to record any instances when the device was not worn (see appendix 9), and this document also included instructions regarding the correct placement of the devices on the right hip. The lead researcher provided a full detailed description regarding the completion of the activity log, and this included providing some pre-completed examples to aid participant understanding. In addition, all participants were asked to begin the process of completing the activity log whilst the researcher was in attendance, in order to provide a further opportunity to clarify any aspects of completing this document. Finally, all students were given the opportunity to raise questions either with the lead researcher, or with the member of PE staff present, to support full understanding and compliance with the activity logs.

All participants were supplied with an accelerometer, and the device reference number and student names were cross-referenced and recorded on a secure Excel document. The researcher provided a brief overview of the accelerometer, and this included information on what the device measured and how recordings are calculated. In addition, the researcher explained the type of data that would be obtained at the completion of the recording cycle, and re-iterated the importance of students carrying on their normal daily routines. The researcher provided a detailed demonstration of how to fit the accelerometer, which included information on the placement of the device on the right hip and information on how to adjust the belt fit where required. Participants were then guided through the process of fitting the device themselves, with appropriate guidance provided where appropriate to ensure all students were wearing the device correctly. Through the direct supervision of the initial fitting, and the activity log document providing further guidance, it was felt that participants were well supported to ensure the on-going correct placement of the accelerometers throughout the data collection period. These processes were employed in order to minimise the risk of incorrect wear location negatively impacting on the data obtained.

The accelerometer was used to measure PA during school hours and also ‘out-of-school’ time, to provide a daily measure relating to the amount of time (minutes) each participant spent engaged in MVPA over the duration of the data collection period (7 days). For the purposes of this study, school hours varied slightly between the two research sites. The school day at site one ran from 08.30 – 15.00, and from 08.45 – 14.55 at site two. Therefore,

these times were utilised to quantify what represented PA within and outside of normal 'school hours'. Of particular interest within this study was the analysis of MVPA levels within PE lessons and on those days where PE lessons took place, to ascertain the impact the PE lessons had on the attainment of daily PA goals in children and young people. The lead researcher was provided with curriculum and PE timetable information from both schools, and this enabled PE lesson times and days to be identified. This process subsequently enabled detailed analysis of accelerometer output, specifically obtained during timetabled PE lessons, to be carried out.

Upon completion of the 7-day data collection cycle, the researcher returned to the research sites in order to collect the accelerometers and activity log documentation. This also provided the opportunity for discussions with participants if required, regarding any perceived issues with the devices or data recording that may have influenced the results obtained.

The accelerometer data was verified to ensure that the minimum daily wear time had been met across participants. In order for data to be considered for inclusion in the study, a minimum daily wear time of >499 minutes was set. According to Cain, et al. (2013) previous research has utilised minimum daily wear times ranging from 6-12 hours, and that this decision should be clearly reported prior to data collection. Previous research by Rich, et al. (2013) also identified that for accelerometer-based studies of 7 days in length, a minimum wear time of greater than or equal to 8 hours produces a reliability co-efficient of 0.96. Therefore, within the present study a minimum daily wear time of >499 minutes was deemed appropriate. Accelerometer counts were therefore excluded on days where the minimum daily wear time criteria was not met.

The total daily wear time was calculated utilising the accelerometer output, which provides both 'wear time start' and 'wear time end' calculations. This information was cross referenced with the activity logs, to identify those times where legitimate 'non-wear time' occurred (for example when bathing). In addition to the daily minimum wear time requirement, participants were also required to have produced a minimum of four complete days of PA data in order to be included within the final analyses. This time frame has been recommended as a valid minimum amount of days to ensure a reliable measurement of normal PA patterns in children (Trost, McIver, and Pate, 2005).

The epoch length within this study was set at 60 seconds in order to support PA data being stored across the full 7 days of recording, and this has been a frequently utilised epoch setting within PA research in studies with young people (Cain, et al., 2013). The data was analysed using the cut points outlined by Freedson (2005), and these are illustrated in the table below.

Table 1. Freedson (2005) ActiGraph Cut Points for Children

PA LABEL	CUT POINTS (counts.min^{-1})
Sedentary	0 – 149
Light	150 – 499
Moderate	500 – 3999
Vigorous	4000 – 7599
Very Vigorous	≥ 7600

7. Physical education observations and the system for observing fitness instruction time

The researcher also performed direct observations within a selection of PE lessons at the recruited schools. This involved using the SOFIT assessment tool to record interval based observations that identified student PA levels, teacher behavior and/or actions, and the lesson context (McKenzie, Sallis, & Nader, 1991). This protocol has been validated as an effective measure of PA levels within PE lessons in both the primary (e.g. Powell, Woodfield, and Nevill, 2016) and secondary school sectors (e.g. Fairclough and Stratton, 2005b). The SOFIT protocol provided additional contextual data regarding the PE teaching group, including the lesson content (i.e. what is being taught), location, number of students present, student gender, timings etc.

The SOFIT time sampling observational tool enabled the researcher to identify key research data that enabled potential links between the delivery / teaching activity, and the levels of PA undertaken, to be established. Prior to the study the lead researcher undertook SOFIT protocol training, utilising the in-depth coding protocols guidance and associated pre-recorded video footage of PE lessons in a range of contexts. In addition, the lead researcher undertook pilot SOFIT coding practices in the field, to ensure familiarity with the process. The SOFIT protocol required the researcher to identify a sub-section of participants for observational analysis, with the number being dictated by the size of the teaching group being

observed. For the present study, this was calculated at four students per lesson. In addition, a fifth participant was identified to be used as a back-up, in line with the SOFIT protocol.

The researcher used 10 second coding 'intervals', with 10 seconds of observation being followed by 10 seconds for recording the data observed. Prior to observations the SOFIT pacing (ALR Systematic Observation) podcast was downloaded on to an IPhone, and this was listened to via headphones to ensure the researcher accurately maintained observation and recording intervals. This protocol has been designed for use within PE classes, and specifically reports on the physical activity engagement, lesson context, and instructor behaviour variables outlined in table 2. All observations using the SOFIT protocol began when 51% of students were in attendance within the main teaching and learning space, and continued until the cessation of the practical PE episode – thereby creating an 'observation period' for data collection purposes. For each SOFIT observation four students were identified as focus subjects for PA coding. A blank copy of the SOFIT recording form used within the study can be found within the appendices, section 10.

Within this study a total of 62 participants were recruited across the two research sites. For the purposes of the SOFIT observations, four participants were selected within each PE lesson to be observed and analysed by the lead researcher (plus one 'back-up' participant). Therefore, across the ten SOFIT observations a total of 40 participants were observed, providing relevant PA data for consideration.

Table 2. SOFIT Codings

<table>
<tr><th>LESSON CONTEXT</th><th>INSTRUCTOR BEHAVIOUR</th></tr>
<tr><td>General Content:
(M) e.g. management</td><td rowspan="2">Teacher involvement

What is the teacher doing?

(P) Promotes fitness (prompts, encourages, praises etc.)
(D) Demonstrates fitness (models)
(I) Instructs generally
(M) Manages
(O) Observes
(T) Other task</td></tr>
<tr><td>PE Lesson Content:

KNOWLEDGE:

(K) e.g. physical fitness, general knowledge, rules, tactics, social behaviour, technique

MOTOR CONTENT:

(F) Fitness
(S) Skill practice
(G) Game play
(O) Other</td></tr>
<tr><th colspan="2">STUDENT PHYSICAL ACTIVITY ENGAGEMENT</th></tr>
<tr><td colspan="2">What is the physical nature of the student’s engagement? What is his/her activity levels?

(1) Lying down
(2) Sitting
(3) Standing
(4) Walking
(5) Vigorous</td></tr>
</table>

The SOFIT protocol also provided more contextual data regarding the PE teaching group, including the lesson content (i.e. what is being taught), location, number of students present, student gender, timings etc.

Within the present study the researcher identified specific lessons that would be observed and analysed using the SOFIT protocol. The identification of the lessons to be observed involved scrutiny of each school's PE curriculum map, and the specific model of their delivery of PE lessons across the year 7 cohort. For the purposes of this study, the aim was to identify PE lessons and activities that enabled SOFIT to be used for the analysis of:

1, a range of different PE activities (including both team and individual sports where possible within the curriculum model)
2, both boys and girls single gender groups (where PE was taught in separate gender-based groups), and mixed gender groups where appropriate
3, a spread of ability groupings (where schools taught in 'ability-based' PE groups)

Throughout the project a total of 10 observations took place utilising the SOFIT protocol, and activities were delivered by PE and sport staff covering a range of different curriculum activities. The schools recruited to the study both teach PE predominantly within single sex groups, although some mixed groups are utilised within the smaller academy. The PE leads also confirmed that they do identify confidence bandings or ability-based groupings to set the groups accordingly. Please refer to table 3 for an outline of the observations that took place.

Table 3. PE lesson observations using SOFIT

Observation Number	Group	Activity
1	Girls+	Dance
2	Girls-	Trampoline
3	Boys+	Table Tennis
4	Boys-	Lacrosse
5	Boys+	Football
6	Girls+	Badminton
7	Boys+	Football
8	Girls-	Trampoline
9	Girls	Rounders
10	Boys	Football

The schedule of SOFIT observations outlined in table 3 presented an accurate reflection of the PE curriculum being delivered at the time of data collection. In addition, through collaborative discussions with the PE leads at each school a schedule that effectively targeted a range of both individual and team activities, a range of different teaching staff, and a number of teaching groups was developed that provided a balanced observation schedule. Previous research such as that conducted by Gao, Hannon, Newton, and Huang (2011) have identified that the activity being delivered can have a significant influence on the levels of MVPA accrued. By focusing on a range of activities it was hoped that the PA data from the present study would be effective in establishing activity levels across a number of different lesson topics, which would accurately reflect a modern PE curriculum within secondary schools in the UK.

The project recruited 62 participants, which included both male and female participants enabling PA analysis by gender (boys n = 30, girls n = 32). Within the present study, 5 SOFIT observations took place focusing on boys PE lessons, and 5 observations of girls PE groups. There were 4 participants identified for observation within each PE lesson, therefore the number of participants used for the SOFIT analysis across the study was 40 (boys n = 20, girls n = 20).

8. Accelerometer data analysis

Analysis was conducted using the Freedson, et al. (2005) recommendations of ≥ 500 counts.min^{-1} to be the baseline cut-off point to recognise MVPA. Data was classified for moderate and vigorous PA levels separately, as well as combined into time spent in MVPA, in order to provide further data investigating specific activity levels at the higher end of the intensity spectrum during PE lessons and across different activities.

The accelerometer devices were programmed to sample at 30 Hz. Data files were reintegrated to a 60 second epoch, and non-wear time was defined as 60 minutes of consecutive zeros, allowing for 2 minutes of non-zero interruptions. The first partial day of wear was excluded from the final analysis, in order to reduce the impact of possible reactivity to wearing the device (e.g. increased PA by the participant in the initial wear stage, due to the perceived novelty factor of wearing the device and being monitored). This process did not exclude any of the planned PE lesson data collections at either institution.

PA levels were expressed as total counts, including sedentary minutes, divided by measured time per day (counts/min, cpm). Time spent classed as 'sedentary' was defined as all minutes less than 100 cpm, light activity was designated as 100 to 3000 cpm, and MVPA as more than 3000 cpm.

Participants were asked to maintain a daily activity log, in order to establish any patterns whereby data was unable to be obtained. This included activities where it was not possible or suitable to wear the accelerometer, such as during water based sports or contact sports (rugby union), and also some leisure time activities where participants may elect not to wear the device. During the downloading of the accelerometer data the diaries were used to identify such gaps, enabling the registering of 'non-wear' time.

9. Statistical analysis

Data was managed using Excel and Actilife (ActiGraph Corp. Pensacola, FL), and imported into IBM SPSS Statistics for Windows (version 24.0. Armonk, NY: IBM Corp.). Descriptive statistics using means and SDs identified average levels of PA per day, and specific sub-sections of the day (i.e. during PE lessons). The accelerometer data identified differences in MVPA attained on days where participants took part in PE lessons, and those where PE was not part of the student's timetable. The researcher also stratified by sex, in order to compare differences between girls and boys within PE lessons and sections of the day. T-tests were used to identify trends and key differences in the levels of MVPA experienced on PE and non-PE days across the data collection periods. In addition, t-tests enabled further analysis of MVPA habits and trends across the sexes using PA as a continuous level, ethnic background, and meeting guidelines (yes/ no) respectively. The use of t-tests within the present study was deemed appropriate as this type of statistical analysis enables the identification of significant differences in results across the mean output of two groups (Kim, 2015).

The SOFIT analysis provided data regarding teacher behaviour, lesson context, and PA engagement within PE lessons. The various SOFIT protocol variables were calculated on a lesson-by-lesson basis via direct observation, providing total counts for various levels of PA engagement, lesson contexts, and teacher behaviors. The counts were subsequently converted to percentage of lesson time, providing an output identifying time per lesson for each construct. This enabled further identification of MVPA levels within PE lessons observed by the lead researcher. The SOFIT protocol was used to enable time spent (minutes) in MVPA

across a range of different PE activities to be established, providing a further avenue for discussion regarding the effectiveness of PE activities and MVPA. SOFIT also identified the % time that the teacher was engaged in key leadership parameters (e.g. promoting fitness, observing etc.), providing an insight to these behaviors and their impact on PA engagement within each observation period.

Results

Accelerometer Analysis

The data presented within this section refers to PA levels recorded using the ActiGraph accelerometers.

1. Physical activity levels – all school days, and physical education day comparisons (Research Aim A)

Table 4 identifies that students were engaged in more MVPA on those days where PE lessons took place, and this difference was statistically significant (p=<0.05). On average, this difference equated to students achieving 20.86 minutes more MVPA on PE days, compared to non-PE days.

In terms of total MVPA levels across the school week, the data provides positive information regarding this sample and their achievement of the recommended minimum levels of MVPA per day. Students within the project, on average, exceeded the daily minimum 60 minutes MVPA target by 13.64 minutes.

Table 4. Average Minutes Spent in MVPA During School Days (n=62)

MVPA All School Days	MVPA PE Days	MVPA Non-PE Days
73.64 ± 28.68 minutes	82.57 ± 27.53 minutes	61.71± 25.80 minutes

2. Moderate to vigorous physical activity levels within PE lessons

Table 5 identifies the average amount of MVPA experienced within PE lessons across the project, utilising data from accelerometers. This highlights that within a 1 hour timetabled PE lesson, students were engaged in MVPA for 19.34 ± 16.94 minutes. Further, when expressed as a percentage of lesson time this equates to 32.23% of the PE lesson being in MVPA.

Table 5. Average Minutes and % Time Spent in MVPA During PE Lessons (*n*=62)

Average MVPA Minutes During PE Lessons	19.34 ± 16.94 minutes
Average % of PE Lessons Spent in MVPA	32.23%

3. Moderate to vigorous physical activity levels by gender (Research Aim B)

In terms of differences in MVPA during PE lessons based on gender, table 6 presents the key accelerometer derived data obtained within this project. This highlights that although boys did engage in higher levels of MVPA during PE lessons, the average difference was 0.97 minutes per lesson and statistically non-significant (*p*=0.32).

Table 6. Average Minutes Spent in MVPA within PE Lessons by Sex

Whole Sample (*n*=62)	**Boys (*n*=30)**	**Girls (*n*=32)**
19.34 ± 16.94 minutes	19.97 ± 17.91 minutes	19 ± 16.09 minutes

4. Moderate to vigorous physical activity engagement within PE lessons by ethnicity (Research Aim C)

Table 7 displays the average levels of MVPA experienced within PE lessons, based on ethnic background. This identifies that those participants from a minority ethnic background engaged in higher levels of MVPA within PE lessons (1.77 minutes more on average per PE lesson), although this difference was non-significant (*p*=0.34).

Table 7. Average Minutes Spent in MVPA Within PE lessons by Ethnicity

Asian and Black African (n=6)	**White British and European (n=56)**
20.96 ± 19.88 minutes	19.19 ± 16.69 minutes

System for Observing Fitness Instruction Time Analysis

Analysis of observation lengths identified that despite the timetabled lesson duration being 60 minutes, the mean actual lesson duration during the observations was 41.8 ± 2.86 minutes. The disparity noted was due to factors including changing time, staff taking registers, and travel to the learning space.

1. Physical activity engagement within physical education lessons

The figures presented in table 8 identify that according to SOFIT observations students within PE lessons were engaged in MVPA for on average 42.65% of the observation time (17.82 minutes per lesson). The results also identify that average non-MVPA time (57.35% of lesson time, 23.97 mins per lesson) was 14.7% (average 6.15 minutes per lesson) greater than MVPA time.

Table 8. Average minutes of student PA engagement by SOFIT category (average lesson duration 41.8 mins; *n*=40)

Student PA Engagement	Average Minutes Per Lesson by PA Engagement Code
Lying down	0 mins
Sitting	4.64 mins
Standing	19.33 mins
Walking / Moderate	12.36 mins
Vigorous (expending more energy than ordinary walking)	5.46 mins

In terms of MVPA levels across the 10 observations, table 9 below presents data on lesson-by-lesson minutes spent in MVPA using the SOFIT protocol.

Table 9. Minutes in moderate and vigorous PA Per SOFIT Observation (*n*=40)

Observation No. & PE Group*	1 Girls+	2 Girls-	3 Boys+	4 Boys-	5 Boys+	6 Girls+	7 Boys+	8 Girls-	9 Girls	10 Boys	Total Mins.	Average Mins ± SD
Code 4 - Walking / moderate	9.67	5.45	10.92	17.09	17.85	16.51	17.92	3.67	5.62	19.5	124.2	12.42 ± 6.05
Code 5 - Vigorous	4.49	4.78	2.05	5.09	6.28	4.47	8.6	7	1.65	10.25	54.66	5.47 ± 2.68
MVPA Totals	14.16	10.23	12.97	22.18	24.13	20.98	26.52	10.67	7.27	29.75	178.86	17.89 ± 7.77

* where a + is indicated in the above table, this identifies that the group under observation was deemed to be a 'higher' ability group according to the PE department curriculum model, and a – indicates a 'lower' ability based group. Where neither a + or – is indicated, this identifies that the group under observation was not set based on ability.

Table 9 identifies that across all observations students were engaged in MVPA for an average duration of 17.89 ± 7.77 minutes per lesson when utilising the SOFIT protocol. When focusing on vigorous physical activity (VPA), the average duration per lesson was 5.47 ± 2.68 minutes.

2. Physical activity engagement by physical education lesson / activity

Figure 1 provides details of the curriculum activities delivered, and the amount of MVPA (recorded in minutes) observed within each PE lesson using the SOFIT protocol.

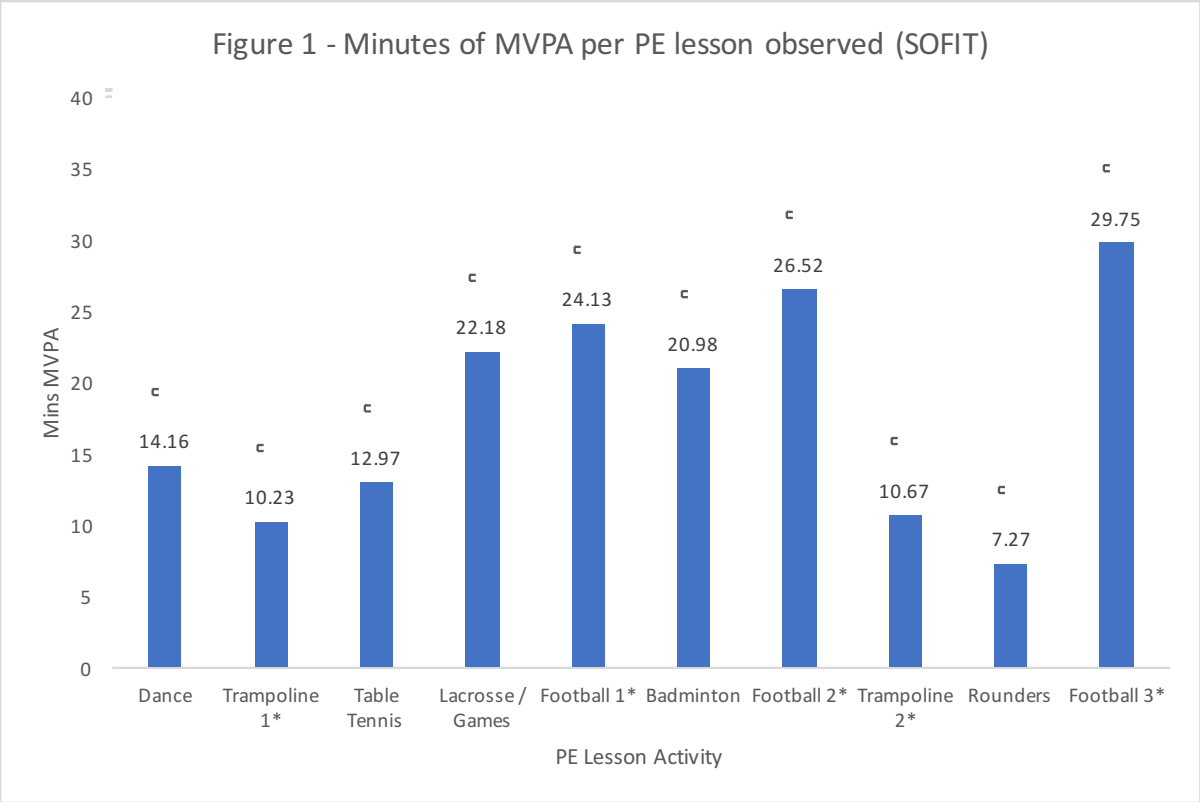

Figure 1. Minutes of moderate to vigorous physical activity per PE lesson observed (SOFIT)
Abbreviations. MVPA - moderate to vigorous physical activity; PE – physical education; SOFIT - system for observing fitness instruction time.
* During the study some curriculum activities were observed using SOFIT more than once, due to the school curriculum model and the timing of academic year. Within figure 1 both trampoline and football were repeat observations, and have therefore been labelled with a numerical value corresponding to the placement of the observed lesson in the schedule.

Figure 1 highlights that football lessons elicited the highest levels of MVPA amongst students. Football 3 recorded 29.75 minutes of MVPA, which represented 76.27% of the actual lesson time. In addition, the average MVPA time across all 3 football lessons was 26.8 minutes.

Conversely, the rounders lesson observed elicited the lowest levels of activity, with a total MVPA of 7.27 minutes representing just 18.18% of the lesson time. The trampoline lessons observed were the next lowest MVPA achieving activities, with trampoline 1 attaining 10.23 minutes of MVPA and trampoline 2 achieving 10.67 minutes. Further details of the % of lesson time spent in MVPA are provided in table 10.

Table 10. Percentage of lesson time spent engaged in MVPA per observation

Dance	Trampoline 1	Table Tennis	Lacrosse / Games	Football 1	Badminton	Football 2	Trampoline 2	Rounders	Football 3	Average %	S.D.
37.27	22.73	30.16	55.46	60.33	48.8	61.67	22.69	18.18	76.27	**43.36**	**19.95**

3. Physical activity engagement in physical education lessons by gender

In terms of time spent in MVPA across genders during the observed PE lessons, it was identified that boys experienced significantly greater time per lesson in MVPA compared to girls (p=0.04). The boys PE groups were engaged in MVPA for an average of 20.93 ± 7.64 minutes per lesson, compared to an average of 12.66 ± 5.25 minutes for the girls lessons observed. Table 11 provides details of the average minutes spent in MVPA during PE lessons for both boys and girls, and the whole sample, using the SOFIT protocol.

Table 11. Minutes Spent in MVPA by Gender (SOFIT)

Whole Sample (n=40)	Boys (n=20)	Girls (n=20)
17.89 (± 7.77)	20.93 (± 7.64)	12.66 (± 5.25)

When focusing on VPA, or code 5 on the SOFIT protocol, the results indicate some variation across lessons and gender. Boys spent an average of 6.45 ± 3.17 minutes per lesson engaged in VPA, compared to girls who achieved 4.47 ± 1.90 minutes. However, this difference was non-significant (p=0.13).

4. Lesson context analysis

The table below provides details of the lesson context analysis for the SOFIT observations.

Table 12. Lesson Context Analysis (SOFIT)

Lesson Context	% of Lesson Time
Management (M)	9.8
Knowledge Content (K)	18.55
Motor Content - Fitness (F)	12.66
Motor Content – Skill practice (S)	26.72
Motor Content – Game play(G)	32.27
Motor Content – Other (O)	0

This table highlights that across the SOFIT observations 71.65% of lesson time was focused on delivering motor content (fitness=12.66%, skill practice=26.72%, game play=32.27%), with knowledge content (18.55%) and management (9.8%) accounting for the remainder of the lesson context delivery.

5. Lesson context analysis by sex

The table below presents further analyses of the lesson context, based on sex.

Table 13. Lesson Context Analysis (SOFIT) by sex

Lesson Context	% of Lesson Time BOYS	% of Lesson Time GIRLS
Management (M)	16.64	3.34
Knowledge Content (K)	19.83	17.33
Motor Content - Fitness (F)	4.54	20.35
Motor Content – Skill practice (S)	16.13	36.73
Motor Content – Game play(G)	42.86	22.26
Motor Content – Other (O)	0	0

The above table highlights that boys spent significantly greater time in Management contexts (p=0.004) across the PE lessons observed. In addition, the results of the t-test analysis also revealed that girls spent significantly greater time in both Fitness (p=0.015) and Skill Practice (p=0.044) contexts. Observed differences in the percentage of lesson time spent in both Game Play and Knowledge Content contexts were evident, however these were non-significant ((p=0.14 and p=0.44 respectively).

6. Teacher involvement analysis

Table 14 below provides details of the teacher involvement / instructor behaviour section of the SOFIT observations.

Table 14. Teacher Involvement Analysis (SOFIT)

Teacher Involvement	% of Lesson Time
Promotes Fitness (P)	7.02
Demonstrates Fitness (D)	4.68
Instructs Generally (I)	33.98
Manages (M)	23.45
Observes (O)	23.38
Other Task (T)	7.49

7. Teacher involvement analysis by sex

The table below presents further analyses of the teacher involvement / instructor behavior construct, based on sex.

Table 15. Teacher Involvement Analysis (SOFIT) by sex

Teacher Involvement	% of Lesson Time BOYS	% of Lesson Time GIRLS
Promotes Fitness (P)	6.83	7.2
Demonstrates Fitness (D)	2.05	7.34
Instructs Generally (I)	30.05	37.95
Manages (M)	28.42	18.42
Observes (O)	26.09	20.64
Other Task (T)	6.56	8.45

Despite the variations highlighted within the results above, none of the stated differences in the teacher involvement analysis was calculated to be statistically significant.

Discussion

The present study identifies that PE lessons within the secondary school setting can play an important role in contributing to the successful achievement of daily MVPA targets.

1. Physical education and daily MVPA attainment (research aim A)

When comparing PE days with non-PE days within this project, results identified that participants engaged in significantly greater levels of MVPA across the day when PE was timetabled within their curriculum (an average of 20.86 minutes more MVPA on PE days). One of the key aims within this project (Research Aim A) was to establish data in order to quantify the contribution that active learning though PE has on the attainment of public-health PA targets. Therefore the researcher was able to reject H_0 A, which predicted that no significant difference in the levels of MVPA experienced on PE days when compared to non-PE days would be evident.

This finding replicates previous research such as that conducted by Chen, Kim, and Gao (2014), and provides further strong evidence of the critical role PE can play in young people's attainment (or otherwise) of health and well-being based PA targets. Therefore, school leaders must ensure that as part of developing a broad and balanced school curriculum, PE is not only protected but enhanced by further extending the amount and regularity of PE lessons in order to support the health and well-being of students. With daily PA targets increasingly being identified as a key public health priority, the opportunity for children and young people to engage in PE lessons more regularly within the school week would have a positive impact on the achievement of MVPA targets and associated health benefits (Sallis, et al., 2012).

Through increasing the regularity of PE lessons within the school curriculum across the learning week, significant gains in the levels of MVPA experienced by children and young people could be attained. In particular, through ensuring that all students within secondary education are accessing high-quality PE lessons, which have a real focus on learning, engagement, and high levels of PA there exists the potential to develop health and well-being across the population both now and into adulthood. The potential impact on student health and well-being that access to regular (even daily) PE lessons and school based PA opportunities could be significant. The realisation of a whole-school curriculum model that

incorporates daily PE lessons is unfortunately not commonplace, despite the clear positive outcomes such a development would have in terms of the attainment of MVPA targets across school age populations (Cheung, 2019). The promotion of opportunities to develop highly active students clearly has relevance to the whole school population, and also has great scope to engage those sections of the secondary population who are the least active and who may not regularly have the necessary access at this important stage in their lives. Where PE becomes a part of the regular routine within education, potentially as part of a physically active core school curriculum, those often most at risk and hard to engage with groups from a PA perspective could potentially receive the greatest benefit. As Cheung (2019) states 'PE lessons are essentially the one time during a day when all students can be active' (p. 71), and therefore such ambitions should be supported in order to seek maximum health and well-being benefits for children and young-people.

The goal of supporting schools to deliver daily PE lessons, alongside providing regular access to a range of non-PE based PA opportunities (for example break and lunchtime activities, physically active learning etc), should be a long-term aim that schools aspire to. This process could be supported through the implementation of government guidance and policies for schools to adhere to (Hills, Dengel, and Lubans, 2015). Such policies would provide a framework whereby school leaders could be held accountable for the promotion of student health and well-being, through mandatory access to PE and PA within the school setting.

In order to facilitate the increased access to high-quality PE within the school setting, there are clearly a number of stakeholders that must work together in order to make such a recommendation a reality. School funding is very much in the public eye, with real-term budgets often cited as being cut. Current data suggests that funding shortfalls of up to £5.4 billion exist over the past 3 years, and that 91% of schools in England have been affected by 'per pupil' funding cuts (NEU, 2019). Consequently, schools are being forced to make difficult decisions in terms of where to prioritise spending. Increasing qualified PE staff to deliver extended high-quality PE lessons and extra-curricular opportunities, alongside improvements in infrastructure such as facilities and equipment, would clearly require a monetary commitment that in the present climate may not be feasible. However, government support for such a campaign could enable additional funding to be diverted into the development of the subject. The potential influence such a development would have on the

health of students would also link to savings elsewhere, due to the reduced burden of non-communicable diseases linked to a lack of PA (Mikkelson, et al., 2019).

The new Education Inspection Framework (EIF) published recently by OFSTED has provided a route for optimism amongst the PE sector, in terms of supporting the subject as a key part of a broad and balanced curriculum (OFSTED, 2019a). The new framework provides a greater emphasis not solely on exam results and data, but also on 'quality of education' and 'personal development' and it is hoped that this will play a role in ensuring that schools recognise more fully that PE can play a vital role in the success of a school. Amongst further consideration will be factors such as a school's provision to ensure mental health and well-being, and this is an area where PE and PA can have a potentially significant part to play (Biddle, et al., 2019). Through OFSTED broadening their focus and inspection framework, it is very much hoped that school leaders will now consider more seriously the vital role that PE plays in a modern broad and balanced school curriculum, and reverse the trend for reducing subject time.

2. Physical education lessons and MVPA attainment based on sex (research aim B)

The present study allowed for analysis of MVPA attainment within PE lessons based on sex, to identify differences in PA levels across boys and girls PE groups. The results obtained within this study provide a valuable insight into the different levels of PA experienced within PE lessons, based on gender. Previous research has often highlighted that girls tend to be less active than boys (WHO, 2014), and results from both the accelerometer derived data and the SOFIT analysis identified that boys did engage in higher levels of MVPA in PE lessons although the extent to which this was evident was somewhat contrasting.

Whilst the accelerometer data did identify that on average girls spent less time in MVPA compared to boys within PE lessons (boys=19.97 ± 17.91 minutes; girls=19 ± 16.09 minutes), the difference was calculated to be 0.97 minutes and statistically non-significant (p=0.32). This finding meant that the researcher was able to accept the null-hypothesis (H_0 B), as no statistically significant difference existed in MVPA based on sex from the accelerometer results.

According to the SOFIT results girls spent significantly less time in MVPA than boys during PE lessons (p=0.04; boys=20.93 ± 7.64 minutes, girls=12.66 ± 5.25 minutes; average MVPA difference = 8.27 minutes), enabling H_0 B to be rejected in relation to the PA data from the SOFIT observations.

The findings of both protocols highlight the apparent discrepancy between activity levels within PE lessons for boys and girls, providing further evidence of the need to carefully consider the design and delivery of the PE curriculum to girls in order to eradicate such inequalities. Previous research has identified a range of potential barriers to girls engagement within PE lessons, including factors such as 'appearance, activity type, and gendered behaviours' (Harris, Sandford, and Hooper, 2018). Furthermore, research has also provided recommendations for methods to engage girls more fully within PE and PA. For example, Timken, McNamee, and Coste (2019) identified that autonomy and relatedness were critical components for successful delivery of PE to girls within their study. Whilst the difference in activity levels within this study was non-significant, it is recommended that practitioners consider carefully the nature and composition of PE groups, including gender-based preferences, in order to maximise engagement and PA levels.

3. Physical education lessons and MVPA attainment based on ethnicity (research aim C)

The present study also provided analyses investigating the impact of a pupil's ethnicity on PA levels within PE lessons. Previous research by the WHO (2014) has identified that minority ethnic groupings often engage is less MVPA compared to their peers. However, results from the present study identified that those students classed as Asian or Black African (n=6) actually engaged in higher levels of MVPA within PE lessons. Asian and Black African participants spent on average 20.96 ± 19.88 minutes engaged in MVPA during PE lessons, compared to their White British and White European peers whose MVPA levels were 19.19 ± 16.69 minutes. The difference in MVPA attainment based on ethnicity was non-significant (p=0.34), thereby enabling H_0 C to be accepted.

Whilst the level of difference in MVPA was non-significant, recognition of the higher MVPA levels based on ethnicity supports other previous research such as that by Belcher et al. (2010), who identified that non-Hispanic Black youths spent more time in MVPA compared to non-Hispanic White youths. There were a relatively low number of ethnic students within the present study, and only two PE observations were utilised that incorporated students

within this classification. Given that one of these observations included the football lesson with the highest level of MVPA across the whole study, this result may be somewhat skewed and further sustained data collection from ethnic minority students would be warranted in future.

Furthermore, studies such as that by Smith, et al. (2018) outline that family limitations and culture may have a negative impact on daily MVPA levels for ethnic minority students, and that school time and extra-curricular clubs were two accessible opportunities for such groups to be physically active. Results from the present study highlight that when provided with the opportunity to be active, for example within the PE lessons observed in this study, ethnic minority students can often be equally or more active than their peers. This finding has important implications in terms of providing opportunities for such groups to engage in sport, exercise, and PA – particularly within the school setting. PE practitioners therefore should aim to encourage and support the whole cohort, including ethnic minority groupings, with an appropriately engaging PE curriculum and extra-curricular offer that takes the needs of a diverse audience into account.

4. Daily moderate to vigorous physical activity levels in children and young people

In terms of MVPA across the school week, results from the present study identify that on average participants were achieving 73.64 ± 28.68 minutes of MVPA per day. Despite previous research identifying a negative correlation between this age group and the achievement of at least 60 minutes of MVPA per day (for example Van Sluijs, et al., 2008), the present study highlights that this cohort was indeed active and achieved an average daily level of MVPA in excess of the recommended floor target. The achievement of this PA target will help ensure that the benefits in terms of physical, mental, and social well-being outlined earlier within this document will be supported for this cohort. Due to the nature of the present study, it is possible that the recruitment of participants would have a natural bias towards students who tend to be more physically active and engaged within PE and sport. As such, these students may be more naturally inquisitive towards the study and their results, and not feel any sense of concern about having their PA habits monitored. Therefore, the achievement of MVPA levels above the recommended minimum daily levels might be expected for this cohort. The topic of recruitment bias for PA studies with children and young

people, specifically relating to this study, is discussed further within the limitations and future considerations section of this document.

5. Physical education lessons and moderate to vigorous physical activity

Whilst the data identifies the positive impact that PE lessons have on achievement of daily MVPA targets, there does appear scope to make PE more effective in terms of increasing student PA during lessons. The successful achievement of this would enhance further the achievement of daily MVPA targets, and with it the health and well-being agenda for students within secondary education. Results from both the SOFIT protocol and accelerometer data identify that the AfPE (2013) recommended minimum level of MVPA was not met within this project. On average students were engaged in MVPA for 17.89 ± 7.77 minutes when using the SOFIT protocol, and 19.34 ± 16.94 minutes based on the accelerometer results. In terms of the AfPE (2013) recommended minimum 50% MVPA target, both sets of data fall below this level. Therefore, consideration should be given to methods of increasing the levels of PA within PE lessons, and this will be discussed further in the subsequent sections.

6. Physical education lessons and contextual factors from SOFIT observations

The inclusion of the SOFIT protocol enabled the researcher to observe PE lessons 'live' and in the applied setting. This method of data collection provided the opportunity for further analysis of PA levels in PE lessons, and also enabled analysis of both lesson context and teacher behavior to investigate the impact these contextual factors might have on PA levels.

The lesson context analysis conducted within this project provides a valuable insight regarding the amount of time students were in engaged in key learning constructs. Results from the present study identify that the majority of lesson time was spent engaged in motor content (71.65%), and this finding replicates other studies this area such as Fairclough et al. (2018) who found that motor content was the predominant lesson context observed.

Within the present study knowledge content accounted 18.55% of lesson time, and this finding is again similar to previous studies within this area. Mersh and Fairclough (2010) found that knowledge content was engaged in for 22% of lesson time.

Whilst both the overall motor and knowledge content results within the present study provide relatively equitable findings to previous studies, the nature of the motor content evident within the lesson observations is worthy of further analysis. The dominant motor focus was on gameplay, accounting for 32.27% of the lesson time during the SOFIT observations. Previous research has identified that situations focusing on gameplay tend to have the greatest potential for MVPA within PE lessons (Hobbs, Daly-Smith, Morley, and McKenna, 2015), therefore the identification of this context as the predominant motor content should support positive attainment of MVPA within the PE lessons.

It is worth noting that although gameplay has often been cited as an effective tool for developing MVPA in PE lessons, such bouts must also be delivered at the appropriate stage and alongside other key learning activities / contexts to ensure effective student learning is taking place. Within the present study observation 10 delivered the highest level of MVPA, and in terms of the focus of this study could be deemed the most effective in engaging participants in MVPA. This lesson engaged students in gameplay for 95.76% of the lesson time, although the educational development and impact of teaching within this episode was negligible.

Perhaps of greater concern within the present study is the identification that just 12.66% of lesson time focused on fitness. According to the SOFIT protocol fitness should be coded to identify 'Time allocated to activities whose major purpose is to alter the physical state of the individual in terms of cardiovascular endurance, strength, or flexibility' (McKenzie, 2012. p. 9), and this also includes any warm-up and cool-down procedures employed. This finding therefore highlights that across this study very little time within lessons was focused on delivering high quality episodes to promote fitness. Through effectively promoting fitness-type activities directly linked to the activity being delivered, it is felt that a significant opportunity for increasing MVPA in PE could be attained. Fitness activities could be delivered in a fun and engaging way, to really support students in developing and understanding the benefits of such activities to overall health, well-being, and individualised performance benefits.

In terms of the teacher behavior construct, across the range of lessons observed in this study the most common teacher behaviour was general instruction (33.98%), and this level is similar to those found in previous studies of this nature (Mersh and Fairclough, 2010).

As stated by Mersh and Fairclough (2010) students are often at their least active when teaching behaviours are classified as general instruction and/or management contexts. Within the lessons observed for this study, it is apparent that a large proportion of the teacher behaviour (57.43%) was linked to these contexts thus potentially imposing a negative influence on MVPA attainment. Therefore this provides further evidence for practitioners to consider the methods being utilised to deliver key learning outcomes within PE lessons. This could focus on reducing the levels of 'management time' and 'direct instruction' behaviours that could limit PA levels, whilst still supporting achievement of key learning goals through more active learning scenarios. For example, management time could be reduced through the effective incorporation of key leadership skills amongst the student population as a key educational focus to develop more self-directed learning strategies.

In terms of SOFIT data based on sex, analysis of the lesson context data did identify evidence of key differences apparent in the delivery of PE lessons across boys and girls PE groups. Data revealed that boys spent significantly greater time in management contexts compared to girls. This finding could, at least partially, be explained through scrutiny of the activities completed for the SOFIT observations. The boys lessons predominantly consisted of team games, whereby teaching staff are often required to manage the environment and activities on a more regular basis. By contrast some of the girls lessons (such as trampoline) were delivered more with on-going activities supplemented with individual coaching / feedback, and therefore less actual management of the group as a whole.

Girls spent significantly greater time engaged in both fitness and skill practice constructs, and these results again could be linked to the nature of the activities completed within the observation lessons. For example, activities such as badminton and trampoline had a very clear learning focus on the skills required for successful performance in these particular sports. This would be expected due to both the highly technical nature of these activities, and the learning stage of the participants.

Finally, whilst some differences were observed across boys and girls PE groups in terms of the teacher involvement analysis, none of the differences were calculated to be statistically significant.

7. Recommendations and wider discussion

The main findings linked to the analysis of PE lessons within the present study should be used to help facilitate further development of a highly effective PE curriculum, in which learning, engagement, and PA levels are maximised to ensure lifelong positive PA habits are developed.

Curriculum design and implementation has the ability to have a significant impact on the levels of PA and learning experienced within PE lessons, and the aim should be to design a curriculum that is creative, individualised, and successful in motivating students to participate in PA (Stratton and Draper, 2019). Results from this study further reinforce that discrepancies can and do exist in terms of PA levels across PE lessons. Stratton (1997) identified that one of the key elements influencing the levels of MVPA experienced by students within PE was the activity being taught. Whilst it is recognised that some activities may require a greater focus on knowledge content and skills based learning, particularly when age and stages of learning are considered, practitioners should aim to maximise learning activities that engage students in 'high-level' physically active learning episodes.

Previous research has devised several planned intervention programs, and recommended enhancements to PE teaching strategies, that aim to support increasing the levels of MVPA experienced within PE lessons. For example, Powell, Woodfield, and Nevill (2015) proposed the SHARP Principles Model, which aimed to increase active learning time in PE. The implementation of this model has been found to significantly increase levels of MVPA experienced within PE lessons, and is one example whereby effective professional development training for PE staff could elicit a sustainable change in teaching practice that enhances key PA outcomes. Anecdotal notes taken during the SOFIT lesson observations in this study also identified that some relatively minor alterations to skills based practices could have elicited a far greater PA response, without harming the learning process. In fact, such changes may well have been successful in engaging learners more fully within the activities, and thereby enhancing not only PA levels but also learning and understanding.

For example, during one football observation a simple passing practice was set up to focus on this key fundamental skill. Whilst the practice was relevant to developing the skills of passing, such as first touch and accuracy of the in-step pass, the participants were very static during the practice – 'wait by the cone to receive the pass, then return the ball to partner'. A

simple suggestion here could have been to add an additional cone behind each player, and asking the students to run to this cone and back after each pass. This would a) increase the PA inherent in the task, b) introduce an element of competition / fun to the task, and c) make a more relevant link to a game-based situation where movement after making a pass is crucial, as opposed to passing and remaining static. This set up could also easily be used to differentiate for the different levels of ability evident across this PE group. Therefore, practitioners and subject leads are recommended to further consider the design of their lessons within schemes of learning, in order to find the optimum balance between learning outcomes and PA levels. A teacher-led focus not solely looking at skill development based learning objectives, but incorporating PA based learning objectives alongside these skill outcomes could clearly have a positive impact on teacher delivery methods, learning focus, and MVPA attainment.

The variation of MVPA minutes across different PE lesson activities indicate that the selection of curriculum activities can have a significant impact on levels of PA within PE lessons. As such, this should be a key factor to consider when designing a curriculum plan within the subject to help support health and well-being amongst students, through maximising activity time. As highlighted in the present study, the levels of MVPA experienced within the lessons observed via the SOFIT protocol ranged from a low of 7.27 minutes during a rounders lesson, up to 29.75 minutes during a football lesson. There are a number of further considerations regarding MVPA levels within PE lessons, however this does identify that across PE lessons significant disparities in the delivery and content of PE lessons can result in a large variation of student PA levels. Again, PE leads should therefore ensure that staff are provided with schemes of learning, and the relevant professional development training, that enables delivery of high quality learning outcomes in a way that also supports development of fundamental fitness levels through enhanced physically active learning.

Further, PE curriculum models also need to evaluate the potential effectiveness of some activities in terms of supporting MVPA targets. This largely refers to the potential, or barriers, that some PE activities have in terms of delivering high levels of sustained PA due to logistical considerations. For example, within the present study the two trampoline lessons both elicited low levels of MVPA. This was due to the simple issue of a PE group having 24 students, with only 4 trampolines on which to bounce. Again, this highlights the important

aspect of considering PE curriculum delivery to ensure it supports and maximises PA. In this particular example, some type of activity stations could have been employed within the teaching area, perhaps to focus on specific fitness/skill requirements linked to trampoline. This would therefore increase levels of MVPA across the group, whilst not hindering opportunities for skill development.

There also needs to be a balance struck between choosing PE activities purely based on the level of activity potential inherent. There will be a variation in activity levels across a range of PE topics depending on the complexity of the task, and the stage of learning of the participants. Further, student engagement and enjoyment of PE activities should be another aspect that is prioritised, in order to develop positive perceptions of PE, sport, and PA. It is worth noting that although the trampoline lessons within this study elicited low levels of MVPA, the students involved were fully engaged and clearly enjoyed the activity itself. The teacher had successfully fostered the student's enjoyment for the activity, and this clearly is a crucial element of effective PE teaching – to develop genuine enjoyment and engagement within activities. As outlined by Stratton and Draper (2019) 'enjoyment is a key part of the physical educators process to engage students in learning' and promote 'lifelong engagement in 'enjoyable' health-promoting PA' (p. 372). Therefore, in this case consideration of how to manipulate group sizes, and/or developing increased opportunities for students to be physically active, would be recommended to increase access to the trampolines and increase PA within this activity.

The tables presented in appendix 11.4 provide a simple comparison of individual v team activities within the observations conducted in this study. The results identify that individual activities elicited an average of 13.80 ± 4.33 minutes per lesson of MVPA. By comparison, team-based activities achieved an average of 21.97 ± 8.69 minutes per lesson. This difference in levels of MVPA between individual and team activities was statistically significant (p= 0.048). Whilst some of the findings might be expected, it does raise a legitimate question regarding how some individual activities are being delivered. Whilst some inevitably have a more fundamental skill learning focus, which may require greater input from the teacher and more requisite non-MVPA episodes, it could be that learning may not be hampered by a more active approach to learning activities. Indeed, Hills, Dengel, and Lubans (2015) identified that high levels of PA can be attained within PE programs, alongside ensuring that positive outcomes across a range of other 'domains' are still achieved. Again, it is not the purpose of

this study to identify one type of activity as better than another in terms of MVPA levels. Rather, it asks practitioners to consider both the PE activities within their curriculum, and also how they are taught, and identify where improvements might be made that will enhance the health outcomes of the students they work with.

Based on the SOFIT observations conducted within this study, PE practitioners should also aim to further develop a focus within lessons on developing student's physical fitness levels. Previous research has identified that over time children and adolescent's levels of cardiorespiratory fitness are deteriorating, and therefore increasing PA levels should be a priority to help reverse this trend (Stratton, et al., 2007). The 'lesson context' analysis presented findings linked to fitness outcomes similar to those observed by Mersh and Fairclough (2010), who identified within their study that just 14.9% of lesson time was devoted to fitness activity contexts. As previously outlined 'Fitness' is coded to identify 'Time allocated to activities whose major purpose is to alter the physical state of the individual in terms of cardiovascular endurance, strength, or flexibility' (McKenzie, 2012. p. 9). Considering the 12.66% figure in this study also includes any warm-up and cool-down sections within each lesson, and the average lesson duration was 41.8 minutes, it seems that during the main body of PE lessons the level of focus on developing student fitness is very low. Therefore, this is an aspect where practitioners have the potential to positively influence student fitness, health, and well-being, via developing a dedicated focus on fitness linked to the activity undertaken.

8. Limitations and future considerations

Whilst the present study provides key evidence and recommendations for improvements to PE content, learning, and PA levels, there are limitations to be acknowledged. Firstly, the present study utilised data taken from two secondary schools within Cambridgeshire. Therefore, this is a relatively small spread of institutions from within a single county in the UK, and consideration to the school profiles should be taken when interpreting the data and applying the findings. The majority of data and participants (n=52) came from a larger than average 11-18 secondary school with 1102 pupils on roll, where the large majority of pupils are of White British heritage and the proportion of disadvantaged students is 'lower than most secondary schools' (OFSTED, 2019b). The remaining participants (n=10) attended a smaller than average secondary school where almost half of the students classified as disadvantaged, and the number of students classified as having special educational needs and

English is an additional language were both above the national average (OFSTED, 2015). The two schools therefore have somewhat different socio-economic profiles based on their student intake, and this range should very much be encouraged within future studies to establish key trends across the whole population. However, the large bias in terms of recruitment numbers from the two schools was slightly disappointing within the present study, and a more even proportion and spread of participants would have been beneficial.

Linked to this, the total number of students recruited within the project was 62, and focused on students within year 7 (ages 11-12). Future research should aim to recruit a wider range of institutions, and higher numbers of participants where possible from across different age ranges. Whilst this number and target population was deemed suitable within the boundaries of the current project, further research should attempt to ascertain results from a greater number and range of participants. Further, with a small institutional and participant recruitment it was not always possible to control for confounding variables within the statistical analyses, and future research should consider repeating the focus of the present study with larger sample sizes across multiple regions across the UK to gain the required level of representative sample.

One of the key difficulties within this type of study is recruiting participants who are genuinely representative of the whole school population, and ensuring no recruitment bias is evident. All relevant information was provided to potential participants at the start of the project, and those interested in volunteering were asked to provide the relevant consents. This process therefore is highly likely to recruit those students who are more active, and regularly take part and compete in various sports, as they will be interested in their results and not 'fear' the process of being monitored. The daily MVPA data received in this project was very positive, and this is again perhaps a reflection on the likely nature of the participants who wanted to be involved. Future research therefore should look at key recruitment tools that will enable a more accurate population sample to be involved in providing PA data. For example, Brown, Schiff, and van Sluijs (2015) highlight the importance of engaging key stakeholders, such as family members, in helping to support children involved within PA research studies. This process could potentially help recruit a wider selection of participants from the school age target population. Furthermore, through working with schools to consider an 'opt-out' process, as opposed to students opting in, may also be a method of widening participant recruitment. As outlined by Miller, et al. (2017) an 'opt-out' process

within health research tends to yield higher levels of recruitment, and also provide a more representative sample. For example, the school could decide to approach this as a whole school or whole year group project, where all students are sampled. Whilst this would still provide the opportunity for some students to decline the invitation, the normalisation of the process would be far more effective as the whole population is doing it. The achievement of this would enable a truly representative sample to be analysed, including the least active populations who may be considered a key priority from a public health perspective.

The timescale of the current project also meant that data collection took place over a number of weeks, within the Spring Term of 2019. Therefore, only limited PE curriculum activities were able to be observed, simply due to the stage of the curriculum delivery within the schools. In light of this future research should aim to expand the timescales for data collection across the academic year, thus enabling observations and data collection from the full range of PE activities. This would then provide extremely valuable PA data across a whole curriculum, as opposed to the much shorter term-based data presented in this study.

The present study has highlighted that the SOFIT protocol has the potential to be a highly effective tool in supporting secondary PE practitioners and leaders when evaluating the levels of PA delivered within PE lessons. As outlined by McKenzie and Smith (2017) the SOFIT protocol can be used in a diverse array of PE settings to monitor PA levels and teacher behaviours, and the present study further supports this view. Furthermore, with the protocol and associated materials being made available free to download, and a range of training and moderation resources also provided, the systematic use of SOFIT is attainable and could enable departmental self-analysis to ensure PA levels are maximised alongside learning and engagement. This protocol could enable a benchmark figure to be established, and provide practitioners with a means to further objectively analyse the effectiveness of curriculum developments and interventions. The achievement of a sustainable and long-term vision for a PE curriculum that maximises PA levels alongside quality learning outcomes, could have a significant impact on the achievement of daily MVPA targets for students. McKenzie and Smith (2017) also identify the importance of strict adherence to established protocols and procedures, to enable more effective reporting of outcomes. Therefore, it is recommended that further research be conducted utilising the SOFIT protocol with a range of PE practitioners across applied PE settings, including evaluation and analysis of SOFIT training

and development opportunities to ensure both inter and intra researcher reliability across outcome measures.

Finally, a considerable limitation within children's PA research appears to be the lack of consensus regarding the cut-points to apply when using accelerometers as a method of tracking MVPA levels. This lack of consensus makes the translation and application of research findings somewhat problematic. The present study utilised Freedson, et al. (2005) cut off points to identify MVPA amongst the subjects, identifying that ≥ 500 counts/minute was the minimum count to identify MVPA. However, alternative research with similar age groups has made recommendations for MVPA minimum counts that include Freedson (1997) at ≥ 803 counts/min, Zhu, Chen, and Zhuang (2013) at ≥ 2800 counts/min, and Hanggi, et al. (2013) at ≥ 3360 counts/minute. As can be seen, there exists a wide discrepancy in the accepted minimum standard count for MVPA to be recorded, and such variations will inevitably lead to significant differences in data outcomes. Therefore, when interpreting or comparing the findings of this study, consideration should be given to children's cut points and the impact the application of these might have had. Future research should aim to develop an industry-wide consensus for the use of accelerometer data amongst children and young people, that would enable more effective analysis of data across the range of very diverse population settings that exist.

9. Conclusions

The findings presented within this study emphasise the important role that PE lessons can play in the achievement of daily PA targets, which have been identified as a key public health priority for children and young people. Through extending access to high-quality PE within the education setting, school leaders and practitioners are uniquely placed to be able to exert significant influence on PA habits for the whole school population. This includes those more at-risk groups, who often may be harder to engage within positive PA behaviours outside of such an environment. This study therefore argues that school leaders should prioritise increasing the regularity of PE lessons, and curriculum time given to the subject, in order to maximise the likelihood of children attaining the 60-minute minimum daily MVPA target.

This study also aims to encourage PE practitioners to consider and evaluate their own practice with a clear focus not only on the learning requirements of a single episode, but also on the levels of PA students are engaged in when trying to attain their learning goals. Primarily, PE leaders are encouraged to consider curriculum design and implementation that develops enjoyment, engagement, and learning activities that ensure students are experiencing levels of PA that support health goals. Finally, the study also highlights the opportunity that exists for practitioners to utilise activity monitoring protocols such as SOFIT to support the process of evaluating current provision and associated levels of activity.

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Appendices

Appendix 1 - School 1 Introductory Letter

Faculty of Science and Technology
Department of Sport & Exercise Science
Anglia Ruskin University
Compass House
Cambridge
CB5 8DZ

Dear

THE SPA PROJECT

I am a postgraduate researcher currently working with Anglia Ruskin University in Cambridge, and I am writing to outline an opportunity for your school to take part in a research project that I am completing.

The SPA (School Physical Activity) Project is investigating young people's levels of physical activity (PA), and will do this by monitoring PA across a 1-week period for year 7 pupils. I am researching how active young people are throughout their normal daily routines, including before, during, and after-school times. My background is within PE teaching, and a specific research interest is to also quantify how active students are within their PE lessons, and the impact of teacher actions on PA in PE.

Participation in the study will provide your school with a unique insight into the daily PA habits of your year 7 students. This information could be extremely beneficial in helping you and your colleagues to reflect on provision and create additional opportunities for your students to be active. In addition, the data could be utilised in a number of different curriculum areas to help enhance the importance and understanding of the health and well-being agenda for young people.

I have enclosed a copy of the parent information sheet that will be supplied should you be interested in your school becoming part of the SPA project. This information sheet provides further details about the project, and what involvement might actually mean for the participants from year 7.

Whilst the enclosed information sheet covers the key elements of the project, I would very much welcome the opportunity to discuss the project in more detail with yourself and perhaps your PE team leader. Should this be of interest, please do not hesitate to contact me via email (Michael.Bond@pgr.anglia.ac.uk) so that we can arrange a mutually convenient meeting time.

May I thank you for your time in this matter.

Kind regards

Mike Bond
Postgraduate Researcher
Anglia Ruskin University

Date

Dear Mike,

This letter is to confirm that I give permission for you to carry out research at our organisation (**INSERT SCHOOL NAME**) for the purposes of your research-based MPhil course at Anglia Ruskin University.

I understand that by giving this permission I am granting you the use and ownership of the data collected, and I am aware that you will write up the results and findings as part of your university course.

I understand that you may disseminate findings at Anglia Ruskin University, and elsewhere, including for publication.

I understand that our organisation will not be named in dissemination and every attempt will be made to ensure anonymity. I also understand that although every attempt will be made to do this, Anglia Ruskin University is unable to completely guarantee that the organisation could not be identified by any party.

I do/do not wish to see a summary of the findings prior to dissemination. If so, I understand that participants will be informed of this.

Yours sincerely

Insert Signature and Name/Title of Headteacher

Please submit on school headed paper/electronic document

Appendix 2 - School 2 Introductory Letter

Faculty of Science and Engineering
Department of Sport & Exercise Science
Anglia Ruskin University
Compass House
Cambridge
CB5 8DZ

Dear ,

THE SPA PROJECT

I am a postgraduate researcher currently working with Anglia Ruskin University in Cambridge, and I have recently met with your Head of PE to discuss an opportunity for North Cambridge Academy to take part in a research project that I am completing.

The SPA (School Physical Activity) Project is investigating young people's levels of physical activity (PA), and will do this by monitoring PA across a 1-week period for year 7 pupils. I am researching how active young people are throughout their normal daily routines, including before, during, and after-school times. My background is within PE teaching, and a specific research interest is to also quantify how active students are within their PE lessons, and the impact of teacher actions on PA in PE.

Participation in the study will provide your school with a unique insight into the daily PA habits of your year 7 students. This information could be extremely beneficial in helping you and your colleagues to reflect on provision and create additional opportunities for your students to be active. In addition, the data could be utilised in a number of different curriculum areas to help enhance the importance and understanding of the health and well-being agenda for young people.

I have enclosed a copy of the parent information sheet that will be supplied should you be interested in your school becoming part of the SPA project. This information sheet provides further details about the project, and what involvement might actually mean for the participants from year 7.

In terms of the data collected, and its associated usage and storage within the project, I can confirm that the following processes are in place to ensure that GDPR guidelines are adhered to:

- Personal data. In terms of the basic personal data collected within the project participants will complete a short questionnaire, and this will include details of name, gender, ethnicity, and date of birth. In addition, this document includes the question 'Do you have any medical conditions that may affect your participation in this study?', along with a space to outline any specific conditions that may be considered relevant.
- Data processing. All of the PA data from the accelerometers will be uploaded and analysed using a computer software package called SPSS. This data analysis will be completed at Anglia Ruskin University by the lead researcher, using personal log-in information and stored electronically within password encrypted documents. All participants in the study will be allocated a unique personal identification number, to ensure anonymity during the analysis of the results.

- Data sharing. In the final written report no institutions or individual participants involved in the research will be identifiable or named. The data created through the research will be utilised by the lead researcher, and may be shared with supervisory research colleagues from Anglia Ruskin University at certain times. The schools will be provided with a copy of the final report, and all stakeholders in the research project will be able to access the key findings though the final published research article.
- Data Storage. The reply slips and questionnaire responses will be securely stored at the point of submission within the host school, and subsequently within locked cabinets and authorised access rooms at Anglia Ruskin University. All electronic data created through the research process will be stored securely, using password protected secure networks, laptops, and documents. The passwords required to access this information will be managed solely by the lead researcher. The data collected will be stored for 6 months, and once this time period has elapsed the information will be deleted.

Whilst the enclosed information sheet covers the key elements of the project, I would very much welcome the opportunity to discuss the project in more detail should this be required. If this would be of interest, please do not hesitate to contact me via email (Michael.Bond@pgr.anglia.ac.uk) so that we can arrange a mutually convenient meeting time.

May I thank you for your time in this matter.

Yours sincerely

Mike Bond
Postgraduate Researcher
Anglia Ruskin University

Date

Dear Mike,

This letter is to confirm that I give permission for you to carry out research at our organisation (**INSERT SCHOOL NAME**) for the purposes of your research-based MPhil course at Anglia Ruskin University.

I understand that by giving this permission I am granting you the use and ownership of the data collected, and I am aware that you will write up the results and findings as part of your university course.

I understand that you may disseminate findings at Anglia Ruskin University, and elsewhere, including for publication.

I understand that our organisation will not be named in dissemination and every attempt will be made to ensure anonymity. I also understand that although every attempt will be made to do this, Anglia Ruskin University is unable to completely guarantee that the organisation could not be identified by any party.

I do/do not wish to see a summary of the findings prior to dissemination. If so, I understand that participants will be informed of this.

Yours sincerely

Insert Signature and Name/Title of Headteacher/Principal

Please submit on school headed paper/electronic document

Appendix 3 - School 1 Parent / Carer Information Sheet

Faculty of Science and Engineering
Department of Sport & Exercise Science
Anglia Ruskin University
Compass House
Cambridge
CB5 8DZ

Parent / Carer Information Sheet
THE SPA (School Physical Activity) PROJECT

I would like to invite your child to take part in the SPA project that is looking at young people's levels of physical activity (PA). Specifically, I am aiming to research how active young people are throughout their normal daily routines.

In order to ensure you make an informed decision, I have produced this information sheet to help parents / carers understand what the project will involve and why it is being carried out. This document will provide you with the key information relating to the project, and hopefully it will answer all of your questions. However, if you still require further information or have any additional questions, I will also provide details of how you can contact me in order to have your questions answered fully.

Why is this project being completed?

The UK government and health agencies recognise the importance of daily PA in helping reduce the development of key health issues across the population, including for children and young people. This includes reducing the incidence and development of chronic diseases, such as type 2 diabetes and heart disease.

Current research indicates that young people are becoming less active, due to a myriad of reasons, and are more at risk of not meeting daily PA goals. As such, concerns have been raised about the health and well-being of young people as PA levels decline.

Physical education (PE) lessons within secondary schools represent an opportunity for students to be physically active, and learn through physical movement. Therefore, PE can play a significant role in helping young people to meet their daily PA goals.

This project is therefore investigating how active young people are throughout the day, including the contribution PE lessons make to their overall levels of PA.

Why has my child been chosen to take part?

The Headteacher of the school has kindly granted permission for me to work with students across year 7. It is the intention of the project to work with all students in year 7 at the school, and this is why your child has been included in the list of potential participants.

Does my child have to take part in this project?

I very much hope that all participants will be keen to take part in the project. However, your child is not obliged to take part, and you have the option to decline the invitation.

If you decide that you would like your child to be involved in the project, I will ask both yourself and your child to sign a consent form confirming that you wish to be included.

Your child's participation in the project is voluntary, and they are free to withdraw at any point.

What will my child be expected to do?

You child will be provided with a small device, known as an accelerometer, that is able to track their PA levels throughout the day. The device is worn on the hip, and does not have any impact on normal movement or activities. All participants will be asked to wear the accelerometer for a 1-week period, in order for me to identify how their PA levels change throughout the course of the day. This will include collecting information during school time (at breaktime and lunchtime, in classroom lessons, and during PE lessons), and also outside of normal school hours.

All participants will be given full guidance on how to attach and use the accelerometer. Once in use, participants are asked to go about their daily patterns as normal. They will not be asked to change anything about their routines and normal behaviour – it is simply an observational tool used to understand more about young people's PA habits over the course of a week.

Are there any additional risks or disadvantages to my child if they take part?

There are no additional risks posed by taking part in the study, above those of normal day-to-day living. The project has been designed specifically to observe PA habits via the accelerometer, and all participants are encouraged to continue with their normal routines. There will be no direct intervention programs or activities as part of this study.

What are the benefits to my child and the school?

It is hoped that participation in the project will be effective in educating students about their own PA habits, engaging them with 'real-life' personal data that enhances their knowledge and understanding of PA and the impact on their own health and well-being.

The project will provide the school with a unique insight into their students, and the PA habits students currently engage in. This information could be used by the school in a number of ways, in order to develop PA across the whole school. For example, the data could support the PE department in reflecting on their current sports club offer, building on identified strengths and enhancing provision for students.

Will my child's involvement in the project remain confidential?

All information and data collected during the project will be kept strictly confidential, and the researcher will ensure that individual participants are not able to be identified in the final report. The data collected will be stored using password protected databases with access strictly limited to research personnel with the relevant authorisation.

Once the research project ends, what happens next?

When the data collection process has been completed, the researcher will begin collating and analysing the results from the project. The final report will identify key themes and conclusions, and aim to make recommendations for future research and practice within schools.

Your school, and in particular the year 7 participants, will be invited to an event where the key findings of the project will be discussed. In addition, copies of the final report will be made available via the school.

If you have any additional questions, or require further information, please do not hesitate to contact me:

Mike Bond (Researcher) – Anglia Ruskin University, Cambridge. Email - Michael.Bond@pgr.anglia.ac.uk

or Lee Smith (Research Supervisor) – Anglia Ruskin University, Cambridge. Email – Lee.Smith@anglia.ac.uk

Appendix 4 - School 2 Parent / Carer Information Sheet

Faculty of Science and Engineering
Department of Sport & Exercise Science
Anglia Ruskin University
Compass House
Cambridge
CB5 8DZ

Parent / Carer Information Sheet
THE SPA (School Physical Activity) PROJECT

I would like to invite your child to take part in the SPA project that is looking at young people's levels of physical activity (PA). Specifically, I am aiming to research how active young people are throughout their normal daily routines.

In order to ensure you make an informed decision, I have produced this information sheet to help parents / carers understand what the project will involve and why it is being carried out. This document will provide you with the key information relating to the project, and hopefully it will answer all of your questions. However, if you still require further information or have any additional questions, I will also provide details of how you can contact me in order to have your questions answered fully.

Why is this project being completed?

The UK government and health agencies recognise the importance of daily PA in helping reduce the development of key health issues across the population, including for children and young people. This includes reducing the incidence and development of chronic diseases, such as type 2 diabetes and heart disease.

Current research indicates that young people are becoming less active, due to a myriad of reasons, and are more at risk of not meeting daily PA goals. As such, concerns have been raised about the health and well-being of young people as PA levels decline.

Physical education (PE) lessons within secondary schools represent an opportunity for students to be physically active, and learn through physical movement. Therefore, PE can play a significant role in helping young people to meet their daily PA goals.

This project is therefore investigating how active young people are throughout the day, including the contribution PE lessons make to their overall levels of PA.

Why has my child been chosen to take part?

The Headteacher of the school has kindly granted permission for me to work with students across year 7. It is the intention of the project to work with all students in year 7 at the school, and this is why your child has been included in the list of potential participants.

Does my child have to take part in this project?

I very much hope that all participants will be keen to take part in the project. However, your child is not obliged to take part, and you have the option to decline the invitation.

If you decide that you would like your child to be involved in the project, I will ask both yourself and your child to sign a consent form confirming that you wish to be included. Your child's participation in the project is voluntary, and they are free to withdraw at any point.

What will my child be expected to do?

You child will be provided with a small device, known as an accelerometer, that is able to track their PA levels throughout the day. The device is worn on the hip, and does not have any impact on normal movement or activities. All participants will be asked to wear the accelerometer for a 1-week period, in order for me to identify how their PA levels change throughout the course of the day (during school - at breaktime and lunchtime, in classroom lessons, and PE lessons; and also outside of school hours).

All participants will be given full guidance on how to attach and use the accelerometer. Once in use, participants are asked to go about their daily patterns as normal. They will not be asked to change anything about their behaviours – it is simply an observational tool used to understand more about young people's PA habits over the course of a week. Participants are also asked to complete a short questionnaire, which will ask for basic information such as date of birth, gender, and ethnicity. In addition, this questionnaire will also ask for details of any medical conditions which may hinder participation in the project.

Are there any additional risks or disadvantages to my child if they take part?

There are no additional risks posed by taking part in the study, above those of normal day-to-day living. The project has been designed specifically to observe PA habits via the accelerometer, and all participants are encouraged to continue with their normal routines. There will be no direct intervention programs or activities as part of this study.

What are the benefits to my child and the school?

It is hoped that participation in the project will be effective in educating students about their own PA habits, engaging them with 'real-life' personal data that enhances their knowledge and understanding of PA and the impact on their own health and well-being.

The project will provide the school with a unique insight into their students, and the PA habits students currently engage in. This information could be used by the school in a number of ways, in order to develop PA across the whole school. For example, the data could support the PE department in reflecting on their current sports club offer, building on identified strengths and enhancing provision for students.

Will my child's involvement in the project remain confidential?

All information collected will be kept strictly confidential, and the researcher will ensure that individual participants are not able to be identified in the final report. The data will be stored using password protected databases with access strictly limited to research personnel with the relevant authorisation.

Once the research project ends, what happens next?

When the data collection process has been completed, the researcher will begin collating and analysing the results from the project. The final report will identify key themes and conclusions, and aim to make recommendations for future research and practice within schools. The data collected will be stored for a period of up to 6 months. Your school, and in particular the year 7 participants, will be invited to an event where the key findings of the project will be discussed. In addition, copies of the final report will be made available via the school.

If you have any additional questions, or require further information, please do not hesitate to contact me:

Mike Bond (Researcher) – Anglia Ruskin University, Cambridge. Email - Michael.Bond@pgr.anglia.ac.uk

or Lee Smith (Research Supervisor) – Anglia Ruskin University, Cambridge. Email – Lee.Smith@anglia.ac.uk

Appendix 5 - Parent / Carer Consent Form

Faculty of Science and Engineering
Department of Sport & Exercise Science
Anglia Ruskin University
Compass House
Cambridge
CB5 8DZ

Participant Consent Form
(Parent/Carer of Young Person Age 11-16)

THE SPA PROJECT

NAME OF PARTICIPANT:

NAME OF PARENT/CARER PROVIDING CONSENT:

Title of the project: Do Secondary Physical Education Lessons Effectively Support Physical Activity Targets?

Main investigator and contact details: Mr Mike Bond (Michael.Bond@pgr.anglia.ac.uk)

Research Supervisor and contact details: Dr Lee Smith (Lee.Smith@anglia.ac.uk)

1. I agree to my son/daughter taking part in the above research project. I have been provided with and read the Participant Information Sheet for the study. I understand what my son/daughter's role will be in this research, and all of my questions have been answered to my satisfaction.

2. I understand that my son/daughter is free to withdraw from the research at any time, without giving a reason.

3. I understand that we are free to ask any questions at any time before and during the study.

4 I understand what will happen to the data collected from my son/daughter for the research.

5. I have been provided with a copy of this form and the Participant Information Sheet.

Data Protection: I agree to the University[1] processing the data which has been supplied. I agree to the processing of such data for any purposes connected with the Research Project as outlined to me.

Name of participant (print)……Signed……Date……

Name of person
providing consent (print)……Signed…… Date……

PARTICIPANTS MUST BE GIVEN A COPY OF THIS FORM TO KEEP FOR THEIR RECORDS

[1] "The University" includes Anglia Ruskin University and its Associate Colleges.

NOTIFICATION OF WISH TO WITHDRAW FROM THIS STUDY

Title of the project: Do Secondary Physical Education Lessons Effectively Support Physical Activity Targets?

If you wish to withdraw from the research, please speak to the lead researcher (Mike Bond) or email them at Michael.Bond@pgr.anglia.ac.uk stating the title of the research project. You do not have to give a reason for why you would like your son/daughter to withdraw. Please let the researcher know whether you are/are not happy for them to use any data from your son/daughter collected to date, in the final write up and dissemination of the research.

Version/Date MJB/21.11.18

Appendix 6 - Participant Information Sheet

Faculty of Science and Engineering
Department of Sport & Exercise Science
Anglia Ruskin University
Compass House
Cambridge
CB5 8DZ

Participant Information Sheet
(Young Person Age 11-16)

THE SPA PROJECT

Hello, my name is Mike and I need your help with a project that I am doing at University. I would like to learn more about how active pupils of secondary school age are throughout the day.

Why is this project being completed?

This SPA (School Physical Activity) project will help me to understand how various things contribute to young people's activity levels over a 1-week period. We (hopefully!) all know that being more active is a good thing for our health, so the project will provide some valuable information on this topic.

Why have I been chosen to take part?

Your Headteacher has kindly given their permission for me to work with students in year 7 at your school. Therefore, I am hoping to work with as many year 7 students as possible.

What will I be expected to do?

Nothing different to usual! You will be provided with a small piece of equipment, called an accelerometer. You will wear this device for a whole week, and go about your normal routines as usual both inside and outside of school.

What is an accelerometer? How will it impact on me in my lessons?

An accelerometer is a small device worn on your hip that monitors your activity levels. It will not impact on you at all, and you will hardly notice that you are wearing it! This device will provide me with the information I need on your levels of activity throughout the week.

How often will this happen?

You will be provided with an accelerometer to wear for a 1 week period. This will happen to each participant only once during the project. I will ask you to provide your permission to take part in the study. This is called an assent form.

What does this mean?

This simply means that you are telling us that you are happy to take part in the study. Your parents / carers will also be asked to provide their consent for you to take part.

Do I have to take part in this study?

No! I very much hope that you will want to take part, but you do not have to. If you decide to take part, and later change your mind, that is also OK. You can cease your participation at any point, and will not be asked to explain why.

Are there any additional risks to taking part in the study?

This project is designed in a way that does not present any additional risks to you as a participant. It should be fun to be a part of, and provide some interesting information regarding how active you are throughout the week.

What should I do now?

Now that you have been given the information about the study, you need to think about whether you are happy to be a part of it or not. If you are happy to take part, you will need to sign the assent form as discussed earlier.

I have further questions, who can I ask about this?

You parents / carers have also been given some more detailed information about the project. They may well be able to answer some of your questions.

If not, you can contact me either in person when I am in the school, or by email - Michael.Bond@pgr.anglia.ac.uk. Alternatively, you could ask your teachers to contact me on your behalf!

Appendix 7 – Participant Assent Form

Faculty of Science and Engineering
Department of Sport & Exercise Science
Anglia Ruskin University
Compass House
Cambridge
CB5 8DZ

Participant Assent Form
(Young Person Age 11-16)

THE SPA PROJECT

Name of Researcher: Mike Bond

Name of Participant:

Child/adolescent (or if unable, parent or guardian on their behalf) to circle all they agree with:

- Have you read the information sheet? Yes/ No
- Has someone explained this project to you? Yes/ No
- Do you understand what this project is about? Yes/ No
- Have all of your questions about this project been answered? Yes/ No
- Do you understand it's OK to stop joining in this project at any time? Yes/ No
- Are you happy to take part? Yes/ No

If any answers are 'no' or you do not want to take part, do not sign your name! If you do want to take part, you can write and sign your name below:

Your Name _____ Date _____ Signature (if appropriate) _____

Your parent/carer's name _____ Date _____ Signature _____

Name of Person taking assent _____ Date _____ Signature _____

Appendix 8 – Participant Pre-Data Collection Medical Questionnaire

Faculty of Science and Engineering
Department of Sport & Exercise Science
Anglia Ruskin University
Compass House
Cambridge
CB5 8DZ

Participant Questionnaire

THE SPA PROJECT

Please complete the table below, by answering each of the questions in the space provided.

Student Name	
Age	
Gender	
Ethnicity (please describe your ethnic group or background)	
Do you have any medical conditions that may affect your participation in this study?	YES / NO
If you answered YES to the previous question, please provide a brief outline in the space provided	

Appendix 9 – Activity Monitor Log

Activity Monitor Log

Dear participant,
Firstly, thank you for agreeing to wear an activity monitor on your hip for 7 days. Your help with this project is very much appreciated. Please see below some general guidance for wearing the activity monitor:

What do I need to do?

- Wear the monitor for 7 consecutive days. Don't worry whether you are active or spend a lot of time sitting or resting. The monitor will record all of your activities, even sitting.
- Put the monitor on after you get up, either under or over your clothes. Wear it on your right hip, underneath and in line with your right armpit. Wear the belt at your natural waistline with the buckle at the front so it is in the same position each day. The black circle is always pointed upwards.

- Record in this Activity Monitor Log the time you put the hip monitor on (straight after getting up) and the time you take it off (just before you go to bed). Please fill in this Activity Monitor Log every day!

When do I take off the monitor?

- Take the monitor off just before you go to bed.
- Take off the monitor if you go swimming, or if you take a bath or shower. Please remember to put them back on once you are dry. When you remove the monitor for these activities, please record the times the device was off and the reason.
- If you are playing a contact sport such as rugby, take the monitor off prior to any contact sessions. Again, record the times when the monitor was not worn in this monitor log.

When will I return it?

- You will wear this monitor for 7 days. I will confirm in due course the exact date and time where we can meet to return the monitor.

If you have any further questions, please do not hesitate to email me at the address below. Thank you once again for your help with this project.

Kind regards
Michael Bond
michael.bond@pgr.anglia.ac.uk

Participant ID:

Day One Activity Monitor Log

Today's date (DD/MM/YY): -

_____

Day:

_____

Time I put on the hip monitor on (straight after getting up):

_____

Time I took the hip monitor off (just before going to sleep):

_____

Times I took the hip monitor off during the day:

- I took the hip monitor off from _____ : _____ am/pm until _____ : _____am/pm because I
  _____
  _____
  ____

- I took the hip monitor off from _____ : _____ am/pm until _____ : _____am/pm because I
  _____
  _____
  ____

- I took the hip monitor off from _____ : _____ am/pm until _____ : _____am/pm because I
  _____
  _____
  ____

ACTIVITY NOTES (use this space if you wish to record any additional information about your activities during the day – please note, this is not compulsory)

Appendix 10 – SOFIT Recording Form

1 = lying
2 = sitting
3 = standing
4 = walking/moderate
5 = vigorous (expending more energy than ordinary walking eg running, jogging, skipping, hopping, pedalling etc)

M = general content
K = knowledge content
F = fitness
S = skill practice
G = game play
O = free play

P = promotes fitness
D = demonstrates fitness
I = Instructs generally
M = manages
O = observes
T = other task

Subject	Interval	Student Activity	Lesson Context	Teacher Involvement
A	1	1 2 3 4 5	M K F S G O	P D I M O T
	2	1 2 3 4 5	M K F S G O	P D I M O T
	3	1 2 3 4 5	M K F S G O	P D I M O T
	4	1 2 3 4 5	M K F S G O	P D I M O T
	5	1 2 3 4 5	M K F S G O	P D I M O T
	6	1 2 3 4 5	M K F S G O	P D I M O T
	7	1 2 3 4 5	M K F S G O	P D I M O T
	8	1 2 3 4 5	M K F S G O	P D I M O T
	9	1 2 3 4 5	M K F S G O	P D I M O T
	10	1 2 3 4 5	M K F S G O	P D I M O T
	11	1 2 3 4 5	M K F S G O	P D I M O T
	12	1 2 3 4 5	M K F S G O	P D I M O T
B	1	1 2 3 4 5	M K F S G O	P D I M O T
	2	1 2 3 4 5	M K F S G O	P D I M O T
	3	1 2 3 4 5	M K F S G O	P D I M O T
	4	1 2 3 4 5	M K F S G O	P D I M O T
	5	1 2 3 4 5	M K F S G O	P D I M O T
	6	1 2 3 4 5	M K F S G O	P D I M O T
	7	1 2 3 4 5	M K F S G O	P D I M O T
	8	1 2 3 4 5	M K F S G O	P D I M O T
	9	1 2 3 4 5	M K F S G O	P D I M O T
	10	1 2 3 4 5	M K F S G O	P D I M O T
	11	1 2 3 4 5	M K F S G O	P D I M O T
	12	1 2 3 4 5	M K F S G O	P D I M O T
C	1	1 2 3 4 5	M K F S G O	P D I M O T
	2	1 2 3 4 5	M K F S G O	P D I M O T
	3	1 2 3 4 5	M K F S G O	P D I M O T
	4	1 2 3 4 5	M K F S G O	P D I M O T
	5	1 2 3 4 5	M K F S G O	P D I M O T
	6	1 2 3 4 5	M K F S G O	P D I M O T
	7	1 2 3 4 5	M K F S G O	P D I M O T
	8	1 2 3 4 5	M K F S G O	P D I M O T
	9	1 2 3 4 5	M K F S G O	P D I M O T
	10	1 2 3 4 5	M K F S G O	P D I M O T
	11	1 2 3 4 5	M K F S G O	P D I M O T
	12	1 2 3 4 5	M K F S G O	P D I M O T
D	1	1 2 3 4 5	M K F S G O	P D I M O T
	2	1 2 3 4 5	M K F S G O	P D I M O T
	3	1 2 3 4 5	M K F S G O	P D I M O T
	4	1 2 3 4 5	M K F S G O	P D I M O T
	5	1 2 3 4 5	M K F S G O	P D I M O T
	6	1 2 3 4 5	M K F S G O	P D I M O T
	7	1 2 3 4 5	M K F S G O	P D I M O T
	8	1 2 3 4 5	M K F S G O	P D I M O T
	9	1 2 3 4 5	M K F S G O	P D I M O T
	10	1 2 3 4 5	M K F S G O	P D I M O T
	11	1 2 3 4 5	M K F S G O	P D I M O T
	12	1 2 3 4 5	M K F S G O	P D I M O T

Lesson Details

DATE	**SCHOOL**	**YEAR GROUP – 7**
PERIOD	**TEACHER**	**GROUP /** **B+ / B- / G+ / G-**
START TIME	**FINISH TIME**	**OBSERVATION DURATION**
TOTAL NUMBER OF STUDENTS	**OBSERVER INITIALS – MJB**	**PAGE 1 2 3 4 of**
ACTIVITY	**LESSON LOCATION**	

Student Selection ID / Characteristics

Participant A	Participant B	Participant C	Participant D

Notes

Appendix 11 – SOFIT Data Analyses

11.1 Background Data for SOFIT Observations

	Dance	Trampoline	Table Tennis	Lacrosse / Games	Football	Badminton	Football	Trampoline	Rounders	Football	Mean	S.D.
Class Size	24	28	26	25	29	22	24	24	12	14	22.8	5.57
Gender	F	F	M	M	M	F	M	F	F	M		
Group	G+	G-	B+	B-	B+	G+	B	G	G	B		
Timetabled Duration (mins)	60	60	60	60	60	60	60	60	60	60	60	0.00
Actual Duration (mins)	38	45	43	40	40	43	43	47	40	39	41.8	2.86
Number of SOFIT Intervals	110	132	126	110	121	125	120	141	121	118	122.4	9.40

11.2 SOFIT Codings for PA Engagement

STUDENT ACTIVITY											TOTALS	%	Mean	S.D.
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
2	28	15	56	1	0	18	3	10	5	0	136	11.11	13.6	17.49
3	41	87	32	48	48	46	43	99	94	28	566	46.24	56.6	26.32
4	28	16	32	47	54	48	50	11	17	59	362	29.58	36.2	17.57
5	13	14	6	14	19	13	24	21	5	31	160	13.07	16	7.96
Total	110	132	126	110	121	125	120	141	121	118	1224	100		

11.3 SOFIT MVPA Analysis Per Activity

STUDENT ACTIVITY	Dance		Trampoline 1			Table Tennis			Lacrosse / Games			Football 1		
Code	% Lesson in Code	Mins in Code	Code	% Lesson in Code	Mins in Code	Code	% Lesson in Code	Mins in Code	Code	% Lesson in Code	Mins in Code	Code	% Lesson in Code	Mins in Code
4	25.45	9.67	4	12.12	5.45	4	25.4	10.92	4	42.73	17.09	4	44.63	17.85
5	11.82	4.49	5	10.61	4.78	5	4.76	2.05	5	12.73	5.09	5	15.7	6.28
MVPA Totals	37.27	14.16	MVPA Totals	22.73	10.23	MVPA Totals	30.16	12.97	MVPA Totals	55.46	22.18	MVPA Totals	60.33	24.13

STUDENT ACTIVITY	Badminton			Football 2			Trampoline 2			Rounders			Football 3		
Code	Code	% Lesson in Code	Mins in Code	Code	% Lesson in Code	Mins in Code	Code	% Lesson in Code	Mins in Code	Code	% Lesson in Code	Mins in Code	Code	% Lesson in Code	Mins in Code
4	4	38.4	16.51	4	41.67	17.92	4	7.8	3.67	4	14.05	5.62	4	50	19.5
5	5	10.4	4.47	5	20	8.6	5	14.89	7	5	4.13	1.65	5	26.27	10.25
MVPA Totals	MVPA Totals	48.8	20.98	MVPA Totals	61.67	26.52	MVPA Totals	22.69	10.67	MVPA Totals	18.18	7.27	MVPA Totals	76.27	29.75

11.4 SOFIT MVPA Levels by Individual and Team Activities

Individual								
OBSERVATION NO.	Dance	Trampoline	Table Tennis	Badminton	Trampoline	Total Mins	Average Mins	S.D.
Code	Mins in Code	Mins in Code	Mins in Code	Mins in Code	Mins in Code			
4	9.67	5.45	10.92	16.51	3.67	46.22	9.24	5.03
5	4.49	4.78	2.05	4.47	7	22.79	4.56	1.75
MVPA Totals	14.16	10.23	12.97	20.98	10.67	69.01	13.80	4.33
Team								
OBSERVATION NO.	Lacrosse / Games	Football	Football	Rounders	Football	Total Mins	Average Mins	S.D.
Code	Mins in Code	Mins in Code	Mins in Code	Mins in Code	Mins in Code			
4	17.09	17.85	17.92	5.62	19.5	77.98	15.60	5.65
5	5.09	6.28	8.6	1.65	10.25	31.87	6.37	3.31
MVPA Totals	22.18	24.13	26.52	7.27	29.75	109.85	21.97	8.69

11.5 SOFIT Codings for Lesson Context

LESSON CONTEXT											TOTALS	%	Mean	S.D.
M	11	1	24	23	25	1	23	1	7	4	120	9.8	12	10.58
K	43	13	66	17	18	20	16	17	16	1	227	18.55	22.7	18.37
F	10	36	0	10	9	8	8	46	28	0	155	12.66	15.5	15.64
S	46	82	4	8	40	31	44	50	22	0	327	26.72	32.7	25.18
G	0	0	32	52	29	65	29	27	48	113	395	32.27	39.5	33.06
O	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
Total	110	132	126	110	121	125	120	141	121	118	1224	100		

11.6 SOFIT Lesson Context Codes - Average Minutes per Lesson

Lesson Context Code	Description	Average Minutes Per Lesson by Lesson Context Code
M	General Content (eg transition, management)	4.10 mins
K	Knowledge Content (eg general knowledge, rules, tactics, technique)	7.75 mins
F	Motor Content - Fitness	5.29 mins
S	Motor Content – Skill Practice	11.17 mins
G	Motor Content – Game Play	13.49 mins
O	Motor Content – Other	0 mins

11.7 SOFIT Teacher Behaviour Codes

TEACHER INVOLVEMENT											TOTALS	%	Mean	S.D.
P	0	7	8	16	13	5	11	13	27	2	102	7.02	10.2	7.79
D	22	8	12	0	3	16	0	2	5	0	68	4.68	6.8	7.63
I	38	47	55	52	53	68	60	52	69	0	494	33.98	49.4	19.65
M	26	26	60	43	47	14	43	32	35	15	341	23.45	34.1	14.53
O	25	51	54	14	22	18	13	51	4	88	340	23.38	34	26.07
T	0	0	0	0	0	27	0	0	34	48	109	7.49	10.9	18.26
Total		139	189	125	138	148	127	150	174	153	1454	100		