MACQUARIE University
SYDNEY · AUSTRALIA

Evaluating the Potential Efficacy of High-Intensity Interval Training within Year 7 Physical Education Classes:
A non-randomised comparison trial.

Nathan Weaver

Department of Educational Studies
Faculty of Human Sciences
Macquarie University

9th October 2017

Supervisor: Dr Dean Dudley

Evaluating the potential efficacy of High-Intensity Interval Training within Year 7 Physical Education Classes: A non-randomized comparison trial.

Nathan J. Weaver

Macquarie University

A thesis presented in partial fulfilment of the requirements for the award of the degree

MASTER OF RESEARCH

9th October 2017

Faculty of Human Sciences

Department of Educational Studies

Abstract

Although High-Intensity Interval Training (HIIT) is perceived as an efficient way to meet health outcomes in Physical Education (PE), the effect HIIT has on students' motivation and the learning environment is unknown. This study compared two PE interventions lasting eight weeks and assessed the potential efficacy of embedding HIIT into a PE program to meet concurrent health and educative outcomes. Participants (N = 166; mean age = 12.9 years) were assigned to one of two study conditions according to intact groupings: HIIT program (n = 84) and Dynamic Physical Education (DPE) program (n =82). Assessments were conducted at baseline and post-intervention. Intervention effects for each variable were examined using measures of central tendency, analysis of variance and effect sizes. Post-intervention analysis demonstrated increases in health indices of both groups and comparing the effect size of each intervention revealed no difference. The DPE group exhibited moderate intervention effects for motivation towards PE, while the mean value of the HIIT group did not change. Systematic direct observation revealed large intervention effects for the provision of feedback within the HIIT intervention when compared to the DPE intervention (*d*= 3.67). This study demonstrates HIIT interventions may elicit positive changes to PE settings, allowing health and educative outcomes to be achieved concurrently.

Author's Declaration

I declare that the work contained in this thesis has not been submitted for a degree in any other university or educational institution. Except where explicitly stated or acknowledged, this thesis is the original work of the author. Ethics Committee approval was obtained from Macquarie University Human Research Ethics Committee (5201600120) at its meeting on 7/6/16.

Signed: ______________________________

Nathan James Weaver

Dedication

I would like to dedicate this publication to my family, all the Weavers and all the Hollands who have supported me without question. You have created the conditions for me to manage life while completing this task successfully. Your support and love has allowed me to remain focused and thoroughly enjoy the journey over the past two years. I would like to mention four special people in my life:

My Mum Lynn and Nan Beryl, who have provided for me and instilled a value of physical activity and education as a means to a happy and healthy life. You both looked into me and saw something worth believing in long before I could believe in myself. I hope this small achievement is evidence that your efforts and reminders of what is important in life have sunk in.

My wife Anita, you have kept me grounded in the beauty of the present, you are my favourite place to go when my tank is empty, and I am searching for composure. I have known for a very long time that you are passionate, courageous and generous, but no language can express the beauty and strength you exude as a new mother.

My daughter Blair, watching you grow over the last eleven months has warmed my heart and provided a personal significance to this study. I look at you, and I see my past, my present and my future. I picture my little girl running around the school playground, with the confidence and competence to play happily with friends. I hope the understanding I have gained from writing this dissertation, in some small way contributes to this dream becoming a reality.

Acknowledgements

I wish to acknowledge and thank the following people who have made significant contributions to this thesis. Firstly, I would like to thank Dr Dean Dudley, as supervisor of this research project, you have provided the guidance and support that has made this a professionally enriching and rewarding experience. You have always placed the ‘person' before the ‘project', and this has allowed me to thoroughly enjoy the experience of being a stay at home Dad while learning the ropes of educational research.

To the Catholic Education Diocese Parramatta and Principal Nic Vidot, thank you for providing permission for the research to be carried out. Allowing me to add another layer to the already hectic academic plan of the school is much appreciated. Your continual emphasis on the importance of ‘doing more and going beyond' has been recognised.

To Dave Frankham and Garry Boardman for sharing your passion for making quality physical education a priority and for all the countless sacrifices, you have made for this study to be successful. I sincerely appreciate the cooperation you have given me, a lot of it occurring in your own time.

Finally, to the 166 Year 7 students who willingly participated in the study. I am overwhelmed by the good nature and care you have displayed toward members of your cohort. I have been extremely impressed by your group's positive attitude towards improving the quality of Physical Education in your school.

Table of Contents

List of Abbreviations

HIIT	High-Intensity Interval Training
DPE	Dynamic Physical Education
PE	Physical Education
PA	Physical Activity
MVPA	Moderate to Vigorous Physical Activity
VPA	Vigorous Physical Activity
QPE	Quality Physical Education
EUROFIT	European tests of Physical Fitness
SOFIT	System for Observing Fitness Instruction Time
PLoCQ	Perceived Locus of Causality Questionnaire
SPARK	Sport Play and Active Recreation for Kids study
M-SPAN	Middle-School Physical Activity and Nutrition study
HOPE	Health Optimizing Physical Education
CDC	U.S. Centers for Disease Control and Prevention
ACHPER	Australian Council for Health Physical Education and Recreation
PDHPE	Personal Development, Health, and Physical Education
Vo2 Max	Maximal Aerobic Capacity
U.S.	United States of America
OECD	Organization for Economic Co-operation Development
TREND	Transparent Reporting of Evaluations with Nonrandomized Designs

List of Figures

List of Tables

Evaluating the potential efficacy of High-Intensity Interval Training within Year 7 Physical Education Classes: A non-randomized comparison trial.

Chapter 1: Introduction

International best practice requirements for physical education (PE) expect students to engage in moderate to vigorous physical activity (MVPA) for at least 50% of PE class time if any health effects are likely to be achieved (Centers for Disease Control and Prevention [CDC], 2011). Australian PE teachers have made attempts to improve student health outcomes by meeting the MVPA target, however, due to the amount of class time required to accomplish this objective, achieving educative goals has proved a difficult feat within Western Sydney PE settings (Dudley, Okely, Cotton, Pearson, & Caputi, 2012). A further finding of Dudley, Okely, Cotton, et al. (2012) was PE teachers who are delivering CDC (2011) recommended levels of MVPA are doing so via ‘game play' at the expense of instruction time and skill practice.

1.1 Purpose and aims of the study

This project seeks to evaluate the potential efficacy of incorporating High-Intensity Interval Training (HIIT) principles within a pedagogically rich learning environment promoting the achievement of concurrent educative and health goals.

1.2 Research questions and hypotheses.

The study focused on the following research questions and hypotheses:

Research question 1. What is the difference between Dynamic Physical Education (DPE) and HIIT on students' comparable health measures often sought through MVPA? (Specifically: maximal aerobic capacity (Vo2 Max) and muscular power)

Hypothesis 1. It is expected that improvement observed in the health indices of students who participate in the HIIT treatment will be equal or greater than the students who participate in the DPE treatment.

Research question 2. What is the difference between DPE and HIIT on the lesson context, teacher interaction, and student activity levels during PE lessons?

Hypothesis 2. It is anticipated within the HIIT group the percentage of PE class time used for skill practice and feedback will be greater than the DPE group.

Research question 3. What is the difference between DPE and HIIT on the motivation of students to take part in PE?

Hypothesis 3. It is anticipated that the motivation of students to take part in the PE experience will not decrease as a result of participation in the HIIT intervention. Furthermore, there will be no significant difference between in the quality of motivation post-intervention.

1.3 Significance of the study

Research conducted over the last decade across the globe (Dumith, Gigante, Domingues, & Kohl III, 2011; Hallal, Victora, Azevedo, & Wells, 2006; Pate et al., 2006) provides an array of evidence demonstrating the need for increased physical activity (PA) within the adolescent population.

Concerning PA levels during PE classes no formal guidelines exist in Australia (Dudley, Okely, Pearson, Cotton, & Caputi, 2012). However, guidelines for the United States of America (U.S.) state that 50% of PE class time should engage students in MVPA to ensure the associated health benefits are a product of PE (CDC, 2011). In support of this, Australian PA and Sedentary Behaviour Guidelines call for 60 minutes of MVPA per day, accrued through a variety of avenues, including PE (Australian Government Department of Health and Ageing, 2014).

A recent study of the changes in PA levels, lesson context, and teacher interaction during PE classes of Western Sydney schools suggests that when teachers are implementing lessons that contain the CDC (2011) recommended levels of MVPA, their predominant means of doing so is via increasing the time students spend in 'game play' (Dudley, Okely, Cotton et al., 2012). This approach means that PE teachers are meeting the demands of the Australian PA Guidelines thus helping students achieve the associated health goals but possibly at the expense of the learning outcomes that reside within the New South Wales (NSW) Years 7-10 PDHPE Syllabus (Board of Studies, 2003). More recently Dudley, Goodyear, and Baxter (2016) have identified the failure to successfully implement QPE programs that can achieve both health and educative outcomes is of growing concern.

1.4 Overview of the methodology

This study was conducted using a quasi-experimental design. Due to the nature of the testing environment, a non-randomised comparison study was run using a pre-test post-test methodology and a test re-test reliability check. The Transparent Reporting of Evaluations with Nonrandomized Designs (TREND) checklist Version 1.0 (Des Jarlais, Lyles, Crepaz, & the TREND group, 2004) was followed where possible to ensure precise reporting of this study.

1.5 Limitations

It is important to note that this study was not sufficiently powered to detect statistically significant differences. The moderate sample size means results and findings are not generalisable. This study has not attempted to account for PA outside of class time which may change the interpretation of data concerning the physical fitness of students. Finally, the multi-stage fitness test only produces estimates of Vo2 Max.

1.6 Delimitations

The study was delimited in the following manner:

- The subjects were from a Catholic co-educational high school, in Western Sydney.
- Measures of student health indices were performed using four items from the European Physical Fitness Test Battery (EUROFIT). Items included standing long jump, handgrip strength test, 10 x 5m shuttle run and the multi-stage fitness test. These measures were identified as dependent variables.

- Measurement of students' motivation to take part in the PE experience was conducted using the Perceived Locus of Causality Questionnaire (PLoCQ). This measure was identified as a dependent variable.
- Measures for the changes in learning environment were performed using the System for Observing Fitness Instruction Time (SOFIT). This measure was identified as a dependent variable.

1.7 Definition of terms

Given the assortment of literature related to the scope of this study, there is a surplus of definitions used for some of the following terms. Therefore, it is crucial to define each term in the context of this study.

- High-Intensity Interval Training – involves repeatedly exercising at a high intensity for 30 seconds to several minutes, separated by 1-5 minutes of [active or passive] recovery (Shirev & Barclay, 2012).
- Moderate to Vigorous Physical Activity – is any activity with an energy expenditure equal to walking, PA expending more energy than ordinary walking it is considered vigorous. (McKenzie, 2015)
- Physical Education – aims to help students develop the skills, knowledge and attitudes necessary for confident, lifelong participation in sport and recreation activities (Hands, 2013).
- Physical Activity – any bodily movement produced by skeletal muscles that require energy expenditure (Casperson, Powell, & Christenson, 1985).

- Potential efficacy – the ability to increase the quality of PE, objectively measured health indices, motivation towards PE experiences, and changes in lesson context allowing teachers to meet health and educative outcomes concurrently.

Chapter 2: Literature Review

This literature review involved a comprehensive search of studies pertaining to PA and health, methods of increasing PA in PE settings, and finally, effective PE pedagogy in Australian secondary schools.

2.1 Physical activity and the health of individuals

2.1.1 The relationship between levels of physical activity and health. The physiological changes in the body that occur as a result of PA are beneficial for human health and development. Substantial evidence has been presented supporting the role PA plays in the prevention of chronic diseases including cardiovascular disease, some cancers, type II diabetes, hypertension, obesity, depression and osteoporosis (e.g. Heath et al., 2012; Lee et al., 2012; Warburton, Nicol, & Bredin, 2006; Waxman, 2005).

Cowan (2016) reinforces the significance of the positive relationship between PA and health by calling for PA to be considered a vital sign alongside the long-established measures of heart rate, respiratory rate, blood pressure and temperature. Moreover, Cowan (2016) illustrates the significance of the inverse relationship between an individual's rate of participation in PA and the risk of chronic disease by emphasising family doctors and physicians often prescribed PA for health.

The prescription of PA for health is far from a new approach. Evidence for the benefits of PA has been available since the 1930's (Blair, LaMante, & Nichaman, 2004) and many recommendations relating to the thresholds of PA have evolved since this time. However, the PA dose is questionable (Blair et al., 2004) with current PA guidelines often being set against baseline PA measures from the 1950's, which result in the Metabolic Equivalence value being underrepresented for the lifestyle behaviours of the current population (Okely et al., 2012).

Back as far as the 1970s, the American College of Sports Medicine prescribed moderate to vigorous exercise for 15 to 60 minutes continuously on 3 to 5 days a week (Blair et al., 2004). Oja and Titze (2011) identify that due to a decline in PA in the 1990s, evidence-based PA guidelines replaced the previous recommendations, with the CDC releasing guidelines in support of at least 30 minutes of accumulated moderate-intensity activity on most days of the week. During 2004 the World Health Organisation presented a global strategy on diet, PA and health. As a result, PA recommendations evolved again, with the required amount of MVPA in our daily lives set at 150 minutes of accumulated moderate-intensity activity per week or 75 minutes of VPA per week (Waxman, 2005). These recommendations were constructed on the notion that one minute of VPA expends the same energy as two minutes of moderate intensity activity and activities could be mixed in any ratio to suit the lifestyle demands of the individual (Okely et al., 2012).

Most Organisation for Economic Co-operation Development (OECD) countries now advocate that adolescents attempt to include at least 60 minutes of moderate activity in their daily routine and incorporate VPA on at least three days a week (Australian Government Department of Health, 2014; U.K Department of Health, Physical Activity, Health Improvement & Protection, 2011; U.S. Department of Health & Human Services, 2008). This higher dosage reflects the advice provided by Blair et al. (2004) to promote an increased quality of life.

2.1.2 Adolescent levels of health-related fitness as a predictor of adult health. A growing body of literature exists that highlights the association between levels of PA in adolescence and levels of health-related fitness (Janssen & Leblanc, 2010). This correlation may at worst indirectly play a role in the development of healthy adult lifestyles, helping reduce the incidence of chronic disease (e.g. Biddle, Gorely, &

Stensel, 2004; Hallal, Victora, Azevedo, & Wells, 2006; Strong et al., 2005; Tammelin et al., 2014).

Ruiz et al. (2009) completed a systematic review of literature published between January 1990 and July 2008 to determine the predictive validity of health-related fitness in youth. This report showed consistent evidence supporting adolescent levels of health-related fitness tracking into adulthood, specifically high levels of cardiorespiratory fitness in childhood and adolescence correlating with a healthier cardiovascular profile later in life. Also, Herman, Craig, Gauvin, and Katzmarzyk (2009) ran a longitudinal study tracking PA and obesity over a 22-year period. The study showed PA did not track from childhood, it was only observed to track from late adolescence/early adulthood onward. This finding further highlights the potential importance of PA interventions in the secondary school years.

2.1.3 The need for increased levels of physical activity of adolescents. Although it would appear that PA levels during adolescence may contribute to the development of healthy lifestyle behaviours later in life, there is a need for concern. The results of the National Secondary Students' Diet and Activity Survey (Morely, Scully, Niven, & Wakefield, 2010) highlight the PA levels of Australian adolescents as a significant issue for communities to address. This survey found that only 15% of Australian teenagers participate in adequate amounts of daily PA.

It is of greater concern that we appear to be at our most active as children with PA levels declining during the lifespan particularly in adolescence. The decrease of PA during adolescence is a consistent finding within research carried out in this area. Dumith et al. (2011) conducted a systematic review of international literature regarding PA patterns during adolescence. They aimed to quantify the change in PA according to a series of study variables, exploring sex and age differences and confirmed a decline in PA levels during adolescence for all variables examined.

On average, the PA change per year, across all studies was a decrease of 7.0%. Although early studies conducted before 1997 identified a greater decline in boys PA, the decline has been more significant in girls in more recent studies. The observed decrease in PA among adolescents is not a new phenomenon. The results from the systematic review (Dumith et al., 2011) highlight a need for further investigation of new approaches to increase the PA levels of our youth. This inquiry is of great importance as in addition to the long-term benefits of PA for human health and development, increased daily PA is attributed to a number of health-enhancing and protecting behaviours among adolescent populations.

Ahn and Fedewa (2011) performed a comprehensive, quantitative synthesis of the literature examining the effects of PA on children's mental health outcomes. Their final analysis included 73 published and unpublished studies, totalling 246 effect sizes. Although overall effects of PA on children's mental health were small but significant, they were able to determine that on average PA led to improved mental health outcomes for all youth.

In addition to improved mental health, an earlier study collected data from 822 students and suggested that adolescents who regularly involve themselves in VPA may be less likely to engage in drug use, and more prone to take part in a number of health-promoting behaviours. A key finding was that longitudinal and experimental studies are needed to ascertain what role regular VPA may play in the onset and continuation of health-enhancing and protecting behaviours among adolescent populations (Delisle, Werch, Wong, Bian, & Weiler, 2010).

2.1.4 Schools as the setting for the promotion of youth physical activity. As the lack of PA among adolescents and the resulting health issues are of concern for many communities, several fronts need to combine to develop a solution. Being the ideal setting for the promotion of PA among youth, schools have a portion of this responsibility and are seen as the perfect point of intervention (Sallis & McKenzie, 1991). However, with the decline in population-level PA, it has been suggested that schools should play an even greater role in providing and promoting PA by extending the scope of their role beyond school hours (Pate & O'Neill, 2008). It is fair to say this added responsibility would be presented to already overworked PE teachers (McKenzie & Lounsbery, 2015) as, within the school structure, a logical avenue to tackle this health concern is through PE (CDC, 2011).

An example of the primary stakeholders working together to develop a solution that does not require PE teachers to extend their role beyond school hours is evident in the U.S. national PA plan (Pate, 2009). The program was created to enhance the role of schools in promoting healthful PA and if implemented successfully, would position schools in the United States as leaders in helping children and youth become more physically active. These recommendations included a target of 50% MVPA for all students in every PE class. In response to the MVPA target not being met in many U.S. PE classes Metzler, McKenzie, van der Mars, Barret-Williams, and Ellis (2013a, 2013b) have recently proposed a new model of PE that utilises the 50% MVPA target to increase student health outcomes through the delivery of active learning experiences. The new model called for the term Health Optimizing PE or HOPE to replace the existing terminology of health-related PE.

HOPE recognises the importance of the promotion of PA and other health-enhancing behaviours among school-age children. However, it is not clear how this model will address the numerous barriers to quality physical education (QPE) that are often cited, including limited curriculum time allocations (e.g. Barroso, McCullum-Gomez, Hoelscher, Kelder, & Murray, 2005; Jenkinson & Benson, 2010; Morgan & Hansen, 2008).

2.1.5 Patterns of physical activity in physical education. A review of PA-based interventions within PE classes found that these interventions can increase students' MVPA during lessons by about 24% compared with usual practice, and this increase could have a substantial positive influence on the total amount of PA children and adolescents accumulate (Lonsdale et al., 2013). On the other hand, although PE classes are seen as the primary vehicle to drive change, objective measures clearly show students typically spend far less than 50% of PE class time in MVPA (e.g., Fairclough & Stratton, 2006; McKenzie, Catellier et al., 2006; McKenzie, Feldman et al., 1995). PA during PE declines during the adolescent years of schooling (Hardy, King, Espinel, Cosgrove, & Bauman, 2010; Dudley, Okely, Pearson et al., 2012) and it is evident current models of PE are unlikely to provide sufficient activity for significant health benefits to be accrued. (Biddle et al., 2004). Moreover, Biddle et al. (2004) determined a post-intervention increase in PA was not common.

2.2 Physical Education’s potential to enhance quality of life

Although it is unlikely, current models of PE can provide sufficient activity for significant health benefits much has been documented about the capacity of PE to improve an individual's quality of life. The development of life skills and positive behaviour patterns is a common aim of PE curricula in most OECD countries. Realising this goal can be a complicated task for PE teachers, it has been shown "the focus of PE has changed to reflect societal demands so frequently that it has become the chameleon of all curricula" (McKenzie & Lounsbery, 2014, p. 289). McKenzie and Lounsbery (2014) further describe the complexities facing those working in the field of PE, using the phrase 'muddled mission of PE' which was first used by Pate and Hohn (1994, p.2) over two decades ago, and it is still applicable to the experience of PE teachers today. Commonly cited barriers such as limited time allocations, low subject status and a crowded curriculum (Jenkinson & Benson, 2010) typify the 'muddled mission'. The amalgamation of these factors raise the question, how do PE teachers improve the health indices of students while maintaining an educative focus?

One of the most frequently cited papers, authored by Sallis and McKenzie (1991) scrutinises the contributions PE makes to child and adult health, and places a focus on health-related PA interventions as a goal for PE. It appears a choice is made to put a focus on the promotion of PA to clarify the mission of PE for those operating within the field, as the amount of PA is a measurable item whereas the quality of education is not. Sallis and McKenzie's seminal paper examined two large longitudinal studies that had been conducted using the health-related PA approach. The Sports Play and Active Recreation for Kids (SPARK) and Middle-School PA and Nutrition (M-SPAN) studies carried out in the U.S. have provided valuable insight into increasing the levels of MVPA within a school environment.

The SPARK (Sallis et al., 1997) study evaluated a health-related PE program for fourth- and fifth-grade students designed to increase PA during PE classes and outside of school. Sallis et al. (1997) reported the time spent being physically active in specialist-led (40 min) and teacher-led (33 min) PE classes was almost double than in control classes (18 min; $P < .001$). Also, researchers administered surveys to ask students how much they enjoyed PE classes. There was no significant impact on PE enjoyment.

M-SPAN (Sallis et al., 2003) was an evolution of the SPARK study with environmental, policy, and social marketing components. The study stressed an alternative approach to increasing student health-related behaviours. Within the M-SPAN framework, PA was encouraged before and after school and after lunch by teachers. Equipment was made available for students to use for PA through the school day. PE teachers awarded class credit for PA conducted outside of PE class. The use of flyers, school bulletins, newsletters, and parent meetings takes the promotion of PA beyond the boundaries of the school. In an evaluation of the M-SPAN intervention, McKenzie et al. (2004) found that the schools in the experimental group increased their level of PA over time at a greater rate than schools in the control group (d= 0.93).

While the results of these health-related PE programs can be encouraging, evaluation of interventions designed to promote PA (Biddle et al., 2004) found the sustainability of non-standard PE programmes is questionable. The influence of PE-based interventions on extra-curricular activity levels needs re-evaluation due to an inability of PE to meet recommended PA levels, and there is a difficulty in using school programmes to achieve change in behaviour outside of school hours. Biddle et al. (2004) concluded by identifying that despite the weak evidence in some areas, it is still prudent to suggest that greater PA in youth is to be encouraged. Calls for the delivery of QPE reflect this view, as “QPE represents active, inclusive, peer-led learning that supports students to develop the physical, social and emotional skills which define self-confident and socially responsible citizens”. (United Nations Educational, Scientific and Cultural Organisation [UNESCO], 2017).

The QPE approach moves the focus from the promotion of PA to a wider-reaching educative focus. Guidelines for PE policymakers state "QPE is the foundation for a lifelong engagement in PA and sport" (UNESCO, 2015, p. 9). It is apparent the mission of QPE is to promote lifelong PA so that citizens will become healthy, active participants in society through a strong educative focus.

The need for this shift in approach towards QPE is apparent. In the HOPE for the future paper, Sallis et al. (2012) evaluated the ‘health-related PE' approach by asking "Is the gym half empty or half full?" The authors reviewed the progress made in the field of PE and identified the hurdles that have appeared since Sallis and McKenzie (1991) produced their seminal paper. HOPE has been proposed as a possible solution to overcome the hurdles they identified:

> HOPE [is] PE that encompasses curriculum and lessons focused on health-related PA and fitness; keeps students active for 50% of the class time; engages all students, regardless of physical ability; and significantly contributes to students' overall PA participation, thereby improving their health. (Sallis et al., 2012, p.131)

A co-author of the HOPE for the future paper worked in the writing team of two well-known PE texts, (Pangrazi & Beighle, 2015; Darst, Pangrazi, Brusseau, & Erwin, 2015). The texts guide PE teachers to implement the goals of HOPE in a PE setting. DPE continues to place a focus on meeting the 50% MVPA target to improve student health indices.

> Some HOPE strands look very much like many current PE programs. For instance, strands with common content units for team sports, individual sports, dance, skill themes, and fitness would still be included in HOPE, but only if they can provide high rates of MVPA. That is, activities that inherently provide few MVPA opportunities,

> such as Softball, would be included only if the activities were modified sufficiently to promote high levels of MVPA (Metzler et al., 2013a, p. 44).

Although the DPE approach seems like an efficient manner to meet the 50% MVPA target, the model does not provide a clear strategy to address the barrier of time. It continues to emphasise an increase in the promotion of PA leading to PE rather than the emphasis being placed on the promotion of QPE leading to an increase in PA. Two questions still need to be raised: (a) How will PE teachers deliver the DPE content in the amount of available PE time? (b) Is devoting 50% of PE class time to MVPA actually in the best interest of our students?

Dudley et al. (2016) highlight the apparent prioritisation of health goals ahead of educative goals that may be preventing HOPE from being more widely used by education systems as a model of QPE. The authors also raise the view that other pedagogical models which prioritize educative goals, such as: Teaching Personal and Social Responsibility Through Physical Activity (Hellison, 1995), Sport Education (Siedentop, 1998) or Cooperative Learning (Dyson & Casey, 2012) have also failed to be adopted widely in PE practice and by public health agencies. Dudley et al. (2016) present a strong case for reviewing current approaches to PE as they state: "the failure to successfully implement QPE programs that can achieve both health and educative outcomes is of growing concern and quite a paradox."

Within the paradox, time is one of the most commonly cited barriers to QPE (Jenkinson & Benson, 2010; Morgan & Hansen, 2008). A contributing factor to this challenge is the high number of pedagogical priorities competing for attention within PE curricula (McKenzie & Lounsbery, 2015). Hattie (2013) outlines "it is not time, but particular uses of time and timing" that have a large impact on the quality of student learning. He goes further to say the greatest predictor of achievement is engaged time and academic learning time.

HIIT may be advantageous in addressing a number of these competing priorities as numerous studies have demonstrated that when compared with MVPA approaches, HIIT results in superior or equal improvement in fitness and cardiovascular health within a reduced period (Gibala & McGee, 2008; Hood, Little, Tarnopolsky, Myslik, & Gibala, 2011; Kemi & Wisloff, 2010; Little et al., 2011; Tjonna et. al, 2008; Trapp, Chisolm, Freund, & Boutcher, 2008; Weston, Wislof, & Coombes, 2007).

HIIT involves repeatedly exercising at a high intensity for 30 seconds to several minutes, separated by 1-5 minutes of [active or passive] recovery (Shirev & Barclay, 2012). The common view of this collection of studies that advocate for the use of HIIT is the vigorous activity segments that characterise HIIT promote greater adaptations to the body due to increased muscular stress, allowing even untrained individuals to work harder than would otherwise be possible at the steady-state intensity. Within this body of research, HIIT has demonstrated success in both healthy and diseased populations. It is well established that HIIT is a strategy to improve physiological outcomes and metabolic health (e.g. Gibala, 2007; Kemi & Wisloff, 2010; Shiraev & Barclay, 2012).

Researchers in favour of HIIT acknowledge that the protocols used to implement HIIT need further refinement and understanding of their application. For example, the Wingate-based training model used in early studies has become an outdated protocol as it requires specialised cycle ergometers and an extremely high level of motivation. Researchers recognise that "given the extreme nature of the exercise, it is doubtful that the general population could safely or practically adopt this model" (Gibala, 2007). A recent study conducted in a school setting (Costigan, Eather, Plotnikoff, Taaffe, Pollock et al., 2015), demonstrated high levels of participation and participant retention. The HIIT protocols used in the 2015 study resembled a resistance and aerobic exercise program, consisting of a 30 second, high-intensity work phase followed by an equal rest interval. It is apparent the amount of time spent on PA has long been a focus for research and policymakers. Gibala (2007) identifies an important area that still requires investigation as "although there is a consensus regarding the importance of PA, the minimum dose necessary to improve health status is unclear."

Within existing literature, the point of contention among prominent researchers is regarding the effectiveness of HIIT due to the hypothesised "poor reach" of this style of PA intervention (Biddle & Batterham, 2015; Hardcastle, Ray, Beal, & Hagger, 2014). A common theory within the body of research against the use of HIIT interventions is people will not be willing to engage in this type of training because of the demanding physical nature. There is a belief that the elevated exercise intensity may be seen as unpleasant and cause avoidance of PA rather than the promotion of PA (Biddle & Batterham, 2015).

A recent study (Saanijoki et al., 2017) demonstrated HIIT leads to endorphin release in the brain, which may lessen the physical and emotional stress caused by the high-intensity exercise. In the study, a less demanding traditional one-hour aerobic exercise class did not have the same effect. The results of this study highlight that exercise endorphin release may be a major mechanism which supports exercise motivation and maintenance. The authors, however, still caution that exercise intensities should be taken into consideration before starting an exercise program as the long-term effect on a participant's motivation to be active is unknown.

2.3 Motivation as the foundation for effective engagement.

2.3.1 Motivation in the context of quality physical education. The importance of the relationship between student motivation and quality education is indisputable. Toshalis and Nakkula (2012), stress motivation is a substantial and steady contributor to the functioning and performance of students in educational settings. However, significant differences have been noticed in the quality of motivation that may be displayed by individuals toward a set activity. Motivation may be distributed along a continuum from high to low self-determination (Deci & Ryan,1985, 2000). According to Vallerand (as cited in Lavigne et al., 2009) motivation occurs at three levels of generality, (a) situational, (b) contextual and (c) global. To place this within a PE context situational motivation occurs at any one moment, and a student's perception of PE can influence their motivation to engage in the pedagogy being offered. The contextual level of motivation refers to the student's willingness to connect with and engage in the type of physical activity or sport being used to frame the unit of work. Finally, within a PE context, the global level of motivation refers to how a student would view their relationship with the school learning environment and PA in general.

When observing motivation through a PE lens, it is crucial to highlight that an increase in the quality of motivation displayed by students is associated with higher levels of effort and lower levels of dropout in sporting activities (Pelletier, Fortier, Vallerand, & Briere, 2002). Further to this, Boiche, Sarrazin, Grouzet, Pelletier, and Chanal (2009) have shown no matter the initial level of skill displayed by a student at the beginning of a teaching cycle there is a direct relationship between the quality of motivation and the quality of performance. In that, a higher self-determined profile toward the learning experience correlated to a higher rate of success.

Ntoumanis (2001) has shown intrinsic motivation towards PE can contribute to an increased intention of being physically active in the future. Although intrinsic motivation has many influences and is only one of many contributing factors to lifelong PA the finding of Ntoumanis (2001) is of great importance as the intention to be physically active aligns with the aim of PE curricula in most OECD countries. A common theme within these documents is the goal of promoting lifelong PA so that citizens will become healthy, active participants in society. As a country operating as part of the OECD, PE curricula in Australia also echoes this theme. The aim of the New South Wales Personal Development, Health and Physical Education curriculum is to "develop students' capacity to enhance personal health and well-being, enjoy an active lifestyle, maximise movement potential and advocate lifelong health and physical activity" (Board of Studies, 2003).

Given that students frequently report PE as their main source of PA (Dyson, Coviello, DiCesare, & Dyson, 2009) at a time where the decline in PA among adolescents is increasing (Blaes, Baquet, Van Praagh, & Berthoin, 2011; Sallis, 2000) understanding and interpreting the students' perspective of their PE experience becomes imperative. The understanding of student motivation towards their PE experiences can enhance a teacher's ability to design PE experiences that students will engage in (Dyson et al., 2009).

2.3.2 Enjoyment for meaningful experiences. In trying to understand the student perspective of PE, enjoyment, or the response reflecting feelings of pleasure, liking and fun (Scanlan & Simons, 1992) has been shown to be one mechanism of influence within the broader construct of motivation. A recent review of 50 empirical studies (Beni, Fletcher, & Chroinin, 2017) highlighted the need for the development of pedagogies to facilitate and promote meaningful engagement in PE and youth sports.

Rowland and Freedson (1994) have previously made a similar point that there is a need for young people to be ‘turned on' to PA for an intrinsic desire to participate in PA to occur. Rowland and Freedson extend their point made concerning the motivation of youth when they highlight that the promotion of higher levels of motivation can only happen when PA is made enjoyable. Dudley, Okely, Pearson, Caputi, and Cotton (2013) used competency motivation theory (Weiss, 2000) as a backdrop to assess the enjoyment of PE among culturally and linguistically diverse students in their first year of secondary school. The findings of Dudley et al. (2013) corroborate previous research that suggested PE environments where students are encouraged to be physically active, are made to feel comfortable and are supported by their teachers tend to be the lessons students enjoy the most (Zhang, Solomon, & Gu, 2012). In addition to this Dudley et al. (2013) were able to identify specific areas of PE that can be addressed to promote student enjoyment, these included increasing teacher promotion, support and encouragement of PA during PE.

In addition to this a number of qualitative studies have also reported similar findings. Enright and O'Sullivan (2010) conducted a Participatory Action research project with 41 female students aged 15-19, which demonstrated that by ‘negotiating the PE curriculum' the traditional authoritarian style of teaching was transformed and student autonomy was increased resulting in meaningful engagement in PE. When the girls in this study received guidance and encouragement throughout their PE experience, they were 'able to take ownership of their learning' and exhibit a higher level of intrinsic motivation. It is important to note that negotiating the curriculum was not without challenge as both students and teachers involved in the research project reported the need for support in persevering beyond the transition period when the initial excitement wore off.

2.4 Conclusions from the literature review

Much of the literature justifies the need for the exploration of new approaches to improving student health indices through PE. Many of the studies show adolescence is a time where students disengage with PA as they move through their high school years and this behaviour tracks later in life. Certain sources point to an overcrowded curriculum reducing the time allocated to PA, while others argue that learning will naturally occur while students experience a variety of movement experiences. Either way, it can result in educative or health outcomes being prioritised at the expense of the other.

It is now a challenge for professionals working within the field of PE to design and implement high-quality PE lessons that make a significant contribution to the achievement of PA targets set for adolescents while maximising the educative focus of the lesson. An educative focus requires occasions for students to process their learning while providing opportunities for teaching behaviours that make a difference, such as skill practice and providing students feedback about their task performance.

Several emerging themes provide strong justification for this study. Firstly, PE teachers are underperforming in their ability to deliver quality PE lessons that address health and educative outcomes concurrently (Biddle et al., 2004; Dudley et al., 2013). Secondly, the amount of PA within a school PE setting is insufficient (Fairclough & Stratton, 2006) and a range of barriers including ‘time' have been identified (Jenkinson & Benson, 2010; Morgan & Hansen, 2009). There is little to no research on the effect HIIT has on the lesson context in a PE setting. Finally, motivation is a key construct leading to behaviour change in a PE setting that can potentially impact a student's decision to be active throughout a lifetime (Ntoumanis, 2001).

2.5 Theoretical framework

2.5.1 Self-Determination Theory's ability to explain physical activity behaviour. Motivation can be understood as a central factor triggering participation in physical activity. Pelletier et al. (2002) have shown that an increase in the quality of motivation displayed by students can be associated with higher levels of effort and lower levels of dropout in sporting activities. The findings of Pelletier et al. (2002) are of particular interest to this study as they indicate the association between motivation and a demanding sporting context can be positive. A popular view of those opposed to HIIT is that the intense nature of HIIT will most likely result in feelings of incompetence and failure leading to a reduced motivation to be physically active (Hardcastle et al., 2014). Given this, Deci and Ryan's Self-Determination Theory (SDT) (as cited in Vallerand, 1997) will be used as the theoretical framework for this research.

Figure 2.1 shows SDT focuses on the quality of motivation rather than the quantity. One of the central tenants of SDT is that an individual must differentiate between types of motivation and the distinction that is most important for SDT is between controlled motivation and autonomous motivation (Deci & Ryan, 1985). This distinction may be the factor that best explains the noticeable differences in the quality of motivation reported by participants in clinical studies and the few school-based trials.

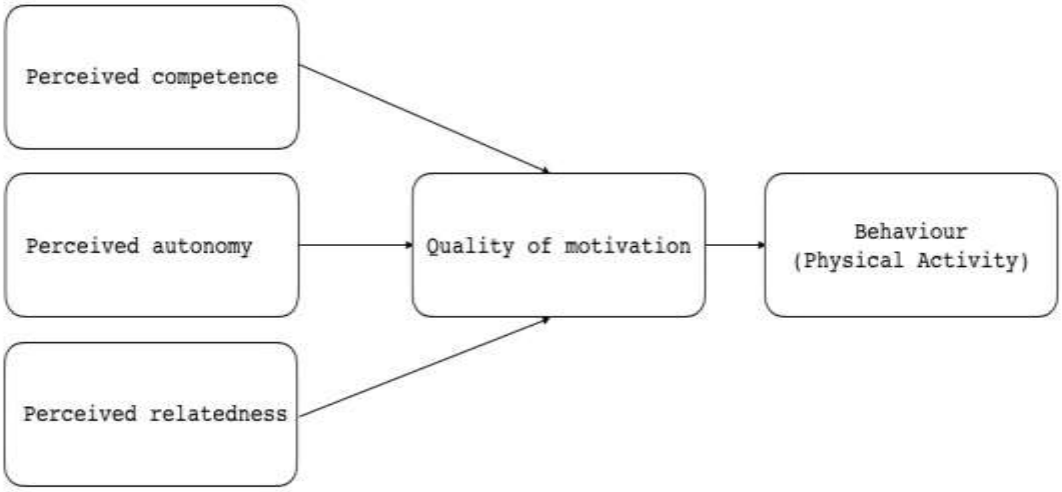

Figure 2.1. *Deci & Ryan's Self-Determination Theory (1985)*

Deci and Ryan (1985) essentially describe controlled motivation as the carrot-and-stick method. When an individual is controlled in their motivation, are either being seduced into behaving a certain way by the offer of a reward or coerced by the threat of punishment. In either case, an individual will experience pressure resulting in tension and anxiety. These feelings then lead to negative consequences for the individual's performance and well-being.

Another negative consequence resulting from controlled motivation that is relevant to this study is that when motivation is controlled people tend to either comply or rebel, and this response ultimately leads to an individual taking the shortest path to the desired outcome decreasing the likelihood of behaviour change being adopted for the long term.

As Deci and Ryan (2000a) note autonomous motivation occurs when a person experiences a full set of volition, willingness and choice about what they are doing. SDT states that an internal need for autonomy exists and humans need to perceive that: (a) we are good at something (competence), (b) we have choices and control over our actions (autonomy), (c) we feel connected through positive associations (relatedness).

To reach a level of autonomous motivation an individual must reach a stage where motivation is internalised and by doing an action they are endorsing that behaviour without internal conflict (Deci & Ryan, 2000b).

2.5.2 Self Determination Theory's ability to explain engagement in learning. The reasoning behind autonomous motivation is appealing to the practice of PE. Liukkonen, Barkoukis, Watt, and Jaakkola (2010) indicated that in a PE setting, a motivational climate fostering self-determination associates with more adaptive outcomes including increased participation, high enjoyment and greater effort. In addition to this Hagger, Chatzisarantis, Culverhouse, and Biddle (2003) advised, if PE students have high levels of intrinsic motivation, the chance of them being ‘better pupils' increases also, in that they will focus and engage with the learning more readily, which leads to positive learning outcomes.

Jones (2009) proposed a model for academic motivation that analysed, evaluated, and synthesised SDT and other research in the field of education into one cohesive pedagogical model. Figure 2.2 illustrates the five elements of lesson design that comprise the MUSIC model for academic motivation. Jones (2009) reports that when a teacher plans a learning experience that focuses on empowerment, usefulness, success, interest, and caring they create the conditions for student motivation to thrive.

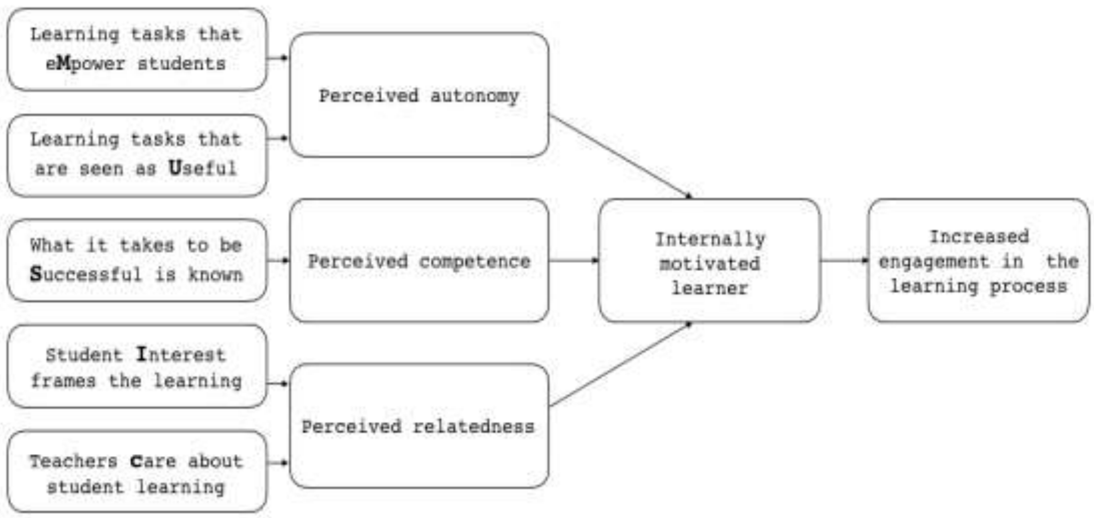

Figure 2.2. *MUSIC model of academic motivation (Jones, 2009)*

Understanding the role motivation plays in adolescent behaviour is of particular interest to this study and SDT was used to guide the design and measurement of each intervention. Through the utilisation of the five components of the MUSIC model of motivation (Jones, 2009) while working within the SDT framework, this study aims to explore the variables of intrinsic and extrinsic motivation to influence the health and learning of secondary school students.

Chapter 3: Methodology

This chapter describes the participants, interventions, instrumentation, procedures, and data analysis used to conduct this study. The TREND statement (Des Jarlais et al., 2004) has been followed where possible to ensure precise reporting of the information relevant to this study.

3.1 Participants

3.1.1 Authorisation to conduct the study and recruit participants. A Principal at a Catholic co-educational high school in Western Sydney was approached and agreed to participate in the study (see Appendix A). The Principal was contacted after authorization to conduct this study was sought and gained from the Macquarie University Human Research Ethics Committee (5201600120) (see Appendix B), and permission to conduct research within the relevant educational organisation was requested and obtained (see Appendix C).

The Year 7 cohort of the school comprising 89 female students and 93 male students were initially approached to participate in this study. Participants were informed that the results of the research project would remain confidential and that their withdrawal from the study would not jeopardise their current or future relationship with Macquarie University or the school. Participants were given ways to express their concerns regarding the study through the Macquarie University Human Research Ethics Committee.

3.1.2 Eligibility criteria for participants. The study was an inclusive study and eligibility was granted to all students in the Year 7 cohort. Informed consent was sought to assess 182 students on their motivation to take part in PE lessons, their level of physical fitness and to determine how active students were in their PE class. Consent was obtained from teachers to observe their interaction with students during PE lessons. Students, parents and guardians were asked to complete a health screening survey for students participating in the study (see Appendix D). Only students who returned consent forms and the health screening survey before the baseline testing date were eligible to participate.

A range of learning needs were identified within the Year 7 population including language disability (n=11), mild to moderate intellectual disability (n=5), Asperger's syndrome (n=2), cereal palsy (n=1) and Tourette's syndrome (n=1). As the study was an inclusive study, the researcher liaised with Leader of Learning Support and Members of the Autism Spectrum Australia team to determine if any additional information was required to promote inclusion.

The Leader of Learning Support and the researcher conducted a briefing for 37 students who receive support at the school. Students from non-English speaking backgrounds also received an invitation to attend this meeting. Learning Support staff followed up this session with a telephone call to the family's home to request parental and student consent.

The Leader of Learning Pastoral Care contacted the parents of the student living with cereal palsy and the student living with Tourette's syndrome to ensure each family understood the research project was inclusive of all students. Both parents were supportive of the study and informed the Leader of Learning that the consent forms had already been returned.

The Leader of Learning Pastoral Care conveyed to the researcher that although the father of the student living with cereal palsy was supportive of the study he had questions regarding the goals of the research project. A meeting was scheduled and occurred after a sports session during Week 8 of Term 2.

The teaching staff from Autism Spectrum Australia indicated the students living with Asperger's syndrome (n=2) and their parents did not wish to be involved in the research project and found the information letter to be adequate in explaining the nature of the study.

3.2 Method of recruitment

Recruitment occurred through an existing professional relationship between the researcher and the school. Also, there was an expression of interest from the PDHPE faculty to explore strategies to meet concurrent health and educative outcomes.

3.3 Recruitment setting

Recruitment of participants occurred in the school setting, and the initial recruitment session happened in the school library, during a scheduled Year Group assembly. During the meeting, students sat in one large group and the nature of the study was explained. The Year 7 Leader of Learning provided students with an opportunity to ask questions about their involvement in the study. Information and permission packs were made available for all students.

Students who were not able to collect an information package (n=21) during the first opportunity were invited to attend a meeting conducted by the Leader of Learning Pastoral Care and the researcher during a recess break. Follow-up reminders occurred in PDHPE classes during a two-week period. At the end of the two-week period, 100% (n=182) of students had received an information and permission package.

At the end of four weeks, 111 students (61%) had indicated consent. Members of the PDHPE staff contacted the remaining 39% (n=71) for consent via a telephone call to the family's home. A pre-written script (see Appendix E) was used to maintain clarity of the information provided. Consent for 166 students (91%) to participate in the study was gained.

3.4 Settings and locations where the data were collected

Throughout the study, data were gathered in a range of settings and situations. To maintain integrity, the same settings were used during baseline and follow-up data collection. During periods of data collection, casual staff provided support in an attempt to minimise the barriers to intervention implementation, and the Head Teacher reduced the cost to the school by covering permanent staff during these times also. However, the complex nature of school timetabling meant at times data collection had to be rescheduled to suit the day-to-day running of the school. The next few paragraphs provide a comprehensive description of the settings and location for each instrument used in the study.

3.4.1 The Perceived Locus of Causality Questionnaire. Trained PE staff administered the PLoCQ during a year assembly held in the school library. Participants in the study were asked to complete the survey independently using a computer tablet. Four Learning Support teachers and five Learning Advisors were available to assist students. The researcher was present at the time of survey completion to clarify any questions related to the administration of the PLoCQ.

A test-retest group (10%) performed the PLoCQ within seven days of completing the initial testing. The test-retest process occurred at baseline and follow-up with all measures conducted in the same settings and locations as described above. Data for the PLoCQ was collected via a Google form and automatically transferred to a Google sheet. Once the google sheet was complete, all the information gathered from the PLoCQ was exported as a Microsoft Excel file. Identification numbers were substituted for each participant's name, and data were matched for each participant accordingly by the researcher.

3.4.2 The European tests of Physical Fitness. The four tests selected from EUROFIT were administered in the school hall. During allocated sport time students completed a fifteen-minute information session where the correct procedure for each test was explained and demonstrated by the researcher. Students were then divided into their house sporting groups and completed a four-station fitness testing circuit. A teacher trained in the administration protocols of the selected fitness tests supervised each station. A test-retest group (10%) performed the EUROFIT test measures within seven days of completing the initial testing. All tests were conducted in the same settings and locations as described above. The test-retest process occurred at baseline and follow-up.

Data from the EUROFIT tests was collected via a Google form and automatically transferred to a Google sheet. Once the google sheet was complete, all the information gathered from the EUROFIT tests were then exported as a Microsoft Excel file. Identification numbers were substituted for each participant's name, and data were entered for each student accordingly by the researcher.

3.4.3 System for Observing Fitness Instruction Time. SOFIT data collection involved the observation of the PA levels of four randomly selected students, the lesson context, and the timing of feedback provided by the PE teacher. These conditions were coded every twenty seconds throughout the PE lesson on a rotational basis. During the study nine usable SOFIT observations occurred. The observations occurred inside the school hall (n=5) and outside on the school playing fields (n=4). Data were collected using the iSOFIT iPad app (The Research Centre in Physical Activity, Health and

Leisure, 2016) which allowed data to be stored locally on the tablet then exported to the researcher's email address as a Microsoft Excel file.

3.5 Interventions

After baseline testing participants were assigned to one of two parallel intervention groups, either Treatment A or Treatment B according to the teacher of their class. Subjects allocated to the Treatment took part in a PE program designed to have students reach a MVPA level for 50% of class time. Principles outlined in DPE for Secondary School Students text (Darst, Pangrazi, Brusseau, & Erwin, 2015) shaped the lesson design of this intervention. Treatment B received a HIIT intervention which was developed following findings and recommendations from a randomised controlled study conducted by Costigan, Eather, Plotnikoff, Taaffe, Pollock, Kennedy et al. (2015). It is important to note the work to rest ratio used in this study was 4:1 compared to the work to rest ratio of 1:1 used by Costigan, Eather, Plotnikoff, Taaffe, Pollock, Kennedy et al. (2015).

The 166 students who took part in the study received treatments designed to promote physical fitness while utilising available learning and teaching time for an educative purpose. Both treatments used in this study are outlined below:

3.5.1 Lesson structure for Treatment A: Dynamic Physical Education.

Teacher A worked with the 84 students in his classes (n=3) and adapted the existing unit of work to keep students moving with a heart rate of 140 beats per minute for at least 50% of the PE experience. The increased amount of movement was achieved by incorporating the following lesson elements and restructuring the regular PE lesson to include the following:

Dynamic Roll Call: This is an activity designed to get the students engaged as soon as the first student enters the learning space. Unlike the traditional roll call where students stand or sit the "dynamic roll call" is a teaching tactic where the teacher marks the class roll while the students are engaged in an instant movement activity preparing them for an efficient, warm up.

Warm-Up: This is an activity designed to increase heart rate, blood circulation, and maximise the percentage of time students are in MVPA.

Skill Instruction and demonstration: This segment of the lesson has two functions the primary purpose is to allow time for the demonstration and explanation of essential skills. During this part, a learning intention and success criteria are explored. Finally, this segment also provides students with a short recovery before completing the remaining activities of the PE lesson.

One-Minute Energizer: This is a short, sharp event designed to increase heart rate, blood circulation, and maximise the percentage of time students are in MVPA.

Technique-based game: This is the segment of the lesson where students practice techniques by participating in games that involve high repetition of specific sporting techniques.

Reflection: During this segment of the lesson, students perform a ‘walk and talk' where they walk around the perimeter of the learning space while discussing their performance against the success criteria.

Modified game: This is the segment of the lesson where students transfer the techniques to a modified game or game-like situation. This part of the lesson should take up approximately one-third of the available class time.

Warm-Down and Feedback: This supports the correct practice of stretching while the body is warm and serves to conclude the class. While students are performing five repetitions of each stretch, the teacher should highlight two group successes and one focus area.

At the completion of the lesson, students would design components of the next lesson by nominating the type of exercise they would like to compete during the next lesson. Students communicated their choice via a Google form, and the most popular selection amongst the class was posted on the class information board and completed the following lesson.

Table 3.1. *Lesson structure for DPE*

Lesson Phase	Example 1	Example 2	Example 3	Example 4
Dynamic Roll Call	Cardio Circuit: Run & Bounce combination.	Cardio Circuit: Run & Squat Jump combination.	Cardio Circuit: Run & High Knees combination.	Cardio Circuit: Run & Side Gallop combination.
Warm-Up	1. Walk along two sides of the court. 2. Walk briskly along two sides. 3. Walk two widths punching air 4. Walk two widths pushing arms forward. 5. Jog two widths with arms by sides. 6. Jog two widths – one pushing up with arms then one pushing forward.	1. Walk around two trees. 2. Walk along the top of a bench or form. 3. Find something circular and walk on it. 4. Jog to the nearest goalpost and back. 5. Jog to a fence and change speed. 6. Jog back and keep moving on the spot.	1. Walk within a specified area. 2. On the signal change to a jog. 3. On next signal change back. 4. Repeat several times varying the length of time between signals.	1. Walk freely around an area and the teacher randomly nominates an activity and number of reps to be performed (Star Jumps, Push Ups, Squats etc.) 2. Students quickly perform that number of repetitions and begin walking again. 3. Repeat several times varying the number with each call.
Skill Instruction & Demonstration	Dependent on skill context and programmed activities.	Dependent on skill context and programmed activities.	Dependent on skill context and programmed activities.	Dependent on skill context and programmed activities.
Energizers	Burpees 60sec	Mountain Climbers 60sec	Sumo Squats 60sec	Tuck Jumps 60sec
Skill Based Game	Dependent on skill context and programmed activities.	Dependent on skill context and programmed activities.	Dependent on skill context and programmed activities.	Dependent on skill context and programmed activities.
Reflection	Brisk Walk and Talk.	Brisk Walk and Talk.	Brisk Walk and Talk.	Brisk Walk and Talk.
Modified Game	Dependent on skill context and programed activities.	Dependent on skill context and programed activities.	Dependent on skill context and programed activities.	Dependent on skill context and programed activities.
Warm-Down & Feedback	Stretching: Knee to chest, press ups and Hip flexor stretch.	Stretching: Toe touch, Side reach and Lower back stretch.	Stretching: Shoulder, Quadriceps and Runner's stretch.	Stretching: Hamstring, Trapezius and Airplane stretch.

Note: To increase student autonomy, students use the options within the examples to design each lesson. The MUSIC model for academic motivation (Jones, 2009) is considered established practice through: M= promotion of student voice during the design of the PE lesson, music choice during PE lessons. U = learning intentions displayed S= success criteria displayed. I = personal physical best award C= feedback provided during the lesson.

3.5.2 Lesson structure for Treatment B: High-Intensity Interval Training.

Teacher B worked with the 82 students in his classes (n=3) and replaced the traditional warm-up activity with an eight-minute HIIT session. The HIIT session was administered using a resistance and aerobic exercise program. Students were required to be physically active with a heart rate of 180 beats per minute for 18% of their PE lesson.

During the HIIT session students manually measured their pulse to promote student autonomy. Manual heart rate measurements occurred during the rest cycle trying to keep the rate above 18 beats every 6 seconds (85% Max HR). Students would record this data on a data collection card and place in a collection box. At the end of the HIIT session Teacher B, would return to the existing teaching methods as prescribed by the learning program of the school.

At the completion of the lesson, students would design the next HIIT session by nominating the type of exercise they would like to compete. Each phase of the HIIT session had four options. Students communicated their choice via a Google form. The most popular selection amongst the class was posted on the class information board and completed the following lesson. To maintain consistency the following lesson elements and structure were used:

Preparation Phase: This activity is designed to increase heart rate and respiration. Students select a set of aerobic activities and complete as many sets as possible in two minutes.

Heart Rate Check: This activity is designed to increase student autonomy. Students stand still and measure their heart rate in a six second period to determine if they are working at the required intensity. The target is 18 beats.

Work Phase: This phase is designed to increase heart rate, respiration and muscular fatigue. Students select a set of aerobic and body weight resistance activities and complete as many sets as possible in two minutes.

Active Recovery: This element of the lesson is designed to decrease levels of student arousal and prepare students for learning. Students select and perform a range of dynamic and static stretches while listening to reflective music.

Table 3.2. *Lesson structure for HIIT*

Lesson Phase	Example 1	Example 2	Example 3	Example 4
Prep Phase (2min)	Jumping Jacks x 10 Running in Place x 10 Rhythmic Jumping x 10	Diamond Jumps x 10 High Knee Run x 10 Speed Skaters x 10	Power Jumping x 10 Mountain Climbers x 10 Tuck Jumps x 10	Squat Jumps x 10 Burpees x 10 Plank Jacks x 10
Passive Recovery/ HR check (30sec)	Standing still take pulse (6 seconds x 10)	Standing still take pulse (6 seconds x 10)	Standing still take pulse (6 seconds x 10)	Standing still take pulse (6 seconds x 10)
Work Phase 1 (2min)	Push Ups x 10 5m Shuttle Sprint x10 Squats x 10 5m Shuttle Sprint x10	Chair Triceps Dips x 10 5m Shuttle Sprint x10 Reverse Lunges x 10 5m Shuttle Sprint x10	Twisting Push Ups x 10 5m Shuttle Sprint x10 Plank Leg Raises x 10 5m Shuttle Sprint x10	Plank to Push Up x 10 5m Shuttle Sprint x10 V-Sit x 10 5m Shuttle Sprint x10
Passive Recovery/ HR check (30sec)	Standing still take pulse (6 seconds x 10)	Standing still take pulse (6 seconds x 10)	Standing still take pulse (6 seconds x 10)	Standing still take pulse (6 seconds x 10)
Work Phase 2 (2min)	Twisting Push Ups x 10 5m Shuttle Sprint x10 Plank Leg Raises x 10 5m Shuttle Sprint x10	Plank to Push Up x 10 5m Shuttle Sprint x10 V-Sit x 10 5m Shuttle Sprint x10	Push Ups x 10 5m Shuttle Sprint x10 Squats x 10 5m Shuttle Sprint x10	Chair Triceps Dips x 10 5m Shuttle Sprint x10 Reverse Lunges x 10 5m Shuttle Sprint x10
Active Recovery (2mins)	Dynamic/Static stretching while watching VIDEO THINK ABOUT IT – Be a team player https://goo.gl/UafN5l	Dynamic/Static stretching while watching VIDEO THINK ABOUT IT – Try your best https://goo.gl/w3Ltlz	Dynamic/Static stretching while watching VIDEO THINK ABOUT IT – Building Patience https://goo.gl/Bj8cai	Dynamic/Static stretching while watching VIDEO THINK ABOUT IT – Be a good friend https://goo.gl/43WMos
Body of Lesson	Teacher returns to the normal teaching program for the remaining lesson time	Teacher returns to the normal teaching program for the remaining lesson time	Teacher returns to the normal teaching program for the remaining lesson time	Teacher returns to the normal teaching program for the remaining lesson time

Note: (a) If fatigue sets in students may walk on the spot while punching the air to keep HR up (b) To increase student autonomy, students use the options within the examples to design each lesson. The MUSIC model for academic motivation (Jones, 2009) is considered established practice through: M= promotion of student voice during the design of the PE lesson, music choice during PE lessons. U = learning intentions displayed S= success criteria displayed. I = personal physical best award C= feedback provided during the lesson

3.5.3 Delivery of intervention. Treatments took place during normal PE classes in the form of teaching and instructional practices. During the study, students were grouped according to intact groupings that existed within the school. The average number of students in each class was 28 (Range = 23-30). Qualified PDHPE teachers delivered each intervention. Teacher A was male, 44 years of age and had 17 years teaching experience. Teacher B was male, 35 years of age and had 12 years teaching experience.

3.5.4 Setting. The setting for the study was a Catholic co-educational school in Western Sydney. The school provided at least two PE lessons a week for all students and did not include any HIIT activities as part of their regular school sports program. During the study, the treatments were delivered within PE classes that occurred inside the school hall and outside on the school playing fields.

3.5.5 Exposure quantity and duration. During the study, subjects participated in five PE lessons every fortnight for eight weeks of the term. Due to the school timetable, some sessions were delivered back to back which meant the frequency of sessions per fortnight was two double lessons and one single lesson. The maximum time available to provide a single session of PE was 50 minutes.

3.5.6 Timespan. The baseline measures for the consenting participants commenced in Week 9 of Term 2, 2016 and a test-retest group (10%) performed the measures for a second time during Week 10 of Term 2, 2016. The instrumentation used to obtain student measures were EUROFIT) and the PLOCQ. Measures of the class environment were also obtained using SOFIT. The last PDHPE lesson of Term 2, 2016 was utilised by the researcher and PE teachers to conduct an information and training session in the school hall. This session outlined the procedures for each treatment during Term 3 PE classes. The intervention phase of the study commenced in Week 1, Term 3, 2016 and lasted eight weeks. The intervention was run within six Year 7 PDHPE classes at the school. This study was conducted in multiple phases. Figure 3.1 shows the timeline for the study.

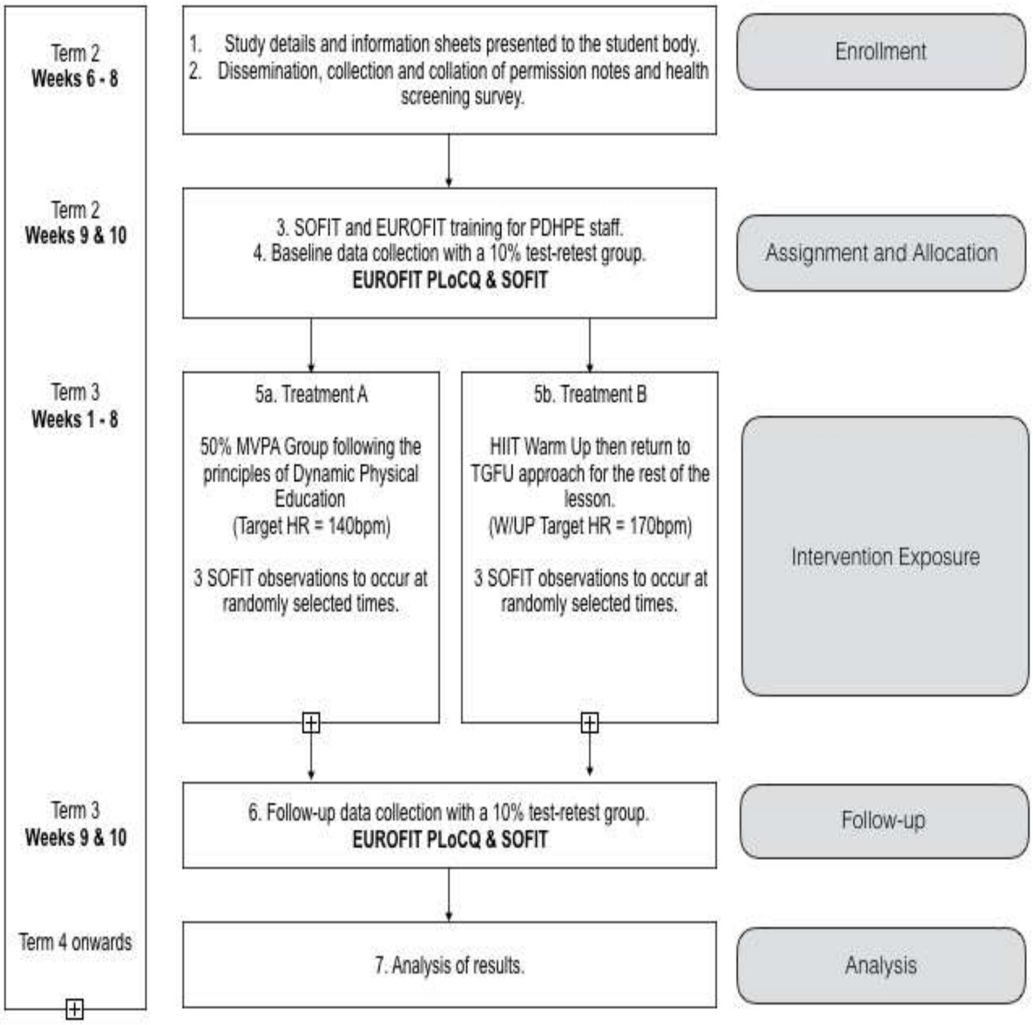

Figure 3.1. *Timeline for the Study*

3.6 Activities to increase compliance or adherence.

Per school policy, a learning environment that supported student autonomy occurred as a result of:

(a) The promotion of student voice and choice during the design of PE lessons. Student involvement created a learning environment where students could own their learning and make important instructional decisions (Enright & O'Sullivan, 2010; Wiliam, 2013);

(b) Placing a focus on 'enjoyment' through music choice and recognition of personal best performances (Costigan, Eather, Plotnikoff, Taaffe, Pollock, Kennedy et al., 2015);

(c) Providing opportunities for self-regulation by having students monitor their heart rates manually (Partridge, King, & Bian, 2011) and displaying learning intentions and success criteria (Wiliam, 2013).

3.7 Outcomes

The first outcome observed within the study was the changes in lesson context. Variations in the learning environment were measured using the SOFIT instrument (McKenzie, Sallis, & Nader, 1992). This instrument was used during the baseline data collection to obtain information about how active students were in their PE class and how often instruction was provided by their teacher. One observation of each teacher occurred during baseline using the paper SOFIT analysis. Data was transferred to the iSOFIT iPad tool for storage and analysis. A further seven observations were made during the intervention exposure phase of the study.

The second outcome focused on changes in physical fitness. Cardiovascular fitness was assessed using the multi-stage shuttle test (Léger, Mercier, Gadoury, & Lambert, 1988). The standing long jump and handgrip tests were used as a measure of muscular strength (Castro-Piñero et al., 2010). The ten by five-meter shuttle run was used to evaluate speed and agility of the students (Adam, Klissouras, Ravazzolo, Renson, & Tuxworth, 1993).

EUROFIT testing procedures (Adam et al., 1993) were followed during implementation of all tests. The four tests selected for this study have also been used within the ALPHA fitness test battery (Ruiz et al., 2011) and all measures of fitness have been determined to have acceptability, reliability and validity in adolescents.

The third outcome measured changes in student motivation to take part in PE lessons. Students' level of intrinsic motivation towards their PE experience was measured using the PLOCQ. This self-report questionnaire assessed student's motivation using subscales intended to measure: intrinsic motivation, identified regulation, introjected regulation, external regulation and amotivation. Lonsdale, Sabiston, Taylor, and Ntoumanis (2011) found researchers should be confident using the PLOCQ as their analyses largely supported the reliability and validity of PLOCQ among secondary students in the United Kingdom.

The study design allowed for the calculation of within and between group variance and effect sizes. These calculations provided valuable information in assessing the potential efficacy of the HIIT intervention. Effect sizes were used to determine the impact of the independent variables (DPE/HIIT) on three dependent variables:

1. Participants level of physical fitness.
2. Participants motivation to take part in PE lessons.
3. The lesson context.

3.8 Data collection methods and methods to enhance the quality

Data was collected during the following phases of the investigation:

Baseline data collection: EUROFIT (N=138), PLOCQ (N=148), SOFIT (N=2)

Implementation data collection: SOFIT (N=7)

Follow-up data collection: EUROFIT (N=151), PLOCQ (N=154)

Physical fitness levels, motivation to take part in PE lessons and the lesson context were the dependent variables. The two treatments, 'DPE' and 'HIIT', were the independent variables. During the study, two variations from the planned protocol occurred. The first variation was due to changes in teaching staff at the end of 2015. The change in teaching staff meant the school was unable to allocate three teachers to the Year 7 cohort during 2016 as initially planned. Although this change had the potential to impact the internal validity and quality of data collected, options were limited. To move forward using a comparison study model, two parallel treatments were needed for observation and comparison to occur.

After discussions with the school leadership regarding the allocation of teaching staff for 2016, a compromise that provided three teachers for the Year 7 cohort and maintained the integrity of the whole school timetable could not be reached. With only two teachers allocated to teach the Year 7 cohort during 2016, the number of groups that could be observed within the Year 7 cohort was also restricted to two.

The change in the number of teaching staff at the end of 2015 meant the number of PE teachers permanently on the campus of the pilot school was reduced from four to three. Two of the teachers were unavailable to perform SOFIT observations due to their involvement in the study as class teachers and the requirement for them to be blinded to the implementation of the alternate treatment. The lack of trained observers resulted in only one of the SOFIT trained PE teachers being available to perform observations during the study. No interrater checks were carried out during the baseline and treatment phases of the study. However, the SOFIT rater achieved the gold standard interrater reliability of 95% during SOFIT training.

Pre-test data were collected at baseline during Week 9 Term 2, 2016 and post-test data was collected at the conclusion of the intervention during Week Nine Term Three, 2016. Each method and procedure used to collect data has been described in detail below.

3.8.1 The European tests of Physical Fitness. To ensure the quality of measurements students (n=138) completed four items from the EUROFIT test battery during school sports time to determine baseline measures of physical fitness. The researcher provided training for staff administering the tests, and a protocol manual was provided on the date of training (see Appendix F). A demonstration of each test was provided by the researcher before students moved to their first test. Students were divided into house groups and completed the fitness tests in a circuit format (see Appendix G)

Explosive strength was evaluated by a standing long jump, using a tape measure. Participants were asked to stand on the sideline of an outdoor basketball court where a tape measure was placed perpendicular to the sideline. Before jumping, students were advised to swing their arms and flex their knees to ensure they could jump forward as far as possible. Students were also encouraged to increase their stability by keeping both legs close together at take-off and landing. The distance to be recorded was determined by the distance from the take-off line to the farthest body part behind the participant that was in contact with the ground. The best of two trials was recorded. The distance jumped was registered to the nearest centimetre (Adam et al., 1993).

Handgrip strength was measured using a handgrip dynamometer model 51DHE, purchased from Ross Hayward Sports. Handgrip measures were read to the nearest kilogram. The dynamometer was held at right angles, with the arm bent and palm facing inward. The dynamometer was compressed as hard as possible for two to three seconds. The best result of two trials was recorded. (Adam et al., 1993). The testing procedures did not indicate a specific limit for the rest period. Therefore, this was not monitored by those administering the test.

Agility and speed were measured using a ten by five-meter shuttle run. Each participant was required to sprint ten times between two lines, five meters apart. The test was performed on a handball court that was five meters by five meters wide. Measurements were recorded to the nearest second.

Cardiorespiratory endurance was estimated using the multi-stage fitness test which requires participants to run back and forth between two lines set twenty meters apart. Running pace was determined by an audio signal projected from the Bleep Test Lite iPhone application (Bitworks Design, 2011). The initial velocity was 8.5 km/hr-1 and increased by 0.5 km/hr-1 every minute. The test was terminated when the participant missed the end lines in time with two consecutive audio signals (Adam et al., 1993). Once students completed the multi-stage fitness test, they were provided fifteen-minutes recovery time before attempting the remaining fitness tests. At the completion of testing, students entered their results instantly to the researcher's spreadsheet via a Google form.

3.8.2 Perceived Locus of Causality Questionnaire. The PLOCQ was completed the following day during a year assembly. It was administered using an online Google form set up in a survey format. The researcher attended the year meeting and read instructions for completing the questionnaire from a pre-written script (see Appendix H). Students were told if they had any questions they were to raise a hand and the researcher would come and respond to their question personally. Data entry devices included phones, iPads and laptop computers.

The PLoCQ (Goudas, Biddle, & Fox, 1994) is a self-report questionnaire that measures the reasons for an individual's actions determined by a continuum from internally motivated to externally motivated behaviour. SDT proposes that when individuals have a more internal perceived locus of causality for behaviour, they will apply greater effort and feel increased satisfaction in acting when compared to times when they have a more external perceived locus of causality (Ryan & Deci, 2000a; 2000b).

The PLOCQ (Goudas et al., 1994) was developed to examine students' motivational regulations towards PE at a contextual level. The PLOCQ PE version uses a 7 point Likert scale rating. It includes semantic anchor statements such as "I take part in PE classes because I want to learn new skills" with the following seven response choices: 1 = strongly disagree, 2 = disagree, 3 = disagree somewhat, 4 = undecided, 5 = agree somewhat, 6 = agree and 7 = strongly agree.

3.8.3 System for Observing Fitness Instruction Time. The SOFIT instrument (McKenzie et al., 1992) was used to obtain simultaneous recordings of three variables. In brief, four students were observed, and their PA levels, the lesson context, and teacher interactions were coded every twenty seconds (behaviour observed for ten seconds followed by ten seconds of recording data) throughout the PE lesson on a rotational basis.

Computer tablets installed with the iSOFIT application (Center for Research in Physical Activity, Health & Leisure, 2016) were used to provide an objective measure of student activity levels, the lesson context, and teacher interaction in providing feedback. PA levels, lesson context and teacher interaction in providing feedback was measured using direct observation of three randomly scheduled PE lessons on three separate days for each class over an eight-week period from July 2016 to September 2016.

The time for observations was determined to start once 51% of students had arrived at the designated teaching area. Observations were resolved once 51% of students had left the designated teaching area. To ensure the observations were arbitrary, the observed students were chosen as the fifth male, fifth female, tenth male and tenth female to arrive at the designated teaching area.

Coding occurred at the conclusion of each ten-second observation interval, comprising activity levels, lesson content and teacher interaction. With regards to lesson context, a determination was made as to whether class time was being allotted for general lesson content or behaviour modification. When behaviour modification was determined it was coded as management. Content coded as knowledge was determined to be the sharing of specific PE subject matter. Furthermore, the occurrence of motor content included the coding of fitness, skill practice or game play. Any context not accommodated in the coding mentioned above was coded as other.

Classifying PA levels occurred by observing a single randomly selected student and determining his/her level of active engagement. This level is an approximation of the intensity each student exhibits during PA. The PA intensity levels of 1 to 3 are used to describe the body position of the student (lying down, sitting, standing). PA intensity is coded as a 4 (moderately active) if walking is observed. The highest activity intensity of 5 (vigorously active) describes when the student is expending more energy than they would during normal walking, this may include actions such as jumping or running. PA coding is based on the observed activity intensity of the target student at the moment the observation interval ends (McKenzie et al., 1992).

Teacher interaction was classified into one of three categories. The first category ‘provides concurrent feedback', related to the teacher providing feedback while students were participating in PA and moving. The second teacher interaction category was ‘provides terminal feedback', related to the teacher stopping PA to provide feedback and students were standing or sitting. The third teacher interaction was ‘no feedback provided' and referred to when none of the previously mentioned behaviours were observed.

Four PDHPE faculty members were trained as SOFIT observers according to the procedure outlined above. Training included an instructional meeting and video assessment where an interrater agreement of 85% or more was achieved by each teacher. Although this 'gold standard' was obtained by all members of the PDHPE team, due to timetabling constraints, only one member of the PDHPE faculty was available to perform SOFIT observations during the study. As observations were made by a single observer, field-based interrater reliability checks were not able to be conducted.

3.9 Information on validated instruments.

3.9.1 European tests of Physical Fitness. EUROFIT is a field-based physical fitness test battery consisting of nine physical fitness tests. This standardised test battery was devised by the Council of Europe, for children of school age and has been used in many European schools since 1988 (Karppanen, Ahonen, Tammelin, Vanhala, & Korpelainen, 2012).

As part of the ALPHA study (Ruiz et al. 2011), a systematic review dealing with the validity and reliability of 15 field-based fitness test batteries in youth from six regions of the world was performed. The review reported findings that the 20-meter shuttle run test was a valid instrument to assess cardiorespiratory fitness, it also supported the handgrip strength test and standing broad jump test as valid instruments to assess musculoskeletal fitness.

A further study conducted by Tsigllis, Douda, and Tokmakidis (2002) examined the one-week test-retest reliability of the EUROFIT test battery applied to undergraduate students. High reproducibility was demonstrated for the field tests used in this study.

According to Mac Donncha, Watson, Watson, McSweeney, and O'Donovan (1999) physical fitness items as outlined by the EUROFIT handbook (Adam et al., 1993) are appropriate for individuals with mild to moderate intellectual disability. The percentage error of the mean, however, is quite large for the 20-meter shuttle test items. Moreover, interclass correlations as a reliability estimate indicate that the physical fitness items in this study are reliable for adolescents with and without mild to moderate intellectual disability.

3.9.2 Perceived Locus of Causality Questionnaire. Motivation in a PE setting is often measured using the Perceived Locus of Causality Questionnaire (e.g. Ha, Lonsdale, Ng, & Lubans, 2014; Standage & Gillison, 2007; Zanetti et al., 2017). The PLoCQ was devised by Goudas et al. (1994) and is grounded in SDT in which they constructed a 20-question survey by adapting items from the Self-Regulation

Questionnaire (Ryan & Connell,1989) as well as items from the amotivation subscale of the Academic Motivation Scale (Vallerand et al., 1992).

The PLoCQ is used to assess a student's perception of the origin of their reasons for engaging in a PE lesson. At one end of the continuum, a student participates due to internalised reasons, in that the student participates willingly and out of free choice. While at the other end of the continuum a student participates because of external motivators, or because they feel compelled to do so as a result of external pressure. Students with high concentrations of self-determined motivation, compared to those with low levels, have been found to be more active during PE and engage in more self-initiated PA (Lonsdale, Sabiston, Raedeke, Ha, & Sum, 2009; Pannekoek, Piek, Kane, & Hagger, 2014).

Research in the field of PE has supported the reliability and validity of PLoCQ subscale scores for research involving children 11 years and older (Ntoumanis, 2001; Standage, Duda, & Ntoumanis, 2003; Wang, Hagger and Liu, 2009). The questionnaire displayed an indication of satisfactory reliability for most of its subscales. (Pannekoek, Piek, Kane, & Hagger, 2014). Evidence of validity and reliability of the subscale scores has also been shown by Lonsdale et al. (2011).

3.9.3 System for Observing Fitness Instruction Time. The SOFIT instrument assesses what occurs within PE classes by facilitating the collection of data relating to the physical activity levels of students, the lesson context, and the teacher's interaction with their students. The system assists key stakeholders in making judgments about PE lessons. The main outcome variable is student PA levels, and these can be reported in the percentage of lesson time spent lying down, sitting, standing, and walking. The amount of lesson time spent in MVPA and VPA can then be calculated.

Monitoring of participant heart rates has been used to calibrate the activity codes in SOFIT (McKenzie et al., 1992; Rowe, Schuldheisz, & van der Mars, 1997) and validated using accelerometers (McKenzie, Sallis, & Armstrong, 1994). The reliability and validity of the SOFIT instrument has been determined by numerous studies (e.g. Pope, Coleman, Gonzalez, Barron, & Heath, 2000; Rowe, van der Mars, Schuldheisz, & Fox, 2004; Rowe, Schuldheisz, & van der Mars, 1997; Sharma, Chuang, Skala, & Atteberry, 2011). These studies have determined SOFIT to be a reliable and valid instrument for research conducted on children aged 2 – 18 years of age.

3.10 Sample size

The sample size for this study was determined by convenience sampling. A Year 7 cohort (N=182) were invited to participate in the study and the number of consenting students were included in the implementation and analysis phases of the study. 166 students provided consent to take part in the study (91%). This group was divided into two sample groups according to the PE class they were enrolled in at the start of the 2016 school year. The sample size for the DPE treatment consisted of (n=84) students, and the sample size of HIIT treatment consisted of (n=82) students. A confidence interval of 95% was set in the between-group analysis to address the issue of how well the sample size reflected the target population statistic.

3.11 Assignment method

Subjects were assigned to treatment conditions using intact groups within the school. Classes 7PD1, 7PD2 and 7PD3 were assigned the HIIT treatment and classes 7PD4, 7PD5 and 7PD6 were assigned the DPE treatment. The assignment of treatment conditions was determined by the confidence of the teacher to implement each treatment. Teachers were asked to nominate the condition they felt most comfortable delivering. To minimise potential bias, both teachers followed the same unit of work and registration process ensuring the same content was covered in each group. Further to this, each class used the same lesson focus questions, learning intentions and success criteria.

Each class was provided access to an information board to facilitate perceived choice and involvement in lesson design. Students voted after class using a google form to make their choice. Students would select an option for each phase of learning, and the option with the highest value was displayed on the information board and performed during the following lesson.

3.12 Blinding (masking)

Blinding of the participants was not used during the interventions. As the study focused on adaptations to levels of PA, it was deemed that each study condition should be explained to the students during the recruitment phase of the study so they may make an informed decision to be part of the study or not. In addition to this, during the final weeks of the preparation phase, students received training in the procedures of the treatments they were to receive. Students were however blinded to the specific research hypotheses.

3.13 Unit of analysis

Since groups of individuals were assigned to the treatment conditions, the analyses were performed at a group level. Within-group analyses and between-group analyses were conducted. A prior estimate of the intra-class correlation coefficient was used to adjust the standard error estimates before calculating confidence intervals. A multilevel analysis was not administered.

3.14 Statistical methods

Using the Statistical Package for Social Sciences (SPSS, v22), descriptive statistics and measures of central tendency were used to describe the effect of the intervention from baseline to follow-up data in the different groups.

EUROFIT data were analysed through the calculation of unadjusted means, mean differences and effect sizes using Cohen's d. This group of calculations were performed for the Beep-Test, hand grip test (left & right), standing long jump and the 10 x 5m shuttle run.

Unadjusted means, mean differences and effect sizes were also calculated for all subscales of the PLoCQ: amotivation, external regulation, introjected regulation, identified regulation and intrinsic motivation. An overall internal perceived locus of causality score was calculated by summing the identified regulation and intrinsic motivation scores then subtracting the introjected regulation and the external regulation scores (Sheldon & Elliot, 1999).

Values for all SOFIT data were determined as percentages. Student PA levels, lesson context, and teacher interaction was measured at baseline and follow-up. Unadjusted means, mean differences and effect sizes using Cohen's d were then calculated for PA intensity, lesson context, and teacher interaction for baseline and follow-up.

Chapter 4: Results

This study collected and analysed data with the results being reported for each of the research questions in this chapter.

4.1 Participant flow

The inclusive design of the study meant all students enrolled in the Year 7 cohort (n=182) were deemed eligible to participate once permission was provided by parents. Figure 4 displays the flow of participants through the study. All 182 students were invited to participate. 16 students declined to participate in the study. The population of enrolled participants was 166 students (91%). All consenting participants completed a medical history survey, and this survey was a screening tool for participation.

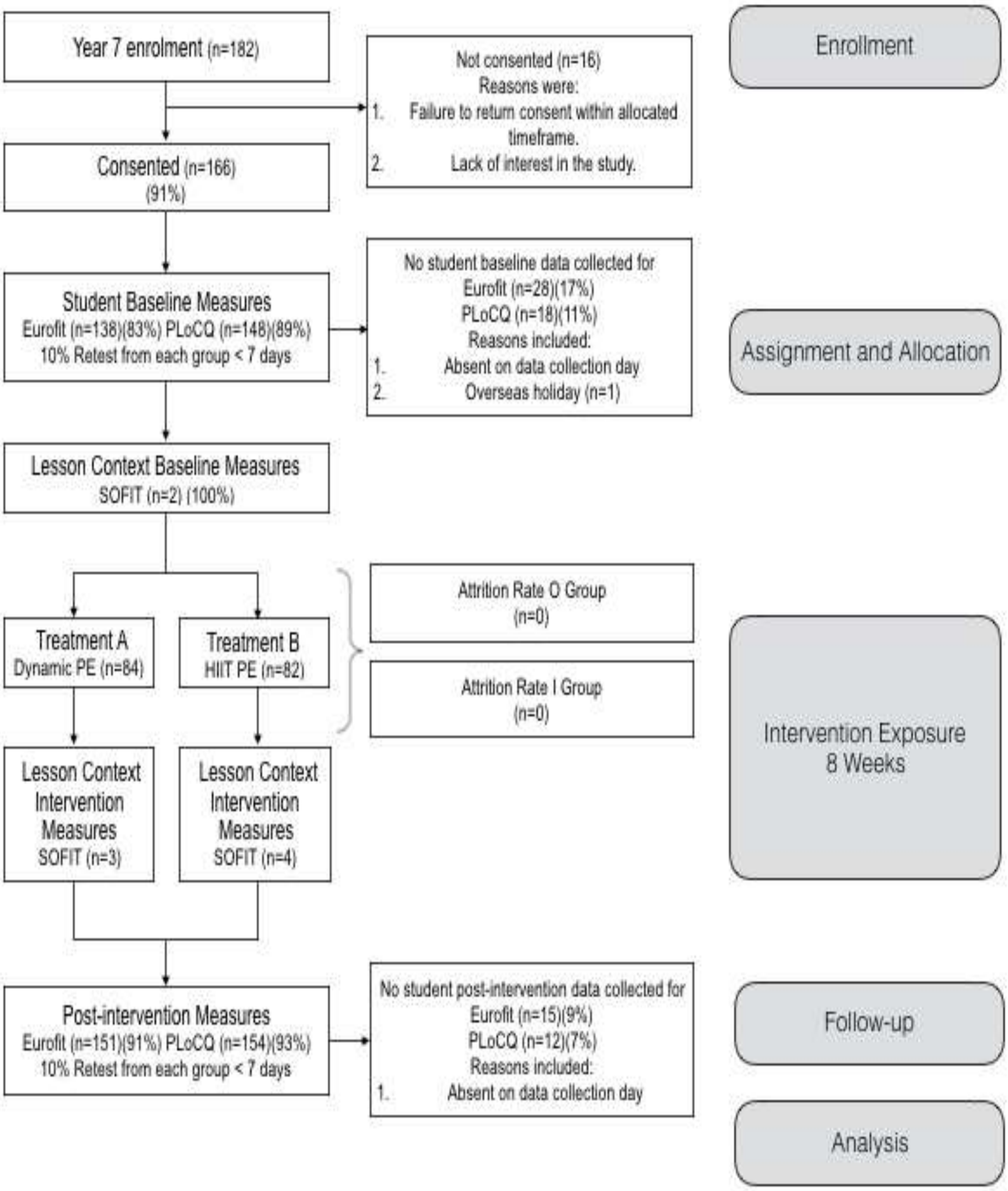

Figure 4.1. *Participant flow through each stage of the study.*

During the baseline testing phase, students were blinded to the treatment they would receive. Table 4.1 presents the number of participants assigned to each study condition and the number of participants who received each treatment. A range of baseline measures were performed before students were informed of the treatment to which they would be assigned. 138 students completed the baseline EUROFIT assessment (83%), 148 sat the PLoCQ (89%) and a SOFIT observation was made of each teacher involved in the study.

Table 4.1. *Assignment, allocation and treatment exposure: the number of participants assigned to each study condition, the number of participants who received each treatment and the number of participants who completed the follow-up by study condition.*

	Treatment A: Dynamic PE	Treatment B: HIIT PE
Number of classes assigned to each study condition.	3	3
Mean age of participants (SD)	12.87 (0.46)	12. 87 (0.34)
Number of participants assigned to each study condition	84	82
Number of participants who received each treatment	84	82
Treatment exposure (lessons)	18.9	18.8
% of male participants	51	50
% of female participants	49	50
Number of participants who completed Baseline EUROFIT and were included in main analysis.	71	67
Number of participants excluded from the EUROFIT main baseline analysis.	13	15
Number of participants who completed Follow up EUROFIT and were included in main analysis.	76	75
Number of participants excluded from the EUROFIT main follow up analysis.	8	7
Change from baseline	+5	+8
Number of participants who completed Baseline PLoCQ and were included in main analysis	75	73
Number of participants excluded from the PLoCQ main baseline analysis.	9	9
Number of participants who completed Follow up PLoCQ and were included in main analysis	77	77
Number of participants excluded from the PLoCQ main follow up analysis.	7	5
Change from baseline	+2	+4

Information collected concerning the participant's age and sex for baseline comparison revealed the average age of participants was 12.87 years, and the percentage of boys and girls taking part in the research project was almost even. Table 4.1 shows, from the 166 students who enrolled in the study, 84 were assigned to the DPE treatment, and 82 were allocated to the HIIT treatment. There were no significant differences between the two groups for age or sex.

Each treatment was delivered in an eight-week period. No participant drop-out occurred during the eight-week treatment however during baseline testing 28 students were absent from school during the scheduled EUROFIT testing time, and 18 students were absent when the PLoCQ was completed. Analyses were conducted using measures of central tendency. Data for students who were absent on the day of data collection were input as zero for the calculation of the sample mean as intention to treat principles were applied.

4.2 Baseline data

4.2.1 Demographic and clinical characteristics. According to the ‘My School' website (https://www.myschool.edu.au) created by the Australian Curriculum Assessment and Reporting Authority, the structure of the pilot school population is one that operates within the non-government sector and caters for secondary school students ranging from Year 7 to Year 12. The school is located in Western Sydney and features a dual campus model. The school has an Index of Community Socio-Educational Advantage value of 1045 which equates to a rating slightly above the average of 1000.

Within the pilot school, 43% of the population has a language background other than English. The attendance rate for semester one of 2016 was 93%, and the semester two attendance was 92%. Baseline data were obtained from the results of the three instruments, and each assessment occurred on a different day. Data from EUROFIT was collected on Thursday 21st July 2016 and data collection for the PLoCQ ended on Friday 22nd July 2016. A 10% test-retest group completed each assessment for a second time on Thursday 28th July 2016. The SOFIT Observation for Teacher A was conducted on Thursday 28th July 2016, and the SOFIT Observation for Teacher B was carried out on Friday 29th July 2016.

4.2.2 Characteristics for each study condition. Information presented in Table 4.1 indicates that at the time of baseline testing, there were on average 28 students per class. The proportion of boys to girls in each class was 51% to 49% respectively. As shown in Table 4.2 students exposed to the DPE treatment spent an average of 31% of lesson time engaged in MVPA, and students who took part in the HIIT treatment spent 33% of lesson time engaged in MVPA. Regarding lesson context, an average of 50% and 39% of lesson time was spent in game play respectively. Both groups spent 0% of lesson time engaged in specific fitness activities, 6% and 7% of lesson time were spent addressing classroom management. Teachers devoted 40% and 37% of class time to knowledge instruction respectively, 0% and 14% in skill practice, and the remaining 1% and 3% of time saw students engaged in activities resembling a recess break, which was coded as ‘other'.

Table 4.2. *Mean values of baseline and follow-up SOFIT measurements by group. Between Group Difference (p-Value) and Effect Size for comparison between treatment groups at follow-up testing.*

	Baseline Sample Mean (SD)	Baseline DPE Group Mean (SD)	Baseline HITT Group Mean (SD)	Follow-up Sample Mean (SD)	Follow-up DPE Group Mean (SD)	Follow-up HITT Group Mean (SD)	Follow-up Between-Group Difference (p-Value)	Effect Size DPE Group (+ve) vs HITT (-ve) (Cohen's *d*)
Observations (n)	*2*	*1*	*1*	*7*	*3*	*4*		
Student Activity								
Sitting	0.24 (0.12)	0.28 (na)	0.21 (na)	0.23 (0.18)	0.12 (0.29)	0.32 (0.12)	0.26	-0.90
Standing	0.43 (0.21)	0.39 (na)	0.46 (na)	0.27 (0.17)	0.23 (0.14)	0.30 (0.13)	0.52	-0.52
Walking	0.12 (0.06)	0.16 (na)	0.07 (na)	0.28 (0.16)	0.39 (0.31)	0.19 (0.09)	0.26	0.88
Very Active	0.20 (0.10)	0.15 (na)	0.25 (na)	0.21 (0.07)	0.25 (0.23)	0.17 (0.09)	0.54	0.46
MVPA	0.32 (0.15)	0.31 (na)	0.33 (na)	0.48 (0.18)	0.64 (0.55)	0.36 (0.08)	0.28	0.71
Lesson Context								
Management	0.06 (0.03)	0.06 (na)	0.07 (na)	0.23 (0.15)	0.24 (0.19)	0.21 (0.21)	0.85	0.15
Knowledge	0.38 (0.19)	0.40 (na)	0.36 (na)	0.22 (0.09)	0.15 (0.15)	0.27 (0.11)	0.27	-0.91
Fitness	0.00 (0.00)	0.00 (na)	0.00 (na)	0.15 (0.12)	0.20 (0.19)	0.12 (0.16)	0.08	0.46
Skill Practice	0.07 (0.05)	0.00 (na)	0.14 (na)	0.00 (0.01)	0.01 (0.01)	0.00 (0.01)	0.25	na
Game Play	0.44 (0.22)	0.50 (na)	0.39 (na)	0.33 (0.10)	0.35 (0.40)	0.33 (0.10)	0.93	0.07
Other	0.02 (0.01)	0.01 (na)	0.03 (na)	0.06 (0.10)	0.05 (0.05)	0.06 (0.08)	0.86	-0.15
Teacher Interaction								
Feedback (*Concurrent*)	0.02 (0.03)	0.06 (na)	0.07 (na)	0.41 (0.17)	0.26 (0.35)	0.53 (0.09)	0.19	-1.06
Feedback (*Terminal)*	0.05 (0.03)	0.04 (na)	0.07 (na)	0.14 (0.10)	0.04 (0.07)	0.21 (0.06)	0.02	-2.61
No Feedback	0.81 (0.40)	0.85 (na)	0.77 (na)	0.41 (0.24)	0.64 (0.52)	0.23 (0.13)	0.18	1.08

An average of 19% of scheduled lesson time was lost in transition at the start and end of class. No class time was lost due to time spent changing clothes and transitioning to and from the locker room, as the school's PE policy was designed so that students did not use class time to get changed. Within the observed DPE lesson, 4.5 minutes of feedback was provided (9%) and in the observed HIIT lesson, 6.5 minutes of feedback received by students (13%). There was no statistically significant difference between groups at baseline. Baseline testing revealed that most time during PE was spent standing in both groups 39% and 46% respectively.

4.2.3 Comparisons of those lost to follow-up and those retained. No participant drop-out occurred during the eight-week treatment phase however at the time of baseline PLoCQ testing 18 students were not in attendance during the scheduled testing time. During the follow-up testing, 12 students were absent from school. The change from baseline was an increase of 6 students. The number of students absent from testing decreased by about 33%.

An increase in follow-up testing was also observed for the EUROFIT measures. During baseline testing 28 students were absent from school and at the time of follow-up testing 15 students were absent from school. The change from baseline was an increase of 13 students. The number of absent students decreased by almost 50%.

4.2.4 Comparison of the study population and the target population of interest. As shown in Table 4.3, comparisons between the study population at baseline and target population of interest were drawn using criterion-based standards from the Australian Fitness Education Award (AFEA) (Australian Council for Health Physical Education and Recreation [ACHPER], 2003).

Table 4.3. *Comparison between study population at baseline and target population of interest for measure of Cardiorespiratory Fitness using AFEA criterion referenced standards.*

	Age	Fitness Level	AEFA Criterion Referenced Standard for Multi Stage Fitness Test		Baseline Treatment A PAZ, Mean (SD)		Baseline Treatment B PAZ, Mean (SD)		Follow up Treatment A PAZ, Mean (SD)		Follow up Treatment B PAZ, Mean (SD)	
			Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Multi Stage Fitness Test: *Cardiorespiratory Fitness* (level & shuttle)	12	BELOW PAZ 1 PAZ 2 PAZ 3	<5.4 5.4 6.4 7.4	<4.1 4.1 4.8 5.5	BELOW, 3.8 (2.13)	BELOW, 3.0 (2.07)	BELOW, 4.7 (2.89)	BELOW, 3.4 (2.09)	BELOW, 5.2 (2.84)	PAZ 1, 4.1 (2.12)	PAZ 2, 7.1 (2.46)	PAZ 1, 4.6 (2.08)
Multi Stage Fitness Test: *Cardiorespiratory Fitness* (level & shuttle)	13	BELOW PAZ 1 PAZ 2 PAZ 3	<5.9 5.9 6.6 8.1	<4.3 4.3 5.3 6.1	BELOW, 5.2 (2.62)	BELOW, 3.2 (1.66)	BELOW, 4.4 (3.28)	BELOW, 3.6 (1.78)	PAZ 1, 6.2 (2.45)	PAZ 1, 5.1 (1.92)	PAZ 1, 6.1 (3.03)	PAZ 1, 4.3 (2.48)

Values in Table 4.3 show that when using criterion-based standards set for the Australian adolescent population, it is evident that during baseline testing the mean values for all treatments were below the threshold for PA Zone 1. This threshold has been identified as the lower limit of cardiovascular fitness required for any long-term health benefits to be observed among Australian adolescents (ACHPER, 2004). 12-year old boys were required to meet a target of level five, shuttle four (5.4). 12-year old boys assigned to the DPE treatment achieved a mean value of level three, shuttle eight (3.8) which is almost two levels below the threshold, while boys allocated to the HIIT treatment achieved a mean value of level four, shuttle seven (4.7).

The 12-year-old girls group were set a target of level four, shuttle one (4.1) and both groups failed to meet this standard. Girls aged 12 years participating in the DPE treatment exhibited a mean value of level three (3.0) which was also below the set standard. Girls taking part in the HIIT Treatment achieved a mean value of level three, shuttle four (3.4).

Results for students aged 13 years were comparable to the students aged 12 years. The minimum target level to bring about enhanced health for boys aged 13 years, was level five, shuttle nine (5.9). Boys aged 13 years completing the DPE treatment produced a mean value of level five, shuttle two (5.2) while boys allotted the HIIT treatment presented a mean value of level four, shuttle four (4.4). Again, both groups were below the minimum level required for long-term health benefits to be achieved as a result of their cardiorespiratory fitness (ACHPER, 2004).

For the 13-year old female group, the lower threshold for improved health due to cardiorespiratory fitness was set at level four, shuttle one (4.1) and both groups failed to meet this standard. Girls aged 13 completing the DPE treatment recorded a mean value of level three, shuttle two (3.2) while girls participating in the HIIT treatment achieved a mean value of level three, shuttle six (3.6).

The comparisons that have been made between the study population at baseline and the target population of interest have shown at baseline students within the study population exhibited levels of cardiorespiratory fitness that were below the minimum level required for any health benefits to be achieved (ACHPER, 2004). It has been shown however, this is typical of Australian students aged 8-15 years old who are often below average when compared to their international peers (Hardy et al., 2010).

4.3 Baseline equivalence

Information regarding baseline equivalence is presented in Table 4.1. Throughout the study students participating in the DPE treatment completed on average 18.9 lessons and students involved in the HIIT Treatment took part in an average of 18.8 lessons. The administration of each treatment occurred during normal PE class time, ensuring any decrease in learning due to lesson length was the same for both treatments.

Subjects were assigned to treatment conditions using intact groups within the school. The mean age of students allotted to the DPE treatment was 12.9 years (SD=0.46) The mean age of students participating in the HIIT treatment was 12.9 years (SD=0.34) 84 students were allocated to the DPE treatment and 82 students were assigned to the HIIT treatment.

The sex ratio of the group completing the DPE treatment was 43 boys and 41 girls, and the group of students assigned to HIIT treatment was made up of 41 boys and 41 girls. The mean number of students in a class allocated to the DPE treatment was 27 (SD=3.21), and the average number of students in a class allocated to the HIIT treatment was 28 (SD=0.58).

An ‘intention to treat' analysis strategy was used to address the impact of non-compliers. Noncompliance, protocol deviations, withdrawal, and anything that happened after the start of the treatment phase was ignored. This approach was used as it best reflects the true nature of a school environment. No significant differences were determined between groups. Therefore, no statistical methods were used to control for differences.

4.4 Numbers analysed

Table 4.1 presents information indicating the number of participants from the DPE group and the HIIT group who were analysed during the baseline testing phase and the follow-up phase.

4.4.1 Analysis of student measures. The number of students analysed in the DPE and HIIT group at baseline using EUROFIT measures was 71 and 67 respectively at follow-up, the number of students who were assessed using the same measures at follow-up was 76 and 75 respectively. The number of students who completed the PLoCQ at baseline from the DPE treatment was 75, and the number of students from the HIIT treatment was 73. At follow-up data were collected from 77 students in the DPE treatment and 77 students from the HIIT treatment.

4.4.2 Analysis of learning environment. As shown in Figure 4.1 during the baseline data collection phase, two SOFIT observations were made. One observation of the DPE class was conducted, and one observation of the HIIT class occurred. During the treatment phase, three usable observations of DPE lessons were made, and four usable observations were made of the HIIT lessons.

4.5 Outcomes and estimation

4.5.1 Question One: ***What is the difference between DPE and HIIT on students' comparable health measures often sought through MVPA?*** Measures obtained from the EUROFIT battery of fitness tests are shown in Table 4.4. At baseline, the population mean for the multi-stage fitness test was level four, shuttle eight (SD=2.49) at the time of follow-up testing the population mean increased by an entire level. Students achieved a mean score of level five, shuttle eight (SD=2.59) Similar improvements were observed within each treatment. During baseline testing students allocated to the DPE treatment achieved a mean value for the multi-stage fitness test of level four, shuttle seven (SD=2.38) when this group was retested at follow-up, the mean increased to level five, shuttle eight.

Table 4.4. Mean values and standard deviations of baseline and follow-up EUROFIT measurements by group. Between Group Difference (p-Value), Within Group Difference and Effect size for comparison between treatment groups at follow-up testing.

	Baseline Sample Mean (SD)	Baseline DPE Group Mean (SD)	Baseline HITT Group Mean (SD)	Follow-up Sample Mean (SD)	Follow-up DPE Group Mean (SD)	Follow-up HITT Group Mean (SD)	Follow-up Between-Group Difference (p-Value)	Follow-up Within Group Difference DPE Group (p-Value)	Follow-up Within Group Difference HITT Group (p-Value)	Effect Size DPE Group (+ve) vs HITT Group (-ve) (Cohen's *d*)
Total number (n)	138	*71*	*67*	151	*76*	*75*				
Multi-stage Fitness Test *level & shuttle*	4.81 (2.49)	4.73 (2.38)	4.9 (2.62)	5.88 (2.59)	5.85 (2.41)	5.92 (2.76)	0.87	<0.01	0.03	0.03
Grip (L) *kg*	16.80 (8.25)	16.23 (8.08)	17.42 (8.46)	16.15 (7.16)	15.58 (7.34)	16.73 (6.96)	0.33	0.65	0.60	0.16
Grip (R) *kg*	18.54 (9.09)	18.37 (9.28)	18.72 (8.95)	17.93 (8.09)	17.39 (8.23)	18.47 (7.95)	0.41	0.50	0.86	-0.14
Sprint *sec*	21.47 (8.47)	21.83 (8.39)	21.09 (8.56)	20.71 (7.19)	20.90 (7.50)	20.52 (6.89)	0.75	0.48	0.66	-0.05
Jump *cm*	165.93 (70.41)	162.23 (67.00)	169.85 (74.15)	170.13 (58.53)	167.43 (57.69)	172.85 (59.55)	0.57	0.61	0.79	0.09

Students completing the HIIT treatment also demonstrated improved performance, at the time of baseline testing the mean for this group was level four, shuttle nine (4.9) and at follow-up, the mean was level five, shuttle nine (5.9). This improvement equates to an estimated increase in Vo2 Max of 3.4 ml/kg/min (ACHPER, 2004). At follow-up, within-group differences were also calculated and returned values of $p < 0.01$ for the DPE treatment and $p = 0.03$ for the HIIT Treatment. An effect size of $d = 0.03$ was observed.

4.5.2 Question Two: ***What is the difference between DPE and HIIT on the lesson context, teacher interaction and student activity levels during PE lessons?***

Table 4.2 presents results related to changes in the lesson context, teacher interaction and student activity levels. With a Cohen's d of 0.71, 98 % of the DPE treatment time was above the mean MVPA% of the HIIT Treatment. 29 % of the two classes time spent in MVPA overlapped, and there was a 93 % chance that a class picked at random from the DPE group would have accrued a greater percentage of MVPA time during PE than a class picked at random from the HIIT Treatment. Although MVPA% favoured the DPE group the most notable changes in the learning environment were observed in the HIIT group. With a Cohen's d of 2.61, 99 % of the HIIT treatment was above the mean of the DPE treatment regarding the amount of terminal feedback provided during class time. 23 % of the two groups overlapped, and there is a 96 % chance that a student picked at random from the HIIT Treatment will have been provided a greater amount of feedback during their learning experience than a student picked at random from the DPE treatment.

4.5.3 Question Three: ***What is the difference between DPE and HIIT on student's motivation to take part in PE?*** Table 4.5 presents measurements from baseline and follow-up for the PLoCQ while Table 4.6 presents the calculated IPLoC scores for both groups. Responses were reported on a seven-point scale ranging from 1 (strongly disagree) to 7 (strongly agree). Subscales designed to measure amotivation (e.g., 'I take part in PE classes but I really feel I am wasting my time in PE'), and external regulation (e.g., 'I take part in PE classes because I'll get into trouble if I don't') were in favour of the DPE treatment.

Table 4.5. *Mean values and standard deviations of baseline and follow-up PLoCQ measures by group. Between Group Difference (p-Value), Within Group Difference and Effect Size for comparison between treatment groups at follow-up testing.*

	Baseline Population Mean (SD)	Baseline DPE Group Mean (SD)	Baseline HIIT Group Mean (SD)	Follow-up Population Mean (SD)	Follow-up DPE Group Mean (SD)	Follow-up HIIT Group Mean (SD)	Follow-up Between-Group Difference (p-Value)	Follow-up Within-Group Difference DPE (p-Value)	Follow-up Within-Group Difference HIIT (p-Value)	Effect Size DPE Group (+ve) vs HIIT Group (-ve) (Cohen's *d*)
Total number *(n)*	*148*	*75*	*73*	*154*	*77*	*77*				
Q1	2.63 (1.61)	2.71 (1.68)	2.55 (1.55)	2.21 (1.50)	2.11 (1.55)	2.31 (1.44)	0.41	0.02	0.33	0.13
Q2	1.92 (1.23)	1.92 (1.29)	1.93 (1.18)	1.85 (1.25)	1.84 (1.25)	1.86 (1.26)	0.92	0.70	0.73	0.02
Q3	2.12 (1.35)	2.05 (1.26)	2.19 (1.43)	1.83 (1.13)	1.57 (0.89)	2.09 (1.30)	0.01	0.01	0.65	0.47
Q4	2.32 (1.44)	2.26 (1.31)	2.37 (1.57)	2.02 (1.29)	1.93 (1.23)	2.11 (1.36)	0.39	0.11	0.28	0.14
AMOTIVATION	**2.25 (1.23)**	**2.24 (1.19)**	**2.26 (1.27)**	**1.98 (1.16)**	**1.86 (1.10)**	**2.09 (1.20)**	**0.22**	**0.04**	**0.40**	**0.20**
Q5	2.47 (1.72)	2.48 (1.75)	2.47 (1.70)	2.45 (1.69)	2.18 (1.48)	2.72 (1.86)	0.05	0.26	0.39	0.32
Q6	4.45 (2.29)	4.53 (2.40)	4.36 (2.18)	3.97 (2.14)	3.87 (2.29)	4.08 (2.00)	0.55	0.09	0.41	0.10
Q7	2.73 (1.87)	2.82 (1.93)	2.64 (1.82)	2.45 (1.57)	2.33 (1.46)	2.57 (1.68)	0.35	0.08	0.81	0.15
Q8	3.73 (2.20)	3.96 (2.25)	3.51 (2.15)	3.30 (2.09)	3.09 (2.04)	3.51 (2.14)	0.22	0.01	1.00	0.20
EXTERNAL REGULATION	**3.35 (1.75)**	**3.45 (1.78)**	**3.24 (1.74)**	**3.04 (1.66)**	**2.87 (1.57)**	**3.22 (1.73)**	**0.19**	**0.04**	**0.94**	**0.21**
Q9	3.53 (2.20)	3.78 (2.32)	3.27 (2.07)	3.28 (2.07)	3.28 (2.17)	3.28 (1.98)	1.00	0.16	0.98	0.05
Q10	2.84 (1.94)	3.12 (2.13)	2.56 (1.72)	3.20 (2.09)	3.51 (2.16)	2.88 (1.97)	0.06	0.26	0.29	0.31
Q11	3.34 (2.14)	3.62 (2.31)	3.05 (1.95)	3.31 (2.10)	3.70 (2.15)	2.92 (1.99)	0.02	0.83	0.69	0.37
Q12	3.37 (2.18)	3.70 (2.35)	3.04 (1.96)	3.42 (2.02)	3.78 (2.02)	3.05 (1.95)	0.02	0.82	0.98	0.37
INTROJECTED REGULATION	**3.27 (1.80)**	**3.55 (1.99)**	**2.98 (1.56)**	**3.30 (1.88)**	**3.57 (1.97)**	**3.03 (1.75)**	**0.07**	**0.95**	**0.85**	**0.29**
Q13	5.70 (2.28)	5.84 (2.30)	5.56 (2.27)	5.94 (1.82)	6.14 (1.59)	5.73 (2.00)	0.16	0.35	0.63	0.22
Q14	5.60 (2.25)	5.75 (2.26)	5.44 (2.25)	5.64 (1.83)	5.88 (1.58)	5.39 (2.02)	0.10	0.68	0.89	0.27
Q15	5.67 (2.21)	5.79 (2.27)	5.55 (2.16)	6.02 (1.78)	6.37 (1.51)	5.66 (1.94)	0.01	0.07	0.74	0.41
Q16	5.68 (2.15)	5.74 (2.20)	5.62 (2.12)	5.79 (1.83)	6.08 (1.59)	5.49 (2.00)	0.05	0.28	0.70	0.33
IDENTIFIED REGULATION	**5.66 (2.10)**	**5.78 (2.17)**	**5.54 (2.05)**	**5.85 (2.05)**	**6.12 (2.00)**	**5.57 (2.02)**	**0.09**	**0.25**	**0.93**	**0.27**
Q17	5.64 (2.27)	5.96 (2.27)	5.32 (2.27)	5.88 (1.82)	6.17 (1.58)	5.58 (1.99)	0.04	0.51	0.46	0.33
Q18	5.62 (2.14)	5.71 (2.23)	5.52 (2.06)	5.91 (1.77)	6.21 (1.57)	5.59 (1.89)	0.03	0.10	0.83	0.36
Q19	5.21 (2.18)	5.62 (2.25)	4.81 (2.09)	5.49 (1.85)	5.91 (1.66)	5.07 (1.91)	0.01	0.37	0.43	0.47
Q20	5.60 (2.15)	5.82 (2.21)	5.38 (2.09)	5.65 (1.81)	5.99 (1.60)	5.30 (1.92)	0.02	0.59	0.81	0.39
INTRINSIC MOTIVATION	**5.52 (2.09)**	**5.78 (2.17)**	**5.26 (2.01)**	**5.73 (2.05)**	**6.07 (2.01)**	**5.39 (1.98)**	**0.04**	**0.39**	**0.69**	**0.34**

Table 4.6. *I-PLoC calculations*

	Baseline Population Mean (SD)	Baseline DPE Group Mean (SD)	Baseline HIIT Group Mean (SD)	Follow-up Population Mean (SD)	Follow-up DPE Group Mean (SD)	Follow-up HIIT Group Mean (SD)	Follow-up Between-Group Difference (p-Value)	Follow-up Within-Group Difference DPE (p-Value)	Follow-up Within-Group Difference HIIT (p-Value)	Effect Size DPE Group (+ve) vs HIIT Group (-ve) (Cohen's *d*)
Total number *(n)*	*148*	*75*	*73*	*154*	*77*	*77*				
EXTERNAL REGULATION	3.35 (1.75)	3.45 (1.78)	3.24 (1.74)	3.04 (1.66)	2.87 (1.57)	3.22 (1.73)	0.19	0.04	0.94	0.21
INTROJECTED REGULATION	3.27 (1.80)	3.55 (1.99)	2.98 (1.56)	3.30 (1.88)	3.57 (1.97)	3.03 (1.75)	0.07	0.95	0.85	0.29
IDENTIFIED REGULATION	5.66 (2.10)	5.78 (2.17)	5.54 (2.05)	5.85 (2.05)	6.12 (2.00)	5.57 (2.02)	0.09	0.25	0.93	0.27
INTRINSIC MOTIVATION	5.52 (2.09)	5.78 (2.17)	5.26 (2.01)	5.73 (2.05)	6.07 (2.01)	5.39 (1.98)	0.04	0.39	0.69	0.34
I-PLOC	**4.56**	**4.55**	**4.57**	**5.23**	**5.75**	**4.70**	**0.13**	**0.35**	**0.17**	**0.11**

Note: (Mean of the Intrinsic Motivation Subscale + Mean of the Identified Regulation Subscale) – (Mean of the External Regulation Subscale + Mean of the Introjected Regulation Subscale) = I-PLoC (Sheldon & Elliot, 1999).

Table 4.5 shows that at baseline the population mean for the amotivation subscale was 2.25 (SD=1.23), the average for Treatment A was 2.24 (SD=1.19), and the average for Treatment B was 2.26 (SD=1.27). An improvement in participant motivation to take part in PE lessons was observed within the population mean and the means of both treatments, however, it was most evident in the DPE treatment where the mean at follow-up was 1.86 (SD=1.10). The higher mean value reported for the HIIT treatment indicates there were a greater number of students who lacked any motivation to engage in PE or felt they gained no benefit from PE.

At baseline the population mean for the external regulation subscale was 3.35 (SD=1.75), the mean for the DPE treatment was 3.45 (SD=1.78), and the mean for the HIIT treatment was 3.24 (SD=1.74). An increase in the quality of student motivation towards PE was observed across all groups. DPE treatment recorded the greatest improvement related to the quality of motivation, with a mean at follow-up was 2.87 (SD=1.57). The increased quality of motivation would suggest that students exposed to the DPE treatment relied less on external influences to trigger their motivation towards PE.

Subscales in the questionnaire designed to measure introjected regulation (e.g., ‘because I would feel bad about myself if I didn't'), identified regulation (e.g., ‘I take part in PE classes because I want to improve in PE') and intrinsic motivation (e.g., ‘I take part in PE classes because PE is exciting'), also favored the DPE treatment.

At baseline the population mean for the introjected regulation subscale was 3.27 (SD=1.80), the mean for the DPE treatment was 3.55 (SD=1.99), and the mean for the HIIT treatment was 2.98 (SD=1.56). An improvement in participant motivation towards PE lessons was observed within the population mean and the means of both treatments, however, it was most evident in the DPE treatment where the mean at follow-up was

3.57 (SD=1.97). Students in the HIIT treatment may have felt guilty if they did not complete or participate in the session.

At baseline the population mean for the identified regulation subscale was 5.66 (SD=2.10), the mean for the DPE treatment was 5.78 (SD=2.17), and the mean for the HIIT Treatment was 5.54 (SD=2.05). A higher motivation to take part in PE lessons was again observed within the population mean and the means of both treatments, the DPE treatment displayed the greatest value for this measure with a mean value at follow-up of 6.12 (SD=2.00).

At baseline the population mean for the intrinsic motivation subscale was 5.52 (SD=2.09), the mean for the DPE treatment was 5.78 (SD=2.17), and the mean for the HIIT Treatment was 5.26 (SD=2.01). An improvement in participant motivation to take part in PE lesson was observed within the population mean and the means of both treatments, however, it was most evident in the DPE treatment where the mean at follow-up was 6.07 (SD=2.01). This indicates that the majority of students exposed to the DPE treatment chose to participate in the PE lesson because they felt it was important for them to do well and they valued the experience. This positive attitude toward their PE experience is revealed again when observing the contextual motivation of the students as a whole. The mean difference in the I-PLoC score at follow-up was 1.20 for the DPE group, while the mean difference for the I-PLoC score for the HIIT group was 0.13. This again highlights that a higher level of motivation to take part in the PE experience was displayed by the DPE group.

Chapter 5: Discussion

The results of this pilot study demonstrate the feasibility of implementing HIIT principles within a Year 7 PE program to achieve health and educative outcomes concurrently. However, further investigation and adaptations to the HIIT treatment are needed to strengthen the acceptability and potential efficacy of the HIIT intervention.

This chapter outlines how the findings from this study relate to prior research related to the discipline of health and PE. It explains the results against a backdrop of current literature and provides recommendations for future research. It is anticipated the new understanding and insights about implementing HIIT principles within a secondary school PE program will help teachers think critically about their ability to achieve health and educative outcomes concurrently in the subject area.

5.1 Research question one

Research question one examined the feasibility and potential efficacy of implementing HIIT principles within a Year 7 PE program to achieve comparable health measures often sought through DPE.

The main findings were as expected and revealed little to no difference in comparable health measures observed between the two intervention groups during pre- and post-intervention testing. This outcome stresses the efficiency of the HIIT treatment in meeting aims of the PE course that are related to student health.

Analysis of the EUROFIT measures all returned comparable effect sizes, ultimately demonstrating improvements in health measures of students within the HIIT treatment are no better or worse than those in the DPE treatment. Using the data related to the multi-stage fitness test, it is possible to paint a picture of what this finding means for a PE setting. With the spread of scores being so large and the overlap much bigger than the difference between the groups, the difference in health measures such as Vo2 max is barely noticeable. Based on a student's post-intervention multi-stage fitness test result, it would be almost impossible to determine which treatment the student completed. In that, the analysis implies only one student within the entire year group would achieve a greater improvement in cardiorespiratory health due to participation in the DPE treatment which was driven by the promotion of MVPA. The lesson structure for the HIIT treatment demonstrates only 16% of the class time would be intentionally directed to the improvement of the health-related fitness of students. Considering 64% and 36% of class time was spent in MVPA within the DPE and HIIT group respectively, the only distinguishing characteristic between the two groups was the amount of time specifically devoted to improving health-related components of fitness.

This study confirms findings from a recent meta-analysis and two systematic reviews on HIIT's ability to improve health-related fitness during adolescents (Costigan, Eather, Plotnikoff, Taaffe, & Lubans, 2015; Eddolls, McNarry, Stratton, Winn, & Mackintosh, 2017). Each of these reviews found that when compared to methods using moderate to vigorous intensities or control groups, HIIT in adolescents is a time effective way to improve cardiorespiratory fitness.

Following recommendations provided by Costigan, Eather, Plotnikoff, Taaffe, Pollock et al. (2015) the work to rest ratio set for this study was increased to determine if a higher dose of HIIT would yield greater physiological adaptations. A work to rest ratio of 4:1 was used in this study compared to the work to rest ratio of 1:1 used by Costiagan, Eather, Plotnikoff, Taaffe, Pollock et al. (2015). To maintain consistency and allow conclusions to be drawn, the duration of the rest phase was 30 seconds in both studies. Although the changes observed in cardiorespiratory fitness within both studies were small, the change seen in the HIIT intervention group of this study was double that of the Resistance and Aerobic Exercise intervention group within the Costigan, Eather, Plotnikoff, Taaffe, Pollock et al. (2015) study. This observation may indicate that a higher dose of HIIT will yield greater improvements in cardiorespiratory fitness. However, it also reveals that an increased dosage of HIIT may be increased effort for little gain.

It is important to note this result may also be explained by the variation in age between the two studies. This study was conducted with a Year 7 cohort, compared to the Costigan, Eather, Plotnikoff, Taaffe, Pollock et al. (2015) study which observed a group of Year 10 students. Although the increased dosage may account for the change, maturation may also account for the differences observed in the two studies.

Cardiorespiratory fitness has been highlighted as a health-related component of fitness where Australian students achieve below average results (Hardy et al., 2010). As a consequence of this, the Australian Fitness Education Award (AFEA) (ACHPER, 2004) criterion-based standards have been applied to this component of fitness to determine if at baseline students were in a PA Zone (ACHPER, 2004) that would bring about enhanced health.

When compared to the criterion based standards for the AFEA at baseline, the average level of cardiorespiratory fitness of all groups in the study was below a PA Zone (ACHPER, 2004) that would bring about enhanced health. Hardy et al. (2010) found Australian students aged 8-15 years old, when compared to age and sex on international standards, are considered to have below average cardiorespiratory fitness levels.

Analysis of post-intervention testing performed against the criterion based standards for the AFEA (ACHPER, 2004) revealed that 12 years old boys in the HIIT treatment demonstrated the largest improvements in Cardiorespiratory fitness and both

HIIT groups improved to a PA Zone (ACHPER, 2004) that would bring about enhanced health. An interesting finding was that the HIIT treatment achieved the greatest average improvement when assessed against criterion-based standards.

This finding challenges an American guideline that states 50% of PE class time should engage students in MVPA to ensure the associated health benefits are achieved (CDC, 2011). In addition to this, the only group not to reach a PA Zone that would bring about enhanced health was the 12 years old males within the DPE treatment. This finding contrasts the existing body of knowledge in support of increased MVPA as the preferred method to improve health within PE classes for all students (McKenzie et al., 2004).

This finding adds to previous research (Costigan, Eather, Plotnikoff, Taaffe, & Lubans, 2015; Costigan, Eather, Plotnikoff, Pollock et al., 2015; Eddolls et al., 2017) that reveals HIIT in adolescence is not only a time effective way to improve cardiorespiratory fitness it may be an efficient method to increase cardiorespiratory fitness to a level that enhances the health of young Australians.

This study supports the findings of Costigan, Eather, Plotnikoff, Pollock et al., (2015) that reported Resistance and Aerobic Exercise training methods deliver the greatest improvements in HIIT interventions when compared to a comparison group. However, a range of other forms of HIIT need to be explored in PE settings to determine which return the greatest improvements in student health measures.

In line with the recommendations provided by Costigan, Eather, Plotnikoff, Pollock et al., (2015) it is the recommendation of this study that future studies consider examinations of longer duration. A previous study has demonstrated significant short-term effects of HIIT interventions can be seen in as little as seven weeks with two doses per week (Eddolls et al., 2017). However it is still unknown what the long-term effects of participation in HIIT are on student's health and PA levels. The fact that this intervention program was sustained over the period of a school term does demonstrate its feasibility in a secondary school PE setting.

5.2 Research question two

Research question two examined the impact of DPE and HIIT on three specific elements of a PE learning environment: the lesson context, student activity levels, and teacher interaction during PE lessons. To the author's knowledge, this is the first known study to examine HIIT from this perspective. SOFIT data was used to determine the feasibility and potential efficacy of implementing HIIT principles within a Year 7 PE program.

The main findings were as expected. Time spent in MVPA was far higher in the DPE group and time spent sitting and standing was greater in the HIIT group. Feedback was observed at a higher rate in the HIIT group, and the activity levels within the HIIT group were lower than those exhibited by the DPE group. Two unanticipated findings also occurred. First, the analysis of data revealed knowledge instruction decreased in both groups during the implementation of the intervention. Second, skill practice also declined in the HIIT group while the percentage of class time allocated to skill practice in the DPE group remained close to zero.

5.2.1 Lesson context. Both lessons observed at baseline did not meet the CDC (2011) recommendation of at least 50% of PE class time being spent in MVPA. Whilst no formal guidelines exist for skill instruction and practice (Dudley, Okely, Pearson et al., 2012) studies such as SPARK (Sallis et al.,1997) and Move it Grove it (van Beurden, Barnett, Zask, Dietrich, Brooks, & Beard, 2003) found proportions of around 30% of class time were required to achieve improvement. On the date of baseline measurement, the percentage of class time dedicated to skill practice in both groups was well below this target.

It was observed that students in the DPE group spent 0% of class time engaged in skill practice and 14% of class time was devoted to skill practice within the HIIT group. Although these measurements are well below the target identified in the international studies, they are consistent with the level of skill instruction and practice observed among other PE classes in Western Sydney schools (Dudley, Okely, Pearson et al., 2012). Furthermore, only 7% and 8% of lesson time at baseline were devoted to providing feedback to students in the DPE and HIIT group respectively. This is troubling as feedback is one of the most highly-ranking influences on learning and achievement in schools (Hattie & Timperly, 2007).

SOFIT data identified knowledge instruction decreased during the implementation of both treatments, however, when using a between-group comparison of effect sizes it was revealed knowledge instruction favoured the HIIT group (d=0.91). An effect size of this nature denotes 82% of the lessons delivered using the HIIT approach were above the mean of those delivered using the DPE approach (Cohen's U3). That means that to observe one more lesson containing a greater percentage of class time dedicated to knowledge instruction in the HIIT group compared to the DPE group, we would only need to observe 3.1 lessons.

Although knowledge instruction favoured the HIIT group, SOFIT data also revealed the amount of fitness instruction that occurred during a typical lesson favoured the DPE treatment. During the intervention period, 68% of the DPE group were above the mean of the HIIT group with 82% of the means between the two groups overlapped. In other words, if 100 DPE lessons were observed, 15.1 of these lessons would contain a greater percentage of class time dedicated to fitness instruction when compared to those presented in the HIIT treatment.

While it is concerning knowledge instruction and skill instruction decreased in both groups during the intervention, this finding supports the information submitted by Dudley, Okely, Cotton et al. (2012) who identified skill instruction and practice as an area of focus for improving the quality of secondary school PE programs.

The importance of knowledge and skill instruction has been highlighted as a key learning strategy in many large studies (Hattie, 2008; Marzarno, 1998) within research related to general education. The statistical analyses conducted by Hattie (2008) and Marzarno (1998) identified the importance of explicitly teaching students the things they need to learn. Although it may seem simple, it is often overlooked that knowledge instruction is key to student learning, as a teacher needs to help make it clear to students what they need to know and demonstrate how things are done before students can transition to performing learning tasks independently (Hattie, 2013).

Both Hattie (2008, 2013) and Marzano (1998) demonstrate that informing students about what they need to know and making it explicit to students what they need to be able to do to achieve success are essential aspects of quality teaching. The distinction drawn by Hattie (2008, 2013) and Marzano (1998) is not a new concept and has previously been raised by Shulman (1982, p.97) where he drew attention to the inconsistency that exists between cognitive learning theories and models of knowledge instruction:

> Although the research on learning has taught us the importance of the active, transforming role of the learner, the research on teaching continues to demonstrate the importance of direct instruction, an approach which seems to suggest a passive view of the student. However, it is important to recognize that direct instruction does not put knowledge into the heads of learners but creates the conditions under which students will use their academic learning time fruitfully (Shulman, 1982, p.97).

MacNamara, Collins, and Giblin (2015) echo Shulman's observations in their commentary specific to the learning context of PE. It highlights that there is a broad range of research to defend the role of structured knowledge and skill instruction in increasing the quality of movement learning (Barnett, Morgan, van Beurden, & Beard, 2008; Pesce et al., 2016; Stodden et al., 2008). Their commentary also highlights a sizeable body of work (Gilbin, Collins, & Button, 2014; Robinson & Goodway, 2009; Stodden et al., 2008) that contests the presumption that the ability to understand and perform movement skills develops naturally as a consequence of age, maturation and general movement experiences.

5.2.2 Student Activity Levels. During the intervention, it was determined that students in the HIIT treatment spend a considerable amount of time sitting when compared to the DPE group. This finding was expected and returned an effect size of 0.90 in favour of the HIIT group. Based on these results, 82% of the time spent sitting in the HIIT group was above the mean of the DPE group. It was also expected that the percentage of class time spent in MVPA within the DPE group would be above that of the HIIT group. The effect size in favour of the DPE group was 0.71 which indicates

76% of the DPE group were above the average of the HIIT group, 72% of the two groups mean overlapped. The size of this overlap means that to have one more lesson with an increased percentage of MVPA we need to monitor only four lessons.

2.2.3 Teacher Interaction. Teacher interaction is the third element of the lesson that was captured by the SOFIT instrument. The results revealed a large effect size (d=1.06) for the provision of concurrent feedback to students in favour of the HIIT Group with 86% of the HIIT group being above the mean of the DPE group. The delivery of terminal feedback was reported as the largest effect size (d=2.61) within the study and was observed within the HIIT group. Every lesson of the DPE group which was observed contained a higher percentage of terminal and concurrent feedback.

There are no known studies that have observed the impact HIIT has on teacher interaction during a PE lesson, however, Hattie and Timperley (2007) identified feedback as ‘one of the most powerful influences on student learning' and achievement. The size of the effects observed concerning feedback within this study are encouraging, and it may be hypothesised that HIIT positively influences teacher interaction resulting in teaching behaviours that improve learning.

Although the findings related to teacher interaction are promising caution must be applied before drawing any further conclusions as feedback was observed in a different context to that of the study conducted by Hattie and Timperley (2007). Within this study, feedback was viewed from a timing perspective, while Hattie and Timperley (2007) reported findings in relation to the quality of feedback provided by teachers. Feedback was seen as (a) concurrent, i.e. feedback that was provided while students were active and participated in a learning experience and (b) terminal, i.e. feedback that is provided at the conclusion of a learning task and while students are seated. The findings of this study are very promising, as one other study has compared the provision of concurrent feedback to terminal feedback (Walsh, Ling, Wang, and Carnahan, 2009). Data presented in the study support the findings of Hattie and Timperley (2007), in that, not all feedback conditions seem equally effective. In addition to this Walsh et al. (2009) determined the provision of terminal feedback associated with better learning outcomes. The levels of terminal feedback provided within the HIIT group were large by comparison to the DPE group. Therefore, it is feasible that the use of HIIT creates the conditions for improved learning.

While the effect size for terminal feedback within the HIIT group was large, so was the effect size of the concurrent feedback. As feedback in this study was defined by the context of timing rather than quality, it is possible that the concurrent feedback observed may be ‘feedback about the self as a person' (Hattie & Timperley, 2007) which is commonly called praise or encouragement. Statements such as ‘well done' and ‘good job' are examples of praise. In the Hattie and Timperley (2007) paper the authors identified praise as "unlikely to be effective because it carries little information and too often deflects attention from the task." Hattie and Timperley (2007) identify two meta-analyses that demonstrate the ineffectiveness of praise (Wilkinson, 1981; Kluger & DeNisi, 1996). Further to this Mueller and Dweck (1998) determined feedback of this nature may undermine children's motivation and performance.

This study has demonstrated that the use of HIIT in a PE setting influences the lesson context, student activity levels and teacher interaction. More information about the provision of feedback by the teacher is now known. The quality of this feedback, however, has not been determined. Future studies may have to consider calibrating the SOFIT instrument to observe the four levels of feedback identified in Hattie and Timperley's (2007) model for feedback. A second recommendation is to distinguish between the provision of ‘praise of effort' and ‘praise of ability' in teacher training documents for future interventions that aim to create an autonomy supportive learning environment.

In addition, due to the complexity of the goals of quality PE a model of teacher training like that used in the SPARK PE programs (Sallis et al., 1997) should be explored in future studies. It would be interesting to determine if HIIT increases spontaneous PA and determine the impact HIIT has on peer to peer feedback provided during a PE lesson.

5.3 Research question three

Research question three considered the impact of HIIT on student's motivation to take part in PE lessons when compared to DPE. The main findings were not as anticipated, with participants in the DPE treatment outperforming participants in the HIIT treatment on all subscales of the PLOCQ. Although no statistical difference in motivation to take part in PE classes were observed at baseline, moderate increases in the levels of intrinsic motivation of students were found within the DPE treatment at follow-up, while changes in intrinsic motivation within the HIIT group were trivial at best.

This finding in relation to the HIIT group supports the results of Costigan, Eather, Plotnikoff, Taaffe, Pollock et al. (2015), that this may be considered an encouraging result as it has been hypothesised the demanding nature of HIIT may lead to exercise avoidance (Biddle & Batterham, 2015). The results obtained from the PLoCQ reveal that although student motivation towards PE increased in the DPE group the motivation of students towards PE did not decrease as a result of exposure to HIIT.

To put into context what these results would look like in a school setting with a medium sized spread of scores and the overlap being slightly larger than the difference between the groups, the difference in motivational scores becomes apparent. This would mean if the intervention was run at a whole school level and a member of the school staff was to have a conversation with a random student in the playground and ask the question ‘do you look forward to PE?' it is likely they would be able to determine what class they were in based on their response. Further to this, within each Year group almost an entire class of students who participate in the DPE treatment would leave their PE experience with an increased desire to participate in future PE experiences and drive their learning. In contrast to this, the quality of motivation displayed by students who took part in the HIIT treatment would essentially remain unchanged.

The findings that have been presented in relation to question three are of particular interest. They identify that although short-term health gains can be achieved promptly, allowing the teacher to focus on the elements of a lesson that results in improved performance further investigation is needed to develop a HIIT model that fosters a greater level of intrinsic motivation. Avoidance of PA is in opposition to the aim of PE curricula in Australia (Australian Curriculum, Assessment & Reporting Authority, 2014) furthermore this is also in opposition to one of the central tenants of QPE which is the promotion of lifelong PA. (UNESCO, 2015)

A second factor to consider is the approach used by Teacher B when delivering the HIIT sessions. Although the treatment was designed in a manner to increase self-determined behaviour, it was clear that due to the fast-paced delivery of the HIIT session, the teacher instinctively delivered the HIIT sessions in a military style, as is standard practice in the personal training industry. This finding confirms a hypothesis made by Costigan Eather, Plotnikoff, Taaffe, Pollock et al. (2015) that if HIIT is delivered using an authoritarian teaching style, the enjoyment of the HIIT experience could be reduced. It is possible the style and delivery of the HIIT session was a greater influence on student motivation than the changes made to the learning environment.

In addition to this, another factor contributing to the difference in motivational scores has previously been identified in response to question two. The high levels of concurrent feedback that were observed in the HIIT treatment may be attributed to the teacher's attempt to foster an autonomy supportive learning environment through the use of praise to elevate student's perceived competence. Elliot and Dweck's (1988) findings regarding the after-effects of praising a student for their ability after sound completion of a learning task may explain the lower motivational scores of the students in the HIIT treatment. As praising student's ability has been shown to reduce motivation and performance in learning situations. (Mueller & Dweck, 1998) The basic premise of Mueller and Dweck (1998) is ‘if you praise lavishly and liberally, you end up praising mediocrity, which in turn sends a message that you believe mediocrity is all you think students are capable of.’

This study has demonstrated there is a further need to refine the HIIT treatment, so it becomes an enjoyable and pleasing experience for all students. Future studies may have to consider the impact praise has on students’ motivation and what forms of teacher training will lead to HIIT being provided in a manner that is autonomy supportive.

It would be interesting to determine if using a high-intensity approach within a game based model would suit the motivational needs of secondary school students as one previous study has applied this methodology to a primary school setting with success (Lambrick, Westrupp, Kaufmann, Stoner, & Faulkner, 2016).

5.4 Strengths of the study

A strength of this study was that it was the first known to objectively quantify the impact HIIT has on lesson context, teacher interaction and student activity levels within a secondary school PE setting. This study also made a comparison using multiple measures assessing both health and educative outcomes of students in a secondary PE setting.

5.5 Limitations of the study

It is important to note that this study is not sufficiently powered to detect statistically significant differences. Only one SOFIT measure was taken of each group at baseline. A single rater system was used during SOFIT observations. The moderate sample size means results and findings are not generalisable and PA outside of class was not taken into account which may change the interpretation of EUROFIT data that was collected. The Multi-stage fitness test only produces estimates of Vo2 max.

5.6 Conclusion

This project aimed to evaluate the potential efficacy of incorporating HIIT principles within a pedagogically rich learning environment promoting the achievement of concurrent educative and health goals. Potential efficacy within this study was defined as – the ability to increase the quality of PE, objectively measured health indices, motivation towards PE experiences, and changes in lesson context allowing teachers to meet health and educative outcomes concurrently. This study has, therefore, demonstrated that HIIT could successfully meet three out of the four criteria set within this definition.

The organisation of the delivery of the HIIT intervention is of particular interest as some factors seem to support student growth, however, at the same time they interact with other factors and create limitations for student achievement in a PE setting. Further investigation is required to develop a model that uses HIIT as a time-efficient medium to help bridge the gap between the promotion of PA in PE and the educative focus required in Australian PE settings. This will ultimately lead to health outcomes and learning goals being achieved simultaneously.

Although there is the need for further refinement, this study demonstrated HIIT interventions might elicit positive changes to PE settings, allowing health and educative outcomes to be achieved at the same time. Within the study population, HIIT has been observed to increase the: quality of PE provided to students, health indices of students and changed the lesson context to allow teachers to achieve concurrent health and educative outcomes. There is a potential to create an educative approach to PE using HIIT principles to ensure the educative focus does not come at the expense of the benefits currently associated with health-related PE.

References

Adam, C., Klissouras, V., Ravazzolo, M., Renson, R., & Tuxworth, W. (1993). EUROFIT: European test of physical fitness (2nd ed.). Rome: Council of Europe, Committee for the development of sport, 10-70.

Ahn, S., & Fedewa, A. L. (2011). A meta-analysis of the relationship between children's physical activity and mental health. *Journal of pediatric psychology*, *36*(4), 385-397.

Australian Council for Health, Physical Education and Recreation. (2004) Australian Fitness Education Award (Revised Edition), Teacher Manual. Adelaide: ACHPER.

Australian Curriculum Assessment and Reporting Authority. (n.d). School Profile. Retrieved March 13, 2017, from https://www.myschool. edu.au.

Australian Government Department of Health (2014). Make your move – Sit less Be Active for life! Retrieved from http://www.health.gov. au/internet/main/publishing.nsf/content/F01F92328EDADA5BCA257BF0001E720D/$File/brochure%20PA%20Guidelines_A5_5-12yrs.PDF

Barnett, L. M., Morgan, P. J., van Beurden, E., & Beard, J. R. (2008). Perceived sports competence mediates the relationship between childhood motor skill proficiency and adolescent physical activity and fitness: a longitudinal assessment. International journal of behavioral nutrition and physical activity, 5(1), 40.

Barroso, C. S., McCullum-Gomez, C., Hoelscher, D. M., Kelder, S. H., & Murray, N. G. (2005). Self-reported barriers to quality physical education by physical education specialists in Texas. Journal of School Health, 75(8), 313-319.

Beni, S., Fletcher, T., & Ní Chróinín, D. (2017). Meaningful experiences in physical education and youth sport: A review of the literature. Quest, 69(3), 291-312.

Biddle, S. J., & Batterham, A. M. (2015). High-intensity interval exercise training for public health: a big HIT or shall we HIT it on the head?. International Journal of Behavioral Nutrition and Physical Activity, 12(1), 95.

Biddle, S. J., Gorely, T., & Stensel, D. J. (2004). Health-enhancing physical activity and sedentary behaviour in children and adolescents. Journal of sports sciences, 22(8), 679-701.

Bitworks Design (2011) Bleep Test Lite (Version 1.06) [Mobile application Software] Retrieved from http://itunes.apple.com

Blaes, A., Baquet, G., Van Praagh, E., & Berthoin, S. (2011). Physical activity patterns in French youth—From childhood to adolescence—

Monitored with high-frequency accelerometry. American Journal of Human Biology, 23(3), 353-358.

Blair, S. N., LaMonte, M. J., & Nichaman, M. Z. (2004). The evolution of physical activity recommendations: how much is enough?. The

American journal of clinical nutrition, 79(5), 913S-920S.

Board of Studies. (2003). Personal Development, Health and Physical Education (PDHPE) Years 7–10 Syllabus. Sydney: Board of Studies.

Boiché, J., Sarrazin, P. G., Grouzet, F. M., Pelletier, L. G., & Chanal, J. P. (2008). Students' motivational profiles and achievement outcomes in physical education: A self-determination perspective. Journal of Educational Psychology, 100(3), 688.

Caspersen, C. J., Powell, K. E., & Christenson, G. M. (1985). Physical activity, exercise, and physical fitness: definitions and distinctions for health-related research. Public health reports, 100(2), 126.

Castro-Piñero, J., Ortega, F. B., Artero, E. G., Girela-Rejón, M. J., Mora, J., Sjöström, M., & Ruiz, J. R. (2010). Assessing muscular strength in youth: usefulness of standing long jump as a general index of muscular fitness. The Journal of Strength & Conditioning Research, 24(7), 1810-1817.

Centers for Disease Control and Prevention (CDC. (2011). School health guidelines to promote healthy eating and physical activity. MMWR. Recommendations and reports: Morbidity and mortality weekly report. Recommendations and reports, 60(RR-5), 1.

Costigan, S. A., Eather, N., Plotnikoff, R. C., Taaffe, D. R., & Lubans, D. R. (2015). High-intensity interval training for improving health- related fitness in adolescents: a systematic review and meta-analysis. Br J Sports Med, bjsports-2014.

Costigan, S. A., Eather, N., Plotnikoff, R. C., Taaffe, D. R., Pollock, E., Kennedy, S. G., & Lubans, D. R. (2015). Preliminary efficacy and feasibility of embedding high intensity interval training into the school day: A pilot randomized controlled trial. Preventive medicine reports, 2, 973-979.

Cowan, R. E. (2016). Exercise is medicine initiative: physical activity as a vital sign and prescription in adult rehabilitation practice. Archives of physical medicine and rehabilitation, 97(9), S232-S237.

Darst, P. W., Pangrazi, R.P., Brusseau, T., & Erwin, H. (2015). Dynamic Physical Education for Secondary School Students (8th ed.). San Francisco, CA: Pearson Education, Inc.

Deci, E. L., & Ryan, R. M. (1985). The general causality orientations scale: Self-determination in personality. Journal of research in personality, 19(2), 109-134.

Deci, E. L., & Ryan, R. M. (2000a). The" what" and" why" of goal pursuits: Human needs and the self-determination of behavior. Psychological inquiry, 11(4), 227-268.

Delisle, T. T., Werch, C. E., Wong, A. H., Bian, H., & Weiler, R. (2010). Relationship between frequency and intensity of physical activity and health behaviors of adolescents. Journal of School Health, 80(3), 134-140.

Des Jarlais, D. C., Lyles, C., Crepaz, N., & Trend Group. (2004). Improving the reporting quality of nonrandomized evaluations of behavioral and public health interventions: the TREND statement. American journal of public health, 94(3), 361-366.

Donncha, C. M., Watson, A. W., McSweeney, T., & O'Donovan, D. J. (1999). Reliability of Eurofit physical fitness items for adolescent males with and without mental retardation. Adapted Physical Activity Quarterly, 16(1), 86-95.

Dudley, D. A., Okely, A. D., Cotton, W. G., Pearson, P., & Caputi, P. (2012). Physical activity levels and movement skill instruction in secondary school physical education. Journal of Science and Medicine in Sport, 15(3), 231-237.

Dudley, D. A., Okely, A. D., Pearson, P., Caputi, P., & Cotton, W. G. (2013). Decline in enjoyment of physical education among culturally and linguistically diverse youth. International Journal of Quantitative Research in Education, 1(4), 408-425.

Dudley, D. A., Okely, A. D., Pearson, P., Cotton, W. G., & Caputi, P. (2012). Changes in physical activity levels, lesson context, and teacher interaction during physical education in culturally and linguistically diverse Australian schools. International Journal of Behavioral Nutrition and Physical Activity, 9(1), 114.

Dudley, D., Goodyear, V., & Baxter, D. (2016). Quality and Health-Optimizing Physical Education: Using Assessment at the Health and Education Nexus. Journal of Teaching in Physical Education, 35(4), 324-336.

Dumith, S. C., Gigante, D. P., Domingues, M. R., & Kohl III, H. W. (2011). Physical activity change during adolescence: a systematic review and a pooled analysis. International journal of epidemiology, 40(3), 685-698.

Dyson, B., & Casey, A. (Eds.). (2012). Cooperative learning in physical education: A research based approach. Routledge.

Dyson, B., DiCesare, E., Coviello, N., & Dyson, L. (2009). Students' perspectives of urban middle school physical education programs. Middle Grades Research Journal, 4(4).

Eddolls, W. T., McNarry, M. A., Stratton, G., Winn, C. O., & Mackintosh, K. A. (2017). High-Intensity Interval Training Interventions in Children and Adolescents: A Systematic Review. Sports Medicine, 1-12.

Elliott, E. S., & Dweck, C. S. (1988). Goals: An approach to motivation and achievement. Journal of personality and social psychology, 54(1), 5.

Enright, E., & O'Sullivan, M. (2010). 'Can I do it in my pyjamas?' Negotiating a physical education curriculum with teenage girls. European Physical Education Review, 16(3), 203-222.

Fairclough, S. J., & Stratton, G. (2006). A review of physical activity levels during elementary school physical education. Journal of teaching in physical education, 25(2), 240-258.

Gibala, M. J. (2007). High-intensity Interval Training: A Time-efficient Strategy for Health Promotion?. Current sports medicine reports, 6(4), 211-213.

Gibala, M. J., & McGee, S. L. (2008). Metabolic adaptations to short-term high-intensity interval training: a little pain for a lot of gain?. Exercise and sport sciences reviews, 36(2), 58-63.

Giblin, S., Collins, D., & Button, C. (2014). Physical literacy: importance, assessment and future directions. Sports Medicine, 44(9), 1177- 1184.

Goudas, M., Biddle, S., & Fox, K. (1994). Perceived locus of causality, goal orientations, and perceived competence in school physical education classes. British Journal of Educational Psychology, 64(3), 453-463.

Ha, A. S., Lonsdale, C., Ng, J. Y., & Lubans, D. R. (2014). A school-based rope skipping intervention for adolescents in Hong Kong: protocol of a matched-pair cluster randomized controlled trial. BMC public health, 14(1), 535.

Hagger, M. S., Chatzisarantis, N. L., Culverhouse, T., & Biddle, S. J. (2003). The processes by which perceived autonomy support in physical education promotes leisure-time physical activity intentions and behavior: a trans-contextual model. Journal of educational psychology, 95(4), 784.

Hallal, P. C., Victora, C. G., Azevedo, M. R., & Wells, J. C. (2006). Adolescent physical activity and health. Sports medicine, 36(12), 1019- 1030.

Hands, B. P. (2013). Physical activity, physical fitness or physical education: Are we betting on the wrong horse?. Active and Healthy Lifestyle Magazine, 20(2).

Hardcastle, S. J., Ray, H., Beale, L., & Hagger, M. S. (2014). Why sprint interval training is inappropriate for a largely sedentary population. Frontiers in psychology, 5.

Hardy, L. L., King, L., Espinel, P., Cosgrove, C., & Bauman, A. NSW schools physical activity and nutrition survey (SPANS) 2010: Full Report. 2011. Sydney: NSW Ministry of Health.

Hattie, J (2013) Understanding Learning: Lessons for Learning, teaching and research. p28 Proceedings of the Australian Council of Educational Research Conference, Melbourne, Australia. Retrieved from http://research.acer.edu.au/cgi/viewcontent.cgi?article=1163&context=research_conference

Hattie, J. (2008). Visible learning: A synthesis of over 800 meta-analyses relating to achievement. Routledge. Hattie, J., & Timperley, H. (2007). The power of feedback. Review of educational research, 77(1), 81-112.

Heath, G. W., Parra, D. C., Sarmiento, O. L., Andersen, L. B., Owen, N., Goenka, S., ... & Lancet Physical Activity Series Working Group. (2012). Evidence-based intervention in physical activity: lessons from around the world. The lancet, 380(9838), 272-281.

Hellison, D. R. (1995). Teaching responsibility through physical activity. Teaching responsibility through physical activity.

Herman, K. M., Craig, C. L., Gauvin, L., & Katzmarzyk, P. T. (2009). Tracking of obesity and physical activity from childhood to adulthood: the Physical Activity Longitudinal Study. Pediatric Obesity, 4(4), 281-288.

Hood, M. S., Little, J. P., Tarnopolsky, M. A., Myslik, F., & Gibala, M. J. (2011). Low-volume interval training improves muscle oxidative capacity in sedentary adults. Medicine and science in sports and exercise, 43(10), 1849-1856.

Janssen, I., & LeBlanc, A. G. (2010). Systematic review of the health benefits of physical activity and fitness in school-aged children and youth. International journal of behavioral nutrition and physical activity, 7(1), 40.

Jenkinson, K. A., & Benson, A. C. (2010). Barriers to providing physical education and physical activity in Victorian state secondary schools. Australian Journal of Teacher Education (Online), 35(8), 1.

Jones, B. D. (2009). Motivating students to engage in learning: The MUSIC model of academic motivation. International Journal of Teaching and Learning in Higher Education, 21(2), 272-285.

Jones, B. D., & Wilkins, J. L. (2013). Testing the MUSIC Model of Academic Motivation through confirmatory factor analysis. Educational Psychology, 33(4), 482-503.

Karppanen, A. K., Ahonen, S. M., Tammelin, T., Vanhala, M., & Korpelainen, R. (2012). Physical activity and fitness in 8-year-old overweight and normal weight children and their parents. International journal of circumpolar health, 71(1), 17621.

Kemi, O. J., & Wisløff, U. (2010). High-Intensity aerobic exercise training improves the heart in health and disease. Journal of cardiopulmonary rehabilitation and prevention, 30(1), 2-11.

Kluger, A. N., & DeNisi, A. (1996). The effects of feedback interventions on performance: A historical review, a meta-analysis, and a preliminary feedback intervention theory.

Lambrick, D., Westrupp, N., Kaufmann, S., Stoner, L., & Faulkner, J. (2016). The effectiveness of a high-intensity games intervention on improving indices of health in young children. Journal of sports sciences, 34(3), 190-198.

Lavigne, G. L., Hauw, N., Vallerand, R. J., Brunel, P., Blanchard, C., Cadorette, I., & Angot, C. (2009). On the dynamic relationships between contextual (or general) and situational (or state) motivation toward exercise and physical activity: A longitudinal test of the top- down and bottom-up hypotheses. International Journal of Sport and Exercise Psychology, 7(2), 147-168.

Lee, I. M., Shiroma, E. J., Lobelo, F., Puska, P., Blair, S. N., Katzmarzyk, P. T., & Lancet Physical Activity Series Working Group. (2012). Effect of physical inactivity on major non-communicable diseases worldwide: an analysis of burden of disease and life expectancy. The Lancet, 380(9838), 219-229.

Leger, L. A., Mercier, D., Gadoury, C., & Lambert, J. (1988). The multistage 20-metre shuttle run test for aerobic fitness. Journal of sports sciences, 6(2), 93-101.

Little, J. P., Gillen, J. B., Percival, M. E., Safdar, A., Tarnopolsky, M. A., Punthakee, Z., ... & Gibala, M. J. (2011). Low-volume high-intensity interval training reduces hyperglycemia and increases muscle mitochondrial capacity in patients with type 2 diabetes. Journal of applied physiology, 111(6), 1554-1560.

Liukkonen, J., Barkoukis, V., Watt, A., & Jaakkola, T. (2010). Motivational climate and students' emotional experiences and effort in physical education. The Journal of Educational Research, 103(5), 295-308.

Lonsdale, C., Rosenkranz, R. R., Peralta, L. R., Bennie, A., Fahey, P., & Lubans, D. R. (2013). A systematic review and meta-analysis of interventions designed to increase moderate-to-vigorous physical activity in school physical education lessons. Preventive Medicine, 56(2), 152-161.

Lonsdale, C., Sabiston, C. M., Raedeke, T. D., Ha, A. S., & Sum, R. K. (2009). Self-determined motivation and students' physical activity during structured physical education lessons and free choice periods. Preventive medicine, 48(1), 69-73.

Lonsdale, C., Sabiston, C. M., Taylor, I. M., & Ntoumanis, N. (2011). Measuring student motivation for physical education: examining the psychometric properties of the perceived locus of causality questionnaire and the situational motivation scale. Psychology of Sport and Exercise, 12(3), 284-292.

MacNamara, Á., Collins, D., & Giblin, S. (2015). Just let them play? Deliberate preparation as the most appropriate foundation for lifelong physical activity. Frontiers in psychology, 6.

Marzano, R. J. (1998). A Theory-Based Meta-Analysis of Research on Instruction.

McKenzie, T. L. (2015). System for observing fitness instruciton time (SOFIT): Description and procedures manual. 2015.

McKenzie, T. L., & Lounsbery, M. A. (2014). The pill not taken: Revisiting physical education teacher effectiveness in a public health context. Research quarterly for exercise and sport, 85(3), 287-292.

McKenzie, T. L., Catellier, D. J., Conway, T., Lytle, L. A., Grieser, M., Webber, L. A., ... & Elder, J. P. (2006). Girls' activity levels and lesson contexts in middle school PE: TAAG baseline. Medicine and science in sports and exercise, 38(7), 1229.

McKenzie, T. L., Feldman, H., Woods, S. E., Romero, K. A., Dahlstrom, V., Stone, E. J., ... & Harsha, D. W. (1995). Children's activity levels and lesson context during third-grade physical education. Research Quarterly for Exercise and Sport, 66(3), 184-193.

McKenzie, T. L., Sallis, J. F., & Armstrong, C. A. (1994). 803 Association Between Direct Observation And Accelerometer Measures Of Children's Physical Activity During Physical Education And Recess. Medicine & Science in Sports & Exercise, 26(5), S143.

McKenzie, T. L., Sallis, J. F., & Nader, P. R. (1992). SOFIT: System for observing fitness instruction time. Journal of teaching in physical Education, 11(2), 195-205.

McKenzie, T. L., Sallis, J. F., Prochaska, J. J., Conway, T. L., Marshall, S. J., & Rosengard, P. (2004). Evaluation of a two-year middle- school physical education intervention: M-SPAN. Medicine & Science in Sports & Exercise, 36(8), 1382-1388.

Metzler, M., McKenzie, T., & Hans van der Mars, B. W. S., & Ellis, R.(2013a). Health Optimizing Physical Education (HOPE): A new curriculum for school programs-Part 1: Establishing the Need and Describing the Model. Journal of Physical Education, Recreation & Dance, 84(4), 41-47.

Metzler, M., McKenzie, T., & Hans van der Mars, B. W. S., & Ellis, R.(2013b). Health Optimizing Physical Education (HOPE): A new curriculum for school programs—Part 2: Teacher Knowledge and Collaboration. Journal of Physical Education, Recreation & Dance, 84(5), 25-34.

Morely, B., Scully, M., Niven, P., & Wakefield, M. (2010). National Secondary Students Diet and Activity Survey, 2009 2010: Main Report. Melbourne: Cancer Council Victoria.

Morgan, P. J., & Hansen, V. (2008). Classroom teachers' perceptions of the impact of barriers to teaching physical education on the quality of physical education programs. Research quarterly for exercise and sport, 79(4), 506-516.

Mueller, C. M., & Dweck, C. S. (1998). Praise for intelligence can undermine children's motivation and performance. Journal of personality and social psychology, 75(1), 33.

Ntoumanis, N. (2001). A self-determination approach to the understanding of motivation in physical education. British journal of educational psychology, 71(2), 225-242.

Ntoumanis, N. (2001). A self-determination approach to the understanding of motivation in physical education. British journal of educational psychology, 71(2), 225-242.

Oja, P., & Titze, S. (2011). Physical activity recommendations for public health: development and policy context. EPMA Journal, 2(3), 253- 259.

Pangrazi, R. P., & Beighle, A. (2015). Dynamic physical education for elementary school children (18th ed.). San Francisco, CA: Benjamin Cummings.

Pannekoek, L., Piek, J. P., Kane., R., & Hagger, M. S. (2014). The children's perceived locus of causality scale for physical education. Journal of Teaching in Physical Education, 33(2), 162-185.

Partridge, J. A., King, K. M., & Bian, W. (2011). Perceptions of heart rate monitor use in high school physical education classes. Physical Educator, 68(1), 30.

Pate, R. R. (2009). A national physical activity plan for the United States. Journal of Physical Activity and Health, 6(Supplement 2), S157.

Pate, R. R., Davis, M. G., Robinson, T. N., Stone, E. J., McKenzie, T. L., & Young, J. C. (2006). Promoting physical activity in children and youth. Circulation, 114(11), 1214-1224.

Pate, R., & O'Neill, J. (2008). After-school interventions to increase physical activity among youth. British journal of sports medicine.

Pate, R.R., & Hohn, R. C. (1994). Introduction: a contemporary mission for physical education. In: Pate RR, Hohn RC (Eds.), Health and fitness through physical education. (p. 2) Champaign, IL: Human Kinetics.

Pelletier, L. G., Fortier, M. S., Vallerand, R. J., & Brière, N. M. (2002). Perceived autonomy support, levels of self-determination, and persistence: a longitudinal investigation. Motivation and Emotion, 25, 279–306.

Pesce, C., Masci, I., Marchetti, R., Vazou, S., Sääkslahti, A., & Tomporowski, P. D. (2016). Deliberate play and preparation jointly benefit motor and cognitive development: mediated and moderated effects. Frontiers in psychology, 7.

Pope, R. P., Coleman, K. J., Gonzalez, B. F., & Heath, E. M. (2000). Validating SOFIT during physical education in a predominantly Hispanic community. Med Sci Sports Exerc, 32(5), S328.

Robinson, L. E., & Goodway, J. D. (2009). Instructional climates in preschool children who are at-risk. Part I: Object-control skill development. Research quarterly for exercise and sport, 80(3), 533-542.

Rowe, P. J., Schuldheisz, J. M., & Van Der Mars, H. (1997). Validation of SOFIT for measuring physical activity of first-to eighth-grade students. Pediatric Exercise Science, 9(2), 136-149.

Rowe, P. J., Schuldheisz, J. M., & Van Der Mars, H. (1997). Validation of SOFIT for measuring physical activity of first-to eighth-grade students. Pediatric Exercise Science, 9(2), 136-149.

Rowe, P., van Der Mars, H., Schuldheisz, J., & Fox, S. (2004). Measuring students' physical activity levels: validating SOFIT for use with high-school students. Journal of Teaching in Physical Education, 23(3), 235-251.

Rowland, T. W., & Freedson, P. S. (1994). Physical activity, fitness, and health in children: a close look. Pediatrics, 93(4), 669-672.

Ruiz, J. R., Castro-Piñero, J., Artero, E. G., Ortega, F. B., Sjöström, M., Suni, J., & Castillo, M. J. (2009). Predictive validity of health-related fitness in youth: a systematic review. British journal of sports medicine.

Ruiz, JR, Espana, RV, Castro, PJ, Artero, EG, Ortega, FB, Cuenca, GM, ... & Gutierrez, A. (2011). ALPHA-fitness test battery: health- related field-based fitness tests assessment in children and adolescents. Hospital Nutrition , 26 (6), 1210.

Ryan, R. M., & Connell, J. P. (1989). Perceived locus of causality and internalization: examining reasons for acting in two domains. Journal of personality and social psychology, 57(5), 749.

Ryan, R. M., & Deci, E. L. (2000a). Self-determination theory and the facilitation of intrinsic motivation, social development, and well- being. American Psychologist, 55(1), 68-78.

Ryan, R. M., & Deci, E. L. (2000b). Intrinsic and extrinsic motivations: Classic definitions and new directions. Contemporary educational psychology, 25(1), 54-67.

Saanijoki, T., Tuominen, L., Tuulari, J. J., Nummenmaa, L., Arponen, E., Kalliokoski, K., ... & Hirvonen, J. (2017). Opioid Release after High- Intensity Interval Training in Healthy Human Subjects. Neuropsychopharmacology, 1, 9.

Sallis, J. F. (2000). Age-related decline in physical activity: a synthesis of human and animal studies. Medicine & Science in Sports & Exercise, 32(9), 1598-1600.

Sallis, J. F., & McKenzie, T. L. (1991). Physical education's role in public health. Research quarterly for exercise and sport, 62(2), 124-137.

Sallis, J. F., McKenzie, T. L., Alcaraz, J. E., Kolody, B., Faucette, N., & Hovell, M. F. (1997). The effects of a 2-year physical education program (SPARK) on physical activity and fitness in elementary school students. Sports, Play and Active Recreation for Kids. American journal of public health, 87(8), 1328-1334.

Sallis, J. F., McKenzie, T. L., Beets, M. W., Beighle, A., Erwin, H., & Lee, S. (2012). Physical education's role in public health: Steps forward and backward over 20 years and HOPE for the future. Research Quarterly for Exercise and Sport, 83(2), 125-135.

Sallis, J. F., McKenzie, T. L., Conway, T. L., Elder, J. P., Prochaska, J. J., Brown, M., ... & Alcaraz, J. E. (2003). Environmental interventions for eating and physical activity: a randomized controlled trial in middle schools. American journal of preventive medicine, 24(3), 209-217.

Scanlan, T. K., & Simons, J. P. (1992). The construct of sport enjoyment. Motivation in sport and exercise, 199-215.

Sharma, S. V., Chuang, R. J., Skala, K., & Atteberry, H. (2011). Measuring physical activity in preschoolers: reliability and validity of the System for Observing Fitness Instruction Time for Preschoolers (SOFIT-P). Measurement in physical education and exercise science, 15(4), 257-273.

Sheldon, K. M., & Elliot, A. J. (1999). Goal striving, need satisfaction, and longitudinal well-being: the self-concordance model. Journal of personality and social psychology, 76(3), 482.

Shiraev, T., & Barclay, G. (2012). Evidence based exercise: Clinical benefits of high intensity interval training. Australian family physician, 41 (12), 960.

Shulman, L. S. (1982). Educational psychology returns to school. (p.97-98)

Siedentop, D. (1998). What is sport education and how does it work?. Journal of physical education, recreation & dance, 69(4), 18-20.

Standage, M., & Gillison, F. (2007). Students' motivational responses toward school physical education and their relationship to general self- esteem and health-related quality of life. Psychology of Sport and Exercise, 8(5), 704-721.

Standage, M., Duda, J. L., & Ntoumanis, N. (2003). A model of contextual motivation in physical education: Using constructs from self- determination and achievement goal theories to predict physical activity intentions. Journal of educational psychology, 95(1), 97.

Stodden, D. F., Goodway, J. D., Langendorfer, S. J., Roberton, M. A., Rudisill, M. E., Garcia, C., & Garcia, L. E. (2008). A developmental perspective on the role of motor skill competence in physical activity: An emergent relationship. Quest, 60(2), 290-306.

Strong, W. B., Malina, R. M., Blimkie, C. J., Daniels, S. R., Dishman, R. K., Gutin, B., ... & Rowland, T. (2005). Evidence based physical activity for school-age youth. The Journal of pediatrics, 146(6), 732-737.

The Research Centre in Physical Activity, Health and Leisure (2016) iSOFIT (Version 1.01) [Mobile application Software] Retrieved from http://itunes.apple.com

Tjønna, A. E., Lee, S. J., Rognmo, Ø., Stølen, T. O., Bye, A., Haram, P. M., ... & Kemi, O. J. (2008). Aerobic interval training versus continuous moderate exercise as a treatment for the metabolic syndrome. Circulation, 118(4), 346-354.

Toshalis, E., & Nakkula, M. J. (2012). Motivation, engagement, and student voice. The Education Digest, 78(1), 29.

Trapp, E. G., Chisholm, D. J., Freund, J., & Boutcher, S. H. (2008). The effects of high-intensity intermittent exercise training on fat loss and fasting insulin levels of young women. International journal of obesity, 32(4), 684.

Tsigilis, N., Douda, H., & Tokmakidis, S. P. (2002). Test-retest reliability of the Eurofit test battery administered to university students. Perceptual and motor skills, 95(3_suppl), 1295-1300.

U.S. Department of Health and Human Services. (2008). 2008 Physical Activity Guidelines for Americans. Fact Sheet for Health Professionals on Physical Activity Guidelines for Children and Adolescents. Retrieved from https://www.cdc. gov/physicalactivity/downloads/pa_fact_sheet_children.pdf

United Kingdom Department of Health, Physical Activity, Health Improvement and Protection (2011). Start Active, Stay Active: A report on Physical Activity for health from the four home countries' Chief Medical Officers. Retrieved from https://www.sportengland. org/media/2928/dh_128210.pdf

United Nations Educational, Scientific and Cultural Organisation (2015). Guidelines for Physical Education policy makers. Retrieved from http://unesdoc.unesco.org/images/0023/002311/231101E.pdf

United Nations Educational, Scientific and Cultural Organisation (2017). Promoting Quality Physical Education Poicy. Retrieved from http: //www.unesco.org/new/en/social-and-human-sciences/themes/physical-education-and-sport/policy-project

Vallerand, R. J. (1997). Toward a hierarchical model of intrinsic and extrinsic motivation. Advances in experimental social psychology, 29, 271-360.

Vallerand, R. J., Pelletier, L. G., Blais, M. R., Briere, N. M., Senecal, C., & Vallieres, E. F. (1992). The Academic Motivation Scale: A measure of intrinsic, extrinsic, and amotivation in education. Educational and psychological measurement, 52(4), 1003-1017.

van Beurden, E., Barnett, L. M., Zask, A., Dietrich, U. C., Brooks, L. O., & Beard, J. (2003). Can we skill and activate children through primary school physical education lessons?"Move it Groove it"—a collaborative health promotion intervention. Preventive medicine, 36(4), 493-501.

Walsh, C. M., Ling, S. C., Wang, C. S., & Carnahan, H. (2009). Concurrent versus terminal feedback: it may be better to wait. Academic Medicine, 84(10), S54-S57.

Wang, J. C., Hagger, M., & Liu, W. C. (2009). A cross-cultural validation of perceived locus of causality scale in physical education context. Research Quarterly for Exercise and Sport, 80(2), 313-325.

Warburton, D. E., Nicol, C. W., & Bredin, S. S. (2006). Health benefits of physical activity: the evidence. Canadian medical association journal, 174(6), 801-809.

Waxman, A. (2005). Why a global strategy on diet, physical activity and health?. In Nutrition and Fitness: Mental Health, Aging, and the Implementation of a Healthy Diet and Physical Activity Lifestyle (Vol. 95, pp. 162-166). Karger Publishers.

Weiss, M. R. (2000). Motivating kids in physical activity. President's Council on Physical Fitness and Sports Research Digest.

Weston, K. S., Wisløff, U., & Coombes, J. S. (2014). High-intensity interval training in patients with lifestyle-induced cardiometabolic disease: a systematic review and meta-analysis. Br J Sports Med, 48(16), 1227-1234.

Wiliam, D. (2013). Assessment: The bridge between teaching and learning. Voices from the Middle, 21(2), 15.

Wilkinson, S. S. (1981). The relationship of teacher praise and student achievement: A meta-analysis of selected research.

Zanetti, M. C., Feltran, G. N., Polito, L. F. T., Dias, H. M., Neves, A. N., & Brandão, M. R. F. (2017). An intervention program on motivation and psychological needs in physical education. Revista de psicología del deporte, 26(4), 34-38.

Zhang, T., Solmon, M. A., & Gu, X. (2012). The role of teachers' support in predicting students' motivation and achievement outcomes in physical education. Journal of Teaching in Physical Education, 31(4), 329-343.

Appendix A. Principal's consent letter

MACQUARIE University SYDNEY·AUSTRALIA

Thursday 16th June 2016

Dear Principal

Your school, has been invited to participate in a research project conducted by Nathan Weaver a research student from Macquarie University. The High Impact Physical Education (HI-PE) Study is an inclusive and innovative approach to learning within secondary school physical education classes and will be looking at a way to increase the time available to teachers for the provision of instructions and feedback while reducing the time required for students to achieve health and fitness related goals.

What is the purpose of the research?

This study aims to evaluate the effect of a pedagogical intervention designed to promote physical activity and learning during physical education classes in a secondary school setting. It is significant because many Australian children do not have the opportunity to spend enough class time participating in moderate to vigorous physical activity, therefore they fail to reach the physical activity levels that are required to achieve any health benefits during physical education classes.

Who is conducting, and who is funding the research?

The project will involve staff at your child's school working together to bring about change in the areas of physical activity and learning. The project is also designed to enhance teacher understanding and confidence in these areas. All research will be conducted by Macquarie University and all researchers have undergone a Working With Children Check.

This study will contribute to the requirements for the Master of Research degree of Mr. Nathan Weaver under the supervision of Dr. Dean Dudley (Faculty of Human Sciences, dean.dudley@mq.edu.au, (02) 9850 4864.)

What will be required of teachers?

This study will run for 6 months and involves several components.

1. **Pre-intervention testing**
   A quick questionnaire will be completed during a single PE lessons. The questionnaire will be about the students' motivation to take part in PE lessons. The teachers involved in the study will be required to administer the questionnaire via a Google form. Nathan Weaver will lead any training regarding the implementation of this questionnaire. Teachers will also be required to administer 4 fitness tests before the intervention begins. The tests will include: beep test, 10x5m shuttle run, standing long jump and the hand grip strength test. Results for these tests will be collected via a Google form. It is important to note these fitness tests are part of the existing PDHPE curriculum at St. Andrews College. As a test retest methodology is being applied to the study - 10% of the cohort will be required to redo the pre-intervention tests.

2. **Implementation of the Intervention**
During the project Year 7 PDHPE classes will be divided into two groups according to the teacher who is responsible for their class. A different learning treatment will be applied to each class however both treatments aim to help students achieve health related goals during PE classes. Each treatment is outlined below:

<u>**Treatment A COMPARISION (DYNAMIC PHYSICAL EDUCATION)**</u>
Students in Mr David Frankham's classes will follow the principles of Dynamic Physical Education where teaching and learning activities within their class are designed to keep students moving with a heart rate of 140bpm for 50% of their PE lesson. Heart rates will be measured manually during this treatment. A calculation of number of beats in 6 seconds x 10 will be used. The classroom teacher will count the time. A standard watch will be used.

<u>**Treatment B INTERVENTION (HIGH IMPACT PHYSICAL EDUCATION)**</u>
Students in Mr Nathan Weaver's classes will replace their traditional warm-up activity with a 5-10 minute activity that involves High Intensity Interval Training exercises. This means students will aim to move with a heart rate of 170bpm for 10% of their PE lesson then return to the normal teaching methods used by Mr Nathan Weaver for the remainder of the lesson. Heart rates will be measured manually during this treatment. A calculation of number of beats in 6 seconds x 10 will be used. The classroom teacher will count the time. A standard watch will be used.

During terms 2 and 3 up to 10 observations of each teachers PE lessons will be made using the System for Observing Fitness Instruction Time (SOFIT) instrument to see what goes on in their PE classes. During this time observations will be made on how active students are and how often instruction is provided by the teacher. No student will be identified and researchers will not be interacting with students.
Members of the PDHPE faculty who are not involved in the implementation of the intervention will be given the opportunity to receive training in the application of the SOFIT tool.

3. **Post intervention testing**
A quick questionnaire will be completed during a single PE lessons. The questionnaire will be about the students' motivation to take part in PE lessons. The teachers involved in the study will be required to administer the questionnaire via a Google form. Teachers will also be required to administer 4 fitness tests with-in 1 week of the completion of the intervention. The tests will include: beep test, 10x5m shuttle run, standing long jump and the hand grip strength test. Results for these tests will be collected via a Google form. As a test retest methodology is being applied to the study - 10% of the cohort will be required to redo the pre-intervention tests.

Teachers may choose not to partake in the HI-PE Study at any time. A minimum of two teachers from your school will need to complete the SOFIT training as part of the intervention. Should your school not meet this requirement, your school will be removed from the study. This removal will result in no negative ramifications for the school, staff or students with Macquarie University now or in the future. The school will also retain any resources already provided to the school as a result of the study.

Will my school be identified within subsequent publications?

No, your school will not be identified during the subsequent publications and reports. No student, staff or community member will be identified at any stage during the observations or subsequent publications and all personal information will be kept confidential. All data collected from the study will be kept in a locked cabinet at Macquarie University, and digital copies saved on a password protected university server.

Results from this study will be made available to you and your school after the study has been completed.

What if I need to ask questions about the research or have a complaint?

More information about this research is available from Nathan Weaver. If you have any complaints or concerns about this research, please do not hesitate to contact the Human Research Ethics Committee (HREC) on the contact details below.

Supervisor – Dr Dean Dudley	dean.dudley@mq.edu.au (02) 9850 4864
Research student – Mr Nathan Weaver	nweaver@parra.catholic.edu.au (02) 9626 4000

The ethical aspects of this study have been approved by the Macquarie University Human Research Ethics Committee. If you have any complaints or reservations about any ethical aspect of your participation in this research, you may contact the Committee through the Director, Research Ethics & Integrity (telephone (02) 9850 7854; email ethics@mq.edu.au). Any complaint you make will be treated in confidence and investigated, and you will be informed of the outcome.

Sincerely,

Nathan Weaver

MACQUARIE
University
SYDNEY·AUSTRALIA

1. I, ..., Principal at .... consent to my participation in a professional learning module as part of the High Impact Physical Education (HI-PE) Study.

2. I understand that I am free to withdraw from the research at any time and that if I do I will not be subjected to any penalty or discriminatory treatment.

3. The purpose of the research has been explained to me, including the potential risks and discomforts associated with the research, and I have read and understood the written information sheet given to me.

4. I understand that any information or personal details gathered in the course of research about me are confidential and that neither my name nor any other identifying information will be used or stored.

5. I understand that my information will be de-identified in the research analysis and that no findings will be identifiable or reported in an identifiable manner.

Principal signature..

Date...

Contact Email.. Contact Phone..

A digital copy of this consent form will be emailed to you by the research team.

The ethical aspects of this study have been approved by the Macquarie University Human Research Ethics Committee. If you have any complaints or reservations about any ethical aspect of your participation in this research, you may contact the Committee through the Director, Research Ethics & Integrity (telephone (02) 9850 7854; email ethics@mq.edu.au). Any complaint you make will be treated in confidence and investigated, and you will be informed of the outcome.

Appendix B. Authorisation to conduct this study HREC.

Office of the Deputy Vice-Chancellor
(Research)

Research Office
Research Hub, Building C5C East
Macquarie University
NSW 2109 Australia
T: +61 (2) 9850 4459
http://www.research.mq.edu.au/
ABN 90 952 801 237

MACQUARIE University
SYDNEY·AUSTRALIA

22 June 2016

Dear Dr Dudley

Reference No: 5201600120

Title: *Evaluating the potential efficacy of incorporating High Intensity Interval Training (HIIT) principles within Year 7 physical education classes to achieve educative and health goals concurrently: A nonrandomized behavioural intervention.*

Thank you for submitting the above application for ethical and scientific review. Your application was considered by the Macquarie University Human Research Ethics Committee (HREC (Medical Sciences)).

I am pleased to advise that ethical and scientific approval has been granted for this project to be conducted at:

- Macquarie University

This research meets the requirements set out in the *National Statement on Ethical Conduct in Human Research* (2007 – Updated May 2015) (the *National Statement*).

Standard Conditions of Approval:

1. Continuing compliance with the requirements of the *National Statement*, which is available at the following website:

http://www.nhmrc.gov.au/book/national-statement-ethical-conduct-human-research

2. This approval is valid for five (5) years, subject to the submission of annual reports. Please submit your reports on the anniversary of the approval for this protocol.

3. All adverse events, including events which might affect the continued ethical and scientific acceptability of the project, must be reported to the HREC within 72 hours.

4. Proposed changes to the protocol and associated documents must be submitted to the Committee for approval before implementation.

It is the responsibility of the Chief investigator to retain a copy of all documentation related to this project and to forward a copy of this approval letter to all personnel listed on the project.

Should you have any queries regarding your project, please contact the Ethics Secretariat on 9850 4194 or by email ethics.secretariat@mq.edu.au

The HREC (Medical Sciences) Terms of Reference and Standard Operating Procedures are available from the Research Office website at:

http://www.research.mq.edu.au/for/researchers/how_to_obtain_ethics_approval/human_research_ethics

The HREC (Medical Sciences) wishes you every success in your research.

Yours sincerely

Professor Tony Eyers
Chair, Macquarie University Human Research Ethics Committee (Medical Sciences)

This HREC is constituted and operates in accordance with the National Health and Medical Research Council's (NHMRC) *National Statement on Ethical Conduct in Human Research* (2007) and the *CPMP/ICH Note for Guidance on Good Clinical Practice.*

Details of this approval are as follows:

Approval Date: 7 June 2016

The following documentation has been reviewed and approved by the HREC (Medical Sciences):

Documents reviewed	Version no.	Date
Revised Macquarie University Ethics Application Form		Received 31/5/2016
Correspondence responding to the issues raised by the HREC (Medical Sciences)		Received 31/5/2016
MQ Participant Information and Consent Form (PICF) (Principal)	1.1*	31/5/2016
MQ Participant Information and Consent Form (PICF) (Information and Consent Forms (Parent, Guardian and Student) & Pre-Study Questionnaire	1.1*	31/5/2016
Perceived Locus of Causality Questionnaire for Physical Education (PLOCQ-PE)	1.1*	31/5/2016
System for Observing Fitness Instruction Time (SOFIT)	1.1*	31/5/2016
European Physical Fitness Test Battery (EUROFIT)	1.1*	31/5/2016
The Adolescent Physical Activity Recall Questionnaire (APARQ)	1.1*	31/5/2016

Documents Noted	Version no.	Date
Correspondence with the CEDP - Research Application to conduct research in Catholic systemic schools in the Diocese of Parramatta		

***If the document has no version date listed one will be created for you. Please ensure the footer of these documents are updated to include this version date to ensure ongoing version control.**

Appendix C. Permission from the educational organisation.

Catholic Education
Diocese of Parramatta

Mr Nathan Weaver
St Andrews College
116 Quakers Road
Marayong NSW 2148.
T: 0477 692 233 |
E: nweaver@parra.catholic.edu.au; dean.dudley@mq.edu.au

16th February, 2016

Dear Nathan,
Thank you for your Application to Conduct Research with schools under the auspices of Catholic Education, Diocese of Parramatta (CEDP) entitled: *High Impact Physical Education (HI-PE) Study*.

The research has been approved.

This letter approves you and/or your research team to approach the principal of the school named in your application:

- St Andrews College, Marayong.

Please note the following points in relation to the research request:

- This approval letter must accompany any approach by your team to a school principal
- It is the school principal who will provide final permission for research to be carried out in the school
- Confidentiality needs to be observed in reporting and must comply with the requirements of the Commonwealth Privacy Amendment (Private Sector) Act 2000.
- Feedback should be provided to schools and a copy of the findings of the research forwarded to the email address shown below.

I look forward to reading the results of this study and wish you the best over the coming months. If you would like to discuss any aspect of this research in our diocese, please do not hesitate to contact me on 02 9407 7070 or pbarrett@parra.catholic.edu.au.

Yours sincerely,

Mr Patrick Barrett
Manager of Programs (Special Purpose)

enabling learning in today's world

12 Victoria Road, Parramatta
tel (02) 9840 5600 fax (02) 9840 5678
Locked Bag 4, North Parramatta NSW 1750
www.parra.catholic.edu.au

Appendix D. Parent and Student consent form.

Dear Parents, Guardians and Students

St. Andrews College has agreed to participate in the High Impact Physical Education (HI-PE) Study run by Mr Nathan Weaver a research student from Macquarie University and PDHPE Teacher at St Andrews College. The HI-PE Study is an inclusive and innovative approach to learning within secondary school physical education classes and will be looking at ways to increase the time available to teachers for quality teaching and learning while reducing the time required for students to achieve health and fitness related goals.

What is the purpose of the research?

This study aims to evaluate the effect of a new teaching and learning program designed to promote physical activity and learning during physical education classes in a secondary school setting. It is important because many Australian children do not have the opportunity to spend enough class time participating in moderate to vigorous physical activity, therefore they fail to reach the physical activity levels that are required to achieve any health benefits during physical education classes.

Who is conducting, and who is funding the research?

The project will involve staff at your child's school working together to bring about change in the area of physical activity and learning. The project is also designed to enhance teacher understanding and confidence in these areas. All research will be conducted by Macquarie University and all researchers have undergone a Working With Children Check.

This study will contribute to the requirements for the Master of Research degree of Mr Nathan Weaver under the supervision of Dr Dean Dudley (Faculty of Human Sciences, dean.dudley@mq.edu.au, (02) 9850 4864.)

What will be required of your child?

The HI-PE project will be implemented in your school as part of the 2016 Year 7 PDHPE curriculum. We are seeking permission to conduct some assessments on your child so that we can evaluate the effect of this project over this time. None of the assessments will hurt your child – in fact you may be interested in their results. These assessments will take place from Term 1, 2016 to Term 4, 2016. These assessments have been outlined in greater detail:

1. We will ask your child to complete a questionnaire on up to three occasions during the project. The questionnaire will be about their motivation to take part in PE classes and completed via an online Google form. If students do not have access to an electronic device a paper copy may be provided if required.

2. We will observe up to five of your child's PE lessons to see what goes on in their PE classes. During physical education classes, researchers will be observing how active students are and how often instruction is provided by the teacher. No student will be identified and researchers will not be interacting with students.

3. We will ask your child to perform the following fitness tests up to three times during the year: beep test, 10x5m shuttle run, standing long jump and the hand grip strength test. These fitness tests are a normal part of the existing PDHPE curriculum at St. Andrews College.

During the project Year 7 PDHPE classes will be divided into two groups according to the teacher who is responsible for their class. A different learning intervention will be applied to each class however both interventions aim to help students achieve health related goals. Students will be asked to count and record their own pulse at times during PE lessons. A calculation of number of beats in 6 seconds x 10 will be used. The classroom teacher will count the time and a standard watch will be used. Each intervention is outlined below:

Intervention A (DYNAMIC PHYSICAL EDUCATION)

Students in Mr David Frankham's classes will follow the principles of Dynamic Physical Education where teaching and learning activities within their class are designed to keep students moving with a heart rate of 140bpm for 50% of their PE lesson.

Intervention B (HIGH IMPACT PHYSICAL EDUCATION)

Students in Mr Nathan Weaver's classes will replace their traditional warm-up activity with a 5-10-minute activity that involves High Intensity Interval Training exercises. This means students will aim to move with a heart rate of 170bpm for 10% of their PE lesson then return to the normal teaching methods used by Mr Nathan Weaver for the remained of the lesson.

There are physical risks (asthma, hypoglycemia etc.) associated with the physically active nature of this study. The intervention is not likely to cause any additional risks to those already identified within Physical Education classes. Teachers will conform to the Guidelines for the Safe Conduct of Sport and Physical Activity in Schools (NSW DEC, 1999) to minimise any potential risk.

Will your child or school be identified within subsequent publications?

Your child will not be identified during the subsequent publications and reports. No student or community member will be identified at any stage during the observations or subsequent publications and all personal information will be kept confidential.

During the study data from questionnaires will be collected using Google forms via Mr Nathan Weaver's Parramatta Catholic Education Office Google Drive account. All data collected will be removed from the Google drive account within 24hrs of the final questionnaire being completed and saved to an external hard drive that will be kept in a locked cabinet at Macquarie University with all other data that has been collected. Any digital copies of the data that has been collected will be saved on a password protected university server.

Results from this study will be made available to you and your school after the study has been completed.

What if I need to ask questions about the research or have a complaint?

More information about this research is available from Mr Nathan Weaver. If you have any complaints or concerns about this research, please do not hesitate to contact the Human Research Ethics Committee (HREC) on the contact details below.

Supervisor – Dr Dean Dudley	dean.dudley@mq.edu.au (02) 9850 4864
Research student – Mr Nathan Weaver	nweaver@parra.catholic.edu.au (02) 9626 4000

The ethical aspects of this study have been approved by the Macquarie University Human Research Ethics Committee. If you have any complaints or reservations about any ethical aspect of your participation in this research, you may contact the Committee through the Director, Research Ethics & Integrity (telephone (02) 9850 7854; email ethics@mq.edu.au). Any complaint you make will be treated in confidence and investigated, and you will be informed of the outcome.

Sincerely,

Mr Nathan Weaver

MACQUARIE University SYDNEY · AUSTRALIA

Parental Consent

1. I, ..., consent for my child .... to participate in the High Impact Physical Education (HI-PE) Study.

2. I understand that I am free to withdraw my child from the research at any time and that if I do they will not be subjected to any penalty or discriminatory treatment.

3. The purpose of the research has been explained to me, including the potential risks and discomforts associated with the research, and I have read and understood the written information sheet given to me.

4. I understand that any information or personal details gathered in the course of research about me are confidential and that neither my child's name nor any other identifying information will be used or stored.

5. I understand that my child's information will be de-identified in the research analysis and that no findings will be identifiable or reported in an identifiable manner.

Parent's name: (please print) ....

Parent's signature...

Date..

Student Consent

1. I, ..., consent to participate in the High Impact Physical Education (HI-PE) Study.

2. I understand that I am free to withdraw from the research at any time and I can do this by speaking with my class teacher or my Leader of Learning.

3. I understand that if I choose to withdraw from the study I will not face any penalty or discriminatory treatment.

4. The purpose of the research has been explained to me, including the potential risks and discomforts associated with the research, and I have read and understood the written information sheet given to me.

Student's name: (please print) ....

Student's signature...

Date..

MACQUARIE
University
SYDNEY·AUSTRALIA

In preparation for the High Impact Physical Education (HI-PE) Study, please tell us about your child's medical history. The aim of this questionnaire is to identify those individuals with a known disease, or signs or symptoms of disease, who may be at a higher risk of an adverse event during physical activity /exercise.

Student Name: ____

Student Class Group: ____

Has your doctor ever told you that your child has a heart condition or have they ever suffered a stroke? If yes, provide details.

YES / NO

____
____
____
____

Has your child ever experienced unexplained pains in their chest at rest or during physical activity/exercise? If yes, provide details.

YES / NO

____
____
____
____

Does your child ever feel faint or have spells of dizziness during physical activity/exercise that causes them to lose balance? If yes, provide details.

YES / NO

____
____
____
____

Has your child had an asthma attack requiring immediate medical attention at any time over the past 12 months? If yes, provide details.

YES / NO

If your child has diabetes (type 1 or type 2) have they had trouble controlling their blood glucose levels in the last 3 months? If yes, provide details.

YES / NO

Does your child have any diagnosed muscle, bone or joint problems that you have been told could be made worse by participating in physical activity/exercise? If yes, provide details.

YES / NO

Does your child have any other medical condition(s) that may make it dangerous for them to participate in physical activity/exercise? If yes, provide details.

YES / NO

Parent's name: (please print) ....

Parent's signature..........

Date..........

Appendix E. Script for phone call home.

Hello, my name is . . . . I am a PDHPE teacher from St Andrew's College. Is this a good time to speak right now?

YES	NO
Thank you, the purpose of this call is to follow up on permission notes regarding the High Impact Physical Education study.	Is there a time I can call you back that is more convenient? The purpose of this call is to follow up on permission notes regarding the High Impact Physical Education study.
I am not sure if you are aware that St. Andrews college has been given the opportunity to take part in a research study run through Macquarie University and been approved by the CEDP. The study will look at ways to improve the quality of physical education we offer here at St. Andrews.	
I am just ringing to seek permission for your child [insert student name] to participate in the study. It is important to note that there is no negative repercussion if you decide to say no.	
Have you seen the information letter that has been provided to all students in year 7?	Would you like me to explain the study for you? [If the answer is yes staff are to read the information letter to the parent]
Do you provide consent for [insert student name] to participate in the study?	Thank you for your time.
As this study is related to PA I need to ask you a series of questions relating to your child's level of health. Do you have time to do this now	Can you please ask [insert child's name] to return the paper copy of the consent form and the health screening survey by tomorrow? Thank you for your time.
Staff member reads the questions from the health screening survey and records the answers on a blank sheet.	
Thank you for your time.	

Appendix F. EUROFIT protocol manual.

Eurofit Fitness Testing Battery

Introduction

The Eurofit Physical Fitness Test Battery is a set of nine physical fitness tests covering flexibility, speed, endurance and strength. The standardised test battery was devised by the Council of Europe, for children of school age and has been used in many European schools since 1988. The test is designed so that it can be performed within 35 to 40 minutes, using very simple equipment.

Tests

The following 9 tests are the standard tests recommended for testing school age children.

Anthropometry: height, weight, BMI.

1. Flamingo Balance test - single leg balance test
2. Plate Tapping - tests speed of limb movement
3. Sit-and-Reach - flexibility test
4. Standing Broad Jump - measures explosive leg power.
5. Handgrip Test - measures static arm strength
6. Sit-Ups in 30 seconds - measures trunk strength
7. Bent Arm Hang - muscular endurance/functional strength
8. 10 x 5 meter Shuttle Run - measures running speed and agility
9. 20 m endurance Couse Navette - cardiorespiratory endurance

For this study we will be using items 4, 5, 8 and 9

4. Standing Broad Jump
5. Handgrip Test
8. 10 x 5 meter Shuttle Run
9. 20 m endurance Couse Navette (Beep Test)

Procedures to implement each test have been provided below and were sourced from the Handbook for the EUROFIT tests of Physical Fitness. (Adam et al., 1993)

Appendix G. Tabloid map.

Fitness-testing sites

Group rotations.

	Upper Level	Ground Level	Asphalt	Outdoor Court
Session 1	Bennelong	Chang	Francis	Gould
Session 2	Gould	Bennelong	Chang	Francis
Session 3	Francis	Gould	Bennelong	Chang
Session 4	Chang	Francis	Gould	Bennelong

IMPORTANT NOTE* Students should be provided a 15min break after completing the Beep Test.

Appendix H. PLoCQ instructions.

Thank you for helping us today. Many students are helping us by completing this questionnaire. By answering these questions, you will help us understand more about why young people like yourself are motivated to take part in physical education. Take your time to read each question in turn and answer it as best you can.

HOW TO COMPLETE THIS FORM

All questions can be answered by checking a box in the space provided.

* Read each question carefully.

* Place a checkmark in the box that represents your answer.

* Raise your hand if you need help, I will assist you.

Thanks again for being part of this important survey!