# ‘CHILDREN OFF THE COUCH’: - THE EFFICACY OF A CURRICULUM-SUPPORTED, WEB-BASED WALKING CHALLENGE TO INCREASE CHILDREN’S PARTICIPATION IN PHYSICAL ACTIVITY AND IMPROVE PSYCHOSOCIAL CORRELATES OF PHYSICAL ACTIVITY

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# FOREWORD

In 2001, the Rockhampton region was chosen for a two-year trial of *10,000 Steps;* Australia's first 'whole of community' project aimed at providing a sustainable model of physical activity promotion (10000 Steps Project Office, 2007; Queensland Health, c. 2010). The project concurrently trialed five intervention strategies to increase physical activity centred around the core component of using pedometers to monitor daily step counts and thereby motivate participants to achieve a target of 10,000 steps per day and an overall increase in physical activity (Brown, Eakin, Mummery, & Trost, 2003; Brown, Mummery, Eakin, & Schofield, 2006). Although not initially included as part of the five strategies the concept of a *10,000 Steps* - *Workplace Challenge* evolved as a response to employer interest in being proactive with their staff and a desire for both employee and employers to engage in an active lifestyle (Steele, 2004). The primary goals of the workplace challenge are to increase participants' awareness of physical activity and its health benefits, and increase their overall physical activity levels. The *10,000 Steps* - *Workplace Challenge* quickly became one of the most popular and frequently utilized strategies within the 10,000 Steps Project.

In 2005, Queensland Health requested that the *10,000 Steps Rockhampton* project team explore the feasibility of implementing the core concepts of the *10,000 Steps* - *Workplace Challenge* within the primary school setting. The work contained in this thesis represents the key learnings and outcomes of implementing the *10,000 Steps* - *Workplace Challenge* in the school setting.

# ABSTRACT


## BACKGROUND

This thesis reports upon research that utilized qualitative and quantitative methods for the design and then subsequent evaluation of a primary school curriculum package that integrated the core concepts of the *10,000 Steps - Workplace Challenge* with the existing syllabi of the Queensland education system. This research involved two inter-related studies: the first, - a feasibility study; the second, - a quasi-experimental efficacy study.

## STUDY ONE: - METHOD AND RESULTS

Study One was a formative evaluation to examine the feasibility of integrating a web-supported, class-based walking program into the normal middle primary curriculum in Queensland. To achieve this purpose, an experienced year-five, classroom teacher implemented a class-based walking challenge designed to replicate the core concepts of the *10,000 Steps - Workplace Challenge*. The formative evaluation was completed during the third school term (July-September) in 2006. Integrative learning experiences that linked with Key Learning Area syllabi in Mathematics, English, Science, Study of Society and the Environment, Technology, and Health and Physical Education were identified.

Subsequently, Study One outcomes were formalized into a package of twelve lesson plans. Online resources for a virtual walk of the Great Wall of China were also developed. Together these resources constituted the curriculum materials for the intervention that was evaluated in Study Two.

**STUDY TWO: - METHOD AND RESULTS**

Study Two was designed to answer the following research question:

> Would a curriculum-supported, web-based walking challenge (the intervention) increase children's *physical activity* and *psychosocial correlates of physical activity* over a six-week period and would any increase be maintained at 3-month follow-up?

To achieve this purpose, a quasi-experimental research design with a non-equivalent comparison group was used. The outcome variables of *physical activity* and *psychosocial correlates of physical activity* were measured at baseline (week 1), post-intervention (week 8) and at 3-month follow-up (week 20). The participants for this study were drawn from middle primary (i.e. years four and five) classes at two local primary schools in Central Queensland, Australia.

Children's physical activity was measured using two objective instruments: - a pedometer (Digi-Walker SW-200 Yamax Corp. Tokyo, Japan) and the Actiheart accelerometer (Mini Mitter, version 2). The psychosocial correlates of physical activity were measured via an 18 item, 7-point Likert scale questionnaire that assessed the Theory of Planned Behaviour (TPB) psychosocial constructs of attitude, subjective norm (SN), perceived behavioural control (PBC), and intention to participate in physical activity.

Mean 4-day (Friday - Monday inclusive), school day and weekend step counts were calculated for children who satisfied inclusion criteria (daily step counts 2,000 - 50,000) for all measurement periods. Mean percentage time spent in sedentary, light, moderate and vigorous physical activity categories were calculated from the Actiheart accelerometer data for whole-of-day (i.e. 6am - 8pm) and afternoon (i.e. 3pm - 6pm). Mean scores for each TPB construct were calculated where higher values reflected dispositions that are more favourable.

To determine the effect of the intervention, a (2) School (intervention vs. comparison) x (3) Time (baseline, post-intervention, 3-month follow-up) Repeated Measures ANOVA was utilized for pedometer and TPB data. A (2) School (intervention vs. comparison) x (2) Time (baseline vs. post-intervention) Repeated Measures ANOVA was utilized for all Actiheart accelerometer determined variables due to poor compliance with measurement protocols at 3-month follow-up.

Due to the small sample sizes obtained during the study an alpha level of 0.10 rather than the conventional 0.05 level was set as the alpha level in this research.

Mean 4-day step counts revealed a significant School x Time interaction over the three time points with intervention children exceeding comparison children by an average of 3,125 steps per day at post-intervention ($p = 0.08$). Subsequent analysis of mean school day (Friday and Monday) and mean weekend steps per day displayed a similar pattern of improvement for the intervention school participants at post-intervention.

Actiheart accelerometer determined 'percentage time spent in vigorous intensity activity' revealed a significant School x Time interaction during the afternoon. This was attributable to a decline from baseline (9.18%) to post-intervention (4.82%) for the comparison school ($p = 0.02$). Further dissection into school day and weekend revealed that the differences were only significant for school day ($p = 0.08$).

The TPB constructs of intention, attitude, SN and PBC revealed two gender specific interactions. For boys, a School x Time effect occurred for PBC between baseline and post-intervention (p = 0.04). This was attributable to a decrease for comparison boys from 6.11 (SD = 0.79) at baseline to 5.46 (SD = 1.16) at post-intervention (p = 0.02). For girls, a significant School x Time effect occurred for attitude between post-intervention and 3-month follow-up (p = 0.07). This was attributable to a decrease for intervention girls from 5.83 (SD = 1.17) at post-intervention to 5.08 (SD = 1.23) at 3-month follow-up (p = 0.03).

**CONCLUSION - STUDIES ONE AND TWO**

This research demonstrated that it was feasible to integrate Mathematics, English, Studies of Society and the Environment, Technology, and Health and Physical Education learning outcomes from the Queensland syllabi using children's personal pedometer data (Study One), and that participation in a curriculum-supported, web-based walking challenge improved children's physical activity levels (Study Two). This was demonstrated by meaningful improvements in mean daily step counts and a beneficial effect upon time spent in vigorous intensity activity during the after-school period. The effect of the intervention upon children's psychosocial correlates of physical activity was mixed, appeared to be gender specific, and warrants further investigation.

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# LIST OF ABBREVIATIONS.

Analysis of Variance ........................................................................................ ANOVA

Australian Curriculum, Assessment and Reporting Authority ....................................ACARA

Core Learning Outcome ........................................................................................CLO

Key Learning Area ........................................................................................ KLA

Moderate and Vigorous Physical Activity ...................................................................... MVPA

National Assessment Plan for Literacy and Numeracy ............................................. NAPLAN

Physical Activity …………………………………………………………………...... PA

Partial Eta Squared ........................................................................................PES

Perceived Behavioural Control ........................................................................................PBC

Subjective Norm ........................................................................................ SN

Theory of Planned Behaviour ........................................................................................ TPB

# DEDICATION

I wish to dedicate this thesis to my loving father whose regular enquiries over many years in regards ‘how’s that doctor studies (sic) going?’ kept me motivated to complete the thesis when mind and body wavered from the task.

# COPYRIGHT STATEMENT

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Firstly, I would like to extend my appreciation to both of my principal supervisors who provided valuable guidance, and prompting as required, during the many years that have been devoted to completing this thesis. Professor Kerry Mummery provided the initial guidance and inspiration for the research task. I thank you Kerry for your approachability, empathy and philosophical belief that candidate self-discipline and intrinsic motivation are the essence of success in doctoral studies. Dr. Mitchell Duncan provided valuable support and guidance at the 'back end' of the journey. I thank you Mitchell for the incredibly detailed advice and feedback that you provided over the past three years. I hope that the final thesis reflects well upon the time and energy that you applied to your supervisory role.

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# DECLARATION

I hereby declare that the work presented in this thesis is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person nor material which to a substantial extent has been accepted for the award of any other degree or diploma of this university or any other institution of higher learning, except where due acknowledgement is made.

David Lapere

*Chapter One*

# INTRODUCTION

## Statement of the Problem

It is generally believed that there has been a secular decline in childhood physical activity over the past two decades and that this reflects the changing lifestyle associated with modern society (Australian Institute of Health and Welfare, 2011; Australian National Obesity Taskforce, 2003; Bundy et al., 2011). Low levels of childhood physical activity is a major concern because of its adverse physical and psychosocial health consequences (Hands, Parker, Glasson, Brickman, & Read, 2004). Recognizing the health and potential financial costs of declining childhood physical activity levels, numerous health and allied government agencies (Australian National Obesity Taskforce, 2003; Department of Health and Ageing, 2004; NSW Health, 2002; Queensland Health, 2002, 2005) advocate the need to promote childhood physical activity.

Intervention strategies targeted at individuals, families, organizations, communities, and the physical environment have been proposed and trialed as means of increasing childhood physical activity (van Sluijs, McMinn, & Griffin, 2007). Reviews of intervention setting effectiveness indicate that the most extensive and promising research on interventions to increase physical activity among young people has been conducted in schools (Salmon, Booth, Phongsavan, Murphy, & Timperio, 2007; van Sluijs, et al., 2007). This is because interventions conducted in the school setting have the potential to access virtually all children between the ages of five and seventeen and may be both prevention and treatment orientated (Reilly, 2006; Reilly & McDowell, 2003; Steinbeck, 2001) and avoid the negative labeling of children (Davidson, 2007; Harrell et al., 1998; Harrell et al., 1996).

Primary school interventions designed to increase childhood physical activity have taken a variety of approaches with mixed benefits (Salmon, et al., 2007; van Sluijs, Kriemler, & McMinn, 2011). As a broad generalization, research shows that enhancing physical activity within structured learning experiences, notably Physical Education lessons, may be effective whereas classroom-based Health Education produces mixed or ineffective results (Kahn et al., 2002). Moreover, where interventions are effective, often the benefits are short-lived and wane with the cessation of the intervention (Dishman & Buckworth, 1996). Furthermore, gains produced during the in-school day do not necessary translate into 'out-of-school' or total daily physical activity (Kahn, et al., 2002).

Although advocates for increasing childhood physical activity argue strongly for increased curriculum time to be devoted to physical activity (Ministerial Review Committee for School Sport and Physical Activity, 2007), other dissenting and influential voices such as the Australian Primary Principals Association (Simos, 2007) complain of a cluttered curriculum and the need to 'return to the basics'. This creates a battle for the allocation of the finite teaching time available in the school day between the health benefits of physical activity/education programs versus the curriculum and learning outcomes imposed by education authorities through their mandated syllabi. Within this contested environment, physical activity/education programs may be marginalized in favour of the more highly regarded academic curriculum areas (Erwin, Beighle, Morgan, & Norland, 2011). Given this reality, the search for a time-effective, school-based, physical activity intervention program continues.

## Aim and Scope

This thesis reports upon the development and testing of a school-based, curriculum-integrated physical activity intervention designed to increase children's participation in physical activity and improve their psychosocial correlates of physical activity. The intervention:

- Utilized a six-week integrated curriculum package that incorporated a web-supported virtual walking challenge,
- Was delivered by middle primary (i.e. years four and five) classroom teachers,
- Provided students with access to pedometers throughout the intervention to provide immediate and daily feedback of ambulatory physical activity in terms of number of steps taken.

Two research studies were necessary to achieve this purpose. Study One was a feasibility study to identify cross-curricular linkages between web-supported, virtual walking challenge activities and the eight Key Learning Area (KLA) syllabi that form the mandated curriculum for Years 1-10 in Queensland. This study informed the development of a curriculum package that, along with the use of personal pedometers and access to a web-supported virtual walking challenge, constituted the intervention for Study Two.

The purpose of Study Two was to determine the efficacy of the intervention to improve children's physical activity as measured by pedometer and Actiheart accelerometer. Theory of Planned Behaviour psychosocial constructs, that is; (i) attitude, (ii) subjective norm (iii) perceived behavioural control, and (iv) intention to participate in physical activity, were secondary outcome variables. Study Two utilized a quasi-experimental research design to determine the efficacy of the intervention to increase physical activity and psychosocial correlates of physical activity.

## Structure of the Thesis

The thesis contains five chapters. A Review of Literature is presented within Chapter Two. This is followed by chapters devoted to the two inter-related studies; i.e., Study One - the feasibility study (Chapter Three), and Study Two - the efficacy study (Chapter Four). Both of these chapters are self-contained and may be read independently so may contain some content overlap in the introductions to provide context to the study. Chapter Five provides a summary of both Studies One and Two, and identifies strengths and limitations of the research and suggests recommendations for future investigations.

## Delimitations

The research contained in this thesis is subject to the following delimitations:

- Study Two was delimited to year four and five students.
- The intervention period was delimited to six-week duration within the third school term.
- The study was delimited to two Catholic primary schools in Central Queensland.
- Outcome measures were delimited to ambulatory physical activity capable of measurement by pedometer and accelerometer, and the four psychosocial constructs of the Theory of Planned Behaviour; that is,
    - attitude,
    - social norm,
    - perceived behavioural control, and
    - intention.
- Follow-up measurement of outcome variables was delimited to 3-month post-intervention, i.e. three months following the cessation of the intervention.

## Limitations

The research contained in this thesis is subject to the following limitations:

- ‘Teacher effects’ were not distinguished from intervention effects. Larger sample sizes within each class of the intervention group would be required to investigate the influence of this variable.
- The differential effect of each component of the intervention was not investigated. The specific contribution of the web-supported walking challenge resource was not distinguished from effects attributed solely to monitoring daily step counts, or, the curriculum activities in which the participants engaged.

## Operational Definitions of Key Terms

*Ambulatory activity*: Ambulatory activities are locomotor activities such as walking and running which are typical of children’s free-play activity.

*Attitude*: Attitudes represent an individual’s predisposition towards engaging in a behaviour and are underpinned by the beliefs that participation in that behaviour will result in certain outcomes, and the evaluation of these outcomes as having positive or negative benefits (Miller, 2005).

*Enriched Physical Education*: Enriched Physical Education refers to primary school Physical Education approaches that seek to improve the quality and/or quantity of Physical Education experiences. Enriched Physical Education approaches may achieve this purpose by a range of strategies including changing curriculum content, pedagogical practices, and the time allocated to the subject.

*Health Education*: Health Education, in its broadest sense, is that subject within the primary school curriculum that seeks to provide children with the knowledge, values, attitudes and behavioural skills conducive to good health (Walmsley, 2000). Health Education is often focused on particular topics such as tobacco, alcohol, nutrition; or it may involve reflecting on our health in a more holistic way (Australian Health Promoting Schools Association, c 2010). The curriculum for Health Education differs between state jurisdictions. Since 2008, the curriculum for Health Education in Queensland has been outlined within the year three, five, seven and nine Essential Learnings documents for Health and Physical Education. Health Education is typically, although not exclusively, delivered through classroom-based learning experiences.

*Middle Primary*: Middle primary is a commonly used descriptor for years four and five of primary schooling in Queensland. Children will typically turn nine and ten in these year levels respectively.

*Multi-Component Physical Activity Promotion*: Multi-component physical activity promotion incorporates multiple elements or strategies to promote physical activity. Additional strategies may include but are not limited to; (i) modifying existing Health Education and Physical Education curricula, (ii) modifying pedagogical strategies, (iii) changing school policies, (iv) changing school environment, and (v) enlisting parent support.

*Perceived Behavioural Control*: Perceived Behavioural Control is an individual's perception about the presence of factors that may facilitate or impede performance of the behaviour and the perceived power of these factors (Ajzen, 2002). Perceived behavioural control is comprised of two components: self-efficacy and controllability (the extent to which performance is up to the actor). Accordingly, measures of perceived behavioural control need to incorporate self-efficacy as well as controllability items that are carefully selected to ensure high internal consistency (Ajzen, 2002).

*Physical Activity:* Physical activity is any bodily movement produced by the contraction of skeletal muscle that increases energy expenditure above the basal level (Caspersen, Powell, & Christensen, 1985).

*Physical Education*: Physical Education, in its broadest sense, is that subject within the primary school curriculum that seeks primarily to use physical activity as a medium through which to enhance children's physical, motor, social, emotional and cognitive development (Walmsley, 2000). Consistent with the essence of this definition, Gallahue and Donnelly (2003) have defined Physical Education to be that portion of the school day devoted to large muscle activities that encourage and develop *learning to move* and *learning through movement*. Since 2008, the curriculum for Physical Education in Queensland has been outlined within the year three, five, seven and nine Essential Learnings documents for Health and Physical Education.

*Primary School:* In Australia, compulsory institutionalized education is separated into primary and secondary schooling. As of 2011, primary schooling in Queensland may commence with the preparatory year (currently non-compulsory), then transition to year one (compulsory) and conclude with year seven. The age at which children commence primary school differs slightly between the states. In Queensland, children eligible to commence the preparatory year or year one must be aged five and six respectively by June 30 in the year of their enrolment.

Primary schooling is organised so that a classroom teacher is responsible for delivering most curriculum areas to twenty to thirty students (28 is currently Education Queensland's target class size). Many primary schools may have one or two specialist teachers who deliver one of the following curriculum areas: Physical Education, The Arts, Music, or Languages other than English (LOTE).

In other jurisdictions, particularly North America, elementary schooling is often the preferred label used to describe primary schooling. Withstanding minor differences in enrolment ages, class sizes, and the number of years completed between the Australian *Primary School* and the North American *Elementary School* the two terms are broadly interchangeable. Given the focus upon the Australian, and in particular the Queensland context, the thesis will use the label ‘primary school’ rather than ‘elementary school’.

*Reactive Behaviour*: Reactive behaviour is a change in normal behaviour because of the participant’s knowledge that their behaviour is being monitored (Rowlands & Eston, 2007).

*Self-efficacy*: Self-efficacy is one’s judgment of his/her capabilities to organise and execute courses of action required to attain designated types of performances (Bandura, 1986). Physical activity self-efficacy refers to one’s confidence in his/her ability to adopt and maintain an active lifestyle under a variety of circumstances and within a specific context (B. Marcus, Selby, Niaura, & Rossi, 1992).

*Subjective Norm:* This refers to the perceived social pressure to engage or not to engage in a behaviour.

*Web-Supported*: Web-Supported is defined as the use of an interactive website to complement and enhance learning experiences delivered in the school setting. Web-supported means that the website and its interactive features ‘value add’ to in-school learning experiences, but are not the primary instructional or information delivery mechanism.

*Virtual Walk*: A virtual walk describes the activity of accumulating actual (real) steps and progressing along an imaginary journey. This may be achieved by mapping progress along a journey using conventional means such maps and scales, or by using web resources that calculate progress and then display this progress visually. The web-supported features of the intervention perform the latter.

*Chapter Two*

# LITERATURE REVIEW

## Introduction

This thesis investigates the efficacy of a *curriculum-supported, web-based walking challenge* (the intervention) to increase children's *physical activity* and *psychosocial correlates of physical activity.* Therefore, the literature review that follows will examine the academic literature relevant to the aims of the research with specific attention to each of the following areas:

- Benefits of Childhood Physical Activity,
- Guidelines for Childhood Physical Activity,
- Tracking of Physical Activity,
- Physical Activity Trends,
- Physical Activity Measurement,
- School-based Physical Activity Interventions,
- Review of Primary School Physical Activity Intervention Strategies,
- Theoretical Framework for the Proposed Intervention,
- Web-supported Physical Activity Interventions, and
- 10,000 Steps - Rockhampton.

## Benefits of Childhood Physical Activity

Physical activity is any bodily movement produced by skeletal muscles that results in an expenditure of energy (Caspersen, et al., 1985). For children, regular physical activity provides substantial benefits to their physical, mental and social health. Benefits include the maintenance of healthy bones, muscles and joints, weight control, fat reduction, efficient heart and lung function, movement skill development, social skill development, and prevention and control of mental conditions such as anxiety and depression (Hands, Parker, Glasson, Brickman, et al., 2004; Trost, 2003, 2005).

For those children whose physical inactivity contributes to the development of overweight and obesity, adverse short term health impacts include gastrointestinal, endocrine and certain orthopaedic problems, social discrimination and associated poor self esteem and depression (Daniels et al., 2005; NSW Department of Health, 2002). Obstructive sleep apnoea, social isolation and menstrual irregularities are also more common amongst overweight or obese children (National Health and Medical Research Council, 2003; Reilly, 2006).

For many children, the adverse health consequences of insufficient physical activity do not present immediately as debilitating illness, but rather gradually accumulate and manifest in adulthood (Berenson, 2002; Boreham & Riddoch, 2001; NSW Department of Health, 2003b). The cost of treatments for adult onset lifestyle diseases associated with insufficient physical activity has substantial economic impacts on public health systems (Abbott et al., 2007; Queensland Health, 2002; Stephenson, Bauman, Armstrong, Smith, & Bellow, 2000). Therefore, considerable effort is required to increase the physical activity of all children and particularly low-active children.

**Children's Physical Activity Guidelines**

To avoid the adverse effects of low levels of physical activity, the Australian Department of Health and Ageing (2004) has produced guidelines for minimum levels of physical activity for children (5-12 year olds) to achieve health benefit. These guidelines state:

> **Guideline 1:** Children and young people should participate in at least 60 minutes (and up to several hours) of moderate- to vigorous-intensity physical activity every day.

**Guideline 2:** Children and young people should not spend more than 2 hours a day using electronic media for entertainment (i.e. computer games, Internet, TV), particularly during daylight hours.

For adolescents (12-18 year olds), Guideline 1 differs slightly to state that adolescents ‘need to be doing at least 60 minutes of moderate to vigorous physical activity every day to keep healthy’. The distinction between children’s and adolescent guidelines recognizes that physical activity amongst both girls and boys tends to decline steadily during adolescence, and that lack of time is often cited as a barrier to adolescents’ participation (National Center for Chronic Disease Prevention and Health Promotion, 1997). Guideline 1 for children and adolescents differs from the Australian adult guidelines in terms of the number of minutes of moderate and vigorous activity that are recommended (i.e. sixty for children versus thirty for adults) and in regards the number of days that they should be active (i.e. daily for children versus ‘on most days’ for adults). These distinctions recognize three important findings; (i) children are naturally more active than adults, (ii) children actually need to be more active than adults for optimal growth and development (Pate, Corbin, & Pangrazi, 1998), and (iii) children require more than 30 minutes of daily physical activity in order to learn and master the movement skills required for a physically active lifestyle (Trost, 2005). Guideline 2 is unique to children and recognizes that sedentary activities such as television watching are strongly associated with excessive adiposity and displaces time for physically active pursuits (Trost, 2005). Internationally, physical activity guidelines for children are now quite consistent across many nations with many recommending that children accumulate sixty minutes of moderate to vigorous physical activity (see Canadian Society for Exercise Physiology, 2011; Centre for Disease Control and Prevention, c 2011; Chief Medical Officers, 2011; World Health Organization, 2010).

Due to the increasing use of pedometers to monitor and motivate individual physical activity, step count guidelines for health benefits have been developed and promoted. For adults, 10,000 Steps has achieved wide recognition as a goal target for good health outcomes (Hultquist, Albright, & Thompson, 2005). For children, step-based physical activity goals vary between 11,000 and 13,000 for girls, and between 13,000 and 16,000 for boys (S. Duncan, Schofield, & Duncan, 2007; President's Council for Physical Fitness and Sports, 2005; Tudor-Locke et al., 2004). Table 1 provides a summary of the most frequently cited step count guidelines for children. The variation in guidelines is due primarily to whether the guideline is based upon normative judgment (Vincent & Pangrazi, 2002), or criterion referenced against either BMI (Tudor-Locke, et al., 2004) or percentage of body fat (S. Duncan, et al., 2007).

**Table 1: Summary of Step Count Guidelines for Primary School Children**

| Author | Study | Guideline | Context for Recommendation |
|---|---|---|---|
| (Vincent & Pangrazi, 2002) | An examination of the activity pattern of primary school children. | 11,000 steps/day for girls<br><br>13,000 steps/day for boys | Children, 6-12 years old (n = 711), wore sealed pedometers for 4 consecutive days. Mean daily step counts ranged from 10,479-11,274 and 12,300-13,989 for girls and boys respectively. Based upon these results, authors suggest that 'a reasonable activity standard might be approximately 11,000 and 13,000 steps per day for girls and boys respectively'. These recommendations were subsequently used by the President's Challenge Physical Activity and Fitness Awards Program as activity targets. |
| (Tudor-Locke, et al., 2004) | BMI-referenced standards for recommended pedometer-determined steps/day in children. | 12,000 steps/day for girls<br><br>15,000 steps/day for boys | 4 school day step counts assessed for 1,954 children (995 girls, 959 boys; ages 6-12 years) from the USA, Australia, and Sweden. The contrasting groups method for establishing criterion-referenced cut points was used to identify optimal age- and sex-specific standards for steps/day related to international BMI cut points for normal weight and overweight/obesity. |
| (S. Duncan, et al., 2007) | Step Count Recommenda-tions for Children Based on Body Fat. | 13,000 steps/day for girls<br><br>16,000 steps/day for boys | Weekday and weekend step counts, assessed over 5 days for New Zealand children aged 5-12 years. The contrasting groups method for determining criterion-referenced cut-off points was used to establish the optimal step count values for predicting overweight based upon % body fat, rather than BMI. Authors rationalized that % body fat being a more accurate measure of adiposity than BMI, particularly for non-European children. |

## Trends in Childhood Physical Activity

It is generally believed that there has been a secular decline in childhood physical activity over the past two decades and that this is due to the changing lifestyle associated with modern society (Australian Institute of Health and Welfare, 2011; Bundy, et al., 2011; National

Health and Medical Research Council, 1997; Salmon, Telford, & Crawford, 2004; WHO Regional Office for Europe, 2007). For example, societal changes have led to reductions in: active recreation (Abbott, et al., 2007; NSW Health, 2002), active transport to and from school (Bauman, Bellow, Vita, Brown, & Owen, 2002), engagement in school physical education programs (Corbin & Pangrazi, 2003), access to convenient community recreation facilities (Lohman, Going, & Metcalfe, 2004), and, changes in family work-leisure balance that restrict active home play opportunities (Bundy, et al., 2011; National Health and Medical Research Council, 1997). Each of these factors contributes to lower childhood physical activity levels and potentially adverse physical and psychosocial health consequences that are both acute and chronic in nature. These and other lifestyle factors that are associated with decreases in children's physical activity are listed in Table 2.

**Table 2: Societal Factors Associated with Secular Decline in Children's Physical Activity Levels**

| Factor | Trend change | Evidence source |
|---|---|---|
| Active Transport | Less walking or cycling to school. | (Bauman, Bellow, et al., 2002)<br>(Lohman, et al., 2004)<br>(NSW Health, 2002)<br>(US Department of Health and Human Services, 2008)<br>(The White House Task Force on Childhood Obesity, 2010) |
| Passive Play | Increased time spent on computer, playing video games and watching TV.<br>The average child watches 2-3 hrs of TV/day. | (Magarey, Daniels, & Boulton, 2001)<br>(Booth et al., 2006)<br>(NSW Health, 2002)<br>(Salmon, et al., 2004)<br>(Bundy, et al., 2011) |
| Active play | Decrease participation rates in active play.<br>Increase in adolescent 'drop out' from sports. | (NSW Health, 2002)<br>(Bundy, et al., 2011) |
| TV programming | Growth in number of TV programs targeting children. | (National Health and Medical Research Council, 1997)<br>(Lohman, et al., 2004) |
| Play environments | People perceive that children will be unsafe at play, or on a bike or bike riding to school. | (NSW Health, 2002 p.3)<br>(Salmon, et al., 2004)<br>(Bundy, et al., 2011)<br>(The White House Task Force on Childhood Obesity, 2010) |
| School | Reduced time allocation for Physical Education.<br>Poor compliance with policy guidelines regarding Physical Education implementation.<br>Increased emphasis upon academic curriculum. | (Corbin & Pangrazi, 2003) |

**Proxy Measures of Trends in Children's Physical Activity**

Relatively little research evidence of the trends in children's physical activity behaviour existed prior to the emergence of rising rates of childhood obesity (Booth, et al., 2006). Without baseline data from earlier times, it was difficult to establish the evidence required for trend analysis. However, proxy measures of childhood physical activity participation have been used to infer a decline in physical activity. For example, health-related fitness measures have been used to infer changes in physical activity because of the confirmed link between regular physical activity and improvement of health-related fitness components among children (National Association for Sport and Physical Education, 2004b). In an Australian study, Dollman, Olds, Norton and Stuart (1999) conducted performance tests upon 1,463 ten and eleven year-old South Australian school children in 1997 and compared their results with similar measures performed in 1985. Compared to the 1985 sample, the 1997 children were heavier, had higher BMIs and were slower over a 1.6 km run test. Dollman and colleagues (1999) found little difference between the fittest and leanest quartiles in 1997 and their 1985 counterparts, however the least fit and fattest quartiles were markedly worse in 1997. Similar findings have been observed by McNaughton, Morgan, Smith and Hannan (1996) who in a 1995 study of 2,450 seven to ten year-old Tasmanian school children detected a marked decline in aerobic performance compared to 1985 data.

A recent meta-analysis of international studies by Tomkinson and Olds (2007) confirmed a precipitous decline in pediatric aerobic performance in industrialized nations. By collating results from 33 studies across 27 countries that examined secular changes in maximal field running tests of aerobic performance, Tomkinson and Olds (2007) demonstrated that there has been a global decline in aerobic performance of 0.36% per annum between 1958 and 2003. The rate of secular decline has been increasing for every decade since the 1970s and has been consistent across ages, genders and geographic region. However, the secular changes detected were not homogenous as some children compared favourably with earlier cohorts (Tomkinson & Olds, 2007).

A similar distributional pattern of secular change has subsequently been reported in the New Zealand setting (Albon, Hamlin, & Ross, 2010). Comparing 550-metre run scores that were collected for 3,306 school children (10 - 14 years), Albon and colleagues found that children's performance had declined by 1.5% and 1.7% per year for boys and girls respectively between 1991 and 2003. Little difference existed between children located in the highest performing and leanest percentiles in 1991 and 2003, but for children in the poorest performing and fattest percentiles, their results were substantially worse in 2003. Taken together, the results of Dollman et al. (1999), McNaughton et al. (1996), Tomkinson and Olds (2007) and Albon et al. (2010) indicate that there has been a significant decline in the aerobic performance of a substantial proportion of Australian children compared with previous generations, and that this trend is similar to that in other industrialized nations.

**Current Status of Australian Children's Physical Activity**

More recently, as community concerns have focused upon the increased prevalence of pediatric obesity, additional data on the physical activity levels of Australian children has been collected and reported. Since 2000, one national and four[1] state-based reports have been published and their major findings have been summarized in Table 3. For Australian children generally, the 2007 Australian National Children's Nutrition and Physical Activity Survey[2] (Australian Government Department of Health and Ageing, 2008), reported that only 40% of nine to thirteen year old children achieved the Australian physical activity guideline on all

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[1] The West Australian Child and Adolescent Physical Activity and Nutrition Survey has been conducted twice; once in 2003 and then again in 2007. Variations in the survey instruments limit the comparisons that can be made between the two surveys.

[2] Assessed children's physical activity using the Multimedia Activity Recall for Children and Adolescents (MARCA) recall questionnaire (Ridley, Olds, & Hill, 2006).

four days of the survey period. When the state-based reports are examined the proportion of children meeting Australia's physical activity guidelines appears to be inconsistent. For example, in Western Australia, results from the 2008 Child and Adolescent Physical Activity and Nutrition Survey[3] (K. Martin et al., 2008), revealed that less than one-half of primary school children (years 3, 5 & 7; n = 923) participated in sixty minutes or more daily physical activity on all of the last seven days of the survey period. In Queensland, the 2004 Healthy Kids Queensland Survey[4] (Abbott, et al., 2007) indicated that only 11.7% and 9.5% of year five boys and girls met Australian physical activity guidelines for all seven days. Whilst In New South Wales, the 2004 Schools Physical Activity and Nutrition Survey[5] (Booth, et al., 2006) revealed that despite seasonal variations, over 80% and 70% of year six boys and girls respectively met the Australian physical activity guidelines for all seven days. With regard to the much higher physical activity levels reported in New South Wales, it may be that this reflected the concerted efforts over the five previous years through the *'Get skilled: Get active'* and *'Healthier Schools' in the Prevention of Obesity in Children and Young People'* initiatives to improve fundamental movement skills (Booth, et al., 2006). Nonetheless, these figures reveal a substantial difference between Western Australian, Queensland and New South Wales survey results. In part, these differences may be due to the different self-report survey instruments used which limits comparisons between the different surveys. Moreover, the suitability of self-report questionnaires as an accurate measurement tool for physical activity, particularly for younger children, is limited due to children's reduced cognitive abilities to recall information (Adamo, Prince, Tricco, Conner-Gorber, & Tremblay, 2009).

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[3] Assessed children's physical activity using a survey questionnaire that comprised items derived from several sources, including Children's Leisure Activities Study Survey (Telford, Salmon, Jolley, & Crawford, 2004), Physical Activity Questionnaire for Adolescents (Kowalski, Crocker, & Faulkner, 1997), Physical Activity Questionnaire for Older Children (Kowalski, et al., 1997), Premier's Physical Activity Taskforce, the NSW Schools Fitness and Physical Activity Survey 1997 (Booth et al., 1997), and the Australian Health and Fitness Survey 1985 (Pyke, 1987), (Hands, Parker, Glasson, Brinkman, & Read, 2004).

[4] Assessed children's physical activity using a similar questionnaire as for the 2003 WA CAPANS Survey (Abbott et al., 2008).

[5] Assessed children's physical activity using a modified version of the Adolescent Physical Activity Recall Questionnaire (Booth, Okely, Chey, & Bauman, 2002).

Objective evidence for the low physical activity level of children has been provided within the same national and state reports using pedometer data. The 2007 Australian National Children's Nutrition and Physical Activity Survey (Australian Government Department of Health and Ageing, 2008) revealed that only 24% and 33% of boys and girls respectively aged nine to thirteen met the Tudor-Locke et al. (2004) BMI criterion referenced guidelines for mean daily steps over six days. In Western Australia, similar low figures were obtained with only 32% and 44% of primary male and female students meeting BMI referenced guidelines for mean daily steps over a minimum of four days. These prevalence figures were consistent with the data obtained from the first iteration of the survey conducted in 2003 (Hands, Parker, Glasson, Brickman, et al., 2004). In Queensland, the Healthy Kids Survey (Abbott, et al., 2007) indicated that 40% and 53% of year five boys and girls met the same guidelines.

Taken together, the proxy measures of children's physical activity and the recent national and state-based surveys provide consistent evidence that there has been a secular decline in children's physical activity over the past three decades. Moreover, large numbers of today's children are insufficiently active to meet the Australian physical activity and health guidelines, or, international recommendations for daily step count targets.

**Table 3: Summary of Australian Children's (5-12 yrs) Physical Activity Behaviour – Reported 2000 to present**

| Study (Author) | Sample | Assessment Instruments | Physical Activity Measure/s | Selected Results for Middle Primary Children |
|---|---|---|---|---|
| Australian National Children's Nutrition and Physical Activity Survey (Australian Government Department of Health and Ageing, 2008) | Australia wide Children aged 9 - 13yrs (n ≈ 1,000). | 'Use of time' measured in children aged 9–16 years using Multimedia Activity Recall for Children and Adolescents recall questionnaire (Ridley, et al., 2006). Children recalled a total of four days. | Proportion (%) of children who met the PA guideline. | 4 different methods used to determine PA guideline compliance. Variation in % who met guideline dependent upon method used to interrogate the data. See (Olds et al., 2007)<br>All days (40% met PA guideline 1)<br>Most Days (68% met PA guideline 1)<br>4 - Day Ave (90% met PA guideline 1)<br>Child x Day (76% met PA guideline 1) |
| | | Pedometer - worn for up to 7 consecutive days. | Mean daily steps for minimum of 6 days. | For 9 - 13 years olds:<br>Boys - 12,961 mean daily steps<br>Girls - 10,875 mean daily steps |
| | | | Percentage satisfying step count guidelines. | President's Challenge Physical Activity and Fitness Awards guidelines - Boys - 46%<br>Girls - 49%<br><br>Achieving step count guidelines proposed by Tudor- Locke (2004)<br>Boys - 24 %<br>Girls - 33%<br><br>*General trends<br>Males more active than females.<br>PA declines with age.<br>Pattern of PA differs between school days and non school days. MVPA peaks before school, at recess, lunch and afterschool for school days.<br>Peak afterschool is lower but sustained longer than other peak periods. |
| Child and Adolescent Physical Activity and Nutrition Survey 2003 (Hands, Parker, Glasson, Brickman, et al., 2004). | Western Australia- Children in years 3, 5 and 7 of primary school and years 8, 10 & 11 of high school (n = 2,880) | Questionnaire developed by taking items from:<br>Children's Leisure Activities Study Survey (Telford, et al., 2004)<br>Physical Activity Questionnaire for Adolescents (Kowalski, Crocker & Faulkner, 1997)<br>Physical Activity Questionnaire for Older Children (Kowalski, et al., 1997)<br>NSW Schools Fitness and Physical Activity Survey 1997 (Booth, et al., 1997)<br>Australian Health and Fitness Survey 1985 (Pyke, 1987) | Number of moderate and vigorous intensity sport, exercise, dance and active play sessions per week | A steady decline with age in the number of activities can be seen with a peak of 11.5 at 8 years followed by a decline to 3.2 activities at 16 years.<br><br>Boys and girls reported similar numbers of activities in any age group.<br><br>Almost 30% of primary school students reported doing no active play.<br><br>Students were more likely to be engaged in physical activity right after school or on the weekend than in the evening.<br><br>Only 3% of the 9 to 16-year-old students reported 60 minutes of daily moderate and vigorous intensity physical activity, although this did not include time in curricular physical education and sport, or active transport. |

| Study (Author) | Sample | Assessment Instruments | Physical Activity Measure/s | Selected Results for Middle Primary Children |
|---|---|---|---|---|
| | | Pedometer worn for 7 consecutive days. | Mean daily steps over minimum of 4 days | Greater activity on weekdays than weekend days<br>Mean steps:<br>For boys - 12,464 for schooldays, 10,956 for weekend and 12, 602 for all day types.<br>For girls - 10,673 for schooldays, 9, 839 for weekend and 10,846 for all day types. |
| Child and Adolescent Physical Activity and Nutrition Survey 2008<br>(K. Martin, et al., 2008) | Western Australia - Children in years 3, 5 and 7 of primary school and years 8, 10 & 11 of high school (n = 923 primary aged children) | Modified Child and Adolescent Physical Activity and Nutrition (CAPANS) 2003 self report questionnaire | Number of days meeting PA guideline 1 in the last week | Primary School Children.<br>Boys more likely to meet the Physical Activity Guideline 1 on all of the last seven days (41.2%) compared with girls (27.4%).<br>Two-thirds of primary school boys (64.0%) and just over one-half of primary school girls (56.8%) met guideline 1 on at least five of the previous seven days. |
| | | Pedometer- worn for 7 to 10 days. Imputation of MVPA recorded on PA diary. | Mean daily steps for minimum of 4 days. Inclusion criteria:<br>4,000 < Step Count > 40,000 | Boys - 13,844 (±4,182) mean daily steps<br>Girls - 12,015 (±3,521) mean daily steps<br><br>Achieving step count guidelines proposed by Tudor- Locke (2004)<br>Boys - 31.7 %<br>Girls - 43.9 % |
| 2004 Healthy Kids Queensland Survey (Abbott, et al., 2008)Abbott et al. (Abbott, et al., 2007) | Queensland Years 1, 5 & 10 (n = 3,691) | Self-report questionnaire using 2003 CAPANS survey of previous 7 days. | Number of days meeting PA guideline 1. | For Year 5 children.<br>Percentage of children who met PA guideline for all 7 days.<br>Boys - 11.7%<br>Girls - 9.5 %<br><br>Percentage of children who met PA guideline for 3 days or more in past 7 days.<br>Boys - 51.7%<br>Girls - 53.5% |
| Abbott et al. (2007) | Queensland Years 1, 5 &10 | Pedometer - worn for five consecutive days including both weekdays and weekend days.<br><br>Diary maintained of daily steps, and time that pedometer was worn and removed. | Mean daily steps.<br>Inclusion criteria - minimum of 4 days, worn for 8 hours each day. | Boys - 14,555 (±4,216) mean daily steps<br>Girls - 12,518 (±3,443) mean daily steps<br><br>Achieving step count guidelines proposed by Tudor- Locke (2004)<br>Boys - 40%<br>Girls - 53%<br><br>*Comparison between school days and weekend days revealed school days to be more active for both boys and girls. |
| 2004 Schools Physical Activity and Nutrition | NSW Kindergarten, Yrs 2,4,6,8 & 10 although modified | Modified Adolescent Physical Activity Recall Questionnaire (APARC) for 7 days (n = 979). | Meeting PA guideline 1 for all 7 days. | Prevalence for Year 6 children *<br>For normal Winter week.<br>Boys - 83.8% |

| Study (Author) | Sample | Assessment Instruments | Physical Activity Measure/s | Selected Results for Middle Primary Children |
|---|---|---|---|---|
| Survey (Booth, et al., 2006) | APARC given to year 6 children only. | | | Girls - 72.4%<br>For normal Summer week.<br>Boys - 88.8%<br>Girls - 80.0%<br><br>*Boys consistently more active than girls.<br>PA declines with age.<br>Children more active in summer than winter. |

* Since the completion of the intervention reported in this thesis, additional data of the physical activity levels of NSW children has been published in the NSW Schools Physical Activity and Nutrition Survey (SPANS) 2010. This survey revealed significant declines of 2.2% (boys) and 1.2% (girls) per annum of year 6 children meeting PA guidelines since 2004 (Hardy, King, Espinel, Cosgrove, & Bauman).

The following section of the literature review will examine the evidence that physical activity tracks between childhood, adolescence and adulthood, and the various forms of physical activity measurement.

**Tracking Studies of Physical Activity**

Tracking studies seek to establish the stability of a particular trait or behaviour over time, or the tendency of individuals to maintain their rank or position within a group over time. Tracking studies for physical activity have shown mixed results (Trost, 2005) with tracking correlations at low to moderate levels from childhood to adulthood (Erlandson et al., 2011; Malina, 2001; Pate, Baranowski, Dowda, & Trost, 1996). Tracking of physical activity is generally higher for males than females, and tends to track more poorly during transitional life phases, i.e. from childhood into adolescence (Erlandson, et al., 2011). Erlandson et al. (2011) report that the evidence of tracking for children increases slightly when biological age, rather than chronological age is examined, as this tends to control for the variability of the onset of adolescence. Whilst the evidence indicates that physical activity generally tracks at low to moderate levels over the life span (Trost, 2005), the link between school-age physical activity influencing adult physical activity is sufficient to justify intervention programs that promote and habituate physical activity for children (NSW Department of Health, 2003a; Telama, 2009; Telama et al., 2005).

**Physical Activity Measurement**

Physical activity is a complex human behaviour that is difficult to measure in a free-living environment, particularly for children (Davidson, 2007; Rowlands & Eston, 2007). However, the accurate and reliable assessment of physical activity is necessary for any research where physical activity is an outcome variable (Adamo, et al., 2009; Rowlands & Eston, 2007). A range of different methods have been used to assess the physical activity of children and these include self-report measures such as questionnaires and diaries, proxy-report from adults, heart rate monitoring, accelerometry, pedometers, direct observation (direct, video, film), indirect calorimetry and doubly-labeled water (Loprinzi & Cardinal, 2011). Each of these methods has strengths and limitations so the most appropriate assessment method for any study will be determined by the research question, study size, budget, population age, assessment time frame, respondent burden, activity information required and the availability of trained staff (Corder, Ekelund, Steele, Wareham, & Brage, 2008; Dollman et al., 2009).

### ***Self-Report and Proxy Report***

Physical activity, due to its complex and multidimensional nature, may be difficult to quantify using recall methods. For adults, the use of questionnaires and diaries can be a valid and reliable assessment instrument that provides an acceptable level of accuracy of their physical activity (Helmerhorst, Brage, Warren, Besson, & Ekelund, 2012; Prince et al., 2008; Sallis & Saelens, 2000). For children however, several comprehensive reviews that have evaluated the reliability and validity of self-report measures have found reliability coefficients that ranged from 0.56 to 0.93 and validity coefficients that ranged from 0.03 to 0.88 (Loprinzi & Cardinal, 2011). For children, particularly those less than ten years of age, their limited cognitive abilities to recall information and the intermittent rather than continuous nature of their physical activity (see Bailey et al., 1995), makes self report methods less effective or appropriate (Adamo, et al., 2009; Cox, Schofield, Greasley, & Kolt, 2006; Rowlands, 2007; Trost, 2005). Proxy reports by parents or teachers of children's physical activity have been used to avoid some of the recall bias caused by children's limited cognitive ability but both Sirard and Pate (2001), and Sallis (1991) found no evidence for the reliability and validity of proxy reports when compared to direct observation of children's physical activity. Despite these deficiencies, physical activity questionnaires still maintain a presence within the physical activity research domain, however they are now generally considered complementary to the much preferred objective instruments of physical activity (Adamo, et al., 2009; Corder, et al., 2008; Goran, 1998; Helmerhorst, et al., 2012; Loprinzi & Cardinal, 2011; Sallis & Saelens, 2000; Trost, 2001, 2005). Contemporary research practice therefore often utilizes a combination of subjective and objective measures to capture the complexity and varied dimensions of physical activity. For example, the previously cited national (i.e. 2007 Australian National Children's Nutrition and Physical Activity Survey) and state surveys (i.e. West Australia - CAPANS 2003 & 2008, Queensland Healthy Kids Survey 2004) use both physical activity questionnaires (subjective) and pedometers (objective) to understand the nature of children's physical activity.

The most frequently used objective methods of physical activity measurement are reviewed briefly in the following sections.

***Direct Observation***

Direct observation is a method by which a trained observer classifies children's free-living physical activity by objectively recording their activity behaviour for a predetermined length of time. Typically, observations occur in natural settings such as at home or during school for a finite period with observations recorded into a computer-based or paper-and-pencil entry form (Loprinzi & Cardinal, 2011).

Common direct observation systems are the *Children Activity Rating Scale (CARS*) (Puhl, Greaves, Hoyt, & Baranowski, 1990), the *System for Observing Play and Leisure Activity in Youth (SOPLAY)* (T. McKenzie, Marshall, Sallis, & Conway, 2000) and the *System for Observing Fitness Instruction Time (SOFIT)* (T. McKenzie, Sallis, & Nader, 1991). The CARS system requires that an observer focus upon one child to rate their activity intensity level from sedentary to vigorous on a scale of one through five. The SOPLAY system captures behavioural and contextual information for groups of children as the observer briefly scans the target area recording the number of boys and girls present, the activity level of each sex (sedentary, walking or very active), the presence of equipment, and the type of activity in which the children are participating (Loprinzi & Cardinal, 2011). The SOFIT system is specifically designed for physical education classes and allows the observer to collect data simultaneously on student activity levels, the lesson context, and teacher behaviour (T. McKenzie, 2009).

The advantage of direct observation is that it may provide rich contextual data associated with physical activity (e.g. social, physical, environmental) and information relating to type and intensity of physical activity (Loprinzi & Cardinal, 2011). The main disadvantage of direct observation is the time-intensive nature of observer training and data coding which limits the duration of observation episodes (Loprinzi & Cardinal, 2011).

### *Indirect Calorimetry and Doubly-Labeled Water*

Both indirect calorimetry and doubly labeled water are accurate methods of measuring energy expenditure but have major limitations for real life research studies (Welk, Corbin, & Dale, 2000). Indirect calorimetry requires confinement to laboratory-like conditions whilst the doubly-labeled water technique only provides gross data of energy expenditure rather than details of the type or pattern of physical activity performed (Eston, Rowlands, & Ingledew, 1998). Both are also very expensive.

### *Heart Rate Monitors*

Heart rate provides an indication of the relative stress placed upon the cardiopulmonary system by physical activity (Armstrong, 1998). Most current heart rate monitors collect data over multiple days and can be downloaded to a computer for further detailed analysis (Rowlands & Eston, 2007).

Energy expenditure and activity intensity can be determined from heart rate because of the linear relationship between heart rate and oxygen consumption over a wide range of exercise intensities (Sirard & Pate, 2001). However, heart rate is affected by factors such as emotional influences, age and fitness level, mode of exercise, weather conditions and body posture, all of which can influence the heart rate - oxygen consumption relationship and thereby contribute to considerable error when used for extended periods of monitoring (Armstrong, 1998; Welk, et al., 2000). Furthermore, heart rate response is delayed after movement and this may obscure the intermittent patterns of children's physical activity. For all of these reasons, but most particularly the failure to capture the rapid short bursts of activity characteristic of children's activity, it is unlikely the heart rate monitoring can provide a comprehensive picture of the temporal pattern of activity typical of children (Rowlands & Eston, 2007).

***Pedometer***

The modern electronic pedometer is a small unobtrusive device worn at the hip and is usually belt-mounted. The internal mechanism of a pedometer typically includes a horizontal, spring suspended lever arm that moves up and down with normal walking and running. With each stride, an electrical circuit open and closes and one event is recorded. The accumulated step count is displayed digitally on a feedback screen (Tudor-Locke, 2002). The pedometer display is readily accessible and easily interpreted by the wearer and this may be motivational or awareness-raising when physical activity goals are either assigned or self-selected (Tudor-Locke, 2002). A limitation of all but the most sophisticated of pedometers is their failure to reveal the pattern of activity in terms of frequency, duration, and intensity (Bassett, 2000; Tudor-Locke, 2002). Moreover, many non-ambulatory activities such as swimming, cycling, and stationary tasks are not captured, or accurately captured, by pedometers.

Research studies have provided good evidence for the reliability and validity of electronic pedometers for; measuring steps taken (Bassett et al., 1996; Crouter, Schneider, Karabalut, & Bassett, 2003; Le Masurier, Lee, & Tudor-Locke, 2004; Schneider, Crouter, & Bassett, 2004), quantification of distance walked, (Bassett, 2000; Bassett, et al., 1996; Beets, Patton, & Edwards, 2005; Tudor-Locke, 2002), assessment of total daily activity (Sequeira, Rickenbach, Wietlisbach, Tullen, & Schutz, 1995), and estimation of activity intensity and duration (Eston, et al., 1998; Rowlands & Eston, 2005; Tudor-Locke, Sisson, Collova, Lee, & Swan, 2005). However, Tudor-Locke (2002) has recommended that steps taken, or steps/day be universally adopted as a standard unit of measurement for collecting, reporting, and interpreting pedometer data.

When used with children specifically, Kilanowski, Consalvi and Epstein (1999) found that the pedometer (Yamax Digi-Walker SW200) correlates highly with both direct observation ($r = 0.95$, $p < 0.001$) and accelerometry ($r = 0.99$ $p < 0.001$) for the measurement of recreational and classroom play. Moreover, Yamax Digi-Walker SW200 pedometers have demonstrated good validity (Ramirez-Marrero, Smith, Kirby, Leenders, & Sherman, 2002) during treadmill walking with boys and girls (mean age 8.8 years), and during self-paced walking on a track and treadmill walking with boys and girls (5-11 years) (Beets, et al., 2005). In their study, Beets Patton and Edwards (2005) found high agreement (intra class correlation coefficient (ICC) of 0.98 - 0.99) for observed steps with treadmill walking at speeds greater 67 metres/sec but agreement declined at slow speeds. This was due to insufficient force (i.e. $\leq$ 0.35 g) to trigger the internal lever arm and thereby record a hip displacement or step taken (Le Masurier & Tudor-Locke, 2003). However, such slow speeds of walking are considered much slower than typical normal walking and therefore should not be an important source of error in studies of free-living activity in ambulatory populations (Le Masurier & Tudor-

Locke, 2003). Eston, Rowlands and Ingledew (1998) found the Yamax Digi-Walker SW200 pedometer to be valid for predicting the energy cost of children's activities.

A wide variety of commercial pedometers are now available and these possess different shapes, size, cost, accuracy and quality (Tudor-Locke, McClain, Hart, Sisson, & Washington, 2009). Brand-to-brand comparisons have been conducted in adults (Le Masurier, et al., 2004; Schneider, et al., 2004) and these have consistently shown the Yamax pedometer (Yamax Corporation, Tokyo, Japan) to be reliable and accurate (Tudor-Locke, et al., 2009). Yamax pedometers are now considered to be the criterion of pedometers (Schneider, et al., 2004) and have been used most frequently in research studies (Tudor-Locke, et al., 2009).

***Accelerometer***

Accelerometers are small devices, (e.g. ActiGraph GT3X model accelerometer is 3.8cm x 3.7cm x 1.8cm and weighs 27 grams) that detect acceleration in one (i.e. uni-axial) or three (tri-axial) planes depending upon the particular model chosen. Accelerometers continuously measure and record body accelerations ranging in magnitude from approximately 0.05 to 2.5 G's and these are summed at user-specified intervals (e.g., 1 second, 5 seconds, 15 seconds, 30 seconds, 1 minute) and then stored in a microcomputer memory. The collection of accelerometer data can continue for extended periods and can be downloaded for analysis. The activity count value can then be entered into a prediction equation to estimate physical activity intensity (i.e. sedentary, light, moderate, vigorous) (Loprinzi & Cardinal, 2011). Accelerometer count data provides information regarding the pattern of ambulatory activity in terms of its intensity and temporal information in regards the time of day that activity occurred (Dishman, Washburn, & Heath, 2007).

Numerous studies have validated different accelerometers for use in children. Sirard and Pate (2001) reviewed seventeen studies that investigated the validity of accelerometry in children and found that associations ranged from r = 0.16 to 0.87 with direct observation and r = 0.37 to 0.94 for indirect calorimetry. Loprinzi and Cardinal (2011) believe the large variation reflects the type of activity monitored and large variations in the ages of children but conclude that accelerometry shows a strong positive correlation with the criterion measure of indirect calorimetry (i.e. typically greater than 0.7).

Fewer studies have examined the reliability of accelerometers with children (Loprinzi & Cardinal, 2011). Sallis et al. (1990) used the Caltrac accelerometer and demonstrated a high correlation ($r > 0.86$) between accelerometers placed on the right and left hips. Whereas Fairweather and colleagues (1999) showed a statistically significant, but not physiologically important, difference between Computer Science and Applications (CSA) accelerometer outputs from the left and right hips (i.e. 32 counts per minute difference). During treadmill trials, test–retest reliability (7 - 13 days) for the Mini-logger accelerometer ranged from 0.61 to 0.84, and that for the Caltrac accelerometer from 0.76 to 0.80 (Troutman, Allor, Hartmann, & Pivarnik, 1999).

Accelerometers are a good objective instrument for the measurement of the pattern and intensity of physical activity in free-living studies. However, a deficiency of waist worn accelerometers is their failure to detect the metabolic cost associated with standing, cycling, upper body movements, static work and vertical lift respectively (Brage et al, 2004). Moreover, accelerometers are relatively expensive and this may prohibit their use in small budget feasibility studies and large-scale epidemiological and surveillance studies (Trost, 2001).

***Actiheart Accelerometer***

It has been suggested by several authors (Brage et al., 2004; Freedson & Miller, 2000; Strath, Bassett, Thompson, & Swartz, 2002) that combining both heart rate monitor and accelerometer data provides a better estimate of physical activity and associated energy expenditure than either method alone. Initial research into the viability of this approach used separate instrumentation for heart rate monitoring and movement accumulation (Haskell, Yee, Evans, & Irby, 1993). However, the relatively recent development of the Actiheart accelerometer, a small (10 grams) heart rate recorder with an integrated omnidirectional accelerometer, has provided a more convenient, user-friendly physical activity assessment instrument.

Research has shown the Actiheart accelerometer to be accurate, valid and reliable in both child and adult populations (Brage, Brage, Franks, Ekelund, & Wareham, 2005; Corder et al., 2007; Corder, Brage, Wareham, & Ekelund, 2005). Brage et al. (2005) found the Actiheart to be technically reliable and valid in a laboratory study. They used twenty adults and measured their response for walking and running at pre-determined speeds on a treadmill whilst wearing an Actiheart and a portable indirect calorimetry system (K4b2, Cosmed, Rome, Italy). Brage et al. found that the integrated heart rate and accelerometer data of the Actiheart more precisely correlated with physical activity intensity (indirect calorimetry measured) than accelerometry or heart rate alone, and that this exceeded levels reported with other activity monitors.

Corder and colleagues (Corder, et al., 2007; Corder, et al., 2005) have reported two studies that have examined the use of the Actiheart with children. Corder et al. (2005), demonstrated that the Actiheart accelerometer to be accurate for the prediction of children's energy expenditure during treadmill walking and running.  Their study used 39 children, (13.2 $\pm$ 0.3 years) and compared Actiheart outputs, i.e. (i) heart rate, (ii) movement, and (iii) heart rate and movement outputs combined, with hip and ankle-mounted Actigraphs (Model 7164, Manufacturing Technologies Inc. Health Systems, Shalimar, FL), and a hip-mounted Actical

(Mini Mitter Co., Inc., Bend, OR) accelerometers. The children were required to wear monitors and indirect calorimeter concurrently whilst completing a progressive treadmill protocol. Backward stepwise linear regression was used to predict energy expenditure from the activity monitor output and this was compared against the criterion measure of indirect calorimetry. The combined Actiheart (heart rate and movement) model explained 86% of the variance in energy expenditure. This was superior to both the hip mounted Actical and Actigraph accelerometers that explained 67% and 50% of the variance respectively.

Corder et al. (2007) conducted a study designed to compare the accuracy of accelerometer and Actiheart based energy expenditure prediction models of children's free-living activity. They had 145 participants (mean age 12.4 years) wear an Actiheart, an Actigraph (Model 7164 LLC, Fort Walton Beach, FL) accelerometer and a portable indirect calorimeter (Cosmed K4b2; Cosmed, Rome, Italy) concurrently. Participants were given approximately five minutes to become familiar with the apparatus and were then asked to perform lying, sitting, slow and brisk walking, running and hop-scotch for five minutes. All activities were self-paced in order to best replicate children's free-living activity. The average of data between minutes 3.5 and 4.5 of each activity was used for analysis. Physical activity energy expenditure predicted from each model was compared against the criterion or measured value calculated from indirect calorimetry. Corder et al. found that both Actigraph and Actiheart provided valid predictions of overall physical activity energy expenditure. However, prediction models that used combined heart rate and accelerometry were more accurate and widely applicable than those based on accelerometry alone.

Actiheart accelerometers are expensive (approx $1000/unit) and this may prohibit their use in all but small-scale studies. Notwithstanding their expense, Rowlands and Eston (2007) suggest that they could be a valid criterion measure of physical activity for use in the field.

The use of pedometers, accelerometers and Actihearts for the assessment of physical activity requires that a monitoring frame be determined.  Trost et al. (2000) determined that four to five days of monitoring by uniaxial accelerometer was necessary in young children to achieve an intra-class correlation (ICC) reliability level of 0.80. Corder et al. (2008) suggest that an optimal balance between feasibility and validity for children requires a minimum of a four day monitoring frame for the Actiheart essentially mirroring the accelerometer recommendations of Trost and colleagues (2000).

After reviewing the various forms of physical activity measurement, the focus of the literature review now turns to intervention strategies used to increase the physical activity levels of children.

**Physical Activity Interventions**

Based upon the relationship between optimal physical activity and enhanced physical and psychosocial health, numerous health and allied government agencies within Australia and internationally (Australian National Obesity Taskforce, 2003; NSW Health, 2002; Queensland Health, 2002, 2005; The White House Task Force on Childhood Obesity, 2010; US Department of Health and Human Services, 2008; WHO Regional Office for Europe, 2007) advocate the need to promote childhood physical activity. Numerous interventions that target individuals, families, organizations, communities or the physical environment (see van Sluijs, et al., 2011), through strategies such as information provision, behaviour skills development, creating favourable social environments or policy changes have been proposed and trialed as means of increasing childhood physical activity (Kahn, et al., 2002). Whilst it is beyond the scope of this review to examine the efficacy of all these approaches, several reviews of intervention effectiveness have found that most have been conducted in the school setting, and that there is some good evidence that school-based physical activity interventions are effective in promoting physical activity and fitness in children. For example, Salmon and colleagues (2007), identified 76 interventions to increase children and adolescent physical activity across all settings, with 57 of these delivered within the school setting. Similarly, van Sluijs and colleagues (2007) identified a total of 57 interventions with 27 implemented within the school setting only and a further twenty involving a combination of school and family or community. The appeal of the school setting for physical activity promotion lies in its potential to; (i) access virtually all school aged children, (ii) be both prevention and treatment orientated, and (iii) avoid the negative labeling of children (Davidson, 2007; M Dobbins, DeCorby, Robeson, Husson, & Tirilis, 2009; Reilly, 2006; Reilly & McDowell, 2003; Steinbeck, 2001).

School-based interventions to increase childhood physical activity have taken a variety of approaches. For example, studies have investigated redesigning playground facilities (Bundy, et al., 2011; Ridgers, Stratton, Fairclough, & Twisk, 2007), improving access to portable play equipment (Verstraete, Cardon, De Clercq, & De Bourdeaudhuil, 2006), enhancing playground markings (Stratton & Mullan, 2005), and incorporating active video game play (M. Duncan & Staples, 2010) to increase children school day physical activity (Ridgers, Fairclough, & Stratton, 2010). However, the primary concern of this research lies within the domain of curriculum instruction and structured classroom learning at the primary school level. For this reason, the literature review will focus upon primary school level curriculum-orientated interventions based upon the following categories:

- Active Classrooms,
- Enriched Physical Education,
- Health Education Curriculum,
- Combination or Multi-component strategies,
- Health Promoting Schools.

The following section describes the characteristics of each approach and briefly examines the research evidence that supports its use.

***Active Classrooms***

Integrating greater physical activity within classroom lessons has been cited as a strategy to increase children's activity levels (Davidson, 2007; Fox, 2004; Kibbe et al., 2011). This idea, captured in the concept of the 'active classroom' includes the use of: (i) educational kinesiology or 'brain gym' approaches, (ii) kinesthetic learning experiences that cater to the preferred learning style of some students, (iii) activity breaks or 'energizers', and (iv) physical activity sessions purposefully designed to reinforce academic concepts and skills (Davidson, 2007).

Educational kinesiology approaches use movements such a 'cross crawl' to stimulate the brain, whilst kinesthetic learning experiences are designed to cater for individual learning styles (i.e. visual, auditory or kinesthetic) and are based upon Gardner's Theory of Multiple Intelligences (Davidson, 2007). Both educational kinesiology and kinesthetic learning experiences are primarily concerned with improving children's academic outcomes, but there is little evidence of their effectiveness for this purpose (Stahl, 1999) and no evidence that relates to physical activity outcomes specifically. However, the use of physical activity breaks within classroom instructional time to 'energize', or, as reinforcement of academic learning has received considerable attention through research of *TAKE 10!* and similar programs.

*TAKE 10!* was developed by the International Life Sciences Institute Center for Health Promotion and was designed to reduce sedentary behaviour during the primary school day by increasing the structured physical activity in the classroom. The *TAKE 10!* program required that classroom teachers conduct one or more 10-minute physical activity sessions per day in addition to regular Physical Education or recess periods. *TAKE 10!*'s goal was to get students moving, without sacrificing time dedicated to academic learning, whilst reinforcing specific learning objectives in math, reading, language arts, science, social studies, and general health (Kibbe, et al., 2011). As of August 2010, *TAKE 10!* had been disseminated to more than 40,000 primary classrooms in the United States and variations had been introduced to China, Brazil and the United Kingdom (Kibbe, et al., 2011).

Research has shown that children's physical activity increased through participation in *TAKE 10!* Stewart, Dennison, Kohl and Doyle (2004) utilized a convenience sample of one class at year one, three and five levels (n = 71). Children's physical activity was assessed by CSA (Computer Science Applications, Inc., Shalimar, Fla.) accelerometer and pedometer (Walk4Life, Plainfield) for five days, which included eight to nine activity sessions per class. Both measures displayed desirable gains within *TAKE 10!* sessions. In fact, after CSA minute-by-minute counts were entered into the age-specific, child-compatible CSA formula for determining energy intensity, all three grades demonstrated exercise levels in the moderate to vigorous intensity range for the full duration of the sessions. Collation of the pedometer data revealed mean step counts during each *TAKE 10!* session of 743, 946 and 1022 for grades one, three and five respectively. Stewart and colleagues (2004) concluded that; (i) *TAKE 10!* fits within the school system and does not require additional staff or extensive training, (ii) provides an effective means of increasing student physical activity through academically linked activities, and (iii) appeals to multiple learning styles of children.

Physical Activity across the Curriculum [6](PAAC) was another intervention to integrate physical activity within academic classes and mirrored the concept of *TAKE 10!* The goal of PAAC was for children to accumulate 90 minutes of moderate to vigorous physical activity each week within academic lessons (DuBose et al., 2008). PAAC was a three-year, cluster randomized, controlled trial with randomization stratified by school size and rural versus urban location (Donnelly et al., 2009). Twenty-four schools completed the study; fourteen PAAC (n = 814 children) and ten control (n = 713 children). Participants were in grades two and three at baseline and were in grades four and five at the end of the study. To measure the effect of PAAC upon activity levels, a volunteer sub-sample of children (PAAC n = 77, Control n = 90) completed a four day accelerometer assessed physical activity measurement protocol during Spring of each year. Children from PAAC schools had significantly higher accelerometer counts during the school day (> 12%, $p < 0.01$) and on weekends (> 17%, $p < 0.01$) and spent 27 % more time in MVPA (METS ≥ 4) ($p < 0.01$) compared to children in control schools. Whilst the increase in school day physical activity was expected, the increase in weekend activity was interesting and led Donnelly et al. (2009) to speculate that PAAC changed children's attitudes and beliefs so that they realized they could be physically active anywhere and during almost any situation rather than relying upon formal activity opportunities. No post-intervention follow up was conducted to determine if improved physical activity levels of PAAC children were maintained, however, a post- intervention survey of PAAC teachers after nine months revealed high levels of PAAC lesson implementation.

[6] PAAC resources included specially designed lessons, *TAKE 10!* resources and access to additional lessons on the PAAC website. Professional development was provided to classroom teachers in a six-hour training session at the beginning of each school year.

Texas I-CAN! (Initiatives for Children's Activity and Nutrition) used a similar intervention strategy to PAAC to train class teachers to modify their lesson plans to incorporate physical activity during academic time. A novel set of active lessons across subjects for prep to year five was developed. Teachers were provided a single day of training and were exposed to the lessons and associated resources. As part of the training, teachers worked in groups to find lessons that would match their upcoming curricular goals, participated in sample lessons, and problem-solved potential barriers to implementation. The efficacy of Texas I-CAN! to improve physical activity was evaluated across eight schools (4 intervention, 4 control) using grade three children (Bartholomew & Jowers, 2011). Forty-seven teachers (25 I-CAN! intervention, 22 control) participated in the study. Intervention teachers were asked to implement Texas I-CAN! lessons on a minimum of four school days per week. Physical activity was assessed using pedometer counts and these increased by more than 300 steps per day for intervention students, whilst control students step counts declined by a similar amount between baseline and post-intervention (p values not reported). A sub-sample of students (n = 200) wore accelerometers (Actigraph, GT1X) to determine the intensity of physical activity during Texas I-CAN lessons. This revealed that approximately 20% of the Texas I-CAN! lessons was spent in moderate–vigorous physical activity (no p values reported).

Common to *TAKE 10!,* PAAC and Texas I-CAN! is the desire to integrate physical activity within the academic curriculum. A variation of this approach occurs when physical activity is used primarily as an energizer. The concept of an energizer is that a short activity break inserted within an extended period of academic instruction may increase children's concentration, mental cognition, and academic performance and reduce fidgeting and other self-stimulatory behaviours (Mahar et al., 2006). The effect of a daily ten minute energizer upon children's physical activity was examined for kindergarten through to grade four students in one school (Mahar, et al., 2006). Classes were randomly assigned to intervention (nine classes, 135 students) and control classes (six classes, 108 students). Prior to implementing energizers all teachers attended a 45-minute training session where they participated in several activities, were taught how to lead students through energizers, and received an energizers resource booklet. Children's in-school physical activity was measured by pedometer (Yamax, Digi-Walker SW 200 Japan) for a school week. Each child had a pedometer appropriately attached at the commencement of the school day and this was removed prior to departure. To measure steps taken during an energizer session, pedometer readings were recorded immediately before a session commenced and recorded again at the cessation of the session. Across all year levels, the intervention classes averaged approximately 782 more daily in-school steps than the control classes. The mean step counts for each grade level during energizer activities ranged from 438 to 595 steps, and the contribution of energizers to daily in-school steps was similar and ranged between 8 -10% for all grade levels. Based upon these results, Mahar et al. (2006) concluded that classroom based physical activity programs are a promising way to increase children`s activity levels without sacrificing academic performance.

Erwin et al. (2011) reported similar intervention effects to Mahar and colleagues (2006) when classroom teachers were encouraged to include at least one ten minute activity break within year three to five classes (n = 106 children, mean age 10.07, SD = 0.93). Using a quasi-experimental research approach (intervention - 9 classes, control - 6 classes), Erwin and colleagues (2011) evaluated the effect of ten minute activity breaks upon children's in-school, pedometer-assessed (Walk4Life, LS 2500, Plainfield, IL) physical activity. A four consecutive school day monitoring frame was used at baseline, post-intervention and at three month post-intervention. Erwin et al. (2011) found that for classes where teachers complied with the 'at least one ten minute activity break' inclusion criteria (n = 5) that children averaged approximately 1,100 more in-school steps per day during winter monitoring and this increased to 1,350 during spring monitoring compared to the control group ($p < 0.01$). However, some teachers reported performing multiple activity breaks per day so the fidelity of the intervention was unclear.

The research evidence indicates that incorporating physical activity within the classroom, as part of physical activity integration (e.g. *TAKE 10*!) or as an energizer, may increase children's in-school physical activity. However, few studies have sought to increase out-of-school activity or have assessed the impact of the intervention beyond the school day. Pangrazi, Beighle, Vehige and Vack (2003) sought to address this by targeting out-of-school physical activity through the Promoting Lifestyle Activity in Youth (PLAY)[7] intervention. PLAY was designed to promote attitudes and behaviours necessary to participate in a lifetime of physical activity and involved self-monitoring by students to develop an awareness of the amount of activity they performed. Pangrazi and colleagues evaluated PLAY over 12-weeks and sought to encourage year four children to accumulate between thirty and sixty minutes of

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[7]PLAY was facilitated by classroom teachers and provided children with 15 minutes of daily physical activity and was implemented in three steps.

Step I: Promote Play Behaviour. (Week 1). Teachers discussed the importance of physical activity and PLAY procedures with the class. Students and teachers participated in 15 minutes of activity each school day. The teacher's role was to prompt students to move. Walking was the minimum level of activity expected. Children chose a pace that was comfortable for them. "Pushing" children to a more rigorous pace was neither required nor expected.

Step 2: Introduce Teacher-Directed Activities. (Weeks 2 - 4). Students and teacher continued to participate in 15 minutes of daily activity. However, in this step, the teacher introduced a variety of games and activities. All teachers taught the same games on the same days. Teachers taught 15 enjoyable games and activities that could be played outside of school with minimal equipment.

Step 3: Encourage Self-Directed Activity. (Weeks 5 - 12). Teachers encouraged students to become self-directed in achieving 30 minutes or more of daily physical activity independent of the teacher. Students recorded their activity on their PLAY log sheet. Participants were encouraged to spend at least 30 minutes a day (outside of school) in activity, be active at least five days per week, and record their daily activity. At the beginning of each school day, students were asked by the classroom teacher to record their previous day's activities. This step sought to teach children to assume responsibility for developing regular physical activity habits.

moderate to vigorous physical activity daily. A treatment – control research design with a stratified sample of 35 schools (n = 606 children, mean age 9.8 yrs) was used. Except for the control group which was selected (n = 6), the remaining schools were randomly assigned to three treatment conditions; i.e. PLAY and Physical Education (n = 10), PLAY only (n = 10) or Physical Education only (n = 9). The effect of the three conditions upon children's physical activity was measured by pedometer (Yamax, MLS2000, Tokyo, Japan) over four school days at the cessation of the intervention. Pangrazi et al. (2003) found that the PLAY only condition exceeded control students mean daily step counts by 1,418 at the cessation of the intervention ($p < 0.05$). Differences between PLAY only condition and the other treatment conditions were not significant. Since post-intervention measurement occurred when the fifteen minute PLAY sessions had ceased, the improvements observed were attributed primarily to changes in out-of-school rather than in-school physical activity. Unfortunately, Pangrazi et al. (2003) failed to conduct baseline measurements so the differences at post-intervention may also have been due to real differences between groups at baseline.

In summary, the research evidence demonstrates the effectiveness of 'Active Classroom' approaches to increase physical activity levels. However, the limited time available in the school day and the generally short duration of the activities may limit the overall contribution that the approach may make to overall improving children's physical activity levels.

***Enriched Physical Education***

For descriptive purposes within the literature review, school based interventions that seek primarily to improve Physical Education curriculum and pedagogy, or the number of structured Physical Education opportunities are collectively referred to as enriched Physical Education approaches.

The World Health Organization has identified Physical Education as the main vehicle of delivery of physical activity in schools (Davidson, 2007) and the US Department of Health and Human Services (2000) has set the aspirational goal that 50% of Physical Education class time be spent in MVPA. Whilst improving the time in MVPA within structured physical education lessons is desirable, the educative purpose of Physical Education may actually act as a constraint to achieve this goal. Time spent providing instruction, modeling movement skills, providing corrective feedback and organizing skills drills and games may limit the MVPA movement opportunities (Davidson, 2007).

Research suggests that the time spent in MVPA within many Physical Education lessons may be low (Fairclough & Stratton, 2006; Nettlefold et al., 2011; Simons-Morton, Parcel, Baranowski, Forthofer, & O'Hara, 1991; van Beurden et al., 2003) and fail to meet recommended guidelines (US Department of Health and Human Services, 2000). For example, an evaluation of the *Go for Health* intervention (Simons-Morton, et al., 1991) found that mean MVPA for third and fourth grade Physical Education (n = 4) classes was less than three minutes (i.e. less than 10% of class time). In other studies levels of approximately 30% of class time spent in MVPA have been more common (T. McKenzie, Feldman, Woods, & Romero, 1995). Notwithstanding the constraints that may limit MVPA in structured Physical Education, Jago et al. (2009) have demonstrated that achieving approximately 70% of class time in MVPA is possible within well resourced Physical Education delivered by skilled specialist teachers. Therefore, improving the quality and/or quantity of Physical Education experiences has the capacity to benefit children's daily physical activity.

Over the past fifty years, the outcome measures for enriched Physical Education interventions have changed. Historically, the enriched Physical Education approach sought to improve children's cardiovascular endurance by engaging children in aerobic activities that satisfied minimum ‘fitness’ criteria. The primary aim of such programs was to engage children in vigorous activities for extended periods. Examples of this type of curriculum intervention include the Vanves experiments in France circa 1950 (McDonald, 1961; J. McKenzie, 1980), the Trois Rivieres study in Quebec circa 1975 (Shephard, 1988), the South Australian Daily Physical Education circa early 1980s (Coonan, 1984), and the Queensland Daily 15/30 Physical Education circa mid 1980s programs (Walmsley, 1999). Uniformly, these interventions engaged students daily in a minimum of thirty minutes of moderate to vigorous physical activity during scheduled class time and produced positive health outcomes, including gains in endurance fitness. No deleterious effects upon academic performance were observed despite the reduced academic curriculum class time (Coonan, 1984; J. McKenzie, 1980; Walmsley, 1999). Notwithstanding the considerable evidence for the effectiveness of all of these programs, none has maintained widespread dissemination into the 1990s and beyond (Walmsley, 1999).

A more recent variant of the fitness-oriented intervention was the Sports, Play, and Active Recreation for Kids (SPARK)[8] initiative. SPARK sought to promote high levels of physical activity and teach movement skills within three 30-minute SPARK lessons each week.

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[8] SPARK Intervention Components. - Physical education lessons were designed to promote high levels of physical activity, teach movement skills, and be enjoyable. Recommended frequency of physical education classes was 3 days a week. A typical SPARK lesson lasted 30 minutes and had two parts: health-fitness activities (15 minutes) and skill-fitness activities (15 minutes). Health-related activity units included aerobic dance, aerobic games, walking/jogging, and jump rope. Progression was developed by modifying the intensity, duration, and complexity of the activities. Nine sport units that developed skill-related fitness included basketball and soccer. These sports and games had the potential for promoting cardiovascular fitness and generalizing to the child's community (e.g., Frisbee games). Low-activity games, such as softball, were modified to make them more active. A self-management program taught behaviour-change skills to help children generalize regular physical activity outside of school. Self-management was taught in weekly 30-minute classroom sessions, and skills included self-monitoring, goal setting, stimulus control, self-reinforcement, self-instruction, and problem solving. The sessions were guided by scripted fourth- and fifth-grade curricula. Each session included a review of the previous week's goals, introduction of a new skill or topic, and goal setting for the next week. Homework and monthly newsletters were intended to stimulate parent--child interaction and support for physical activity.

(Sallis, McKenzie, Alcaraz, Kolody, & Faucette, 1997). Through participation in SPARK, it was anticipated that children's physical activity would improve and this would lead to increased physical fitness and more MVPA outside-of-school. Using a quasi-experimental research design, the effect of SPARK was evaluated over two years with fourth and fifth grade students (Sallis, et al., 1997). Seven schools were assigned to three conditions; i.e. SPARK taught by physical education specialist (condition 1, n = 2 schools, n = 32 classes), SPARK taught by a trained classroom teacher (condition 2, n = 2 schools, n = 33 classes), and the control condition of standard physical education taught by a regular classroom teacher (condition 3, n = 3 schools, n= 33 classes). Outcome measures were: (i) MVPA within physical education lessons (SOFIT observational assessment instrument), (ii) physical activity outside-of-school (accelerometer and 1-day recall questionnaire assessed), and (iii) health related fitness scores (assessed by modified FITNESS GRAM). Results revealed that specialist-led (condition 1) and trained classroom teacher (condition 2) students participated in more MVPA than the control group (condition 3) with mean minutes per week values of 40.2, 32.7 and 17.8 respectively ($p < 0.01$). In part, these results were attributable to the differences in the mean number of minutes of Physical Education delivered each week; i.e. 79.1 (condition 1), 64.5 (condition 2) and 38 (condition 3) ($p < 0.01$). The increased physical activity for both SPARK conditions generally failed to lead to improvement in health related fitness measures although girls in the specialist-led group (condition 1) improved significantly for mile-run time and one minute sit up score. No increase in out-of-school activity was observed for any of the three conditions. Sallis et al. (1997) concluded that improved physical education curriculum, combined with well-designed training for physical education specialists and classroom teachers (conditions 1 and 2) substantially increased the amount of physical activity children received in school.

Since the dissemination of revised Lifetime Activity Guidelines for adults and children by the American College of Sports Medicine and the US Department of Health and Human Services in the mid 1990s, fitness oriented interventions are less common (American College of Sports Medicine, 2000). Where enriched Physical Education programs now exist, the outcome variables of greatest interest are likely to be physical activity and health benefits, rather than fitness or performance measures. The recent implementation of the Queensland Government's Smart Moves (Queensland Government, 2007) policy is an example of such an approach. Smart Moves requires that all state primary schools provide their students with the opportunity to engage in at least thirty minutes of daily, moderate intensity physical activity during curriculum time (Queensland Government, 2007). To date, no research into the efficacy of the Smart Moves program to improve children's physical activity has been performed, nor has a process evaluation confirmed its implementation as outlined within policy documents.

In summary, the research literature supports the use of a variety of enriched Physical Education approaches to increase children's physical activity within structured learning experiences and as part of school day activity. However, evidence for Physical Education increasing 'out-of-school' physical activity is lacking. Given that Physical Education constitutes less than one per cent of a child's waking time it is unlikely that Physical Education alone will be sufficient to meet children's activity guidelines (Davidson, 2007).

### ***Health Education Curriculum***

Health promotion within the primary school setting has often relied upon the Health Education curriculum to provide children with the knowledge, attitudes, values, and behavioural skills conducive to good health (Walmsley, 1999). Higher quality Health Education curricula are designed to produce behaviour change through personal and behavioural factors that provide students with the knowledge and skills they need for rational decision making (Kahn, et al., 2002; Task Force on Community Preventive Services, 2002). Issues addressed within the typical school Health Education program include drug and alcohol use, tobacco, healthy eating, obesity, mental health, communicable and non-communicable diseases (Stewart-Brown, 2006).

Reflecting broader societal concerns with the childhood obesity epidemic, physical activity promotion has become more prominent within school Health Education curricula in recent times. Often this is as part of nutrition and physical activity units designed to enhance weight control and management by increasing overall physical activity levels and improving nutritional practices. The 'Know your Body'[9] curriculum is an example of such a program (A. Marcus, Wheeler, Cullen, & Crane, 1987). Research by Marcus et al. (1987) into the effectiveness of the program among low socio-economic status children aged nine to eleven in Los Angeles, revealed an increase in physical activity measured post intervention for children who received curriculum instruction and health screening. However, a replication study by Bush et al. (1989) failed to show an increase in physical activity. Research (Harrison, Burns, McGuinness, Heslin, & Murphy, 2006) into the efficacy of similar approaches such as 'Switch Off – Get Active', a ten-lesson controlled health education intervention that emphasized self-monitoring, budgeting of time and selective viewing of television, demonstrated significant improvements in self-reported physical activity and self-efficacy for physical activity. Neither of the reported studies examined the durability of the intervention effects through follow-up assessments.

[9] 'Know your Body' curriculum designed to provide children with the skills needed to adopt behaviours that reduce the risk of developing cardiovascular disease. These classes focused on nutrition, physical fitness and preventing cigarette smoking.

Several systematic reviews that have examined the effectiveness of school Health Education to increase children's physical activity have generally found either mixed or no effects (Kahn, et al., 2002; Naylor & McKay, 2009). Accordingly, the US Task Force on Community Preventive Services (2002) has not recommended classroom-based health education focused on information provision due to insufficient evidence.

***Multi-Component Physical Activity Promotion Strategies***

Multi-component physical activity promotion strategies seek to incorporate either a wider range of curriculum disciplines, or additional strategies to enhance the effectiveness of Health Education curricula. Many multi-component strategies combine dietary and physical activity improvement objectives (see Davis et al., 2003; Going et al., 2003; Gortmaker, Cheung, et al., 1999; Gortmaker, Peterson, et al., 1999). *Planet Health* (Gortmaker, Peterson, et al., 1999)[10] and *Eat Well and Keep Moving* (Gortmaker, Cheung, et al., 1999)[11] were two multi-component curriculum interventions that shared the common features of using interdisciplinary approaches with learning experiences integrated into Language Arts, Mathematics, Science, and Social Studies. Both interventions sought to decrease television viewing and consumption of high-fat foods and increase physical activity and fruit and

[10] Planet Health utilized an interdisciplinary curriculum approach, with intervention material incorporated into major subject areas (language arts, math, science, social studies and PE), using grade- and subject-appropriate skills and competencies. The intervention focused on 4 behavioural outcomes: reducing television viewing to less than 2 hours per day; increasing moderate and vigorous physical activity; decreasing consumption of high-fat foods; and increasing consumption of fruits and vegetables to 5 serves a day or more. In classroom lessons, each theme was addressed in 1 lesson per subject (language arts, math, science, and social studies), for a total of 16 core lessons each in year 1 and year 2 (32 total).

[11] The Eat Well and Keep Moving Program was taught by classroom teachers over 2 years in math, science, language arts, and social studies classes. Intervention materials focused on decreasing consumption of foods high in total and saturated fat and increasing fruit and vegetable intake, as well as reducing television viewing and increasing physical activity. Units were implemented during each of 2 school years and consisted of 13 lessons each for grades 4 and 5.

vegetable intake and were conducted over two years. *Planet Health* involved grade six and seven students whereas *Eat Well and Keep Moving* involved grade four and five children. Whilst both interventions were able to demonstrate some favourable outcomes in regards to better nutritional practices and a decrease in television viewing, particularly for females, neither led to significant changes in participants' self-reported physical activity. Given that both *Planet Health* and *Eat Well and Keep Moving* interventions relied primarily upon information dissemination, albeit using an interdisciplinary approach, they may have lacked sufficient intensity as only sixteen *Planet Health* and thirteen *Eat Well and Keep Moving* lessons were conducted within any one school year. Moreover, since the children's physical activity was measured by self report these may have lacked the precision to detect small but significant meaningful changes in physical activity.

A multi-component intervention with greater intensity of lessons was the Cardiovascular Health in Children (CHIC) study. CHIC was an eight week program taught by classroom and physical education teachers which provided an exercise program (3 lessons per week) and lessons focused upon nutrition and smoking (2 lessons per week) and was designed to reduce cardiovascular disease risk factors in children. Harrel et al. (1996) used a randomized, controlled field trial in twelve schools, stratified by geographic region and urban/rural setting with 1,274 third and fourth grade students to test the efficacy of CHIC. Outcome measures included a modified Healthy Heart Knowledge test and self-report physical activity questionnaire. At post-intervention children in the intervention group had greater knowledge of physical activity and an increase in self-reported physical activity compared with children in the control group.

The most comprehensive intervention for increasing physical activity in school children was the American Child and Adolescent Trial for Cardiovascular Health (CATCH)[12] study (NSW Department of Health, 2003a). CATCH sought to improve children's cardiovascular health using a comprehensive multi-component intervention that involved; (i) modified Physical Education (CATCH PE), (ii) food service delivery, (iii) classroom curricula promoting cardiovascular health, and (iv) home/family involvement (Luepker, et al., 1998). The effectiveness of CATCH was investigated through a multicenter, randomized trial of 96 schools (Intervention n = 56, Control n = 40) that were geographically dispersed throughout the United States. CATCH commenced with grade three children (n = 5,106 mean age 8.76 at baseline) and continued for two and a half years.  Physical activity outcome measures were time spent in MVPA during Physical Education lessons (SOFIT assessed) and leisure time physical activity (Self-Administered Physical Activity Checklist). Luepker and colleagues

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[12] The CATCH intervention consisted of school-based (school food service, physical education, curricula) and family-based (home curricula, fun nights) components. School food service changes and physical education enhancement were continuous programs over the 3 school years. The classroom and home curricula were implemented by classroom teachers over a defined time period during each school year, and addressed eating habits (3rd through 5th grades), physical activity (4th and 5th grades), and cigarette smoking (5th grade only).

CATCH PE had the goal to increase the amount of MVPA to 40% of the physical education class. Additional physical activity opportunities were created by providing recommendations for lessons, activities, and equipment and by assisting teachers to improve instructional and management techniques. Intervention components included PE curriculum and materials, professional development (in-service) sessions, and on-site consultations with teachers. The curriculum included the CATCH PE Guidebook, which described the program's philosophy and goals, made recommendations for class structure and management, and provided sample lesson and unit plans. Teachers were provided with a CATCH PE Activity Box, which contained developmentally appropriate activities on index cards organised into instructional units, such as aerobic games, aerobic sports, jump rope, and rhythmic activities. Physical education specialists and teachers had 1 to 1.5 days of CATCH training each school year.

The classroom curricula included the Adventures of Hearty Heart and Friends, Go for Health-4, and Go for Health-5, for the 3rd through 5th grades, respectively. They consisted of 15, 24, and 16 lessons over 5, 12, and 8 weeks in the 3rd, 4th, and 5th grades, respectively. Each lesson was 30 to 40 minutes in length. The curricula targeted specific psychosocial factors and involved skills development focused on eating behaviours and physical activity patterns. (Luepker et al., 1998; T. McKenzie et al., 2003)

(1998) reported that the percentage of physical education class time devoted to moderate to vigorous physical activity significantly increased during CATCH PE compared with the control schools, surpassing the 50% of class time goal. Self-reported leisure time activity indicated that time spent in vigorous physical activity was significantly higher ($p < 0.01$) for CATCH students (58 mins) compared with control schools (46 mins). A five year follow up of CATCH schools revealed that the proportion of time in MVPA during Physical Education was maintained (T. McKenzie, et al., 2003).

Similar improvements in MVPA were obtained from the 'Go for Health'[13] program (Simons-Morton, et al., 1991) that incorporated three components; (i) behaviourally based Health Education curriculum, (ii) fitness orientated Physical Education, and (iii) lower fat and sodium school lunches.  Simons-Morton et al. (1991) evaluated this program using a two year quasi-experimental research study directed at grade three and four students (4 schools: Intervention n = 2, Comparison n =2). Time spent in MVPA during Physical Education lessons was assessed using the Children's Physical Activity Observation Form at baseline, mid-intervention and post-intervention. Mean percentage time spent in MVPA for participants increased from 10% at baseline to 40% at post-intervention. Out-of-school, total daily activity, and post intervention adherence of outcome measures were not reported.

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13  The three Go For Health (GFH) intervention components were the GFH curriculum, Children's Active Physical Education (CAPE), and the New School Lunch (NSL).

GFH classroom Health Education taught knowledge and skills essential to lifelong performance of the target diet and physical activity behaviours and fostered the transfer of learning about these behaviours from school to out-of-school environments.  Six behaviourally based modules were taught.

The NSL was designed to provide lower- fat, lower-sodium lunches within the context of the existing school lunch program. Food purchasing, menus, recipes and food preparation practices were modified.

CAPE was designed to encourage enjoyable MVPA among children during PE classes. Five units were taught. Each unit was 6 to 8 weeks in duration. Each unit included two or three main cardiovascular fitness activities, such as dancing, running, aerobic games, jump rope, and obstacle courses (Simons-Morton, et al., 1991).

The Pathways Obesity Prevention Program (PATHWAYS) was another example of an American multi-component intervention. PATHWAYS was a multi-centred, randomized trial delivered over three years designed to test the effectiveness of school and family-based interventions for the primary prevention of obesity in American Indian students. Four components were utilized within the program including classroom curriculum, food service, physical activity, and family modules (Davis, et al., 2003). The physical activity component utilized a culturally sensitive adaptation of the Sport, Play and Active Recreation for Kids (SPARK) curriculum and a program of exercise breaks[14] created for PATHWAYS for use by classroom teachers. Non-significant improvements in before school, lunchtime, within Physical Education, and after-school physical activity were obtained after the three-year intervention. Whilst three of the four intervention schools displayed desirable changes in physical activity, limitations associated with just one day of accelerometer data collection may have contributed to the failure to obtain significant results (Going, et al., 2003).

On balance the research literature indicates that multi-component strategies may improve in-school physical activity where this is part of the intervention strategy, but the effect upon out-of-school activity is limited possibly due to measurement deficiencies (i.e. self-report measures which are known to lack precision with children) or a failure to measure whole-day physical activity.

***Health Promoting Schools***

An extension of the multi-component intervention strategy is that of the Health Promoting School. The Health Promoting School (HPS) concept seeks to improve children's health and

[14] The program of exercise breaks were designed to be either teacher-or student-led. Colour-coded activities were organised by fitness component in a file-box. Depending on the time available, one to two activities were performed to target a single fitness component (muscle strength and endurance, flexibility, aerobic endurance) or multiple activities could be organised in a circuit format to address multiple components.

learning outcomes through the interrelationship of three important areas: (i) curriculum, teaching and learning practices; (ii) school organization, ethos and environment; and (iii) partnerships and services (Australian Health Promoting Schools Association, c 2000). The underlying premise of the Health Promoting School (HPS) concept is that by linking the curriculum with the school environment and community, a greater range of the factors that affect children's health will have a better chance of being addressed than if explored through classroom curriculum alone (St Leger, 1999). In short, the HPS concept extends upon traditional curricula, notably Health Education, to incorporate a whole-of-school, multi-faceted approach.

The Health Promoting School (HPS) is a popular initiative as evidenced by the participation of forty-three nations in the European Network of Health Promoting Schools in 2006. (Stewart-Brown, 2006). Reviews of literature in the school health promotion field reveal that limited evidence for the efficacy of the HPS approach is available because no studies have adopted all of the components of the approach (Lister-Sharp, Chapman, Stewart-Brown, & Sowden, 1999; Mukoma & Flisher, 2004; Stewart-Brown, 2006). However, several reviews (Lister-Sharp, et al., 1999; Stewart-Brown, 2006) have found that multi-faceted interventions that include either school policy and environment modification, or partnerships with parents and community have stronger and more lasting effects compared with interventions lacking these features.

Indirect evidence for the efficacy of the Health Promoting Schools approach to change health related behavior has been provided by 'school effects' research (West, 2006). 'School effects' research stems from educational rather than health research where the focus has been to explain the variability in pupil learning between schools. This research has examined the extent to which schools' performance in exam results can be explained by the characteristics of pupils in those schools, for example their socio-economic status or family structure, as compared with effects attributable to the school.

West (2006) examined the 'school effects' on health outcomes in the '*West of Scotland 11 to 16 Study'* that allowed the effects of children's own characteristics (e.g. social class or family background) on an outcome (e.g. smoking) to be separated from that of the school or prior experience. In West's longitudinal study, 2,196 children who were first observed at age eleven in primary school (n = 135 schools) were followed as they progressed through secondary school (n = 43 schools). Children were assessed by self-report questionnaire in primary school and again in secondary school when they were aged thirteen and fifteen years. Children's smoking, diet, drinking and illicit drug use behaviours were assessed at all three time-points. Children's ratings of 'school ethos' was obtained by assessing children's perceptions of school characteristics, their attachment to school, engagement with education, and the number of teachers they got on with were collected at age thirteen and fifteen. West's analysis showed an independent 'school effect' on smoking, drinking and illicit drug use at age thirteen and fifteen. When children's ethos indicators were analysed they completely explained 'school effects' on smoking, and partially explained drinking and illicit drug use. West concluded that the positive 'school effects' that were obtained were due to school ethos characteristics that are a core component within the HPS framework. Although West's study did not examine physical activity, the changes in other health related behaviours that were observed indicate that the approach may be useful to positively change physical activity.

Notwithstanding the limited evidence to support the Health Promoting School approach, the expert consensus within the literature (see Lister-Sharp, et al., 1999; St Leger, 1999; Stewart-Brown, 2006; West, 2006) suggests that the approach is a promising framework to address school health promotion.

**Review of Primary School Physical Activity Intervention Strategies**

The literature review has demonstrated that physical activity promotion within the primary school setting may increase physical activity during the school day (Erwin, et al., 2011; T. McKenzie, et al., 2003; Stewart, et al., 2004). Research evidence supports the use of direct strategies such as 'Active Classrooms' and enhanced Physical Education approaches to increase physical activity levels whilst children are immersed in structured learning experiences (Cale & Harris, 2006; Kahn, et al., 2002). However, the potential benefits of such interventions are ultimately limited by the time available to devote to physical activity during the in-school day. For example, in regards to structured Physical Education in particular, only one percent of a child's waking time is taken up by structured Physical Education so it is therefore unlikely to have the significant impact suggested by the World Health Organization and other advocates (Davidson, 2007).

Health Education curriculum interventions that are solely informational in nature have generally failed, or shown mixed effects, to increase children's physical activity levels (Kahn, et al., 2002; Salmon, et al., 2007). However, Health Education curriculum approaches that incorporate behavioural  skill development have displayed a capacity to improve children's physical activity levels (Kahn, et al., 2002). Moreover, when Health Education curricula are complemented with additional strategies as part of multi-component or 'whole of school' approaches, there is a greater likelihood that improved physical activity outcomes will be achieved and that the benefits will be sustained (Cale & Harris, 2006; B. Marcus et al., 2006).

Whilst research indicates that children's in-school physical activity can improve through targeted interventions, the evidence of increased out-of-school physical activity is less convincing (Cale & Harris, 2006; M  Dobbins, et al., 2009; Kriemler et al., 2011; B. Marcus, et al., 2006; Salmon, et al., 2007; Stone, McKenzie, Welk, & Booth, 1998). In part, this is because fewer studies have assessed out-of-school physical activity when evaluating school-based interventions (Kriemler, et al., 2011). Yet, given that the majority of children's physical activity occurs outside-of-the-school day and school programs (Cale & Harris, 2006), the efficacy of these interventions to increase out-of-school physical activity requires greater investigation (Stone, et al., 1998).

**Sustainability of School-Based Physical Activity Interventions**

Research of most school-based physical activity interventions has generally sought to detect changes in children's behavior immediately post intervention (M  Dobbins, et al., 2009). Where follow-up measurement has occurred to determine the sustainability of intervention outcomes this has usually been short-term; i.e. at 6 months.  Dobbins and colleagues (2009) conducted a systematic review of the effectiveness of school-based interventions in promoting physical activity and fitness in children and adolescents, and found only one intervention that has been investigated for long term effects; i.e. 11 years post-intervention. Therefore, evidence for the sustainability of school-based physical activity is quite limited primarily due to the failure to measure long-term effects in research studies.

The focus of the Literature Review will now turn to the issue of curriculum congestion within the primary school sector. As will be highlighted, this phenomenon has changed the culture and priorities of many Australian primary schools with negative consequences for Physical Education or physical activity promotion (M  Dobbins, et al., 2009).

**Congested Curriculum**

Despite the evidence that curriculum approaches may improve children's in-school physical activity, they may fail to maintain longevity, or, achieve widespread dissemination across schools and school systems (see Walmsley, 1999 for Australian, specifically Queensland, evidence). In part, this may be due to a congested curriculum phenomenon that has occurred as new topics and disciplines have been incrementally added to the traditional curriculum (Lubans, Morgan, & Tudor-Locke, 2009; Meldrum & Peters, 2012; Morgan & Hansen, 2007). The congested curriculum phenomenon was observed in the Queensland primary school context between 1998 and 2008 when the mandated learning program was outlined within eight Years 1-10 Key Learning Areas[15] syllabi. Each Key Learning Area (KLA) syllabus specified Core Learning Outcomes (CLOs) that were arranged in six levels of increasing sophistication and complexity. Taken together, the eight KLAs required that numerous CLOs be addressed. For example, across years four and five, it was expected that children would be provided with multiple opportunities to achieve 100 CLOs. Since 2008, the Queensland Studies Authority has attempted to reduce the cluttered curriculum by writing year three, five, seven and nine Essential Learnings documents that have extracted the 'essential core' of the former Years 1-10 KLA syllabi.

**National Assessment Plan: - Literacy and Numeracy (NAPLAN) and a Narrowing Curriculum**

Concurrent with Queensland's curriculum transition from the Years 1-10 KLA syllabi to Essential Learnings has been the introduction of Australia-wide testing in the form of the National Assessment Plan: - Literacy and Numeracy (NAPLAN) (Australian Curriculum Assessment and Reporting Authority, 2010). This testing regime requires that all Australian school children in years three, five, seven and nine are tested over the same two days nationally. The test results provide information of individual student learning, and aggregated and comparative data of school and state performance in the key areas of literacy and

[15] Since the Hobart Declaration of the Australian Education Council, the agreed curriculum for all Australian States and Territories for the compulsory years of schooling has been structured under eight Key Learning Areas. Although the title of these differ slightly between states and territories, the eight KLAs for Queensland are Math, Science, English, HPE, The Arts, Technology, Languages other than English, and Study of Society and the Environment.

numeracy. School cohort results of the NAPLAN test are published on the My School website (http://www.myschool.edu.au/) and this information is readily available for public scrutiny.

NAPLAN has been labeled a ‘high-stakes’ testing regime as important judgments of student, teacher, school and state achievement are based upon the results (O'Keeffe, 2011). Students’ judgment of their personal learning progress may be made against the national benchmarks, whilst the reputation of teachers, schools and state education systems are made comparative to the collated data that is obtained. Under these circumstances, the desire of school administers for students to perform well may lead classroom teachers to bias their teaching towards literacy and numeracy; i.e. the ‘assessed curriculum’ of NAPLAN (Bartholomew & Jowers, 2011; Filbrun & Fletcher, 2005; Karp, 2004; Molland, c.2003; Morgan & Hansen, 2007). This has led some education critics to complain of a ‘narrowing curriculum’ as non-core academic subjects such as Physical Education are marginalized (Bartholomew & Jowers, 2011; Belardi, 2011; Meldrum & Peters, 2012).

NAPLAN ‘high stakes’ testing has reinforced the historical bias of education authorities, policy makers and school administrators toward academic curriculum at the expense of school-based physical activity (DuBose, et al., 2008; Graham et al., 2002; Jago, et al., 2009; Kahn, et al., 2002; Morgan & Hansen, 2007; Shephard, 1997; WHO Regional Office for Europe, 2007). Some curriculum advisors have encouraged teachers to meet the challenge of the congested curriculum, and now paradoxically a narrowing curriculum, by designing units of work that address educational outcomes across multiple discipline areas. The latter is usually labeled ‘cross-curricular integration’ (Fogarty, 1991). From a physical activity promotion perspective, effective cross-curriculum integration may improve children’s knowledge, attitudes, values and behaviour conducive to physical activity without loss of academic learning time. Moreover, this may occur without increasing the duration or frequency of Physical Education lessons.

The literature review will now examine a range of integrative approaches.

**Integrative Curriculum Approaches**

Cross-curricular integration involves taking the outcomes or learning from one curriculum area and applying to another. An example of this is the use of pedometers to measure steps taken within a Physical Education lesson and using that data within mathematics to calculate class average, median and mode values. Previous research by James et al. (1997), Katz (2001) and Rye et al. (2005) has revealed that pedometers can be used to foster innovative learning about science, mathematics and technology within informal educational settings (Inchley, Cuthbert, & Grimes, 2007). For example, Rye et al. (2005) conducted an exploratory study to investigate teachers' use of pedometers within after-school, community-based science and mathematics enrichment programs for secondary students. Teachers received a weekend professional development course, a copy of a resource text *Pedometer Power* (Pangrazi, Beighle, & Sidman, 2003) and ten pedometers for their extra-curricular clubs. As a condition of taking a set of pedometers, teachers agreed to conduct two activities within their clubs, one of which had to come from *Pedometer Power* whilst the other could be teacher created. Teachers were then required to submit a report of the pedometer activities that they performed within their program. Examples of some the activities undertaken were Frisbee basketball, writing about ways to increase their physical activity levels, investigating kilocalorie expenditure, and experiments to test factors that may affect step-counts and step-count challenges. Rye et al. (2005) concluded that pedometers contributed in meaningful ways to increase Science and Mathematics education and health awareness. Rye et al.'s primary focus was to use pedometers to generate innovative learning experiences, so there was no attempt to determine if physical activity behaviour changed through participation in the enrichment programs.

Two American primary school programs: '*Running and Reading across America'* (Andres, nd) and '*Move across America'* (Simon, nd) illustrate the concept of physical activity curricular integration through a virtual walk. In the *Running and Reading across America* program, children in grades two and three ran or walked laps around a 400-metre track during Physical Education. Each lap was logged and a running total was calculated individually for the student, each class, and the entire school. As a student reached the ten-mile mark they received a foot sticker that was displayed on their photo card in the school lobby, and then given a bead in the shape of a foot to tie onto a shoelace. For each additional ten miles, a student received an additional foot sticker. As a class reached the fifty-mile mark collectively, a large foot was displayed by their class on the wall in the hallway, and for each additional fifty miles, an additional foot was displayed. A large map of the United States was displayed in the school foyer, and as the school logged miles, the miles were graphed on the map. This was an ongoing, year-long venture, which incorporated running and walking, English, Geography, mapping skills, goal setting and Mathematics.

The *Move Across America* program (Action for Healthy Kids, c 2007) targeted children in grades three to five. The children were required to walk or run laps of a 400-metre track during their recess periods. Each time children completed a lap they received a tongue depressor that had a healthy tip to reinforce healthy habits. Students then turned in the tongue depressors and their laps were recorded at the end of their recess break. Each time ten laps were reached students received a plastic shoe token. Class progress was plotted on a map at the end of the week. The program related Physical Education to Mathematics, Geography, Health and positive reinforcement of good behaviours and healthy lifestyles.

Both '*Running and Reading across America'* (Andres, nd) and '*Move across America'* (Simon, nd) used the concept of completing a virtual walk around the country to provide a common theme for linking disciplines. However, neither program has published details of the integrative learning experiences that were developed. Furthermore, neither program has been rigorously evaluated to demonstrate either learning or physical activity outcomes, although both were rated as excellent against Action for Healthy Kids evaluative criteria such as being engaging, interactive, feasible, cost-effective, practical and based upon theory (see Action for Healthy Kids, n.d.).

Although pedometers are not essential to achieve physical activity curriculum integration, several features of the pedometer may contribute to superior engagement during school-based, physical activity interventions. As discussed previously, pedometers provide cumulative, easily understood and readily available visual feedback of personal behaviour in real time. This feedback may increase awareness of personal physical activity levels and this may trigger or hone behavioural choices. In addition to providing feedback, pedometers may also act as an environmental cue or prompt for the wearer to be active (Inchley, et al., 2007). Taken together these features of pedometers are ideally suited to a program that involves self-monitoring, self-selected incremental goal setting and personalized feedback and they have been shown to effective for such programs (Tudor-Locke & Lutes, 2009). However, most studies of pedometer-based programs have been of relatively short duration, and it is unclear to what extent observed changes are sustainable, or whether it is possible to continue to accrue benefits over the long-term (Tudor-Locke & Lutes, 2009). Nonetheless, the finer grained feedback provided by pedometers, (i.e. steps taken versus laps walked) as steps are accumulated along a virtual walk, and the relative ease of obtaining step counts in real life situations, may provide additional opportunities for curricular integration.

### Virtual Walk, Pedometer Use and Curriculum Integration

Oliver, Schofield and McEvoy (2006) were the first to investigate the feasibility of cross-curricular integration of a virtual walk by using a pedometer to measure steps taken. Oliver, Schofield and McEvoy's research extended upon the *Running and Reading across America* and *Move across America* virtual walk concept by designing a four-week unit based on the completion of a competitive between classes virtual walk in New Zealand. To achieve this purpose, a comprehensive, stand-alone primary school unit linking a virtual walk with English, Social Studies, Mathematics, Statistics and Physical Education was developed in collaboration with primary school teachers. The classroom teachers then delivered the unit simultaneously to three year five and six classes involving 78 children. The primary outcome measure for this study was physical activity and this was measured by pedometer (Digi-Walker SW-200, Yamax Corp., Tokyo, Japan) at baseline for three school days and for each school day (i.e. 16 days) throughout the four week intervention. For this study, pedometers were used both as a measurement instrument and intervention tool.

Oliver et al.'s (2006) research revealed non-significant changes in physical activity throughout the intervention period for the entire sample. Subsequently, the sample was grouped into quartiles based upon baseline steps. The top quartile for each gender were removed to reduce ceiling effects within the data analysis. Four sub-groups based on arbitrary cutoffs and existing step-based physical activity recommendations for children, were formed to identify trends in intervention effectiveness, and to highlight the subgroup(s) that benefited most from the intervention. The four groups were formed as follows:

- Group A. - girls and boys with the top quartile of each gender omitted,
- Group B. - girls and boys accumulating less than 15,000 steps daily,

- Group C. - girls and boys accumulating less than 12,000 and 15,000 steps daily respectively (i.e. meeting Tudor-Locke BMI referenced daily step guidelines),
- Group D. - girls and boys accumulating less than 11,000 and 13,000 steps daily respectively (i.e. meeting the President's Council for Physical Fitness and Sports guidelines).

An analysis of the four sub-groups revealed a response pattern whereby the lower the initial level of physical activity, the greater the improvement in mean daily steps throughout the intervention. For each subgroup, statistically significant improvements in step counts from baseline were detected. For group A boys (n = 22), mean daily steps increased from 15,466 to 16,340, a 5.6% increase, however this was not significant (p = 0.1). For group A girls (n = 24), mean daily steps increased from 12,467 to 14,253, a 14% increase (p = 0.04). For group B boys (n = 11), mean daily steps increased from 12,793 to 14,498, a 13% increase (p = 0.04). For group B girls (n = 16), mean daily steps increased from 10,399 to 13,668, a 31% increase (p = 0.01). For group C boys, inclusion criteria were the same as group B (i.e. accumulating less than 15,000 steps daily) so the findings for boys in groups B and C are identical. For group C girls (n = 7), mean daily steps increased from 6,323 to 12,655, a 100% increase (p = 0.01). For group D boys (n = 6), mean daily steps increased from 11,722 to 14,208, a 21% increase, however this was not significant (p = 0.07). For group D girls (n = 6), mean daily steps increased from 5,452 to 12,613, a 131% increase (p = 0.02). These results indicated that for the physically inactive, the intervention had moderate to large positive effect on physical activity (Oliver, Schofield & McEvoy, 2006). Furthermore, the results demonstrated objectively for the first time the effectiveness of a physical activity unit integrated across curriculum areas and the utility of pedometer use in a school setting.

Oliver, Schofield and McEvoy (2006) acknowledged a number of limitations within their study, these included;

- Convenience sampling meant that children were not randomized,
- The student cohort was relatively homogenous,
- There was no comparison group so the amount of physical activity change directly attributable to the resource implementation and/or pedometer provision could not be quantified,
- The study was of a short duration and no follow-up was conducted, and
- Changes in physical activity knowledge, attitudes, and beliefs were not measured.

Oliver and colleagues also questioned the sustainability of the thematic unit beyond four-weeks as this would require significant additional teacher input and planning. Based upon the results and limitations of the research, and evidence that intervention duration may lead to larger and more sustained effects (Stewart-Brown, 2006), some research questions that warrant further investigation include:

- Is it feasible to plan and implement a thematic, curriculum-integrated unit beyond four weeks?
- Would an intervention of longer duration increase physical activity outcomes?
- Would psychosocial correlates of physical activity be improved through a curriculum-integrated physical activity unit?
- Would improvements in physical activity or psychosocial correlates of physical activity be maintained following the cessation of a curriculum-integrated physical activity unit?
- Would additional features incorporated into a curriculum-supported, web-based virtual walk provide greater motivation and interest for students, leading to increased physical activity outcomes? In particular, would access to online goal-setting,

immediate visual feedback of daily step counts, tabulation of mean steps taken over time, and motivational feedback and electronic postcards at milestones along team-orientated virtual walks increase physical activity levels? These are features of the 10,000 Steps - Workplace Challenge and are discussed later within the thesis.

- Would a curriculum-supported, web-based virtual walk increase the amount of time children spend in MVPA and thereby increase the likelihood of achieving the Department of Health and Ageing's guideline for the minimum level of physical activity required to achieve health benefit: i.e. at least 60 minutes of MVPA every day?

The research discussed in Studies One and Two, (i.e. Chapters 3 and 4 of the thesis) sought to answer these questions.

**Theoretical Framework**

Behaviour change theories are models that assist in explaining health related behaviour and associated issues of human motivation, and behaviour adoption and maintenance (S. Oliver & Peersman, 2001). Common to each model is an attempt to describe correlates of health related behaviours ranging from interpersonal, intrapersonal, environmental and social factors. Interpersonal and intrapersonal correlates are addressed in theories such as the Health Belief (Becker, 1974), Transtheoretical (Prochaska & DiClemente, 1984), Theory of Planned Behaviour (Ajzen, 1991) and Social Cognitive Theory (Bandura, 1986) models. All of these models have been used successfully as theoretical frameworks to inform the design of physical activity interventions (B. Marcus, et al., 2006; S. Oliver & Peersman, 2001).

For this thesis, Ajzen's Theory of Planned Behaviour (TPB) is the theoretical model of choice. This is because the TPB is a parsimonious model (McEachan) that has been frequently cited as an influential model for the prediction of human social behaviour (Ajzen, 2011), and has been used to inform intervention strategies in a wide range of health behaviours (Armitage & Conner, 2001; Godin & Kok, 1996; McEachan, Conner, Taylor, & Lawton, 2011). The TPB offers a clear theoretical account of the links between attitudes, intentions and behaviour and informs how these constructs may be operationalized within a behaviour change intervention (Baban & Craciun, 2007).

The TPB posits that actual behaviour is guided by three considerations:

- Behavioural Beliefs. These are beliefs about the likely consequences of the behaviour.
- Normative Beliefs. These are beliefs about the normative expectations of others.
- Control Beliefs. These are beliefs about the presence of factors that may facilitate or hinder the performance of the behaviour (Armitage & Conner, 2001).

In their respective aggregates, behavioural beliefs produce a favourable or unfavourable attitude towards the behaviour (attitudes). Normative beliefs result in an individual's perception of whether people important to the individual think the behaviour should be performed (subjective norm). Control beliefs give rise to perceived behavioural control over factors that may facilitate or hinder the performance of the behaviour (perceived behavioural control). In combination, attitudes towards the behaviour, subjective norms (SN), and perceived behavioural control (PBC), lead to the formation of a behavioural intention. For behaviours that are under high volitional control, intentions correlate highly and predict behaviours. Under circumstances where high volitional control does not exist, PBC exerts an independent effect between behavioural intention and actual behaviour. The inclusion of PBC provides information about perceived constraints upon behaviour and is thought to explain why intentions do not always predict behaviour (Armitage & Conner, 2001). A pictorial depiction of the TPB is provided in Figure 1.

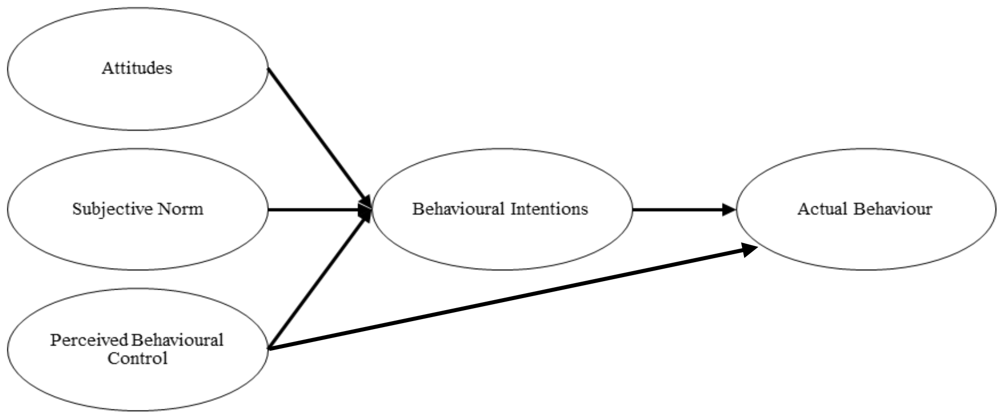


**Figure 1: Pictorial Depiction of the Theory of Planned Behaviour Model**

The efficacy of the TPB model to explain and predict a range of behaviours has been well established. Godin and Kok (1996) conducted a review to verify the efficiency of the theory to predict health-related behaviours and determined that the components of the TPB explained, on average, 41 percent of the variance in intention and 31 percent of the variance in behaviour. A meta-analysis by Armitage and Conner (2001) of 185 independent studies that used the TPB, demonstrated the efficacy of TPB as a predictor of intentions and actions across a broad spectrum of behaviours. Their meta-analysis demonstrated that 27% and 39% of the variance in actual behaviour and behavioural intentions was explained by its psychosocial constructs. Armitage and Conner's (2001) meta-analysis provided average correlation values of TPB (Attitudes, SN and PBC) constructs with behavioural intentions and actual behaviour. Across all behaviours, the average correlation value of behavioural intention with actual behaviour was $r = 0.47$, although this increased to $r = 0.63$ when PBC and behavioural intention were considered together. Using Cohen's (1992) recommendations for a variable's effect size with correlation value, Armitage and Conner showed that each TPB construct has a medium to large effect size upon actual behaviour. More recently, McEachan, Conner, Taylor and Lawton (2011) completed a meta-analysis of 206 published articles and found strong relationships between TPB constructs and prospective health behaviours. Again, using Cohen's (1992) classification of effect sizes, McEachan and colleagues revealed medium to large effect size (mean p = 0.43) for Intention, medium effect size (mean p = 0.31) for Attitude and PBC, and a small-medium effect size (mean p = 0.22) for SN with prospective behaviours. Taken together, the meta-analysis of Armitage and Conner (2001), and McEachan et al. (2011) have demonstrated the capacity of the TPB to predict actual behaviour and inform the design of behavioural interventions premised on improving the four key psychosocial constructs of attitude, SN, PBC, and intention.

With respect to physical activity behaviour, the TPB constructs have been shown to be strong correlates of physical activity behaviour in adults (Bauman, Sallis, Dzewaltowski, & Owen, 2002; McEachan, et al., 2011), whilst other researchers have demonstrated the efficacy of the TPB constructs to account for a small to large proportion of variances in intentions and physical activity behaviours in children (Craig, Goldberg, & Dietz, 1996; J. Martin, Oliver, & McCaughtry, 2007; Mummery, Spence, & Hudec, 2000; Rhodes, Macdonald, & McKay, 2006) and adolescents (McEachan, et al., 2011).

Research indicates that interventions are most likely to predict intention and behavioural change if they are based upon or informed by evidence based theory (Baban & Craciun, 2007). In a review to describe the health change models and theories that underpin effective interventions and the empirical studies that warrant their successful use, Baban and Craciun (2007) determined that interventions were most likely to determine intention and behavioral change if they were based on the Theory Planned Behavior. Interventions to change behaviour can be directed at one or more of the TPB constructs, i.e. attitudes, SN or PBC (Baban & Craciun, 2007). Changes in these factors should produce changes in behaviour intentions, and given adequate control over the behaviour, the new intentions should be performed under appropriate conditions.

To date, the Theory of Planned Behaviour has not been used to inform the design of school-based physical activity interventions. A systematic review (M Dobbins, Husson, DeCorby, & LaRocca, 2013) to summarize the evidence of the effectiveness of school-based interventions in promoting physical activity in children and adolescents revealed that several behaviour change models have been used to develop the physical activity interventions. The most commonly used theories were social cognitive theory and the health-belief model. However, their review failed to ascertain if any particular behaviour change model produced superior outcomes when compared with other models. Despite this, it is recommended that interventions are informed by appropriate theory theoretically sound behavior change models, and that such interventions are associated with positive impact upon children's MVPA levels and the proportion of children who engaged in MVPA during school hours (M Dobbins, et al., 2013). In this regard, the evidence suggests that the TPB is a robust theory to guide behaviour change and may therefore be useful in school based research studies particularly when centred on class room delivered interventions.

**Web-Based Physical Activity Interventions**

A distinctive feature of the proposed intervention for this research is the use of the internet as a delivery mechanism for a virtual walking challenge. Therefore, the review will briefly examine the research that supports the use of web-delivered interventions generally before investigating the evidence for the efficacy of the *10,000 Steps - Workplace Challenge* specifically

The Internet is a relatively new, but increasingly common, tool for the delivery of physical activity interventions (Vandelanotte, Spathonis, Eakin, & Owen, 2007). The advantage of the Internet for physical activity interventions lies in the fact that, (i) large numbers of individuals can be reached at lower costs than with face-to-face interventions, (ii) participants can access large amounts of information, and (iii) they can choose the time when they would like to interact and receive information (Norman et al., 2007). Several reviews on the effectiveness of web-based physical activity interventions have consistently shown small but positive effects on physical activity (Davies, Spence, Vandelanotte, Caperchione, & Mummery, 2012; Van Den Berg, Schoones, & Vlieland, 2007; Vandelanotte, et al., 2007). As with other physical activity interventions, the greatest effects are in short-term physical activity, with a smaller effect being found for longer-term behaviour change (Davies, Spence, et al., 2012).

Increased exposure to web-based interventions has been shown to improve their effectiveness with a clear dose–response relationship between the intensity of the intervention and improvement in physical activity (Davies, Spence, et al., 2012). Until recently, there was limited knowledge about which specific intervention elements were able to maintain website engagement (Davies, Corry, et al., 2012).  Characteristics of an intervention, such as personally tailored feedback, interactive elements, email or phone contact, self monitoring, goal setting, updated content, and the number of intervention contacts were all thought to be among the important factors related to of use of and exposure to interventions (Brouwer et al., 2011; Davies, Corry, et al., 2012).  Recent systematic reviews investigating this issue have found that (i) peer and counsellor support results in a longer website visit, (ii) that email and phone contact and regular updates of the website result in more log-ins (Brouwer, et al., 2011) and (iii) that interactive components and structured educational materials improved engagement and PA outcomes (Davies, Corry, et al., 2012).

The literature review now examines the evidence for the effectiveness of the *10,000 Steps - Workplace Challenge.*

**10,000 Steps – Workplace Challenge**

*10,000 Steps Rockhampton* commenced in 2001 as a collaborative research project[16] and was aimed at providing a sustainable model of physical activity promotion at the community level (10000 Steps Project Office, 2007). The project concurrently trialed several intervention strategies to increase physical activity centred around the core component of using pedometers to monitor daily step counts and thereby motivate participants to achieve a target of 10,000 steps per day and an overall increase in physical activity (Brown, et al., 2003; Brown, et al., 2006). These strategies included:

- Local media campaigns.
- Promotion of physical activity through general practice and other health services.
- Improving social support among disadvantaged groups.
- Policy and environmental change.
- Community micro-grant scheme (Brown, et al., 2006).

Brown et al. (2006) evaluated the 10,000 Steps program over a two-year period between 2001 and 2003. Physical activity was assessed by self-report (computer assisted telephone interview survey) using the Active Australia questionnaire that focused upon time spent walking and in MVPA during the last week. Brown et al.'s evaluation revealed that *10,000 Steps - Rockhampton* had a beneficial effect upon community physical activity levels although the effect failed to achieve statistical significance for the entire population. However, when males and females responses were analyzed separately, women from the intervention community were shown to have a significant improvement in the number of respondents classified as active; - possibly because they were early adopters of the program

[16] 10000 Steps Rockhampton involved collaborative effort between the University of Queensland, CQ-University, the Queensland University of Technology, Sports Medicine Australia and the National Heart Foundation.

(Brown, et al., 2006). Since 2004, *10,000 Steps* has been disseminated widely at the individual, workplace and community level across Queensland and throughout Australia (10000 Steps Project Office, 2007)

Initially, the concept of a *10,000 Steps - Workplace Challenge* was not one of the five promotional strategies for *10.000 Steps Rockhampton*. However, it quickly evolved in response to a desire by employers for their staff to engage in a more active lifestyle. The primary goals of the *10,000 Steps - Workplace Challenge* are to:

- Increase participants' physical activity awareness.
- Increase the overall physical activity levels among staff in the workplace.
- Improve the awareness of the health benefits associated with a more active lifestyle.

The workplace challenge involves the formation of teams within the work site. Individual team members wear a pedometer and accumulate steps as they contribute to their team's progress along a virtual walk. Participants 'log on' to the 10,000 Steps website to enter daily step totals and then view their team's progress. Participants may also view graphs depicting their daily step totals, receive average step count information and receive electronic postcards when their team reaches milestones along the virtual walk. Workplaces may choose from an existing virtual journey or create their own. Participants may focus upon either individual or team goals. For example, an individual may set a goal to achieve mean daily steps of 8,000, or alternatively, a team goal may focus upon completing or virtual walk in a set time, or racing another team to a destination.

The efficacy of the workplace challenge to increase physical activity and the psychosocial correlates of physical activity was examined within a Rockhampton workplace (n = 500 employees). Steele (2004) used a multiple–baseline experimental research design and divided the workplace into three organizational units. Each unit received the *10,000 Steps -*

*Workplace Challenge* as the intervention at different times. Physical activity (International Physical Activity Questionnaire) and psychosocial data was collected on four occasions using self-report questionnaires. Steele (2004) found that ‘walking at work’ failed to increase for all of the organizational units, although all displayed significant improvements in ‘reported minutes of walking for leisure time’ following the intervention. For those organization units where follow-up data was obtained, the improvements were maintained or improved further. Physical activity self efficacy did not display any consistent pattern of change through the intervention, but social support for physical activity displayed significant improvements in all three organizational units across time. These findings demonstrated the efficacy of the Workplace Challenge concept to enhance leisure time physical activity and psychosocial correlates of physical activity. However, Steele’s results should be viewed cautiously as the evaluation was based upon organizational units within the same workplace so the possibility exists that the results may be affected by co-worker awareness of the aims and purpose of the intervention. A process evaluation (Steele, 2004) of the intervention revealed it was well received by participants and that pedometers provided motivation to achieve activity goals.

Additional evidence to support the efficacy of *10,000 Steps - Workplace Challenge* has been published as a series of anecdotal case reports (10000 Steps Project Office, 2007). These case reports lack the rigor typically associated with academic research. However, taken together, the twenty-one case reports provide consistent evidence to support the benefits and effectiveness of the workplace walking challenge concept to improve participant motivation and physical activity.

The suitability of the 10,000 Steps program for school children has been investigated through a pilot study involving three Rockhampton primary schools (Davies, Duncan, et al., 2012). Using six focus groups (one teacher and one student group from each school) Davies and colleagues sought to determine the applicability of the 10,000 Steps program in the primary school environment. Key findings were:

- Respondents displayed a positive response and awareness to the 10,000 Steps program
- Respondents all enjoyed using the 10,000 Steps pedometers to measure their daily steps
- Student liked the concept of the program, recording their steps every day and attempting to improve on their previous days' step count
- Students enjoyed being able to track their steps and visit the different towns during a walking challenge. However the teacher believed that a shorter distance would be of greater benefit to the students as this would allow them to complete the challenge within the school term
- Teachers believed that the program would be more sustainable if integrated into the school curriculum as this may lessen the time burden associated with completing the challenge activities outside of normal curriculum activities.

Minor problems identified with implementing the 10,000 Steps program in the primary school setting included (i) the ability to falsely accumulate steps, (ii) difficulty in remembering to record daily steps, and (iii) students disliked being unable to wear the pedometer out of school hours.  Hall and colleagues concluded that the 10,000 Steps program was applicable in the primary school setting. However, it needed to be tailored to the school environment and incorporate the primary school curriculum to increase sustainability and uptake.

Collectively, Steele's (2004) evaluation study, Oliver et al.'s (2006) efficacy study, Davies et al.'s pilot study (2012), and the previously discussed '*Running and Reading across America'* (Andres, nd) and '*Move across America'* (Simon, nd) programs, suggest that the general approach of the *10,000 Steps - Workplace Challenge* may be useful in the primary school setting.

**Summary**

The literature review has provided evidence to indicate that a curriculum-supported, web-based walking challenge may be an effective intervention strategy within the primary school to increase children's physical activity. Evidence has been presented of the efficacy of many primary school physical activity promotion strategies to increase children's daily activity, but many of these approaches are ultimately limited by the finite time available for teaching and learning within the school day. Given the reality of a cluttered and narrowing curriculum, and the time constraints upon teachers to address many learning outcomes within syllabus documents, physical activity promotion within the primary school setting may be more successful if it complements and integrates within the existing curriculum to optimize children's in-school and out-of-school activity.

To date, there has been limited research into the efficacy of integrated curriculum and class-based walking challenges to improve children's physical activity in the primary school setting.  Moreover, there has been no research to determine if web-supported virtual walks that utilize the features of the *10,000 Steps - Workplace Challenge* increase children's physical activity, or, improve their psychosocial correlates of physical activity. Given the evidence that the *10,000 Steps - Workplace Challenge* improved adults' leisure time physical activity, and some psychosocial correlates of physical activity, the utility of integrating a web-supported virtual walk within classroom learning activities to achieve similar outcomes warrants investigation. Study One, - a feasibility study and Study Two, - an efficacy study, reported in chapters three and four respectively, report the outcomes of such an investigation.

*Chapter Three*

# STUDY ONE: - The Feasibililty of Integrating a Web-Supported Virtual Walk with Queensland's Mandated Syllabi for Middle Primary Schooling.

## Introduction

As discussed within the literature review, for many Australian primary school children their level of physical activity is insufficient to meet either time in moderate to vigorous physical activity (MVPA) guidelines or step count guidelines (Abbott, et al., 2007; Australian Government Department of Health and Ageing, 2008). For these children, insufficient physical activity may lead to adverse health consequences in childhood and contribute to chronic illness in adulthood (Hands, Parker, Glasson, Brickman, et al., 2004). Consequently, numerous government and health promotion agencies have advocated for intervention programs to elevate activity levels. Schools, due to their access to virtually all children between five and seventeen years of age, have traditionally been a critical site for intervention delivery (M Dobbins, et al., 2009). Historically, interventions within the school setting have focused upon improving the quality or quantity of Physical Education, or have used Health Education for information dissemination. However, whilst there is evidence that Physical Education interventions, in particular, may improve physical activity levels there are time constraints within the school curriculum/setting that limit the use of this strategy (Davidson, 2007; Salmon, et al., 2007).

There is considerable evidence that a crowded and / or narrow school curriculum (see Simos, 2007) has caused reductions in the amount of time available for Physical Education and other physical activity programs (Morgan & Hansen, 2007). One strategy to overcome the congested curriculum phenomenon has been to integrate physical activity with other subject areas using activity breaks such as *TAKE 10!* Such programs are effective in increasing children's in-school physical activity, however the approaches are generally limited by the short duration of sessions (i.e. around 10 minutes per session) and their reliance upon teacher direction within academic lessons. An alternative strategy that has received relatively little research attention is that of physical activity curriculum integration focused primarily upon increasing activity beyond the school day (M. Oliver, et al., 2006). This may be particularly applicable to the primary school sector where the classroom teacher[17] may create links between subjects without the need for teacher coordination that typically exists in the secondary school environment.

Oliver, Schofield and McEvoy (2006) trialed this strategy in New Zealand with year five and six children using pedometer assessed physical activity and a virtual walk as an integrating concept. Oliver et al.'s (2006) research demonstrated that effective cross-curricular integration was possible and that children's daily physical activity improved during the intervention, particularly for low-active children. The improvements in children's physical activity were attributable to gains 'beyond the school day' rather than within the school day.

The concept of pedometer assessed physical activity and progress along a virtual walk is also used within the *10,000 Steps – Workplace Challenge.* The challenge concept involves the formation of teams within the workplace. Team members wear a pedometer and accumulate steps as they contribute towards their teams' progress along a virtual walk. Team progress is mapped on the interactive 10,000 Steps website which provides electronic postcards at key milestones, informative health information and personalized graphs of individual

[17] Primary schooling is typically structured with a class of 20-30 children with a classroom teacher primarily responsible for the delivery of most curriculum areas. In secondary schooling children usually have a different teacher for each subject.

performance. Steele (2004) has shown the *10,000 Steps - Workplace Challenge* to be effective at increasing adults' leisure time physical activity.

The combined evidence from Oliver et al. (2006) and Steele (2004) suggests that further research to fully investigate the potential of web-supported, class-based walking challenges to increase children's physical activity is warranted. To investigate this further within the Queensland primary school context it is necessary to establish the feasibility of curriculum integration with the state mandated syllabi. Therefore, the purpose of this study was to establish the feasibility of integrating the *10,000 Steps - Workplace Challenge* concept with the Queensland syllabi for the middle primary years[18]. Accordingly, this chapter reports upon the curriculum linkages that were identified and discusses barriers and constraints to implementation. Given the similarity of the Queensland Key Learning Area (KLA) syllabi with those of the other Australian states and territories, the findings are also applicable to other jurisdictions. Recommendations for schools and teachers contemplating similar programs have been provided.

**Method**

A formative evaluation to examine the feasibility of integrating a web-supported class-based walking program into the middle primary curriculum was conducted. To achieve this purpose, an experienced year five, classroom teacher[19] from a Catholic primary school implemented a class-based walking challenge designed to replicate the core concepts of the

[18] Within the Queensland schooling system, 'middle primary' typically refers to years four and five. As of 2008, syllabus outcomes within the eight KLA Essential Learning documents have been written for the middle primary phase of learning within the year 5 Essential Learnings documents. The documents outline the curriculum that is expected to be covered over the two-year band (year 4 and 5) rather than identify specific outcomes for each year level separately.

[19] The teacher had taught for seven years in either Queensland or British primary schools. The previous three years were at the year 5 level.

*10,000 Steps -Workplace Challenge.* The class-based walking challenge and subsequent identification of cross-curricular linkages occurred during the third school term in 2006.

The participating teacher agreed to identify cross-curricular linkages of a walking challenge delivered at the year five level, to implement where possible, and identify barriers to the delivery of a walking challenge in the primary school setting. The teacher was encouraged to implement the walking challenge in any way that satisfied the learning needs of children, whilst meeting the curricular expectations of the Queensland Key Learning Area syllabi for year four and five. The teacher maintained a diary record of learning experiences conceptualized and delivered, whilst identifying and recording any implementation problems. At the conclusion of the walking challenge, the classroom teacher's knowledge and experience was obtained during a semi-structured, audio-recorded interview. The recordings were transcribed to identify major themes and these were then presented to the teacher to confirm the validity of the results.

Two day-long, face to face meetings were held between the researcher and the classroom teacher in order to conduct this research. The first meeting preceded the delivery of the walking challenge and was devoted to brainstorming curriculum activities, general planning and organization. The second meeting followed the walking challenge and was a data collection, lesson writing, and evaluation session. Telephone contact was maintained between the classroom teacher and researcher throughout the feasibility study to discuss possible learning experiences and students' engagement with the various activities.

Although the primary focus of the research was to identify cross-curricular linkages of the web-supported class-based walking program, indirect feedback was also obtained from parents and students as part of the teacher's ongoing informal evaluation. This occurred periodically as the teacher sought student feedback of the various learning experiences and parents' perception of the impact upon family life.

Ethical approval to undertake the research was granted from the Central Queensland University Human Research Ethics committee. Approval to conduct research within the catholic school was granted by the local Diocese (see Appendix 1 for a copy of the approval request).

**Cross – Curricular Activities**

A nine-week walking challenge within a single school term provided an extended period for the implementation of the curriculum intervention. This allowed sufficient time for the teacher to familiarize students during in-class learning experiences with the use of the pedometers. As part of orientation activities, the correct placement of pedometers was shown to students, as well as how to open and close the pedometer and the effect of hand jiggling etc. This had the benefit of reducing the novelty factor so that children quickly became comfortable wearing the device without the constant temptation to handle and check step counts. Once children had acquired competence to use the pedometers, greater responsibility was provided to children in week two of the intervention as they adopted a routine of wearing the pedometer for all viable activities. This meant that children would remove pedometers during showering and other water-based activities and during contact activities where accidental damage to the pedometer or injury to their body was possible. Table 4 provides an overview and progression sequence of the learning experiences that were conducted over the nine weeks of the walking challenge.

**Table 4: Weekly Summary of Curriculum Activities using Pedometers**

| Week | Activity | KLA/s | Brief Description |
|---|---|---|---|
| 1 | Familiarization activities | Math Language SOSE | • Children used scale on maps to measure distances between Australian locations. Children used these skills to estimate travel time between locations.<br>• Children completed simple activities to familiarize themselves with wearing and operating pedometers, to estimate distances and the number of steps required to reach a destination and to remove the curiosity factor and temptation to shake and interfere with their pedometers.<br>• Children established the length of their own steps.<br>• Introductory activities to complete step logs. |
| 2 | Specific Walking Challenges | Math SOSE Language | • Children engaged in specific class challenges to walk to set destinations.<br>• Challenges changed every few days, distances were extended each time.<br>• Step Logs were changed to simplify recording of data. |
| 3 | Team Challenges | Math Language SOSE | • Students broke into friendship groups, selected a destination that could be a tourist destination.<br>• Researched distance to destination, prepared a short presentation about their destination. |
| 4 | Team Challenges and Games.<br>Overseas challenges. | Math SOSE Language Religious Education ITC. | • Children researched biblical locations. Used atlases and scale to establish distance and steps. Completed as a challenge (e.g. walk from Port Said to Mt. Sinai in Egypt).<br>• In groups, children began to develop simple games that could generate the most activity in the shortest time.<br>• Children began to use Microsoft Excel to develop spreadsheets of their weekly activity. Results were graphed and used to detect patterns in activity and set goals.<br>• Team challenge to walk south over four days, team with the highest average distance would be the winners. |
| 5 | Step Logs<br>Team Games | Math<br>Team skills<br>Science | • Children maintained step logs.<br>• Children presented and played games developed by groups. Maintained a step log throughout the activity to predict and record steps during each short game.<br>• Students hypothesized which characteristics of games would most greatly influence step counts.<br>• Later discussed aspects of games that promoted activity in a short time and compared to predictions. |
| 6 | Step logs<br>Team Games | Math<br>Team skills | • Children maintained step logs.<br>• Children refined games based on discussions to develop new versions that would promote even greater activity in a short time.<br>• Children designed and presented games. |
| 7 - 9 | Team Challenges | Math<br>Technology | • Team captains set up teams on the 10,000 Steps web site.<br>• Children worked in teams to record, collate and enter daily steps into the 10,000 Steps web site. |

## Results

The chapter will now discuss the specific learning experiences derived from the walking challenge. These learning experiences were specifically designed to meet Core Learning Outcomes within Queensland Key Learning Area syllabi for years four and five.

### *Mathematics Key Learning Area*

The use of the walking challenge data was deemed appropriate in addressing the core learning outcomes from the Queensland Years1-10 Mathematics KLA. The concept of averaging numbers was introduced and practiced extensively using step-count data accumulated over days and weeks of the walking challenge. The concept of approximation was also addressed as children would use the pedometers to record step counts over set distances (i.e. 50 metres) and then ascertain average stride length. Children were then required to estimate their step counts for other known and unknown distances.

Average stride length for the class was determined and then total step counts to predetermined destinations were established. As these destinations were relatively close, the progress of the class (combined effort) was mapped. For example, the class completed a virtual walk from the Gold Coast to Brisbane and returned in one day. Multiple digit addition and subtraction was utilized in this task to measure progress toward goal and calculate remaining steps to target. Whilst not undertaken as part of the walking challenge, the mathematics concept of percentage could also be introduced and/or consolidated using the real data from this learning experience. For example, what percentage of the journey has the class completed? The participating classroom teacher reported that students appeared to show an increased proficiency working with and discussing numbers over 10,000; - an outcome above the expectations for middle primary. Line graphs were also used to visually display step counts taken on a weekly basis.

### *Study of Society Environment (SOSE) Key Learning Area*

A number of SOSE outcomes were addressed through the walking challenge. Mapping skills were addressed by having students identify routes and calculate distances (using scales) to self-selected tourist destinations. Map interpretation and the use of compass to orientate maps were included in these activities. Students were then given broad parameters to identify a tourist destination that their team would walk to as part of a virtual journey. The route and length of journey (and associated step counts) were calculated. Teams then monitored and mapped their progress to that destination. Concurrently, with the mapping activity, teams collectively researched the local region to develop a tourist brochure for that destination.

### *English Key Learning Area*

Outcomes for English KLA were addressed as part of the walking challenge by means of two written and oral presentation learning tasks. One written task, a tourist brochure required written text be presented in an appropriate genre for class perusal, and this was accompanied by an oral presentation jointly delivered by all group members. In a similar vein, students were also required to formulate an active game to be taught to their colleagues. In developing the game, teams of students worked cooperatively to formulate rules, write these formally in clear and concise language, and then finally to present the game and rules to their colleagues prior to actual engagement. The task was reported by the participating teacher as being an acceptable means of having students clarify instructions and answer questions from peers.

***Science Key Learning Area***

In small groups, students were required to develop an active game with the explicit purpose of maximizing physical activity and step counts for the entire class (Week 3). Each group presented their game to the class and this was followed by participation in the game that was intended to be five minutes in duration. Prior to the commencement of the game, each participant was required to estimate how many steps he or she would take within the game. Following the game, step counts were recorded and then later cumulated for the class. Six games were presented in total. Game characteristics and cumulative class step counts during the game were then analysed by the class. A number of relationships were identified and scientific hypotheses or inferences were then made. For example, elimination games reduce physical activity, rectangular fields increase step counts more so than similarly sized square fields, and complex rules increase stoppage time and reduce step counts. Based upon these findings, groups were required to re-design their game, trial their new version and then evaluate this to maximize step counts. The primary science concept to be developed was that of testing a hypothesis and then controlling for variables.

***Health and Physical Education Key Learning Area***

Outcomes in all three strands of the Queensland Years 1-10 HPE KLA were found to be successfully addressed using the walking challenge. Health Education[20] (Strand 1) outcomes were addressed throughout the walking challenge. The engagement of the students in the class-

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[20] Study One was conducted in 2006. At that time the mandated curriculum for Queensland middle primary was outlined with Years 1-10 KLA syllabi. Health Education outcomes were stated within Strand 1 of the Years 1-10 Health and Physical Education KLA syllabus. In 2008, the year three, five, seven and nine HPE Essential Learnings documents superceded the Years 1-10 HPE KLA syllabus.

based walking challenge inevitably led to class discussions of physical activity levels and the relationship to health.  The target of 10,000 steps and the significance of this as a threshold or goal level of physical activity for adults also introduced important health concepts.

Physical Education (Strand 2) of the KLA focused upon the development and refinement of motor skills. The walking challenge and the curricular activities associated with the challenge did not seek to enhance directly motor skill development of children.  However, health related fitness components of children appeared to be enhanced through greater participation in physical activity.  Anecdotal feedback from the students indicated that they were conscious of modifying their behaviour in order to increase daily step counts.

Personal Development (Strand 3) outcomes were achieved via group processes in the tourist brochure and active game development tasks.  Both of these tasks required cooperation and effective group processes for successful completion.  Individual goal setting and achievement of goals within the challenge may have improved the self-concept and self-esteem of many students.

***Technology Key Learning Area***

Technology outcomes were addressed through the walking challenge by using spreadsheets and the internet to access and present information. Daily step counts were entered into an excel spreadsheet from which calculate functions were used to obtain weekly total and daily average. The graph function was used to construct bar graphs of their daily step total. These were labeled and the ‘copy and paste’ function used to insert the graph into a Word document. The excel data entry and graphing process was repeated over several weeks and created a visual representation of each child’s weekly pattern of physical activity.

Both students and parents provided ongoing anecdotal feedback throughout the nine weeks of the Walking Challenge activities to the classroom teacher and these were obtained during a semi-structured, audio-recorded interview at the conclusion of the Walking Challenge.

### *Student Feedback Provided to the Teacher*

Students reported that they were excited to wear the pedometers and enthusiastically engaged in the walking challenge. The majority of students reported that they enjoyed the curriculum activities that integrated with the walking challenge, especially the various team challenges in which they engaged. Students indicated that they were strongly motivated to increase their step counts during team challenges. Some students felt the nine weeks of the walking challenge was too long and would have preferred a challenge of shorter duration: - the most commonly suggested period was four weeks.

Because of an unanticipated disruption to the walking challenge, weeks four and five of the walking challenge required students to monitor and record daily step counts without significant curriculum activities utilizing the data. Students consistently indicated that wearing the pedometer and recording data became boring at this time. Students also reported that wearing the pedometer for the full duration of the day was achieved easily with forgetfulness being a minor problem.

### *Parental Feedback Provided to the Teacher*

Feedback from parents revealed that the expectation for children to wear their pedometer for the entire waking-day occurred with little disruption to the normal routine of family life. Parents also thought that younger children could successfully engage with the walking challenge activities although much more support, prompts and reinforcement would be required at younger ages.

## Discussion

This study has demonstrated that it is feasible to integrate physical activity into the middle primary school curriculum using; (i) pedometer assessed physical activity as a source of data for learning experiences and (ii) engagement in virtual walks to link with core learning outcomes. Curriculum linkages with Mathematics, Study of Society and the Environment, Health and Physical Education, Technology, Science, and English were developed. Although not directly measured as a research outcome it appeared that children's physical activity increased through their engagement in some of the learning experience, particularly those that; (i) involved personal goal setting to increase their total step counts, and, (ii) participation in team virtual walks or challenges.

Due to resource and time constraints, it was not feasible for the principal researcher to obtain feedback regarding the walking challenge tasks and implementation difficulties directly from the parents or students involved. This was a limitation of the research design. However, the principal researcher encouraged the classroom teacher to elicit this feedback during the nine weeks of the study. This feedback, albeit filtered through the classroom teacher, was obtained during a semi-structured interview at the conclusion of the walking challenge. This feedback was used to inform the ongoing development of walking challenge activities.

Feedback from the students indicated that they were excited to wear the pedometers and that they enjoyed the curriculum activities that integrated with the walking challenge, especially the various team challenges in which they engaged. This aligns with research by Cirignano, Du and

Morgan (2010) that year four and five students are particularly responsive to wearing pedometers to monitor their activity and demonstrate stronger responses in pedometer interventions compared with older children. Moreover, students consistently indicated that wearing the pedometer and recording data became boring during weeks four and five when they were required to monitor and record daily step counts without significant curriculum activities utilizing the data. It appeared that the excitement, novelty and motivational aspects of wearing a pedometer faded quickly without focused curriculum learning experiences devoted to the walking challenge. This observation appears to align with research undertaken by Butcher, Fairclough, Stratton and Richardson (2007) who found that feedback from pedometers alone was insufficient to increase in children's school-time steps without the provision of additional information to encourage children's physical activity..

The students' school uniform did not require the use of belts. This presented a small problem as the Digi-Walker DW 200 pedometer is designed to fit snugly onto a standard sized belt. Both boys and girls in this study preferred to wear their pedometers tucked over the lip of their shorts or skirts respectively. This presented two problems. With a belt mounting, no physical contact occurs between skin and the plastic of the pedometer. This was not the case for the children in this study. Many found the pedometer to be uncomfortable initially, but this dissipated over several days. In addition, without the snug fit that comes with a belt mount, the pedometers were prone to slippage or being dropped which may lead to inaccurate measurement of step counts. Many students reported that this occurred initially, however, by attaching a small safety cord and wearing a belt for the duration of the study both problems were reduced. Whilst not an issue for this study, in circumstances where girls wear a dress rather than a skirt for their school attire it would be necessary to wear belts to secure the pedometers.

Prior to the commencement of the walking challenge it was anticipated that some demands may be placed upon parents to remind children of the need to wear their pedometers. Parents indicated that this rarely occurred and served to confirm the choice of the middle primary as the target audience for this intervention.

The anecdotal feedback suggests that integrating physical activity into the middle primary school curriculum may be an effective strategy to increase activity levels. Although not tested in this study it is important to examine changes in physical activity levels in future studies.

***Suitability of Promotional Materials***

Firm targets for the walking challenge were not provided for the students in terms of 'must walk 10,000 Steps', however, students clearly established this as a target because '10,000 Steps' promotional posters were displayed on the classroom walls. 10,000 steps is a commonly used step count target for adults and is associated with improvements in metabolic health (Tudor-Locke et al., 2011). For children, the target figure is considerably higher with recommendations varying between 11,000 and 13,000 steps per day for girls and between 13,000 and 16,000 steps per day for boys (S. Duncan, et al., 2007; President's Council for Physical Fitness and Sports, 2005; Tudor-Locke, et al., 2004). Because the children well exceeded the adult target of 10,000 steps, the participating teacher believed that they acquired an inflated view of their performance. The positive outcome of this was that students' general self-esteem and self-concept in regards physical activity appeared to elevate disproportionately to their true performance. It is recommended that age specific promotional materials need to be developed to avoid misconceptions of this type being replicated.

The resources and support provided by the *10,000 Steps* website (see http://10000steps.org.au) were used sparingly during the study because it was not feasible to produce a school domain email account for each student. Consequently, only email accounts for team captains were developed. This meant that only the six team captains (i.e. 6 teams of approximately 5 members in the class) accessed the *10,000 Steps* website regularly to enter their personal step counts and that of their 'off-line' team members. This restricted the access to the *10,000 Steps* website for many students. Therefore, it is recommended that designers of similar websites should provide easier access with a 'master key' facility provided for the class teacher. This would allow simpler data entry and provide easier oversight by teachers of student's efforts and progress. Moreover, easier access to the interactive feedback that is available on the *10,000 Steps* website may further motivate students to increase their physical activity.

***Purchase cost***

The school and CQ-University jointly funded the purchase of a class set of pedometers (30 units) for the walking challenge. At approximately $25 per unit, this is a significant expense for most schools. In line with advice sourced from the *10,000 Steps* (www.10000steps.org.au), a class set of pedometers (with safety straps and instructional booklet) were purchased, placed in VCR cassette for individual storage, assigned to the school library and then made available to other classes, students and community members to use.

This research has shown the Digi-Walker DW 200 pedometer to be sufficiently robust to handle the constant handling and rough treatment characteristic of children's play activity. Only one pedometer was broken during the nine-week feasibility study, although it should be noted that the pedometers were removed during body contact activities.

## Summary

This study sought to determine the feasibility of using a web-supported class-based walking challenge by identifying cross-curricular linkages to the mandated Queensland middle primary curriculum. In this regard, the research indicated that a walking challenge that utilized pedometers to measure and record physical activity could provide data and inform learning experiences for effective cross-curricular integration. The research also confirmed the utility of cross-curricular integration in terms of ‘value adding’ to the walking challenge participation. Both teacher observation and student feedback indicated that simply giving children a pedometer to measure daily step counts as part of a walking challenge failed to sustain student interest and motivation. What was vitally important was, ‘what the teacher did with the data’. Imagination and creativity are key assets for all teachers and this certainly applied to extrapolating learning experiences to achieve broad cross-curricular learning outcomes from web-supported class-based walking challenges.

In summary, this research study demonstrated that it is feasible to integrate a web-supported class-based walking challenge with the Queensland middle primary curriculum. In addition, specific cross-curricular learning experiences were developed, and some impediments to the delivery of a web-supported virtual walk in the school setting were identified.

*Chapter Four*

# STUDY TWO: - The Efficacy of a Curriculum-Supported, Web-Based Walking Challenge to Increase Children's Participation in Physical Activity and Improve Psychosocial Correlates of Physical Activity.

## Introduction

For many Australian primary school children their level of physical activity is insufficient to meet guidelines based on either time spent in moderate to vigorous physical activity or daily step counts (Australian Government Department of Health and Ageing, 2008; Hands, Parker, Glasson, Brickman, et al., 2004). This may lead to adverse health consequences in childhood or contribute to chronic illness in adulthood (Trost, 2003). To address this, schools have often been used as sites for physical activity promotion (Salmon, et al., 2007) and there is some good evidence that such interventions are effective in promoting physical activity and fitness in children (Dobbins, 2009).

In the past, school-based physical activity promotion has often relied upon increasing the duration or frequency of structured Physical Education lessons, or improving the quality of classroom based Health Education (Kahn, et al., 2002). Despite some evidence of the efficacy of these approaches, they often fail to maintain longevity, or, achieve widespread dissemination across schools. In part, this may be due to a congested curriculum that occurs over time as new topics and disciplines have been included within the traditional curriculum. Furthermore, it is likely that the crowded curriculum phenomenon has increased within many educational jurisdictions with the proliferation of high stake testing regimes in recent years. Such testing regimes may have further focused teachers' curriculum delivery towards literacy and numeracy learning outcomes, particularly in the primary school sector. Under these circumstances, traditional approaches to physical activity promotion within primary schools may receive less consideration, or, time allocation. An alternative approach that has received little attention to date is that of physical activity cross-curricular integration. With the advent of the modern electronic pedometer, curricular integration of physical activity within a wide range of subject areas is now possible using children's own pedometer measured step count data and is an approach that warrants further investigation.

Oliver, Schofield and McEvoy (2006) demonstrated with year five and six children in New Zealand that it was possible to achieve effective curriculum integration using the concept of a virtual walk. Moreover, Oliver and colleagues revealed that children's physical activity improved throughout the intervention, especially for low-active sub-groups. Study One, demonstrated that it was feasible to integrate web-based virtual walking challenges with the Queensland middle primary syllabi. This chapter extends upon Study One to describe the subsequent development of a *curriculum-supported and web-based walking challenge* package and examines the efficacy of the intervention to increase children's physical activity and improve psychosocial correlates of physical activity.

**The 'Intervention'**

Following Study One, a '*curriculum-supported and web-based walking challenge*' was constructed collaboratively with the further assistance of three experienced middle primary classroom teachers. A six-week cross-curricular intervention package was produced that had two distinct components; i.e. (i) twelve prepared lessons that integrated Mathematics, English, Study of Society and the Environment, Science, Health and Physical Education, and Technology, with (ii) participation in a web-based virtual walking challenge. The class teachers were asked to implement as many of the lessons as they could but were allowed some discretion to modify, adapt or extend the lessons to suit their teaching program. The web-supported virtual walk challenge required teams of ten to use the Internet to record their steps along a virtual walk of the Great Wall of China. The walk was designed to take approximately four weeks and to occur during the lead up to the Beijing Olympics. Students were required to access the *10,000 Steps* website (see http://www.10000steps.org.au/help/website-challenges/) and enter their daily step counts on a regular basis. The 10,000 Steps website provides a range of informative, educational and motivational material for the students regarding the benefits of physical activity, in addition to a visual display of their progress towards their destination. Participants could also view graphs depicting their daily step totals and receive average step count information. At significant milestones along the journey, children receive electronic postcards informing them of particular geographic, historic or cultural highlights. Teachers were encouraged to actively participate and model physical activity participation through the virtual walk of the Great Wall of China by being a team member. Student participation in the Great Wall of China virtual walk was a mandatory, non-negotiable component of the intervention that the school and class teachers agreed to implement.

The researcher compiled the content and designed the web resources of the Great Wall of China virtual walk with the assistance of the 10,000 Steps Project team. The 12 lesson plans and the electronic postcards from the virtual walk of the Great Wall of China are provided in Appendices 2 to 18.

The design of the curriculum supported and web-based walking challenge was informed by the Theory of Planned Behaviour (TPB) (Ajzen, 1991). Lessons plans were developed cognizant of ways to positively influence attitude, subjective norm (SN) and perceived behavioural control (PBC) via academic activities and physical activity. For example, several of the Health and Physical Education Essential Learnings for middle primary relate to the health benefits of physical activity. Learning experiences to achieve these outcomes were integrated within the walking challenge to increase children's knowledge of the importance of physical activity (behavioural beliefs). Children's SN were targeted within the team orientated virtual walks as the classroom teacher, parents and peers would provide support and encouragement to achieve personal, team or class goals. PBC was addressed within learning experiences focused upon goal setting, monitoring and evaluating performance, identifying barriers to participation, and problem solving to overcome obstacles to performance. Improvements in attitudes, SN and PBC should all contribute to stronger intentions to be physically active and actual physical activity (Ajzen, 1991).

Study Two was designed to determine the efficacy of the *curriculum-supported and web-based walking challenge* to increase children's physical activity and improve psychosocial correlates of physical activity. The purpose of Study Two was to examine the following research questions:

**RQ 1** Would a '*curriculum-supported and web-based walking challenge*' (the intervention) change children's physical activity over a six-week period and would any change be maintained at 3-month follow-up?

**RQ 2** Would the intervention change TPB psychosocial correlates of physical activity over a six-week period and would any change be maintained at 3-month follow-up?

**Design**

To achieve this purpose, a quasi-experimental design with a non-equivalent comparison group was used. Research designs of this type are used commonly in education research because the random sampling and assignment of children to control and intervention groups is not possible, or quite impractical, within the school setting (L. Cohen & Manion, 2007). To minimize the possibility of confounding variables contaminating intervention effects, special effort was made to ensure that intervention and comparison groups were as similar as possible (Frankfort-Nachmias & Nachmias, 2006). This was achieved by selecting schools of similar size and character[21] from the same community with classes matched by year level. The outcome variables of children's *physical activity* and *psychosocial correlates of physical activity* were measured at baseline (week1), post-intervention (week 8) and at 3-month follow-up (week 20). The six-week intervention was delivered during weeks 2 – 7 inclusive of the research period.

Ethical approval (No EC00158) to undertake the research was granted from the Central Queensland University Human Research Ethics committee and the school principals. Prior to the commencement of the research information sessions were provided for parents (after school) and children (within class session). Parents and students provided informed consent to participate in the research (Appendix 19).

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[21] Both schools are relatively small catholic primary schools. The intervention school had an Index of Community Socio-Educational Advantage (ICSEA) score of 1070 whilst the comparison school had an ICSEA of 1010 in 2012. Every school has an ICSEA value on a scale that has a mean of 1000 and a standard deviation of 100. Whilst this score changes each year as the student population changes, it does indicate that the backgrounds of the student populations are similar.

**Statistical Power Calculation**

The statistical power calculation for this study was calculated a priori based on the effect size reported in similar research conducted by Oliver, Schofield and McEvoy (2006). Their research investigated the effect of a four-week integrated curriculum walking challenge with 61, year 5 and 6 children in Auckland. Their study shared similar features to the proposed study and revealed significant improvement in physical activity between baseline and *during* the intervention for important sub-groups of their study. The four sub-groups of students were:

- Group A, - boys and girls with the top quartile omitted,
- Group B, - girls and boys accumulating less than 15,000 steps daily,
- Group C, - girls and boys accumulating less than 12,000 and 15,000 steps respectively, and
- Group D, - girls and boys achieving less than 11,000 and 13,000 steps respectively

Oliver et al.'s research revealed a pattern whereby the lower the initial level of children's physical activity, the greater the intervention effects. For example, for group B, percentage change in daily step count exceeded 20%, for group C percentage change was approximately 30 %, and for group D percentage change approached 50%. For girls within the lowest initial physical activity groups, i.e. groups C and D, the change in step counts exceeded 100% and 120% respectively. Their research indicated that for important sub-groups, notably, the physically inactive, effect size was in the moderate to large range (Oliver, Schofield & McEvoy, 2006). However, Oliver et al.'s study did not blind students to the purpose of the pedometer during their initial physical activity assessment. Conceivably, this may have led to reactive behaviour that increased children's initial step counts and thereby reduced the magnitude of any changes attributable to the intervention. Compared with Oliver and colleagues study, the intervention for this research is of longer duration and incorporates the use of high quality web-resources that are interactive, informative and motivational in nature. These features may increase student engagement and lead to a larger effect size for this intervention. Using Cohen's (1992) minimum sample size calculator, the sample sizes required to demonstrate medium and large effects sizes using two groups are 64 and 26 respectively.

**Participants**

The participants for this study were drawn from middle primary classes at two schools in Central Queensland, Australia. The schools were randomly assigned to intervention and comparison conditions. The intervention school comprised 85 children in three middle primary classes (i.e. three, year four and five composite classes), with a mean age of 9.7 years (SD = 0.6) and a mean BMI of 18.2 (SD = 2.8). All middle primary children at the intervention school engaged in the integrated curriculum and web-supported class-based walking challenge as part of their core teaching and learning activities.

The comparison school comprised 55 children in two middle primary classes (i.e. one year four and one year five class) with a mean age 9.7 years (SD = 0.6) and a mean BMI of 18.4 (SD = 2.9). All children in the comparison school engaged with their normal curriculum and teaching and learning program. All middle primary children from both intervention and comparison schools provided informed consent to participate in the research. Independent sample t-tests revealed no significant differences between schools for mean age or BMI ($p < 0.05$). Table 5 provides an overview of the intervention and comparison participants at baseline.

**Table 5: Study 2 – Comparison – Between Intervention and Comparison Schools at Baseline**

| Variable | Baseline | |
|---|---|---|
| | Intervention | Comparison |
| **Number of Students** | 85 | 55 |
| **Gender** | | |
| - **Male (%)** | 46 (54) | 22 (40) |
| - **Female (%)** | 39 (46) | 33 (60) |
| **Mean Age (SD)** | 9.66 (0.63) | 9.75 (0.59) |
| **Mean BMI (SD)** | 18.18 (2.79) | 18.40 (2.95) |
| **Mean Daily Step Count (SD)** | 12096 (4072) n = 53 | 12319(2895) n = 36 * |
| **Mean % time in sedentary physical activity (SD)** | 62.79 (7.30) n = 36 | 60.34 (9.57) n = 25 * |
| **Mean % time in light physical activity (SD)** | 17.44 (7.4) | 19.5 (9.51) |
| **Mean % time in moderate physical activity (SD)** | 15.05 (5.2) | 14.61 (5.94) |
| **Mean % time in vigorous physical activity (SD)** | 4.7 (3.1) | 4.8 (3.5) |
| **Mean Intention (SD)** | 6.21 (1.22) n = 77 | 6.01 (1.03) n = 47 * |
| **Mean Attitude (SD)** | 5.93 (1.18) | 6.15 (0.95) |
| **Mean SN (SD)** | 5.79 (1.37) | 5.35 (1.17) |
| **Mean PBC (SD)** | 5.75 (1.27) | 5.80 (1.10 |
| **ICSEA Value** | 1070 | 1010 |

**Notes:**
* Number of students who met inclusion criteria at baseline
Independent sample t-tests revealed no significant differences between schools for mean age, BMI, mean daily step counts, mean percentage time in each of the physical activity categories, or TPB constructs, $p < 0.05$.

## Measures

Children's physical activity was measured using two objective instruments: - a pedometer (Digi-Walker SW-200 Yamax Corp. Tokyo, Japan) and the Actiheart Accelerometer (Mini Mitter, version 2). The Actiheart and pedometer assessment were completed concurrently.

### *Digi-Walker SW-200 Pedometer*

The Digi-Walker SW-200 is one of the most accurate and reliable pedometers for assessing steps taken (Bassett, et al., 1996; Crouter, et al., 2003; Ramirez-Marrero, et al., 2002) and has been used extensively in the pediatric population (Beets, et al., 2005; Kang & Brinthaupt, 2009). Instruction in the use and placement of the pedometer was provided as part of the school curriculum and the children were then required to wear the device for four complete days, Friday through to Monday inclusive. A four day monitoring frame has been used in recent Australian state-based research studies (Abbott, et al., 2007; K. Martin, et al., 2008) and provides a reliable indication of weekly physical activity (Tudor-Locke et al., 2005). Children were required to remove the pedometer only during sleep and for contact sports and aquatic activities. Each child received a step count diary and requested to record their daily step counts and indicate times when the pedometer was removed (Appendix 22). All children agreed to participate in the pedometer measurement activities.

### *Actiheart Accelerometer*

The Actiheart activity monitor is a small (10 gram) heart rate recorder with an integrated omnidirectional accelerometer that is attached to the chest by two ECG adhesive tabs. The Actiheart is capable of continuously recording and storing data in fifteen-second epochs for twelve days. This data is downloadable using Actiheart proprietary software to obtain minute by minute physical activity intensity values, and has been shown to be an accurate and reliable device for measuring physical activity in children (Brage, et al., 2005; Corder, et al., 2005). The fifteen-second epoch function was selected for this study to best capture the intermittent nature of children's physical activity (Bailey, et al., 1995; Edwardson & Gorely, 2010; Loprinzi & Cardinal, 2011; McClain, Abraham, Brusseau, & Tudor-Locke, 2008; Welk, et al., 2000). The researcher had access to fifty Actiheart accelerometers only so this limited the number of participants that could be recruited for this aspect of the research study.

Children were randomly selected with replacement from each school and invited to participate in the Actiheart monitoring. Fifty children from the intervention and 43 from the comparison school accepted this invitation with parental consent. Participants were shown how to correctly locate and attach the Actiheart accelerometer to their chest and were requested to wear the device for five consecutive days (Thursday – Monday inclusive) and overnight for one evening only. This expectation was consistent for all three measurement time-points. Each child received a Physical Activity Diary and asked to record their daily step count and indicate when the pedometer and Actiheart accelerometer were removed (Appendix 22).

A minimum of a four day monitoring frame (including one weekend day) has been recommended to achieve an optimal balance between feasibility and validity for assessing children's physical activity (Corder, et al., 2008). A five day monitoring period was selected to increase the likelihood of a complete four day monitoring period being completed. Children wore the device for their entire day, but were required to remove the Actiheart for contact sports and aquatic activities.  Information sheets were provided for parents so that they could assist with locating and replacing ECG adhesive tabs as required (Appendix 23).

***Psychosocial Constructs***

Psychosocial correlates of physical activity were secondary outcome variables and were measured using the TPB constructs of attitude, SN, PBC, and intention to participate in physical activity. TPB constructs were measured within an 18 item, 7-point Likert scale questionnaire that adhered to the design principles recommended by Ajzen (2006). Attitude towards physical activity was measured through six questions, whilst SN, PBC and intention to participate in physical activity were assessed through four questions devoted to each construct. Children's attitude toward physical activity were measured through items that assessed whether *doing 60 minutes of moderate intensity physical activity each day for the next week* would be beneficial, good, pleasant, useful, fun and enjoyable. Subjective Norm was assessed by questions that ascertained if *most people who are important to them*, and *friends* expected them to do 60 minutes of moderate intensity physical activity each day for the next week. PBC was assessed by questions that ascertained whether doing 60 minutes of moderate intensity physical activity each day for the next week was 'completely up to me', 'beyond my control', easy, or 'whether they were confident they could achieve this if they wanted to'. Intention was assessed by questions ascertaining if the student 'will do', 'plan to', 'expect to' or 'intend to' do 60 minutes of moderate intensity physical activity each day for the next week'.  Questions relating to each construct were distributed throughout the survey. Negative questions were reverse-scored to ensure that the direction was consistent for all items and higher scores represented a more positive disposition (See Appendix 23 for a copy of the questionnaire).

The questionnaire was completed during class time with support provided to the students through a class discussion of 'what is meant by sixty minutes of moderate physical activity'. The researcher and classroom teacher led the students through the questionnaire by reading the survey questions and responding to any questions that arose during the baseline survey. Subsequently, the classroom teacher performed this role.

***Validity***

During its construction phase, the TPB questionnaire was tested for face validity. Face validity refers to whether the test looks valid to technically untrained observers (Anastasi, 1988). Face validity was assessed by seeking feedback from the five classroom teachers whose students would complete the questionnaire. Based upon the initial feedback provided, minor changes in questionnaire structure and language choice, and the use of example responses were included. The TPB questionnaire was also tested for content validity to ensure that the items of the questionnaire were appropriate and adequate to meet the research objectives. For this purpose, a panel of experts was consulted. The panel consisted of one professor experienced in the construction and use of TPB questionnaires, a PhD graduate who had used a TPB questionnaire within their own research, and another experienced Research Fellow. Following their input, further minor structural changes were made to the questionnaire.

***Reliability***

Internal consistency was used to ascertain reliability of the four TPB constructs. Internal consistency measures to what extent the items that attempt to measure a single conceptual construct provide consistent or similar responses (Brace, 2008). For this purpose Cronbach's alpha (α) was used a measure of internal consistency based on correlation between items measuring a single conceptual domain (Cronbach, 1951). A commonly accepted rule of thumb is that an alpha level of 0.6 – 0.7 indicates acceptable reliability, and 0.8 or higher indicates good reliability (Kline, 1999). All TPB constructs showed acceptable reliability with alpha values ranging from 0.65 to 0.87 (Table 6).

**Table 6: Cronbach's Alpha Coefficients for the Theory of Planned Behaviour Questionnaire**

| Construct | Cronbach's Alpha (α) | Number of Items |
|---|---|---|
| Attitude | 0.87 | 6 |
| Subjective Norm (SN) | 0.70 | 4 |
| Perceived Behavioural Control (PBC) | 0.65 | 4 |
| Intention | 0.80 | 4 |

## Analysis

### *Step Counts*

A valid total daily step count was any value between 2,000 and 50,000 steps. Students below 2,000 steps were considered not to have worn their pedometer correctly, whereas students above a 50,000 step count were assumed not to have zeroed the pedometer as instructed. Mean 4-day step count was calculated if the participant satisfied the 2,000 – 50,000 steps inclusion criteria for all four days at each measurement timeslot. Sixteen of 85 children from the intervention, and thirteen of 55 children from the comparison school met this inclusion criterion at all three time-points. Mean steps counts for school days (i.e. Friday and Monday only) and weekend (i.e. Saturday and Sunday only) were calculated if the 2,000 – 50,000 step count inclusion criterion was satisfied for both days. As school days and weekend-days required a lower number of valid days to be included for analysis, slightly larger sample sizes were obtained for these outcome variables. Twenty and 17 participants met school day inclusion criterion for intervention and comparison schools respectively. Seventeen and 19 participants satisfied inclusion criterion for weekend days for intervention and comparison schools respectively. Independent groups t-test found no differences in mean four day steps at baseline between those children who met inclusion criteria at all three time-points compared with those who failed to meet inclusion criteria at all three time-points, $t(51) = 0.71$, $p = 0.47$.

***Actiheart Accelerometer Data***

A minimum of ten hours of valid Actiheart data between 6am and 8pm was required to be included for further analysis. A minimum of ten hours of daily wear time has previously been used in youth accelerometer assessed research (Rowlands, 2007). To assess activity, three days of data collection were used for the calculation of mean time in sedentary, light, moderate, and vigorous physical activities categories. This provided an optimum balance between data quality (the number of valid days for each participant), and data quantity (the number of participants achieving inclusion criteria at each measurement period). The use of mean percentage valid time in each of the various intensity categories allowed comparison between individuals, and between baseline and post intervention scores, by eliminating raw score fluctuations due to variations in the number of minutes of invalid data. Twenty-seven of 50 participants from the intervention, and nineteen of 43 participants from the comparison school satisfied this inclusion criterion for a minimum of three days for both baseline and post-intervention measurement periods. Only ten and five children from intervention and comparison schools respectively met the inclusion criteria at 3-month follow-up.

Mean percentage time in each intensity category was also calculated for the afternoon / after-school timeslot. The afternoon period was defined as the three-hour period between 3pm and 6pm. An inclusion criterion was set that this period would have no more than eighteen minutes of invalid data to be included for further analysis. There is no single accepted criterion for the identification of how much wear time is necessary to constitute a valid time frame for a selected portion of a day (Corder, et al., 2008). Eighteen minutes of non-wear time is 10% of the total afternoon period and was chosen as it was a conservative cut-point that would ensure that the children's activity behaviour pattern was accurately captured. Twenty four of 50 children from the intervention, and eighteen of 43 children from the comparison school satisfied this inclusion criterion for a minimum of three days for both baseline and post-intervention measurement periods.

A majority of participants failed to provide valid data for a minimum of three days at the 3-month follow-up measurement period.. Because of this low compliance, the 3-month follow-up period was excluded from subsequent statistical analysis for all Actiheart variables.

***Theory of Planned Behaviour Variables***

Mean scores for each of the TPB constructs of intention, attitude, SN and PBC were calculated after negatively scored questions were re-coded to ensure that high values reflected favourable dispositions towards each construct. Participants with incomplete data sets (i.e. questionnaires not answered fully) were excluded from further analysis. Forty-seven of 85 children from the intervention school and 34 of 55 from the comparison school provided complete questionnaire data at all three time-points.

**Statistical Analysis**

All of the outcome variables were analysed at baseline using independent sample t-tests with a statistical level of significance set at $p < 0.05$. No significant differences between schools were detected for any of the physical activity measures or TPB constructs at baseline. Mean values for all outcome variables are listed in Table 7.

To determine the effect of the intervention upon pedometer measured physical activity, a (2) School (intervention vs. comparison) x (3) Time (baseline, post-intervention, 3-month follow-up) Repeated Measures ANOVA was utilized. To determine the effect of the intervention upon time spent in the sedentary, light, moderate and vigorous physical activity categories, a (2) School (intervention vs. comparison) x (2) Time (baseline, post-intervention) Repeated Measures ANOVA was utilized. Due to the generally small sample sizes obtained for the pedometer, Actiheart accelerometer and TPB data, the statistical power was reduced. Preliminary statistical analysis confirmed this with observed power consistently less than the traditional 0.80. Accordingly, an alpha level of 0.10 rather than the conventional 0.05 level was set as the level of significance for School x Time effects for this research. To identify differences when significant interactions were present a series of separate repeated measures ANOVA to detect differences across time-points for each school, and independent sample t-tests to determine differences between schools at each time-point were performed. Collectively, these statistical techniques revealed the difference between schools due to the effect of the intervention, and indicated how the difference occurred over the three time points. Main effects of time (i.e. comparison between time points for all participants) have not been reported as these may simply reflect seasonal differences, or other influences, that have acted upon both intervention and comparison schools concurrently.

## Pathway of Participants through the Physical Activity and TPB Assessment

### Baseline Characteristics

**Intervention School**
N = 85, Males 46 Females 39
**Actiheart Accelerometer**
50 children randomly selected and volunteer
**Pedometer and TPB Questionnaire**
All children consent and volunteer to engage with these assessment activities for all three time-points.

**Comparison School**
N = 55, Males 22 Females 33
**Actiheart Accelerometer**
All children invited to participate - 43 volunteer
**Pedometer and TPB Questionnaire**
All children consent and volunteer to engage with these assessment activities for all three time-points.

### Baseline Response

**Actiheart Accelerometer**
44 returned with complete data
36 met the inclusion criteria
6 drop outs due to skin reactions.
**Pedometer**
57 daily logs returned
53 met the inclusion criteria
**TPB Questionnaire**
79 questionnaires returned
77 met the inclusion criteria

**Actiheart Accelerometer**
39 returned with complete data
25 met the inclusion criteria
4 drop outs due to skin reactions
**Pedometer**
45 daily logs returned
36 met the inclusion criteria
**TPB Questionnaire**
50 questionnaires returned
47 met the inclusion criteria

### Post-Intervention Response

**Actiheart Accelerometer**
36 children who successfully completed at baseline recruited
31 returned with complete data
27 met the inclusion criteria
**Pedometer**
43 daily logs returned
36 met the inclusion criteria
**TPB Questionnaire**
76 questionnaires returned
71 met the inclusion criteria

**Actiheart Accelerometer**
25 children who successfully completed at baseline recruited
25 returned with complete data
19 met the inclusion criteria
**Pedometer**
35 daily logs returned
29 met the inclusion criteria
**TPB Questionnaire**
54 questionnaires returned
49 met the inclusion criteria

### 3 Month Follow-Up Response

**Actiheart Accelerometer**
27children who successfully completed post-intervention recruited
22 returned with complete data
9 met the inclusion criteria
**Pedometer**
50 daily logs returned
36 met the inclusion criteria
**TPB Questionnaire**
69 questionnaires returned
62 met the inclusion criteria

**Actiheart Accelerometer**
23 children who successfully completed post-intervention recruited
19 returned with complete data
5 met the inclusion criteria
**Pedometer**
33 daily logs returned
20 met the inclusion criteria
**TPB Questionnaire**
48 questionnaires returned
46 met the inclusion criteria

**Figure 2: Pathway of Participants through the Physical Activity and TPB Assessment**

**Intervention Implementation**

The intervention, in particular teacher engagement and curriculum delivery, was monitored during the 6-week implementation phase with weekly meetings. In conceptualizing the intervention, it was envisaged that teachers may exercise some discretion to modify the delivery of the 12 suggested lessons to best fit with their teaching program. The teachers did exercise this discretion. All teachers implemented the first four lessons 'as written and as sequenced' during the first two weeks of the intervention phase. Subsequently, due to an unanticipated change to the yearly curriculum plan[22], the latter lessons were modified to integrate with a Study of Society and Environment unit that was being taught about the early Australian gold rush in Ballarat. Through this unit, the teachers were able to make meaningful connections between Chinese culture and history, the participation of Chinese miners during the gold rush, and children's progress along the virtual walk of the Great Wall of China. These modifications were compatible with the intent of the intervention. Student participation in the virtual walk of the Great Wall of China was a non-negotiable, mandatory component of the intervention that the school agreed to undertake. This aspect of the intervention commenced in week 3 and continued to the end of week 6. Student log-ins revealed that this component of the intervention was implemented fully.

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[22] The yearly curriculum plan is a document that outlines how a particular year level (in this school year 4 and 5 combined) will meet syllabus outcomes across all KLAs that are taught. At the beginning of the year when the 12 lessons plans were conceptualized with the assistance of the class teachers, the 12 lessons aligned with the curriculum plan. However, the curriculum plan changed during term 2. Changes to curriculum plans within schools are not uncommon and provide an essential level of flexibility for schools to modify their curriculum to meet emergent priorities. The modifications that were made aligned with the intent of the curriculum-supported, web-based virtual walking challenge concept.

**Student Drop Out**

The statistical analysis of the research was adversely affected by the small number of children who satisfied inclusion criteria for Actiheart accelerometer and pedometer assessed physical activity across baseline, post-intervention and 3-month follow-up time-points. A number of factors have contributed to this. For the Actiheart accelerometer, which attaches to the chest via two adhesive pads, a number of children developed skin reactions to the 3M Red Dot 2560 adhesive tabs. For some children the onset of the skin irritation occurred within hours of attaching the adhesive tabs, whereas for other children skin irritation developed gradually over several days. This was unexpected and unforeseeable. Advice from medical professionals prior to commencing the research did not elucidate this as a potential problem. Once a skin irritation developed children were directed to cease wearing the ECG tabs.

A second problem with the Actiheart accelerometer output became apparent once the data was downloaded at baseline. The Actiheart accelerometer requires good connections between the ECG adhesive tabs and the skin, and between the ECG tabs and the accelerometer and ECG transponder terminals to receive its data input. Whether the Actiheart accelerometer has truly recorded participant's physical activity accurately can only be fully determined once it has been downloaded to a computer. The data can then be graphically displayed to show when, and to what extent, the subject has been physically active (Appendix 24). An examination of participants' graphs revealed that the quality of the Actiheart data differed greatly between participants. For many children, the Actiheart units were returned believing that they had completed the measurement protocol as requested; i.e. for 5 days and overnight for one evening. The displays indicated that this occurred. However, the displays also indicated that for some children, the unit was not receiving data input cleanly, probably due to poor connections, and this in turn led to many participants failing to meet the inclusion criteria.

A final factor that adversely affected the sample size was the noticeably higher dropout rate at the 3-month follow up. It seemed that the 3-month break between the completion of the intervention and the follow-up period led to reduced motivation and compliance with measurement protocols. It is also possible that end of school year events that coincided with the 3-month follow-up may have increased the challenges associated with the measurement protocol at this time point.

In regards the pedometer assessment of physical activity, the percentage of children who completed 4 days of measurement (i.e. returned Pedometer Diaries) exceeded 50% for both intervention and control groups across all three measurement time points. However, to satisfy inclusion criteria across all three time-points, students needed to complete all 12 days (i.e. 3 time points x 4 days) of measurement. This was an expectation that exceeded the capabilities of many children.

Due to the high drop-out rate observed across all three measurement time-points, independent sample t-tests were performed for all physical activity measures at baseline, comparing those participants who satisfied inclusion criteria at all three times (i.e. those for whom results are reported), compared with those participants who 'dropped out'. No significant differences were detected between the groups.

**Results**

Since both intervention and comparison schools were of similar size, drawn from the same regional community, and reflected a similar socio-economic-cultural profile, it was assumed that the differences in children's physical activity observed between schools across the measurement periods were attributable to the effect of the intervention rather than extraneous factors. Table 7 displays both the pedometer and Actiheart data obtained from this study.

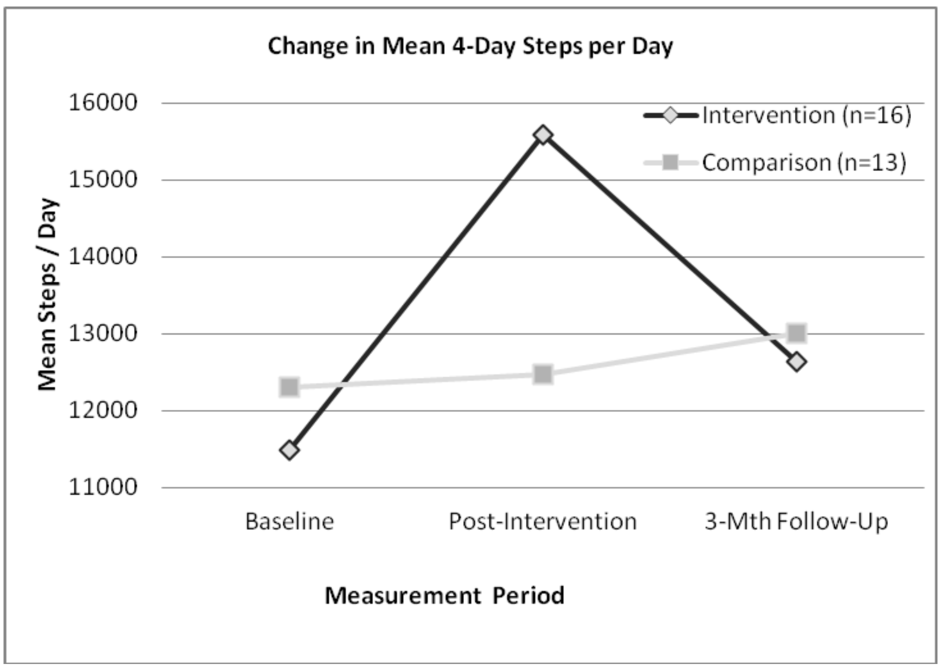
**Table 7: Summary of Physical Activity Outcomes: - Pedometer and Actiheart Assessed**

| Variable | Baseline | | | | Post Test | | Follow Up – 3 months | |
|---|---|---|---|---|---|---|---|---|
| | N | Intervention M (SD) | N | Comparison M (SD) | Intervention M (SD) | Comparison M (SD) | Intervention M (SD) | Comparison M (SD) |
| **Step Counts** | | | | | | | | |
| 4 Days | 16 | 11482 (3693) | 13 | 12306 (2605) | 15585 (6441) | 12460 (1710) | 12641 (3791) | 13005 (3851) ‡ |
| School Days | 20 | 12585 (4250) | 17 | 13282 (2455) | 14763 (5586) | 12271 (2594) | 14258 (3912) | 12906 (3998) † |
| Weekend Days | 17 | 10734 (3878) | 19 | 11850 (3316) | 15730 (7613) | 12823 (3561) | 11151 (4946) | 12218 (3963) ∞ |
| **Actiheart Whole Day.** | | | | | | | | |
| % Time in SA. | 27 | 62.33 (7.57) | 19 | 59.99 (9.53) | 65.20 (6.95) | 61.92 (7.78) | | |
| % Time in LA | 27 | 17.71 (8.30) | 19 | 18.74(10.76) | 15.99 (6.87) | 18.98 (8.98) | | |
| % Time in MA. | 27 | 15.40 (4.97) | 19 | 16.01 (5.46) | 15.05 (5.95) | 15.03 (6.95) | | |
| % Time in VA. | 27 | 4.56 (3.17) | 19 | 5.25 (3.15) | 3.76(2.78) | 4.06 (2.79) | | |
| **3-6pm** | | | | | | | | |
| % Time in SA. | 24 | 52.69(14.50) | 18 | 46.85 (17.36) | 52.44 (11.89) | 53.56 (17.27) | | |
| % Time in LA | 24 | 19.14(10.36) | 18 | 19.93 (12.37) | 18.90 (19.75) | 20.08 (13.70) | | |
| % Time in MA. | 24 | 20.87 (8.23) | 18 | 24.05 (10.97) | 21.80 (9.92) | 21.54 (13.37) | | |
| % Time in VA. | 24 | 7.30 (7.36) | 18 | 9.18 (8.61) | 6.86 (5.95) | 4.82 (4.76) α | | |

Notes:
‡ School x Time effect over three time-points, F (1.68, 45.52) = 3.43, p =.05, PES = .11.
† School x Time effect over three time-points, F (2, 70) = 2.58, p = .08, PES = .07.
∞ School x Time effect over three time-points, F (1.68, 57.06) = 2.72, p =.08, PES = .07.
α School x Time effect, F (1, 40) = 3.36, p = .07, PES = .08.
SA - Sedentary intensity physical activity
LA - Light intensity physical activity
MA - Moderate intensity physical activity
VA - Vigorous intensity physical activity

### *Mean 4–Day Step Counts.*

Changes in mean 4-day step counts revealed a significant School x Time interaction over the three time-points, F (1.68, 45.52) = 3.43, p = 0.05, PES = 0.11. Between time-points contrast revealed significant School x Time effects between baseline and post-intervention, F (1, 27) = 4.93, p = 0.03, PES = 0.15, and between post-intervention and 3-month follow-up, F (1, 27) = 3.28, p = 0.08, PES = 0.11. Separate group repeated measures ANOVA across time-points for each school revealed significant differences for the intervention school only. Between baseline and post-intervention there was an average increase of 4,103 steps for the intervention school, F (1, 15) = 8.11, p = 0.01, PES = 0.35. This was followed by an average decline of 2,944 steps from post-intervention to the 3-month follow-up time-point, F (1, 15) = 4.06, p = 0.06, PES = 0.21. Independent sample t-tests at each time-point revealed a significant difference between schools at post-intervention only with intervention children exceeding comparison children by an average 3,125 steps per day, t (17.55) = 1.86, p = 0.08. Figure 3 displays the mean 4-day step count changes over the three measurement periods.

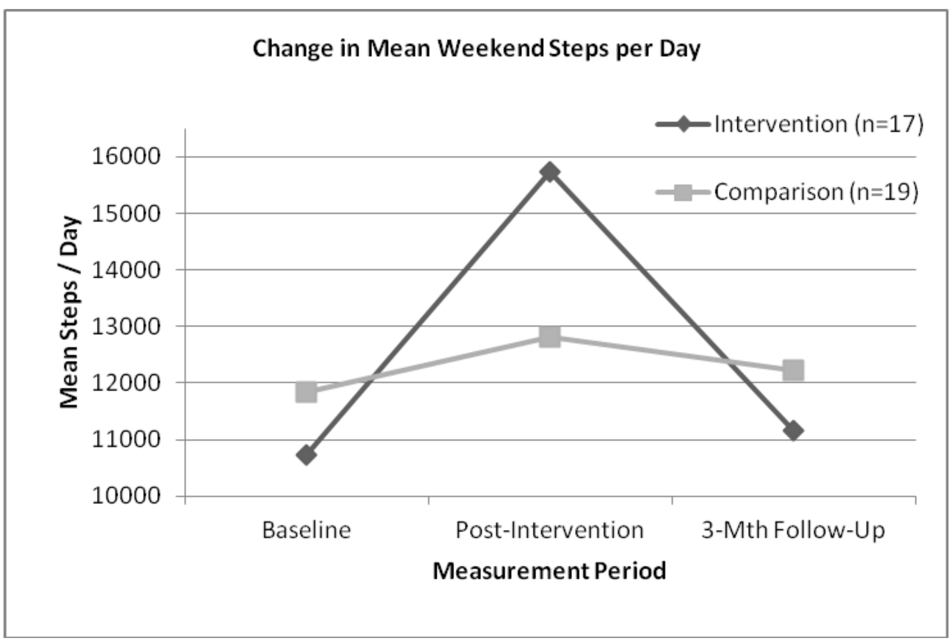



Notes:
School x Time effect over three time-points, F (1.68, 45.52) = 3.43, p = 0.05, PES = 0.11.
School x Time effect between baseline and post-intervention, F (1, 27) = 4.93, p = 0.03, PES = 0.15
School x Time effect between post-intervention and 3-month follow-up, F (1, 27) = 3.28, p = 0.08, PES = 0.11
Intervention group increase din mean steps between baseline and post-intervention, F (1, 15) = 8.11, p = 0.01, PES = 0.35.
Intervention group decreased in mean steps between post-intervention and 3-month follow-up, F (1, 15) = 4.06, p = 0.06, PES = 0.21
Between groups difference at post-intervention, t (17.55) = 1.86, p = 0.08.

**Figure 3: Change in Mean 4-Day Steps per Day**

***Mean Weekend Steps / Day***

In line with the pattern of mean 4-day step counts, mean weekend steps per day revealed a significant School x Time interaction over the three time-points, F (1.68, 57.06) = 2.72, p = 0.08, PES = 0.07. Between time-points contrast revealed School x Time effects between baseline and post-intervention, F (1, 34) = 3.60, p = 0.07, PES = 0.10, and between post-intervention and 3-month follow-up, F (1, 34) = 2.96, p = 0.09, PES = 0.08. Separate group repeated measures ANOVA across time-points revealed a significant increase of 4,996 steps for intervention children between baseline and post-intervention, F (1, 16) = 7.62, p = 0.01, PES = 0.32. This was followed by an average decline of 4,579 steps at the 3-month follow-up time-point, F (1, 16) = 5.61, p = 0.03, PES = 0.26. Independent sample t-tests at each time-point revealed no significant difference between schools at any time point. Figure 4 displays the mean weekend steps per day changes over the three measurement periods.

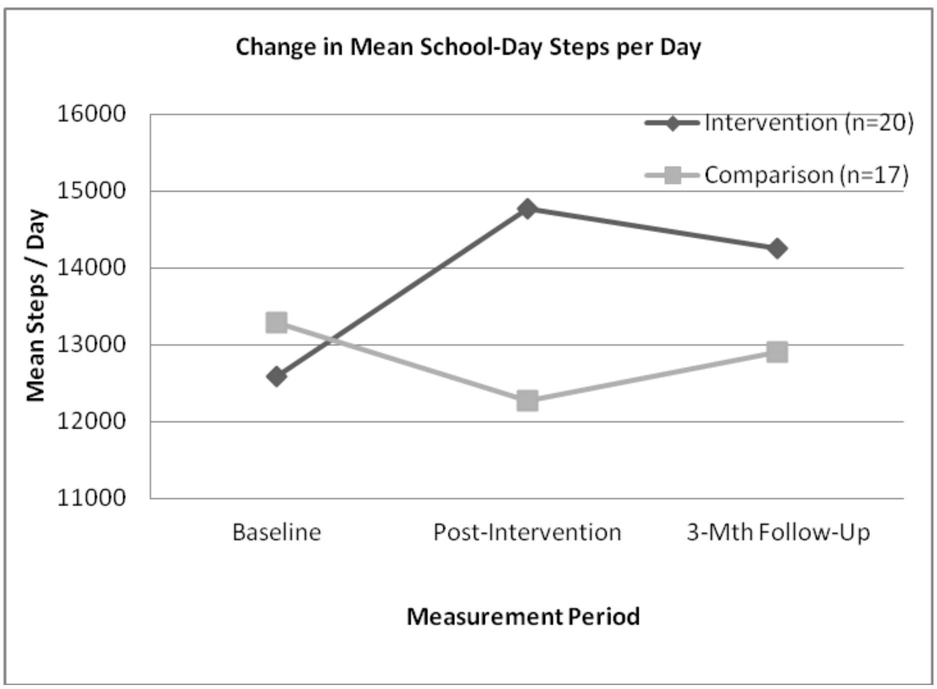



Notes:
School x Time effect over three time-points, F (1.68, 57.06) = 2.72, p = 0.08, PES = 0.07.
School x Time effect between baseline and post-intervention, F (1, 34) = 3.60, p = 0.07, PES = 0.10.
School x Time effect between post-intervention and 3-month follow-up, F (1, 34) = 2.96, p = 0.09, PES = 0.08.
Intervention group increased in mean weekend steps between baseline and post-intervention, F (1, 16) = 7.62, p = 0.01, PES = 0.32.
Intervention group decreased in mean weekend steps between post-intervention and 3-mth follow-up, F (1, 16) = 7.62, p = 0.01, PES = 0.32.

**Figure 4: Change in a Mean Weekend Steps per Day**

### *Mean School Day Step Counts*

Mean school day step counts displayed a School x Time effect over the three time-points, $F(2, 70) = 2.58$, $p = 0.08$, PES = 0.07. Between time-points contrasts revealed a School x Time effect occurred between baseline and post-intervention time points only, $F(1, 35) = 5.26$, $p = 0.03$, PES = 0.13. Separate group repeated measures ANOVA across time-points revealed an average increase of 2,178 steps per day for intervention children between baseline and post-intervention, $F(1, 19) = 4.12$, $p = 0.06$. Independent sample t-tests at each time-point revealed a significant difference between schools at post-intervention, with an average additional 2,492 steps taken for the intervention group compared to the comparison group, $t(27.75) = 1.78$, $p = 0.08$. Figure 5 displays the mean school day step count changes over the three measurement periods.

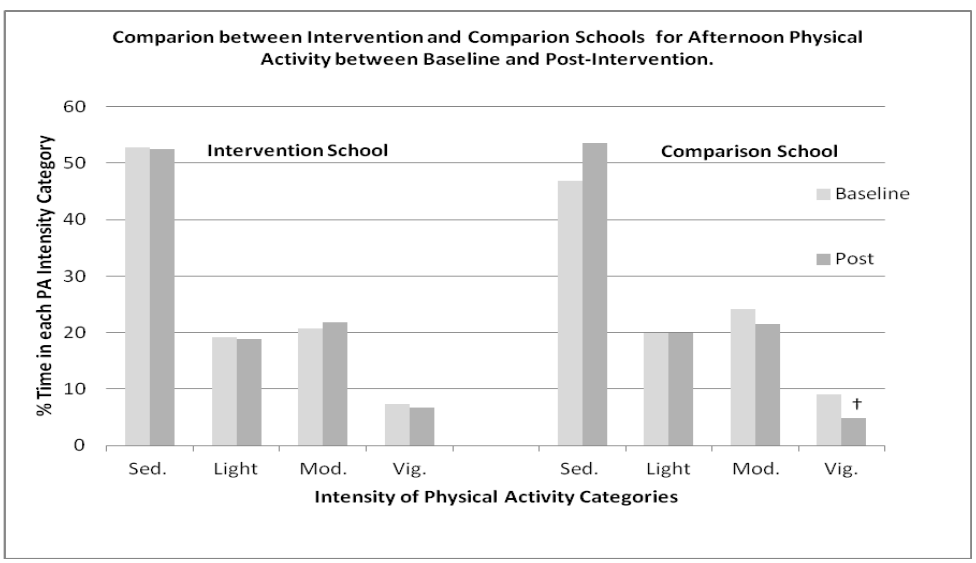



Notes:
School x Time effect over 3 time-points, $F(2, 70) = 2.58$, $p = 0.08$, PES = 0.07.
School x Time effect between baseline and post-intervention, $F(1, 35) = 5.26$, $p = 0.03$, PES = 0.13.
Intervention group increased in mean school day steps from baseline to post-intervention, $F(1, 19) = 4.12$, $p = 0.06$.
Between groups difference at post-intervention, $t(27.75) = 1.78$, $p = 0.08$.

**Figure 5: Change in Mean School Day Steps per Day**

### *Actiheart Accelerometer Data*

Mean percentage times for a minimum of three valid days, spent in each of the sedentary, light, moderate, and vigorous physical activity categories are displayed in Table 6. No significant School x Time effects were detected for the whole-day data. The afternoon, 3pm – 6pm period, was examined to determine if the intervention had particular effects during this period. No School x Time effects were detected for percentage time either spent in sedentary, light or moderate intensity categories. However, a School x Time effect was observed for percentage time spent in vigorous physical activity, F (1, 40) = 3.36, p = 0.07, PES = 0.08. Separate group repeated measures ANOVA revealed a decline for the comparison school from baseline (Mean = 9.18, SD = 8.61) to post-intervention (Mean = 4.82, SD = 4.76), F (1, 17) = 6.57, p = 0.02, PES = 0.28. Independent sample t-tests at each time point revealed no differences between groups. The change in time spent in vigorous physical activity in the afternoon is illustrated in Figure 6. Further dissection into school days and weekend days revealed that the changes were only significant for school days, F (1, 39) = 3.25, p = 0.08, PES = 0.08 (data not shown).




Notes:
† School x Time effect, F (1, 40) = 3.36, p = 0.07, PES = 0.08.
† Comparison group declined in '% Time spent in vigorous activity' between baseline and post, F (1, 17) = 6.57, p = 0.02, PES = 0.28.

**Figure 6: Percentage of Time Spent in Physical Activity Intensity Categories During the Afternoon**

### *Theory of Planned Behaviour Variables*

No significant School x Time effects were obtained for any of the TPB constructs for a 'whole of sample' statistical analysis over the three time-points. Subsequently, due to the slightly larger samples sizes obtained for the questionnaire data, boys and girls were analysed separately to determine if the genders differed in their response to the intervention. This analysis revealed gender specific School x Time effects for two of the TPB constructs. Mean values for all of the TPB constructs at each measurement time-point are displayed in Table 7.

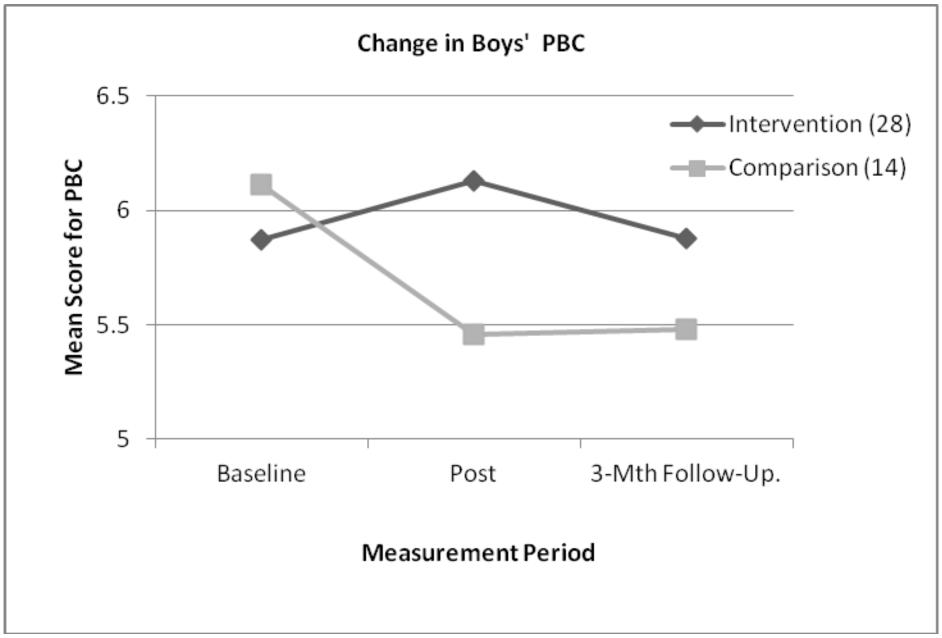
**Table 6. Theory of Planned Behaviour Constructs – Summary of all Outputs**

| Variables | N | Baseline Intervention M (SD) | N | Baseline Comparison M (SD) | Post-Intervention Intervention M (SD) | Post-Intervention Comparison M (SD) | Follow-Up-3 Mth. Intervention M (SD) | Follow-Up-3 Mth. Comparison M (SD) |
|---|---|---|---|---|---|---|---|---|
| Intention (all) | 47 | 6.21 (1.22) | 34 | 6.01 (1.03) | 5.79 (1.40) | 5.69 (1.44) | 6.10 (1.08) | 6.01 (1.03) |
| Intention (boys) | 28 | 6.35 (1.33) | 14 | 5.80 (1.12) | 6.13 (1.39) | 5.57 (1.69) | 6.36 (0.87) | 5.73 (1.28) |
| Intention (girls) | 19 | 6.00 (1.04) | 20 | 6.15 (0.97) | 5.29 (1.27) | 5.77 (1.27) | 5.72 (1.27) | 6.20 (0.91) |
| Attitude (all) | 47 | 5.93 (1.18) | 34 | 6.15 (0.95) | 6.21 (1.00) | 6.14 (0.73) | 5.87 (1.16) | 6.02 (0.88) |
| Attitude (boys) | 28 | 6.04 (1.33) | 14 | 6.27 (0.96) | 6.46 (0.79) | 6.15 (0.79) | 6.40 (0.75) | 5.99 (1.05) |
| Attitude (girls) | 19 | 5.77 (0.92) | 20 | 6.07 (0.96) | 5.83 (1.17) | 6.12 (0.71) | 5.08 (1.23) | 6.05 (0.78) † |
| SN (all) | 47 | 5.79 (1.37) | 34 | 5.35 (1.17) | 5.84 (1.14) | 5.17 (1.30) | 5.79 (1.09) | 5.56 (1.21) |
| SN (boys) | 28 | 5.86 (1.51) | 14 | 5.20 (1.39) | 6.03 (0.99) | 4.87 (1.61) | 5.86 (1.04) | 5.35 (0.90) |
| SN (girls) | 19 | 5.70 (1.17) | 20 | 5.46 (1.03) | 5.55 (1.31) | 5.37 (1.02) | 5.70 (1.18) | 5.70 (1.39) |
| PBC (all) | 47 | 5.75 (1.27) | 34 | 5.80 (1.10) | 5.83 (1.03) | 5.30 (1.14) | 5.61 (1.29) | 5.40 (0.93) |
| PBC (boys) | 28 | 5.87 (1.35) | 14 | 6.11 (0.79) | 6.13 (0.71) | 5.46 (1.16) | 5.88 (1.05) | 5.48(0.91) ‡ |
| PBC (girls) | 19 | 5.57 (1.15) | 20 | 5.59 (1.24) | 5.38 (1.26) | 5.19 (1.13) | 5.20 (1.52) | 5.34 (0.96) |

Notes:
† Group x Time effect across three time-points. F (2,74) = 2.77, p = 0.07, PES = 0.07.
† Group x Time effect between post-intervention and 3-mth follow-up, F (1,37) = 3.51, p = 0.07, PES = 0.09.
‡ Group x Time effect across three time-points. F (2, 80) = 2.87, p = 0.06, PES = 0.07.
‡ Group x Time effect between baseline and post-intervention, F (1, 40) = 4.48, p = 0.04, PES = 0.10.

### *Perceived Behavioural Control*

For boys, mean PBC scores revealed a School x Time effect over the three time-points, F (2, 80) = 2.87, p = 0.06, PES = 0.07. Between time-points analysis showed this effect occurred between baseline and post-intervention measurement periods, F (1, 40) = 4.48, p = 0.04, PES = 0.10. Separate group repeated measures ANOVA to investigate differences across time-points revealed that for comparison boys, lower mean PBC values occurred at post-intervention, F (1, 13) = 6.94, p = 0.02, and 3-month follow-up, F (1, 13) = 5.82, p = 0.03, compared with baseline values. Independent sample t-tests at each time-point revealed a significant difference between schools at post-intervention with lower PBC levels observed for comparison boys, t (17.97) = 2, p = 0.06. These changes in mean PBC for boys are displayed in Figure 7.

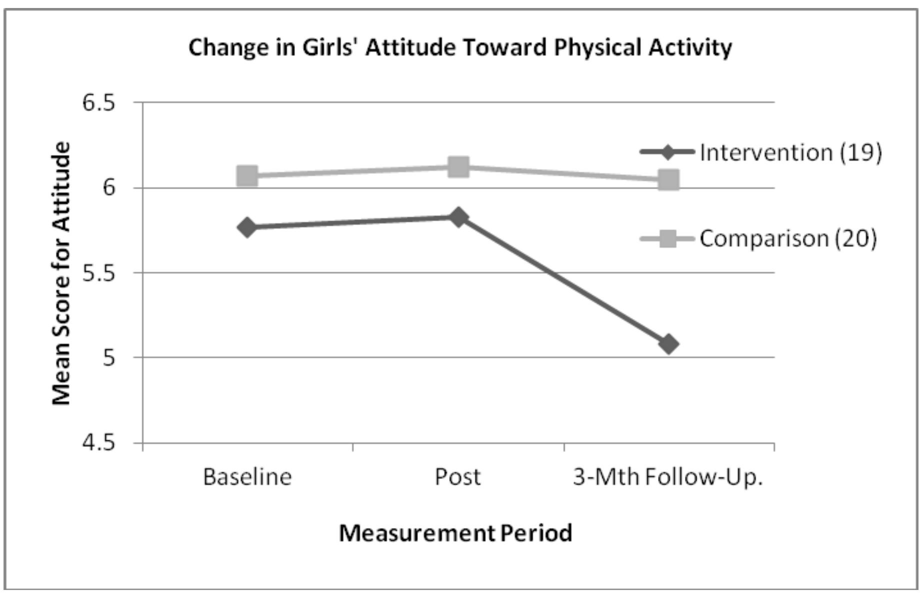



Notes:
School x Time effect over three time-points, F (2, 80) = 2.87, p = 0.06, PES = 0.07.
School x Time effect between baseline and post, F (1, 40) = 4.48, p = 0.04, PES = 0.10.
Comparison group: Lower mean PBC at post compared with baseline, F (1, 13) = 6.94, p = 0.02
Comparison group: Lower mean PBC at 3-mth follow-up compared with baseline, F (1, 13) = 5.82, p = 0.03
Between groups difference at post only, t (17.97) = 2, p = 0.06.

**Figure 7: Change in Boys' PBC**

***Attitude***

For girls, a significant School x Time effect was observed over the three time-points, F (2, 74) = 2.77, p = 0.07, PES = 0.07. A between time-points analysis showed this interaction effect occurred between post-intervention and 3-month follow-up, F (1, 37) = 3.51, p = 0.07, PES = 0.09. Separate group repeated measures ANOVA revealed for intervention girls that a lower mean attitude score occurred at 3-month follow-up compared with baseline, F (1, 18) = 8.09, p = 0.01, and post-intervention, F (1, 18) = 5.40, p = 0.03. Independent sample t-tests at each time-point revealed a significant difference between schools occurred at 3-month follow-up with a lower mean attitude score observed for intervention girls, t (37) = 2.96, p = 0.01. The changes in mean attitude values for girls are displayed in Figure 8.




Notes:
School x Time effect over three time-points, F (2, 74) = 2.77, p = 0.07, PES = 0.07.
School x Time effect between post and 3-mth follow–up, F (1, 37) = 3.51, p = 0.07, PES = 0.09.
Between groups difference at 3-mth follow–up, t (37) = 2.96, p = 0.01.

**Figure 8: Change in Girls' Attitude Towards Physical Activity**

**Discussion**

This research has shown that a six-week unit that supported participation in a class-based on-line walking challenge improved children's daily physical activity levels. All step count variables examined, i.e. mean 4-day, mean school day and mean weekend steps revealed School x Time effect sizes (i.e. PES varied between 0.07 and 0.15) in the moderate to large range when compared with Cohen's (1988) commonly used guidelines; i.e. 0.01 = small effect, 0.06 = moderate effect, 0.14 = large effect. For all step count variables, the intervention group improved mean daily steps from baseline to post-intervention by a minimum of 3,000 relative to the comparison group. This effect size equates to approximately twenty minutes of continuous, moderate intensity physical activity daily (i.e. brisk walking cadence equates to near 140 for this age group, see Sutherland, Olshen, Cooper, & Woo, 1980). Or, if considered in terms of the school curriculum delivery, this equates to the number of steps accumulated in forty minutes of quality daily physical education (Scruggs, 2005). Given that increasing actual physical activity during class time was not the primary focus of this study, and that teachers did not consciously incorporate additional physical activities within academic classes after the intervention, it is likely that the additional mean daily steps taken are attributable to increases in activity outside of class time and the school day.

Previously Oliver, Schofield and McEvoy (2006) demonstrated within the New Zealand setting the feasibility of integrating physical activity within the primary school curriculum by incorporating student's self determined step counts and participation in virtual walking journeys. However, the evidence of the efficacy of physical activity integration to improve children's physical activity levels was rather limited. In the Oliver study, a four-week integrated curriculum unit produced no improvement in accumulated step counts for the participants 'as a whole', but substantial improvements for the least active children during the intervention. The results obtained by Oliver and colleagues were possibly impacted by ceiling effects as 70% of children already met step count guidelines of 12,000 and 15,000 for girls and boys respectively at baseline. It is also noteworthy, that Oliver et al.'s study did not include a follow up assessment; therefore, the long-term effects were not able to be determined.

The Actiheart accelerometer data displayed a favourable effect of the intervention between baseline and post-intervention periods for the *percentage of time spent in vigorous activity during the afternoon*. For children from the intervention school, the percentage remained similar to baseline levels whilst the comparison school declined from 9.18% to 4.82%. The effect of the intervention during the afternoon period was protective in nature and served to limit the decline in vigorous physical activity observed in the comparison school. Further dissection into school day and weekend revealed that the interaction was significant for school days only, $F(1, 39) = 3.25$, $p = 0.08$, PES = 0.08 (not shown).

It is unclear why the daily step counts have shown substantial improvement for the intervention school without corresponding increases in the percentage of time spent in either of the light, moderate or vigorous physical activity intensity categories. It is possible that the children's daily step counts reflect increased physical activity outside of the Actiheart monitoring period; i.e. before 6am and after 8pm, or, differences in wear time between accelerometer and pedometers during the monitoring time frame; i.e. may have worn pedometer but not accelerometer (or vice versa) between 6am and 8pm.

Comparison of the Actiheart data between whole-day and afternoon periods revealed that children spent a smaller proportion of their time in sedentary activity, and a higher proportion in light, moderate and vigorous physical activity during the afternoon. This supports the notion that the afternoon period, particularly on school days, is a time that provides opportunities for children to be more active. Given that the intervention sought to increase children's physical activity during their unstructured, discretionary time, which is largely outside the hours of the school day, the improvements that occurred during the afternoon were encouraging.

Compared with Oliver, Schofield and McEvoy's study (2006), the effects of this intervention upon children's physical activity displayed significant improvement for a 'whole of sample' statistical analysis. These improvements may reflect the much lower initial levels of physical activity for participants in this study. Only 39% of girls and 33% of boys met 12,000 and 15,000 steps per day guidelines at baseline in this study, whereas 70% of children achieved this in the Oliver study. This may have provided a much greater scope for improvement than observed previously. Other explanatory factors may be the longer duration of this intervention, i.e. six-weeks versus the four-week program used by Oliver, or, due to the additional features of an online virtual walking journey (and associated motivational and feedback instruments) that may have encouraged greater participation.

Web-based physical activity interventions have consistently shown a consistent but small beneficial effect (Dobbins, 2009). The 'effect size' of the improvement for mean 4-day steps from this research was large (Cohen, 1988 commonly used guidelines are 0.01 = small effect, 0.06 = moderate effect, 0.14 = large effect). A range of factors may explain this. Firstly, it is possible that children in middle primary school are particularly responsive to a web-based physical activity intervention. Secondly, it is possible that integration of curriculum activities in combination with the web-based virtual walk of the Great Wall of China has led to a larger effect. Thirdly, it is possible that teacher involvement and encouragement has led to more substantial improvements when compared to interventions that lack the involvement of 'significant others' as is the case in some purely web-based interventions.

The stability of the improvements in children's physical activity levels observed for the intervention group were generally short-lived.  Only mean school day step counts displayed any stability following the intervention with a non significant trend toward higher daily steps for the intervention group.  As illustrated in Figure 2, the increased step counts observed immediately post-intervention for the intervention school, weakened over the 3-month follow-up period but the decline was not statistically significant. Although the failure to sustain increased physical activity levels for the intervention school was disappointing, it is not unexpected as past research indicates that this is common in physical activity interventions generally (Dishman & Buckworth, 1996) and for web-based, physical activity interventions specifically (Vandelanotte, et al., 2007). Most school-based physical activity programs have used interventions that are of longer duration (M  Dobbins, et al., 2009).  It is therefore possible that the 6-week duration of this intervention was not sufficient to habituate the behavioural changes induced by the intervention. Hence, it may be desirable to increase the duration of the intervention beyond six weeks. To achieve this, shorter, but more frequent, integrative units could be scheduled throughout an entire school year to better habituate the changes to physical activity.  This would extend, albeit with reduced intensity, the duration of the intervention whilst avoiding possible over-exposure of the treatment. This possibility aligns with teacher feedback from Study One, and the Davies et al. pilot study (2012), that shorter units may more effectively sustain student enthusiasm and engagement.

The psychosocial correlates of physical activity measured within this research generally displayed little change, possibly due to the high initial levels for all of the Theory of Planned

Behaviour constructs. At baseline, mean values for each construct exceeded 5.2, which indicated a high mean score on a 7-point Likert scale questionnaire. Such high values may have caused ceiling effects and limited the potential for improvement. In addition, the small sample size limited the ability to detect intervention effects. For example, there were generally favourable, albeit non-significant, trends observed in the TPB output data, however the 'effect size' was insufficient to demonstrate significance. This is supported by previous research by Gravel and Godin (2010) that revealed the TPB constructs explained a smaller proportion of the variance of children's participation in physical activities as compared with adults. The smaller explanatory powers of TPB constructs for children's physical activity behaviour may reduce the utility of TPB for studies involving children.

Of the two significant results detected, the improvement in Perceived Behavioural Control for intervention males between baseline and post-intervention was encouraging and aligned with initial expectations. That is, as participants sought to increase their physical activity they would utilize problem-solving strategies to overcome previously perceived constraints or barriers and this would lead to greater PBC. On the other hand, the deterioration in the attitude for intervention females between post-intervention and 3-month follow-up time-points is counter-intuitive and was unexpected. Why a deterioration in attitudes toward physical activity would occur at 3-month follow-up without any evidence of such a trend immediately post-intervention is perplexing. Further research to confirm this effect incorporating qualitative participant interview strategies is recommended based upon these research findings.

Why does integrating physical activity using pedometers with integrated learning activities improve children's physical activity? Children at the primary school level are concrete rather than abstract thinkers and need concrete reasons for persisting in an activity (National

Association for Sport and Physical Education, 2004a). As concrete thinkers, children focus on the 'here and now' and need immediate feedback and evidence of success in engagement if they are to persist for long periods. Pedometers provide this feedback of children's physical activity level. Moreover, children may engage in close monitoring of their performance and set personal step count targets to be achieved through self-selected activities at their preferred time. This may ensure a level of success that is not achievable in the more competitive and athletic tasks that characterize sport and physical education. For this reason, virtual walking challenge type tasks, or, other step count improvement strategies for children, may be more appealing for low-active children, - the very demographic who would most benefit from increased physical activity. It is also likely that children may obtain a better understanding of their current activity status, and the amount of physical activity that is required in order to meet recommended guidelines for physical activity.

Weiss et al. (2000) also notes that interventions designed to enhance perceptions of competence, social support, and enjoyment will result in children increasing their physical activity participation levels. Virtual walking challenges satisfy each of these criteria. By successfully completing the walking tasks that are not dependent upon athleticism or motor skill proficiency, all children can be successful and improve their perceptions of competence. Moreover, social support can be provided by teachers, peers and family members, and enjoyment increased if students self select their preferred physical activities at their preferred time.

**Limitations**

Several factors may limit the generalizability of these research findings. Firstly, the observed power of statistical tests was below the traditionally set 0.80 level. It was hypothesized that this was due to the small sample size of the current study. This was confirmed by using the observed effect sizes and re-computing the estimated sample size using Gpower (Faul, Erdfelder, Lang, & Buchner, 2007). Gpower indicated that a 2-group x 3-time Repeated Measures ANOVA required a sample size of 66 students to observe a statistical difference between groups with an effect size of .10, a power of 0.80 and an alpha level of 0.05. Therefore, the decision to set an alpha level of .10 as the level of statistical significance was justified although this has doubled the likelihood of a Type 1 hypothesis testing error. Further research with substantially larger sample sizes would be desirable to replicate the results that we have reported. Larger sample sizes would also allow greater examination of differences in response to the intervention between genders, and whether low-active participants at baseline displayed greater changes in physical activity. Previous research (M. Oliver, et al., 2006; Sallis, et al., 1997) has shown that physical activity promotion may lead to differential outcomes but it has not been possible to explore this with the small sample sizes in this research.

Children's compliance with the Actiheart measurement protocols was adversely affected as many children developed minor skin reactions to the 3M Red Dot 2560 adhesive tabs. For some children the onset of skin irritation occurred within hours of attaching the adhesive tabs, whereas for other children skin irritation developed gradually over several days. Approximately 10 % of children were adversely affected either acutely or chronically. In both instances, the children were advised to cease wearing the ECG tabs. This was a major impediment to obtaining greater numbers of participants meeting the inclusion criteria for the Actiheart data. This led to a much smaller sample size and is a limitation of this research.

The high dropout rate of participants over the three measurement time-points has increased the likelihood of retention bias. An independent group t-test that compared the participants who 'completed all three measurement activities successfully' against those who 'failed to complete all three measurement activities successfully' found no significant difference between groups at baseline for any of the outcome measures. This suggests that there was no bias in retention based upon physical activity levels. However, with a high dropout rate, other forms of bias may exist. For example, it is possible that a retention bias based upon participants enthusiasm and enjoyment of the intervention. That is, those children who have enjoyed the intervention have sustained participation and commitment to the measurement protocols whilst less enthusiastic participants have withdrawn.

The schools were located in Central Queensland, Australia. The prevailing weather over the duration of this research was typically mild and conducive to outdoor free-play activity. Hence, the opportunity for children to increase their physical activity was likely unaffected by inclement weather. It is likely that climatic considerations in other geographic settings may act as an additional barrier to changing children's physical activity.

This study targeted children in middle primary; i.e. in year levels four and five. Children in these year levels are typically nine and ten years of age. Research indicates that this may be an age group that is particularly responsive to wearing pedometers to monitor their physical activity (Cirignano, Du, & Morgan, 2010). The efficacy of this intervention approach in other age groups is unknown. For example, during Study One, feedback from parents indicated a belief that younger children would not have the cognitive maturity to engage in an extended virtual walking challenge. On the other hand, although older children may have the cognitive maturity, it is possible that other influences during the transitional years of adolescent might limit their enthusiasm and participation in virtual walking challenge activities.

**Recommendations**

As discussed previously, children's compliance with the Actiheart measurement protocol was adversely affected as many children developed minor skin reactions to the 3M Red Dot 2560 adhesive tabs. Moreover, the Actiheart accelerometer also requires good connections between skin, adhesive tabs and the accelerometer terminals to obtain high quality data. This may be difficult to obtain with middle primary children. Therefore, it is not recommended that the Actiheart accelerometer be used as a physical activity measurement instrument for middle primary children, particularly if the measurement period is for an extended period. If the Actiheart accelerometer is to be used with children, hypo-allergenic adhesive tabs should be considered in the future.

This research has demonstrated the effectiveness of integrating a web-based virtual walking challenge within lessons. However, designing high quality integrated lessons or units may be beyond the time or material resources of busy classroom teachers. For this reason, it is recommended that curriculum designers, or, physical activity promotion agencies, assume the responsibility for the development of such materials. With the initial input from experienced teachers, it should be possible to develop a wide range of learning experiences that align with subject syllabi for virtually any education jurisdiction. It should be possible to develop a selection of virtual walking challenges, integrated units, or stand alone lessons from which classroom teachers can then choose 'off the shelf' those that suit their educational purposes.

This research did not attempt to distinguish between the contributions of the various elements of the intervention. Moreover, there has been no attempt to determine if academic learning outcomes were improved because of participation in the intervention. Further research to clarify which elements of the intervention are most effective is warranted, as is, an investigation of the cognitive or social benefits that children derive through participation in such programs.

## Conclusion

This research has demonstrated the effectiveness of integrating a web-based virtual walking challenge within lessons to increase children's physical activity. This was evidenced by meaningful improvements in both average daily step counts, and time spent in vigorous intensity activity particularly during the after-school period. Consequently, further development of integrated physical activity curriculum approaches and resources is recommended as an effective strategy to increase children's daily physical activity. The effect of the curriculum-supported, web-based walking challenge upon children's psychosocial correlates of physical activity was mixed and gender specific.

*Chapter Five*

# SUMMARY, RECOMMENDATIONS AND CONCLUSIONS

## Introduction

Despite widespread awareness of the benefits of a physically active lifestyle, rates of physical inactivity remain elevated amongst children in many developed nations (Abbott, et al., 2007; World Health Organization, 2010). In Australia, many children fail to meet the recommended physical activity guidelines established by the Australian Department of Health and Aging . Consequently, increasing children's physical activity levels is a public health priority in most industrialized nations (Department of Health and Ageing, 2004; World Health Organization, 2010). Schools, due to their access to virtually all children between the ages five and seventeen, are often selected as sites for physical activity promotion as programs may be both prevention and treatment orientated, and are likely to avoid the negative labeling of children (M Dobbins, et al., 2009; Reilly, 2006).

Historically, physical activity promotion programs in schools have mainly focused upon modifying the existing Health Education or Physical Education curriculum to increase the time devoted to physical activity (Kahn, et al., 2002). An alternative approach is to use curriculum integration to increase the children's exposure to physical activity within the curriculum without diminishing the time devoted to core disciplines. Oliver, Schofield and McEvoy (2006) trialed this approach in the New Zealand primary school setting in 2004 and succeeded in improving physical activity levels for less active children.

**Summary of Studies One and Two**

The current research has extended upon the earlier work of Oliver, Schofield and McEvoy (2006) to examine the efficacy of physical activity curriculum intervention using the concept of the *10,000 Steps - Workplace Challenge* as a stimulus for curriculum integration. To achieve this purpose, two inter-related studies were undertaken: - Study One, a feasibility study, and Study Two, - a quasi-experimental efficacy study.

Study One was a formative evaluation to examine the feasibility of integrating a web-supported class-based walking program into the middle primary school curriculum. To achieve this purpose, an experienced year five teacher implemented a class-based walking challenge designed to replicate the core concepts of the *10,000 Steps - Workplace Challenge*. Integrative learning experiences were identified that linked the walking challenge and associated activities with the year five Essential Learnings in Mathematics, Science, Study of Society and the Environment, Technology, English and Health and Physical Education. Study One demonstrated that walking challenges could provide data to inform learning experiences for effective cross-curricular integration, and confirmed the utility of cross-curricular integration in terms of 'value adding' to the children's participation in walking challenges.

Study One outcomes were formalized into a package of twelve lessons that linked with a range of Key Learning Area syllabi. In addition, in order to achieve greater curriculum integration (i.e. curriculum links with Study of Society and Environment), online resources for a virtual walk of the Great Wall of China were developed. The resources were targeted at middle primary school children and were designed to build upon the public interest in China during the lead up to the Beijing Olympics in 2008.

The content of the twelve lessons and the design of the web-based virtual walk aligned with the core concepts of the Theory of Planned Behaviour (Ajzen, 1991). Together, the package of twelve prepared lessons and the web-supported virtual walk of the Great Wall of China formed the resource materials for the intervention that was the focus of Study Two.

Study Two was designed to answer the following question:

> Would a 'curriculum supported and web-based walking challenge' (the intervention) increase children's *physical activity* and *psychosocial correlates of physical activity* over a six-week period and would any increase be maintained at 3-month follow-up?

To achieve this purpose, a quasi-experimental design with a non-equivalent comparison group was used. The outcome variables *physical activity* and *psychosocial correlates of physical activity* were measured at baseline (week 1), post-intervention (week 8) and at 3-month follow-up (week 20).

The participants for this study were drawn from middle primary classes at two local primary schools in Central Queensland, Australia. Children's physical activity was measured using two objective instruments: - a pedometer and the Actiheart accelerometer. Mean 4-day, school day and weekend day step counts were obtained from the pedometer data. Mean percentage time spent in sedentary, light, moderate and vigorous physical activity categories for the whole-day and afternoon periods (3 – 6 pm.) were obtained from the Actiheart accelerometer data. The psychosocial correlates of physical activity were measured using the TPB constructs of Attitude, SN, PBC, and Intention to participate in physical activity.

To determine the effect of the intervention, statistical analysis utilized a (2) School (intervention vs. comparison) X (3) Time (baseline, post-intervention, 3-month follow-up) Repeated Measures ANOVA for pedometer and TPB outcome variables. Due to poor compliance with the Actiheart measurement protocols at 3-month follow-up, a (2) School (intervention vs. comparison) X (2) Time (baseline vs. post-intervention) Repeated Measures ANOVA was utilized for all Actiheart accelerometer determined variables. Due to the generally small sample sizes obtained for the pedometer, Actiheart accelerometer and TPB data the statistical power was reduced. Accordingly, an alpha level of 0.10 rather than the conventional 0.05 level was set as the level of significance for School x Time effects for this research. Significant School x Time effects were subsequently analyzed using separate groups repeated measures ANOVA to detect differences across time-points for each school, and independent sample t-tests to determine differences between schools at each time-point.

Mean daily step counts over 4-days (i.e. Friday to Monday inclusive), were calculated for children who satisfied inclusion criteria for all measurement periods. Changes in mean 4-day step counts revealed significant School x Time effects between baseline and post-intervention ($p = 0.05$) and between post-intervention and 3-month follow-up ($p = 0.08$). Subsequent analysis revealed significant differences between schools occurred at post-intervention only with intervention children exceeding comparison children by 3,125 steps per day. When the four measurement days were separated into school days and weekend days, differences in physical activity responses were detected. Mean weekend step counts mirrored the pattern of mean 4-day step counts with a significant increase for intervention children between baseline and post-intervention ($p = 0.01$) followed by a significant decrease between post-intervention and 3-month follow-up (p = 0.03). For mean school day steps, a School x Time effect occurred between baseline and post-intervention only (p = 0.03).

From the Actiheart accelerometer data, a significant School x Time effect was detected during the afternoon period (3-6pm) for percentage time spent in vigorous physical activity (p = 0.07). Between baseline and post-intervention, the comparison school declined from 9.18% to 4.82% (p = 0.02) whilst the intervention school remained stable. Further dissection into school days and weekend days revealed that the interaction effects were only significant for school days (p = 0.08).

The improvements in mean 4-day, weekend and school day steps observed immediately following the intervention declined and were not maintained at 3-month follow up. However, a tendency for school day steps counts to remain elevated for intervention children (albeit not achieving statistical significance) at the 3-month follow-up suggests that there may be better sustainability of school day physical activity which warrants further investigation.

The Theory of Planned Behaviour constructs generally displayed little change due to the intervention. However, two gender specific interactions were detected. For boys, a School x Time interaction occurred for PBC between baseline and post-intervention (p = 0.04). This was attributable to a decrease for comparison boys from 6.11 (SD = 0.79) at baseline to 5.46 (SD = 1.16) at post-intervention (p = 0.02). For girls, a significant School x Time interaction occurred for attitude between post-intervention and 3-month follow-up (p =.07). This was attributable to a decrease for intervention girls from 5.83 (SD = 1.17) at post-intervention to 5.08 (SD = 1.23) at 3-month follow-up (p = 0.03).

Study Two demonstrated that a curriculum-supported, web-based walking challenge could improve children's physical activity. This was evidenced by meaningful improvements in pedometer step counts, and a beneficial effect upon time spent in vigorous intensity activity during the after-school period. For all pedometer assessed outcome variables, the intervention effects were consistently within the moderate to large effect size (Cohen, 1988).

**Limitations.**

Several factors may limit the generalizability of these research findings. Firstly, due to the generally small sample sizes, the power of the research has not met the traditional 0.80 level. Therefore, the decision to set an alpha level of 0.10 as the level of statistical significance has doubled the likelihood of a Type 1 hypothesis testing error. Further research with substantially larger sample sizes would be desirable to replicate the results that have are reported in this thesis.

The schools were located in Central Queensland, Australia. The prevailing weather over the duration of this research was typically mild and conducive to outdoor free-play activity. It is likely that climatic considerations in other geographic settings may act as an additional barrier to changing children's physical activity.

The year levels targeted for this research comprised years four and five; i.e. the middle primary years. Research indicates that this may be an age group that is particularly responsive to wearing pedometers to monitor their physical activity (Cirignano, et al., 2010). The efficacy of this intervention for other age groups is unknown.

Children's compliance with the Actiheart measurement protocols were adversely affected when many children developed minor skin reactions to the 3M Red Dot 2560 adhesive tabs. This limited the number of participants who met the inclusion criteria for the Act heart data and in turn led to a much smaller sample size than envisaged.

**Strengths of the Research**

School based decision-making has been pivotal to curriculum delivery in Queensland. It has allowed state mandated syllabi to be modified to suit the unique needs of local communities and schools. It is equally true that curriculum packages, or programs, are enacted differently from school to school. Therefore, 'what gets taught' and 'how it gets taught' in primary classrooms is determined locally either by the school principal, the designated 'Head of Curriculum' or individual classroom teachers. For this reason, the twelve-lesson curriculum package that accompanied the Great Wall of China virtual walk allowed the classroom teachers discretion in how to implement, modify and extend in any manner that suited their educational needs. A formal process evaluation was not conducted as part of this research study to ensure that intervention teachers implemented the twelve lesson plans 'as written and as sequenced'. In fact, it is unlikely that the intervention school would have agreed to be involved in the research project if this were a strict research requirement. However, the engagement with the Great Wall of China virtual walk was a non-negotiable element of the intervention implementation. Student login data accessible through the *10,000 Steps* website confirmed that this occurred.

It is both a weakness and strength of the research project that teacher discretion for the delivery of the twelve lessons has occurred. From a negative perspective, the failure to observe strict adherence to the implementation of all twelve lessons 'as written and as sequenced' allows criticism in regards the fidelity of the intervention. From a positive perspective, the use of teacher discretion to modify and sequence lessons to suit their unique learning needs reflects real world practice. Whilst cognizant of these conflicting perspectives, the decision to favour 'real world practice' and increase the generalizability of the research findings to other school settings was taken.

**Future Recommendations**

Although this research has demonstrated the feasibility of integrating physical activity within lessons that align with the mandated Queensland syllabi, designing high quality integrated lessons or units may be beyond the time or material resources of busy classroom teachers. For this reason, it is recommended that curriculum designers, or, physical activity promotion agencies, assume the responsibility for the development of such materials. With the initial input from experienced teachers, it should be possible to develop a selection of virtual walking challenges, integrated units, or stand alone lessons from which classroom teachers can then choose 'off the shelf' those that suit their educational purposes. Therefore, it is recommended that further work in this area focus on the development of an online repository of lesson plans that allow effective cross-curricular integration.

The six-week duration of the intervention was insufficient to habituate children's physical activity to achieve any sustained increase at 3-month follow-up. It is therefore recommended that a series of four short (4 -6 week) integrated physical activity units be dispersed throughout the school year to increase children's exposure to the treatment which may in turn lead to more sustained effects.

This research did not attempt to distinguish between the contributions of the various elements of the intervention. Moreover, there has been no attempt to determine if academic learning outcomes were improved because of participation in the intervention. Further research to clarify which elements of the intervention are most effective is warranted, as is, an investigation of the learning benefits that children derive through participation in such programs.

The 10,000 Steps website primarily targets adults to promote increased physical activity by accumulating 10,000 steps each day. To better cater for children and school groups who may access the repository of virtual walks, it is recommended that age specific promotional materials be developed to avoid confusion between child, adolescent and adult physical activity guidelines.

**Conclusion.**

This research has shown that it is feasible to integrate Mathematics, English, Technology, Studies of Society and the Environment, and Health and Physical Education learning outcomes from the Queensland syllabi using children's personal pedometer data (Study One), and that participation in a curriculum-supported, web-based walking challenge improved children's daily physical activity levels (Study Two). This was evidenced by meaningful improvements in pedometer step counts and a beneficial effect upon time spent in vigorous intensity activity particularly during the after-school period. Consequently, further development of integrated physical activity curriculum approaches and resources is recommended as an effective strategy to increase children's daily physical activity.

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## Appendix 1 – Application to Conduct Research

**Application**

**TO CONDUCT RESEARCH**

**IN**

**Brisbane Catholic Education SCHOOLs**

**ARCHDIOCESE OF BRISBANE**

| |
|---|
| Principal researcher contact details<br><br>Name: Dr. [redacted]<br><br>Address: Faculty of Sciences, Engineering and Health.<br>CQU, Building 17,<br>Rockhampton, Qld.<br>4702<br><br>Telephone: [redacted] Fax: [redacted]<br><br>E-mail address: [redacted]@cqu.edu.au |
| The supervisor(s) of your research programme<br><br>Name: [redacted]<br><br>Address: Faculty of Arts, Humanities, and Education,<br>CQU, Building 33<br>Rockhampton, Qld.<br>4702.<br><br>Telephone: [redacted] Fax: [redacted]<br><br>E-mail address: [redacted] |

Are you a current employee of Brisbane Catholic Education

☐ Yes ☒ No

If yes, please provide your Employer ID number:

The title of your research project:

**An exploratory study to identify cross-curricular linkages of a class-based walking challenge administered by a classroom teacher at the year 5 level.**

A brief overview of the research project, describing in particular the research procedures and the extent of student, teacher and parental involvement in the project.

This exploratory study will identify potential cross-curricular linkages of a class-based walking challenge administered by a classroom teacher at the year 5 level. These cross-curricular linkages will then inform the design and development of resources to be incorporated into a more substantial study titled; "*An examination of the efficacy of an 'integrated curriculum and class-based walking challenge' to enhance selected psychological determinants of, attitudes towards, and participation of, children in voluntary ambulatory physical activity*". This particular research project will be undertaken in 2007 and is described fully in an attached appendix.

The researchers firmly believe that the effectiveness and longevity of any curriculum initiative that is imposed upon classroom teachers is directly related to perceptions of relevance, convenience and accessibility. The proposed '*integrated curriculum and class-based walking challenge*' to be developed from this exploratory study will aim to increase children's voluntary physical activity level through well designed class activities that achieve multiple Core Learning Outcomes across multiple Key Learning Areas. It is a primary aim of the research team that the proposed curriculum intervention eases rather than adds to the congested curriculum phenomena that many classroom teachers experience. Accordingly, this initial study is considered critical for the identification of potential cross-curricular linkages and the subsequent design of 'integrated curriculum and class-based walking challenge' resource materials.

The exploratory study will require that children in a selected year 5 class engage in a class-based walking challenge. The challenge seeks to apply the core concepts of the highly successful Rockhampton 10000 Steps Workplace Challenge to a primary school setting. The core features of the Challenge Concept are:

1. Form teams within workplace / class / school (recommended 10 people)
2. Wear pedometers and accumulate steps as a team
3. Record step count on website to complete virtual walking journeys
4. Workplaces/schools can choose from existing journeys or create their own
5. Track the workplace and team progress on the interactive 10,000 Steps website
6. Individual Goal – increase current physical activity and reach personal goals for the

challenge

7. **7.** Team Goal – to work as a team to complete the selected 'virtual' journey This is a group or class activity and encourages a supportive and cooperative approach to group achievement. The online resources are located at http://10000steps.org.au/?page=workplaces/index

The research project will require children to wear a hip mounted pedometer to record daily step counts for the entire school day for the duration of the third school term. Daily step count totals will be entered by the class teacher onto the Rockhampton 10000 Steps website. Individual and group feedback will be provided in regards progress to predetermined goals. The use of pedometers (an accurate but inexpensive means of immediate behavioural feedback), the motivational aspects of pedometers, and the group orientated nature of the activity and the associated 'esprit de corps' that develops should increase children's voluntary physical activity level. This is a primary aim of the study. Notwithstanding this important outcome, the step count data obtained and the achievement of milestones along a virtual journey will be used to achieve other teacher determined curricular outcomes.

Other than actually wearing the pedometer and the small amount of time required collating individual student daily step counts, it is not envisaged that any additional disruption to normal class activity will occur. For example, it is NOT envisaged that the class teacher undertake additional physical activity or physical education lessons with their students.

For students, the expectation is that they would apply their personal pedometer as soon as practicable in the morning and remove as late as practicable in the evening to obtain accurate daily step counts. Children will need to record their daily step count prior to resetting for the following day. Since the ultimate aim of the research is to increase children's voluntary physical activity level, it is not the researcher's intention that children feel obliged or coerced into further physical activity.

For parents, guardians and caregivers, the impact of the research project should be minimal, however, their assistance to encourage and prompt children's observance of the wearing and recording protocols of the pedometers would be particularly helpful.

For the teacher involved in this research, it will be necessary to engage in two meetings. The first, preceding the delivery of the walking challenge, will be a planning and organization session. The second, following the walking challenge, will be a feedback and evaluation session. The teacher will also need to enter step count information to the interactive website on a regular basis or allocate this role to students.

A brief description outlining the benefits of the research to the participants. For example, how will teachers and students benefit from your research? Please specify any long term and more general benefits to the Brisbane Catholic Education community understanding of educational processes.

The immediate benefit for the selected class should be an increase in their voluntary physical activity level. Given the widely publicised concern with increasing prevalence of childhood overweight and obesity this is a very positive outcome. Both through the walking challenge and associated curricular activities, children should also acquire additional knowledge, values and attitudes conducive to increased physical activity and good health.

In a broader sense, the benefit of this research is its capacity to inform curriculum design of 'an integrated curriculum and class-based walking challenge' suitable for the primary school setting. Given the proven success of adult oriented walking challenges aimed at the workplace (unpublished evaluation study), there is great merit in the development of age appropriate and curriculum aligned interventions of a similar type for the primary school sector. This is an ambitious curriculum design endeavour, but if successful, has the potential through dissemination state wide to enhance physical activity participation of many middle primary school children.

A brief description of the research design and methodology and any strategies to be employed to ensure validity and reliability. Copies of data collection instruments, and surveys where available, should be attached.

This is a qualitative research project that will utilize semi-structured interview technique to identify cross-curricular linkages of a class-based walking challenge delivered by a class teacher of year 5 students. A willing, enthusiastic and creative teacher has been approached and has agreed to undertake the research project. Tentative approval has also been obtained from school administrators to conduct the research and provide the necessary resources: i.e. a class set of pedometers.

For this particular research, the walking challenge itself is not the focus of the study. Rather, it is the experience of the class teacher whilst delivering the walking challenge and the ideas for curricular integration that are generated that are of most interest. This type of research outcome is most usefully acquired through in-depth semi-structured interview technique.

Issues of validity and reliability will be addressed by ensuring that the semi-structured interview is recorded using tape recorder. The interview will be transcribed and analysed for major themes and/or outcomes. A summary of the analysis will be provided for the teacher to confirm the researcher's interpretation, or to clarify any points of possible confusion.

A letter outlining the nature of the research must accompany approaches to principals seeking approval to conduct research in respective schools for which they are responsible and the commitment required of the school personnel. A copy of this letter must be included with the proposal.

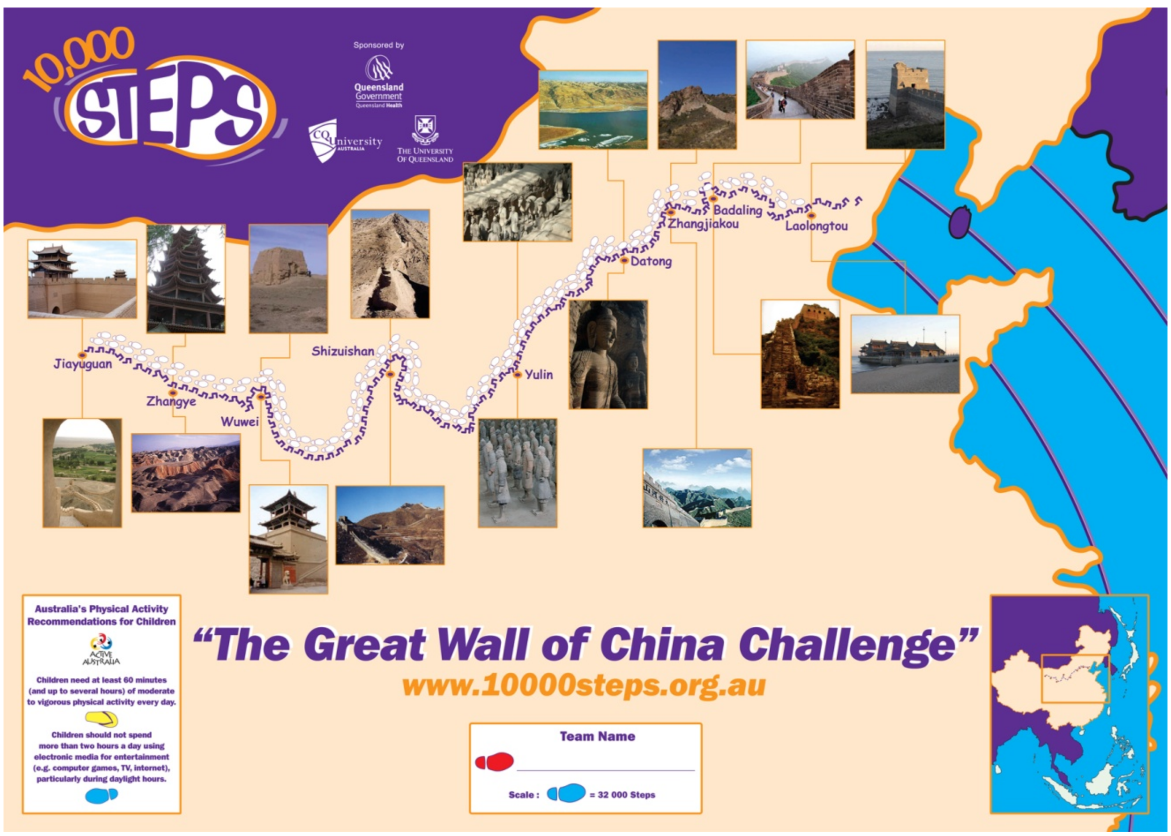
Specify how you intend to obtain parental approval and include examples of permission letters/consent forms.

Parental approval will be obtained through an explanatory letter that would be sent home by direct mail. The letter would require that parents sign and return indicating their consent for the research project. The explanatory letter will provide basic details of the walking challenge, its purpose and subsequent expectations of children in terms of wearing their pedometer. The explanatory letter would also invite parents to an information session should further clarification be required at a time deemed convenient for parental attendance. The classroom teacher and research supervisor would

| |
|---|
| jointly present this session. |
| Provide details of compliance with the *Commission for Children and Young People and Child Guardian Act 2000* by providing evidence of possession of a Working with Children Check Suitability Card or evidence that a Working with Children Suitability Card (blue card) is not required.<br><br>The classroom teacher is registered with the Queensland College of Teachers. The research supervisor has Queensland College of Teachers registration (625 174). The research supervisor should not have direct contact with children in this research study. |
| Provide details of procedures for establishing confidentially and procedures for protecting privacy of the participants including information management practices. Information should only be collected for the purpose of the research application. Any subsequent use of information must be clearly outlined in your application and must have ethical approval from a university ethics committee. |
| List in some detail, the schools or groups that will be requested to participate in the research. Include the name of the school and the suburb.<br><br>Mr [redacted], grade 5 teacher at [redacted] has agreed to undertake this research project if approved.<br><br>Administrative support from the [redacted] Primary School leadership team has already been indicated through a verbal approval to purchase a class set of pedometers to be used throughout the research project. The pedometers will remain the property of the College and will used as a class set for similar class activities in the future. |
| Indicate the period of the year during which the research activity will commence and be concluded.<br><br>The research will be conducted during the third school term of this year, i.e. July 10$^{th}$ to Sept. 22. |
| All applications must be signed and dated by the principal researcher. |
| The signature of the supervisor, head of university department, director of the research agency, employing authority or tertiary institution must be included to verify the details of the research proposal. |
| Please attach a copy of the Ethical Clearance approval from the University's Ethics Department. |

**Appendix 2 – Wall Chart of Great Wall of China virtual walk.**

This map is displayed on the 10000 Steps website and provides a visual representation of an individual's or team's progress toward their destination. As participants progressed from Jiayuguan (the beginning) to Laolongtou each footprint was 'coloured in' to represent the completion of 32,000 steps. At each significant milestone participants received an electronic postcard that provided either historical, cultural or geographic information of that area. Motivational feedback was also provided to encourage progress to the next milestone.



**Appendix 3 – Electronic Postcards 1 and 2.**

Electronic Postcard No. 1 sent from Jiayaguan Pass- The start of the Great Wall of China


Electronic Postcard No.2 sent from Zhangye

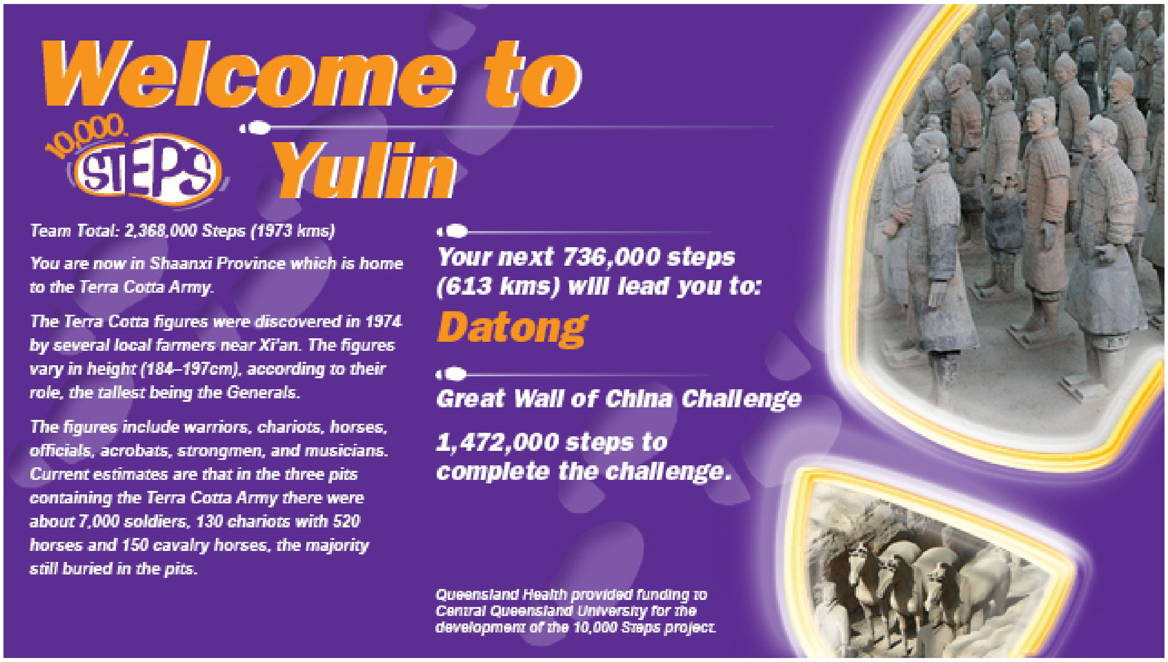
**Appendix 4 – Electronic Postcards 3 and 4.**

Electronic Postcard No. 3 sent from Wuwei.


Electronic Postcard No. 4 sent from Shizuishan.

## Appendix 5 – Electronic Postcards 5 and 6.

Electronic Postcard No. 5 sent from  Yulin.




Electronic Postcard No. 6 sent from  Datong

**Appendix 6 – Electronic Postcards 7 and 8.**

Electronic Postcard No. 7 sent from Zhangjiakou


Electronic Postcard No. 8 sent from Bandaling

**Appendix 7 – Electronic Postcard 9.**

Electronic Postcard No. 9 sent from Laolongtou - The end of the Great Wall of China virtual walk.

## Appendix 8 – Learning Experience Plan 1

| **Year Level:** | **Duration:** | **Focus/Topic:** |
|---|---|---|
| 5 | 30 - 40minutes | Introduction to Pedometers |

**Lesson Goal / Objective**
To familiarize students with pedometers, their operation, correct use, how to wear, and allow an opportunity to experiment.

**Core Learning Outcome/s:**
- Health and Physical Education PA 3.4. Students suggest how people and the availability of facilities influence choices relating to physical activities. (by provision of equipment and apparel and through role modelling and through personal involvement).

**Intended Learning Outcome/s:**

Students: (declarative/know)
- Understand how a pedometer works, functions.
- Understand how to avoid getting erroneous data.

Students: (procedural/do)
- Place pedometer correctly.
- Open and close and read data.

| **All resources required for lesson:** | • Personal pedometer for each student and teacher. |
|---|---|

| **Time** | **Learning Processes (Eg. Teacher talk/methods & Strategies/supporting diagrams, etc)** | **Teaching Considerations &/or Resources for each activity** | **Assessment** |
|---|---|---|---|
| <br>2 mins | *Introduction/Orientation*<br>Activity 1 Teacher led discussion re:<br>What a pedometer does – measure steps taken by measuring hip displacement for each step during normal walking / running. To achieve this purpose accurately, the pedometer must be placed 'in the right spot' to measure hip movement. | Individual pedometer required for all of these activities. | |
| 2 mins | Activity 2 Distribute pedometers<br>Have students play / experiment / shake pedometers.<br>Discuss the effect the effect of improper use on accurate | | |

| Time | Learning Processes<br>(Eg. Teacher talk/methods & Strategies/supporting diagrams, etc) | Teaching Considerations &/or Resources for each activity | Assessment |
|---|---|---|---|
| <br><br><br>2 mins<br><br><br><br><br>10 mins<br><br><br><br><br><br><br>3 mins | measurement. (i.e. - will not provide true and accurate measure of steps taken).<br><br>Activity 3 Demonstrate how to attach<br>On hip, - on top of front of thigh.<br>How to attach safety belt and the importance of this; i.e. - prevents damage should the pedometer dislodge from lip of pants/short/skirt.<br><br>*Enhancing Phase*<br>Activity 4 Go for class walk<br>Have students predict number of steps to be taken to a predetermined destinations; i.e. - around oval, to a tree, approx 100 metres. Perform 3 times over varying distances. Students practice\se resetting pedometer after each activity.<br><br>Activity 5<br>At completion, have class discussion to examine differences in step counts obtained.  What would account for the differences between participants (i.e. step cadence variations), and predictions and actual measured steps?<br><br>Through this activity let students be inquisitive, to experiment and remove the novelty factor and encourage a sense of honest performance.<br><br>Encourage students to more accurately predict their steps over short distances. | | |
| 10 mins | Activity 6<br>Students walk and then run over the allotted distance to investigate changes in step counts between walking and running. | | |

| Time | Learning Processes<br>(Eg. Teacher talk/methods & Strategies/supporting diagrams, etc) | Teaching Considerations &/or Resources for each activity | Assessment |
|---|---|---|---|
| 5 mins | <u>Synthesizing Phase - Debrief</u><br>Question students why step count varies between walking and running (i.e. increase in cadence and stride length with running).<br><br>Check for understanding re:<br>1. Use<br>2. Placement<br>3. Care and maintenance<br><br>Discuss how to obtain accurate step counts.<br>Introduce general concept of 'pedometer etiquette'. That is, caring for and using a pedometer in a way that allows it to operate normally and provide accurate feedback / results / information. | | Can students state:<br>• purpose of pedometer.<br>• correct placement position.<br>• when to be removed to avoid damage.<br>• show how to reset the pedometer.<br>• why individual variations occur. |

## Appendix 9 – Learning Experience Plan 2

| **Year Level:** | **Duration:** | **Focus/Topic:** |
|---|---|---|
| 5 | 40 - 45minutes | Averaging |

**Lesson Goal / Objective**

For students to ascertain their average walking step length.

**Teacher Considerations / Teacher Notes:**

Depending upon resources available, this lesson may be completed in parts, e.g. Average revision in the morning, engage in group step count activities throughout the day, and final calculation activities upon completion of earlier activities.

**Core Learning Outcome/s: - Math**

M 3.1 Students identify and use equivalent forms of standard units when measuring, comparing and ordering, and estimate using a range of personal referents.

N 3.2 Students identify and solve addition and subtraction problems involving whole number and decimal fractions in context.

N 3.3 Students identify and solve multiplication and division problems involving whole number and decimal fractions in context.

**Intended Learning Outcome/s:**

Students: (declarative/know)

- Relationship between equivalent forms of standard units.

Students: (procedural/do)

- Perform averaging calculations.
- Measure using standard units.

| **All resources required for lesson:** | • Measuring tapes with centimetres marked.<br>• Calculators. |
|---|---|

| Time | Learning Processes<br>(eg. Teacher talk/methods & strategies/supporting diagrams, etc) | Teaching considerations &/or<br>Resources for each activity | Assessment |
| --- | --- | --- | --- |
| 5 mins | <u>Introduction/Orientation</u><br><br>Review of concept of 'average'. Reinforce the concept of average as a value which can be used to predict future events. E.g - average rainfall, average scores. Knowing an average step length will allow students to predict and calculate future distances walked.<br><br><u>Enhancing Phase</u> | | |
| 15 mins | <u>Activity 1</u><br>In small groups of 4-5, children measure in centimetres the distance covered in 10 normal steps. Use group members to ensure 10 steps only taken.<br><br>Students then divide this number by 10 to obtain their average normal step length. Convert this into metre scale.<br><br><u>Activity 2</u><br>Use the individual data obtained by each group member to calculate a group average. | 15 metre measuring tape with cms marked. One per group. | |
| 5 mins | <u>Activity 3</u><br>Collate the values for each group to calculate a class average for step length. | Calculators may be necessary for this task. | |

| Time | Learning Processes<br>(eg. Teacher talk/methods & strategies/supporting diagrams, etc) | Teaching considerations &/or<br>Resources for each activity | Assessment |
|---|---|---|---|
| 5 mins<br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br>5 mins | ** A class step length average in metres is preferable when setting class goals and determining class steps required to walk to a destination as well as calculating distance covered from class step counts.<br><br><u>Activity 4</u><br>If time permits, Activities 1-3 could be repeated but use 'normal running' as the activity mode.<br><br><u>Synthesizing Phase / Review</u><br><br>Question students to:<br>• Identify the key concept of averaging; i.e. adding samples of data and then dividing by the number of samples.<br><br>• Relationship between units of measurement. How many centimetres in 1 metre. How many metres in 900 cms? How many centimetres in 0.80 metres? | | Can students state the process of averaging.<br>Can students identify relationship between equivalent forms of standard units. |

## Appendix 10 – Learning Experience Plan 3

| **Year Level:** | **Duration:** | **Focus/Topic:** |
|---|---|---|
| 5 | 40 | Determining Distance |

| **Lesson Goal / Objective** |
|---|
| To use pedometer data and average step length to determine distance. |

| **Core Learning Outcome/s: - Math** |
|---|
| N 3. 3 Students identify and solve multiplication and division problems involving whole number and decimal fractions in context. |

**Intended Learning Outcome/s:**

Students: <u>(declarative/know)</u>

Students: <u>(procedural/do)</u>

- Calculate distance covered knowing their average step length and step count.
- Place pedometer correctly.
- Open and close and read data.

| **All resources required for lesson:** | • Personal pedometer for each student and teacher.<br>• Calculator. |
|---|---|

| **Time** | **Learning Processes (eg. Teacher talk/methods & strategies/supporting diagrams, etc)** | **Teaching considerations &/or Resources for each activity** | **Assessment** |
|---|---|---|---|
| 5 mins | <u>Introduction / Orientation.</u><br><br>Teacher led discussion to recap lesson 1. Address pedometer etiquette. What does a pedometer measure? How do you obtain an accurate figure for number of steps taken per day? Anticipated response - Wear the pedometer correctly and attach as soon as feasible in the morning and remove prior to sleeping at night. Pedometer to be removed if it is likely to get wet (i.e. – | | |

| Time | Learning Processes<br>(eg. Teacher talk/methods & strategies/supporting diagrams, etc) | Teaching considerations &/or<br>Resources for each activity | Assessment |
|---|---|---|---|
| | not waterproof) and removed for combative activities where it could be damaged. Use safety cord to prevent accidental falls.<br><br>Have students recall what was their average step length (in metres) for this activity.<br><br><u>Enhancing Phase</u><br><u>Activity 1</u><br>Students participate in a guided structured walk to a predetermined destination. Walk to location. Upon return to classroom, students record total number of steps. | | |
| 15 mins | Teacher using their own step count data models the multiplication process to calculate distance covered. Eg. 0.9m (step length) multiplied by 500 (number of steps taken) equals 450 metres.<br><br>Student perform using own data. | Pedometer correctly attached needed by each student and the teacher.<br><br>Important that pedometers are reset to 0 at start. | |
| 5 mins | <u>Activity 2</u>.<br>Compare results? Discuss discrepancies. Expect to see uniformity. Emphasize that the calculation is a distance in metres. | | |
| 5 mins | What factors might account for variations? i.e.<br>• Incorrect placement of pedometers so it fails to record accurately. | | |

| Time | Learning Processes<br>(eg. Teacher talk/methods & strategies/supporting diagrams, etc) | Teaching considerations &/or<br>Resources for each activity | Assessment |
|---|---|---|---|
| <br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br>5 mins<br><br><br><br><br><br><br>5 Mins | • Failure to reset and conclude step counts accurately.<br>• Variation in walking stride from day to day. May vary slightly due to energy levels etc.<br><br><u>Activity 3</u>.<br>Repeat activity in small groups to self-selected targets (i.e. approx 100 metres away). Have each student within group calculate distance and compare with other group members to compare accuracy of calculations. Remind students to reset prior to each episode.<br><br><u>Synthesizing Phase</u><br><br><u>Activity 4</u>.<br>Have students report findings to the class as individuals and as groups.<br><br><u>Review</u><br>Have a student demonstrate correct placement of pedometer. Question class of correct etiquette for ensuring accurate step counts for whole day activity. Specific questions might be:<br>• When should you place the pedometer on at the beginning of the day?<br>• For what types of activities should pedometer be removed?<br>• How do you reset the pedometer? | | Can students calculate distance covered knowing their average step length and step count? |

## Appendix 11 – Learing Experience Plan 4

| **Year Level:** | **Duration:** | **Focus/Topic:** |
|---|---|---|
| 5 | Completed over the school day | Data collection, filling in step log and establishing routines |

| **Lesson Goal / Objective** |
|---|
| To model correct use of Step Log diary and establish routine of recording steps. |

| **Core Learning Outcome/s:** |
|---|
| Maths: CD 3.2 Students design and trial data collection methods and use existing sources of data.<br>N 3.3 Students identify and solve multiplication and division problems involving whole number and decimal fractions in context.<br>N 3.2 Students identify and solve addition and subtraction problems involving whole number and decimal fractions in context. |

| **Intended Learning Outcome/s:** | |
|---|---|
| Students: <u>(declarative/know)</u> | Students: <u>(procedural/do)</u><br>• Fill in Step Log.<br>• Collect and organise data. |

| **All resources required for lesson:** | • Personal pedometer for each student and teacher. Fictitious data for step logs. Step log sheets |
|---|---|

| **Time** | **Learning Processes (eg. Teacher talk/methods & strategies/supporting diagrams, etc)** | **Teaching considerations &/or Resources for each activity** | **Assessment** |
|---|---|---|---|
| | <u>Introduction / Orientation</u> | | |
| 10 mins | <u>Activity 1</u><br>Teacher led discussion re:<br><br>Purpose of step log to:<br>• Record numbers of steps for each day.<br>• Determine distance covered by each student. | | |

| Time | Learning Processes<br>(eg. Teacher talk/methods & strategies/supporting diagrams, etc) | Teaching considerations &/or<br>Resources for each activity | Assessment |
|---|---|---|---|
| <br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br>10 mins | Teacher demonstrates / models how to fill in logbook with improvised values. Draw students' attention to need for accuracy for reporting step counts.<br><br>Need to discuss the need for 'step equivalents' for those activities which cannot be measured by pedometers, i.e. combative activities, aquatics, roller-blading and cycling etc.<br><br><u>Enhancing Phase</u><br><br><u>Activity 2</u><br>Provide 2 step-log templates and fictitious data and children complete one of the templates. For example, Fred on day 1 was active for 15 minutes at Morning Tea playing touch football, 30 minutes at lunchtime at training, and after school went to swimming training for 60 minutes. Pedometer reading was 6340 at the designated reset time.<br><br>Once students have completed using fictitious data, continue using personal data.<br><br>As appropriate throughout the school day (possibly after activity breaks) have students complete their step log. This will establish the routine required throughout the walking challenge. | ** An accepted equivalence for moderate to vigorous activities that do not lend themselves to participants wearing pedometers is 100 steps / minute. If more accurate equivalence comparisons are required refer to site: | <br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br>Can the students complete the Step Log diary accurately? |

## Appendix 12 – Learning Experience Plan 5

| **Year Level:** | **Duration:** | **Focus/Topic:** |
|---|---|---|
| 5 | Ongoing throughout the school day | Understanding Virtual Walks |

| **Lesson Goal / Objective** |
|---|
| To engage students in a virtual walking challenge. |

| **Core Learning Outcome/s: - Math** |
|---|
| MATH; N 3.3 Students identify and solve multiplication and division problems involving whole number and decimal fractions in context.<br>CN 2.2 Students collect and organise data.<br>SOSE: PS 2.4 Students make and use simple maps. |

| **Intended Learning Outcome/s:** | |
|---|---|
| Students: <u>(declarative/know)</u><br>• The importance of accuracy in their calculations. | Students: <u>(procedural/do)</u><br>• Can organise data into a step log.<br>• Perform calculations to determine daily and step count totals. |

| **All resources required for lesson:** | • Map, pencil and paper, calculator, pedometers and step logs. |
|---|---|

| **Time** | **Learning Processes (eg. Teacher talk/methods & strategies/supporting diagrams, etc)** | **Teaching considerations &/or Resources for each activity** | **Assessment** |
|---|---|---|---|
| 2 mins | <u>Introduction / Orientation</u><br><br><u>Activity 1</u><br>Indicate that the aim today is to do a 'virtual' class walk. The intent is to see how far the class can travel collectively during the school day.<br><br><u>Enhancing Phase</u> | • Pedometer for each student.<br>• Referdex street map of proposed journey.<br>• Step Log diary. | |

| Time | Learning Processes<br>(eg. Teacher talk/methods & strategies/supporting diagrams, etc) | Teaching considerations &/or Resources for each activity | Assessment |
| --- | --- | --- | --- |
| <br><br><br>10 mins<br><br><br><br><br><br><br>5 mins<br><br><br><br><br><br><br><br><br><br><br>5 mins | <u>Activity 2</u><br>Provide each student with a street map (i.e. Referdex) of the proposed journey. Must have a scale.<br><br>Guide class discussion to decide on an origin and destination. What would be achievable as a class walk within one school day? How many steps during morning recess? Lunch etc?<br><br>Students to use scale to determine distance between the two in kilometres.<br><br>Convert kilometres into metres and then divide by the class average step length (calculated in previous lesson) to determine the number of steps required by the class to reach the destination.<br><br>Have children predict the amount of time for the class to reach the destination. * This is best as a cumulative class walk as progress will be much quicker.<br><br>Have class map the progress toward destination at various intervals, i.e. after morning tea, lunch or any time they are completing step log.<br><br>As class progresses along the virtual journey, discuss relevant landmarks so they can visualize the journey.<br><br><u>Synthesizing Phase / Debrief</u>.<br><br>Were you surprised at how far you went in a day? | | Can students:<br>• Organise data into a step log.<br>• Perform calculations to determine to determine daily |

| **Time** | **Learning Processes (eg. Teacher talk/methods & strategies/supporting diagrams, etc)** | **Teaching considerations &/or Resources for each activity** | **Assessment** |
|---|---|---|---|
| | Home task: What would be another achievable destination? | | and step count totals. |

## Appendix 13 – Learning Experience Plan 6

| **Year Level:** | **Duration:** | **Focus/Topic:** |
|---|---|---|
| 5 | Ongoing throughout the day | Virtual walk integrating mapping skills |

**Lesson Goal / Objective**

Continuation of previous lesson using Internet (RACQ) website to determine precise distances between locations.

**Core Learning Outcome/s:**

- SOSE: PS 2.4 Students make and use simple maps.
- TECHNOLOGY: INF 2.2 Students use simple techniques for accessing and presenting information for themselves and others.

**Intended Learning Outcome/s:**

Students: (declarative/know)

Students: (procedural/do)

- Calculate distance between two places using map and scale.
- Calculate number of steps to be taken.

| **All resources required for lesson:** | • Access to a computer laboratory – preferably one computer per child. |
|---|---|

| **Time** | **Learning Processes (eg. Teacher talk/methods & strategies/supporting diagrams, etc)** | **Teaching considerations &/or Resources for each activity** | **Assessment** |
|---|---|---|---|
| 2 mins<br><br><br><br><br>5 mins | Introduction / Orientation<br><br>Discuss student suggestions re destinations from previous lesson. Agree on suitable destination.<br><br>Enhancing phase<br><br>Activity 1<br>Teacher demonstrates use of RACQ website (TRIP Planner) to determine distance between origin and destination. | Access to computer laboratory required. | |

| Time | Learning Processes<br>(eg. Teacher talk/methods & strategies/supporting diagrams, etc) | Teaching considerations &/or<br>Resources for each activity | Assessment |
|---|---|---|---|
| 10 mins | <u>Activity 2</u><br>Have class access computer laboratory, preferably a computer with Internet access for each child. Provide hand out sheet where students will need to replicate Trip Planning procedure for a further 5- 10 origin – destination scenarios. | | |
| | <u>Activity 3</u><br>Follow procedure as for previous lesson to map progress toward destination. Provide each student with a street map (i.e. Referdex) of the proposed journey. Must have a scale. | | |
| 5 mins | Guide class discussion to decide on an origin and destination. | | |
| | <u>Activity 4</u><br>Students to use scale to determine distance between the origin and destination in kilometres. Convert kilometres into metres and then divide by the class average step length to determine the number of steps required by the class to reach the destination. | | |
| 5 mins | | A calculator / group may be necessary. | |
| | <u>Activity 5</u><br>Have children predict the amount of time for the class to reach the destination. * This is best as a cumulative class walk as progress will be much quicker. Have class map the progress toward destination at various intervals, i.e. after morning tea, lunch or any time they are completing step logs. As class progresses along the virtual journey, discuss relevant landmarks so they can visualize the journey. | | Can students:<br>• Organise data into a step log.<br>• Perform calculations to determine to determine daily and step count totals. |

| Time | Learning Processes<br>(eg. Teacher talk/methods & strategies/supporting diagrams, etc) | Teaching considerations &/or<br>Resources for each activity | Assessment |
|---|---|---|---|
| Ongoing throughout the day<br><br><br>5mins | <u>Synthesizing phase - Debrief</u><br><br>• How long will it take to reach your destination?<br>• In real life, what factors might affect how long it takes to reach your destination? | | |

## Appendix 14 – Learning Experience Plan7

| Year Level: | Duration: | Focus/Topic: |
|---|---|---|
| 5 | | Virtual walk to tourist destination |

| **Lesson Goal / Objective** |
|---|
| Children to use skills gained to travel, as a team, to a tourist attraction from an agreed origin. As a team, students research and present a spoken presentation outlining features to be seen at tourist attraction. |

| **Core Learning Outcome/s:** |
|---|
| • INF 3.2 Students select and use techniques for generating, modifying and presenting information for different purposes.<br>• OP 2.1 When speaking students use basic generic structure and patterns of words or sentences appropriate to the text type, use simple changes in voice, body language and facial expressions to gain audience interest.<br>• OP 3.3 Students organise and link ideas using generic structure, layout and text connectives. |

| **Intended Learning Outcome/s:** | |
|---|---|
| Students: (declarative/know) | Students: (procedural/do)<br>• Work co-operatively as a team.<br>• Calculate distance to be travelled and number of steps to be taken. |

| **All resources required for lesson:** | • Access to computers, atlas, Referdex, calculators. |
|---|---|

| Time | Learning Processes<br>(eg. Teacher talk/methods & strategies/supporting diagrams, etc) | Teaching considerations &/or Resources for each activity | Assessment |
|---|---|---|---|
| 3 mins | Introduction / Orientation<br><br>Discuss with students that they must organise themselves into teams to complete the next walking challenge. Size of teams could vary in order to travel to destinations of greater or shorter distance. | | |

| Time | Learning Processes<br>(eg. Teacher talk/methods & strategies/supporting diagrams, etc) | Teaching considerations &/or<br>Resources for each activity | Assessment |
|---|---|---|---|
| | <u>Enhancing Phase</u> | | |
| 10 mins | <u>Activity 1</u><br>Agree on a starting point, e.g., Caloundra, have children choose a tourist destination to walk to as a team. Negotiate selections with teams, encourage teams to select destinations within a certain distance, e.g. 30 km, of the origin. Have teams select a range of different destinations so that teams are not travelling to same place.<br><br><u>Activity 2</u><br>Students use resources, Internet etc to find suitable destination. | | |
| 10 mins | Teams choose to use atlas, Referdex or Internet resources to determine distance to destination. Independently complete calculations to establish number of steps required as per Act from previous lesson, i.e. Convert kilometres into metres and then divide by the class average step length to determine the number of steps required by the class to reach the destination.<br><br>Teams independently monitor their own progress towards their goal.<br><br>Teams then research together a 'fact file' to present to the class at the completion of the challenge about the destination and what visitors could expect to see/experience there.<br><br><u>Synthesizing Phase</u> | Access to computer laboratory required | Can students determine distance to be travelled, and number of steps to be taken.<br><br>Whilst not explicitly taught within this lesson, this task allows students to use basic generic structure and patterns of words or sentences appropriate to the text type, use simple changes in voice, body language and facial expressions to gain audience interest. |
| 15 mins | <u>Activity 3</u><br>Group presentations of Destination 'fact file'. | | |

## Appendix 15 – Learning Experience Plan 8

| **Year Level:** | **Duration:** | **Focus/Topic:** |
|---|---|---|
| 5 | | Constructing Spreadsheet |

**Lesson Goal / Objective**

Students to use Spreadsheet program in conjunction with a word processing program to construct a spreadsheet, use a chart wizard, and cutting and pasting into a word processing document.

**Core Learning Outcome/s: - Math**

- Technology TP 2.1: Students organise knowledge ideas and data about how needs and wants might be met and use this information when meeting design challenges.
- Technology INF 3.2 Students select and use techniques for generating, modifying and presenting information for different purposes.

**Intended Learning Outcome/s:**

| Students: <u>(declarative/know)</u> | Students: <u>(procedural/do)</u> |
|---|---|
| | • Create a spreadsheet, create a graph from this, and cut and paste into a word processing document. |

| **All resources required for lesson:** | • Access to a computer, ideally a computer lab with one computer per student and step log data from previous week. |
|---|---|

| **Time** | **Learning Processes (eg. Teacher talk/methods & strategies/supporting diagrams, etc)** | **Teaching considerations &/or Resources for each activity** | **Assessment** |
|---|---|---|---|
| 2 mins | <u>Introduction / Orientation</u><br><br>Provide students with overview of the lesson goal; i.e. to create a spreadsheet, create a graph from this, and cut and paste into a word processing document.<br><br><u>Enhancing Phase</u> | Access to a computer laboratory required or similar capability. | |

| **Time** | **Learning Processes**<br>**(eg. Teacher talk/methods & strategies/supporting diagrams, etc)** | **Teaching considerations &/or Resources for each activity** | **Assessment** |
|---|---|---|---|
| | <u>Activity 1</u><br>Teacher to model data entry process. | | |
| 5 mins | Teacher has prepared templates for ‘Step Log Spreadsheets’ and step log word processing document available on each computer. | | |
| | Children insert personal data from their hard copies onto excel document. | | |
| 5 mins | | | |
| | <u>Activity 2</u> | | |
| 5 mins | Teacher model use of ‘chart wizard’ to construct a graph.<br>Emphasize naming of axes and title and how to construct a horizontal line graph.<br>Students use chart wizard to replicate. | | |
| | <u>Activity 3</u> | | |
| 5 mins | Teacher demonstrates how to open word processing template and how to cut and paste from spreadsheet program to word processing program. | | |
| 5 mins | Students replicate and insert responses to questions as required. | | |
| | <u>Activity 4</u><br>Teacher models how to save and print completed documents as required. | | |
| 5 mins | Students replicate.<br><br>This lesson should be revisited on a weekly basis. This will | | Can students create a spreadsheet, create a graph from this, and cut and paste into a word processing |

| Time | Learning Processes<br>(eg. Teacher talk/methods & strategies/supporting diagrams, etc) | Teaching considerations &/or<br>Resources for each activity | Assessment |
|---|---|---|---|
| | provide additional practice and allows students to reflect upon and monitor performance and set goals for future activity. | | document. |

## Appendix 16 – Learning Experience Plan 9

| **Year Level:** | **Duration:** | **Focus/Topic:** |
|---|---|---|
| 5 | A series of learning experiences | Designing movement games to maximize step counts |

**Lesson Goal / Objective**

- To design a game to maximize step counts.
- To design a poster that informs colleagues of game rules and characteristics.
- Students will understand scientific terms, hypothesis, variable, fair test.

**Teacher Considerations / Teacher Notes:**

The next ___ lessons are intended to model a process of scientific investigation.
Over a series of ___ lessons, students will be involved in developing a solution to a posed problem, testing that solution, collecting and analyzing data. These results are used to develop a hypothesis and test that by redesigning their original solution. Conclusions will be drawn from these activities.

**Core Learning Outcome/s:**

- Technology: TP 3.2 Students collaboratively generate design ideas and communicate these using presentations models and technical terms.
- Technology: TP 3.4 Students test and judge how effectively their own and others processes and products meet the design challenge.
- Science SS 2.2 Students identify some ways that scientists think and work.
- Science SS 3.2 Students recognize the need for quantitative data.
- Health and Physical Education PA 3.2 Students observe rules and demonstrate an awareness of others in play and simple games.
- Health and Physical Education EPD 3.4 Students demonstrate communication, cooperation and decision making skills to collaborate in social, team or group situations.
- English OP 3.3 When writing and shaping, students organise and link ideas, use layout, use visual resources, use paragraphs for separate points.

**Intended Learning Outcome/s:**

Students: <u>(declarative/know)</u>

Students: <u>(procedural/do)</u>

- Plan, in groups, a simple game designed to increase participants' step counts.

| | |
|---|---|
| **All resources required for lesson:** | • Poster paper, marker pens |

| Time | Learning Processes<br>(eg. Teacher talk/methods & strategies/supporting diagrams, etc) | Teaching considerations &/or Resources for each activity | Assessment |
|---|---|---|---|
| <br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br>5 mins | <u>Introduction / Orientation</u><br><br>Through the previous lessons, students have learnt much about their own activity and what influences them to be more and less active. They have also learnt skills to reflect on their own activity and to set goals for their own performance.<br><br>Throughout the following lessons, students are required to develop simple games, which they believe will markedly increase activity in a short amount of time.<br><br>Students are required to work in small teams to develop games, to test their ideas and make changes based on their findings.<br><br><u>Activity 1</u><br>Lead a discussion about what sorts of simple games children are familiar with which children knew made them very active in a short time, e.g. Tiggy, Stuck in the Mud.<br><br>Have students identify features of these games, which encourage participants to be more active; i.e. chasing games, avoiding elimination etc.<br><br>Discuss with children the complexity of these games and that often the most enjoyable games are those with the simplest rules and are easiest to learn to play quickly.<br><br><u>Enhancing Phase</u> | | |

| Time | **Learning Processes**<br>**(eg. Teacher talk/methods & strategies/supporting diagrams, etc)** | **Teaching considerations &/or Resources for each activity** | **Assessment** |
|---|---|---|---|
| | <u>Activity 2</u><br>Pose question to students:<br><br>How would you design a simple game with features and rules that makes players more active in a short space of time? How might you test whether one game is more active than another? | | |
| 5 mins | Provide children with details of the task:<br><br>To develop a simple game to teach to your peers.<br><br>You will need to:<br>• Write simple rules that can be learnt easily.<br>• Draw a diagram of the playing space including measurements and any minimal equipment required.<br>• Design a poster to inform peers of game rules and features.<br>• Prepare a short presentation to teach the game to their peers. (to be presented to class in next lesson). | Discussion to include variables such as, dimensions of play space, complexity of rules, minimal use of extra equipment, safety, to consider the impact on activity levels of elimination from games. | |
| 10 mins | Clarify elements of the task with students.<br><br>Set groups of four to work, regularly checking and discussing group progress throughout the class.<br><br>Stop groups after approximately 10 mins to discuss the basics of their games, discuss advantages, disadvantages, changes which may need to be made to rules, equipment and playing space.<br><br>Set students to work again to complete their basic tasks. | Paper and marker pens issued to each group. | |

| Time | Learning Processes<br>(eg. Teacher talk/methods & strategies/supporting diagrams, etc) | Teaching considerations &/or<br>Resources for each activity | Assessment |
|---|---|---|---|
| 10 mins<br><br>5 mins | <u>Synthesize Phase / Debrief</u><br><br>Confirm goal of the task, i.e. to maximize physical activity for all participants and requirements of group presentation.<br>Inform class when presentation and playing of games will occur. | | Can children plan, in groups, a simple game designed to increase participants' step counts? |

## Appendix 17 – Learning Experience Plan 10

| Year Level: | Duration: | Focus/Topic: |
|---|---|---|
| 5 | 40 minutes | Game Presentation |

| Lesson Goal / Objective |
|---|
| For students to present their games to peers, play the games and collect step count data. |

| Teacher Considerations / Teacher Notes: |
|---|
| Teachers may choose to conduct this Learning Experience over several lessons depending upon class size and the number of games to be presented. Ideally, 2 - 4 games in each session is realistic for good student participation and activity. |

| Core Learning Outcome/s: |
|---|
| • English OP 3.1 - When speaking students use logical sequence when organizing ideas.<br>• Health and Physical Education PA 3.2 Students observe rules and demonstrate an awareness of others in play and simple games.<br>• Smart Moves integration within the curriculum. |

| Intended Learning Outcome/s: | |
|---|---|
| Students: <u>(declarative/know)</u> | Students: <u>(procedural/do)</u><br>• Explain rules of game and supervise. |

| All resources required for lesson: | • PE equipment as required for each game.<br>• Team Posters.<br>• Oval or indoor play area.<br>• Recording sheets. |
|---|---|

| Time | Learning Processes (eg. Teacher talk/methods & strategies/supporting diagrams, etc) | Teaching considerations &/or Resources for each activity | Assessment |
|---|---|---|---|
| | <u>Introduction / Orientation</u> | | |

| Time | Learning Processes<br>(eg. Teacher talk/methods & strategies/supporting diagrams, etc) | Teaching considerations &/or<br>Resources for each activity | Assessment |
|---|---|---|---|
| 5 mins | Have student groups present their game to their peers and clarify questions that may be posed by their colleagues.<br><br>Move to play space and activity to be supervised by students. | | Can students use logical sequence when organizing ideas to explain the rules of their game? |
| Approx 20 mins | Enhancing Phase<br><br>Recap game briefly, distribute step log tally sheets and reset pedometers prior to each game. Discuss predictions for participant activity during each game.<br><br>Each game to be of 4 minutes duration.<br><br>After each game, participants to record step counts.<br><br>Return to classroom to collate game 'step-count' total.<br><br>Graph class results for each game. | Class results may be divided by gender to determine differences and provide additional graphing opportunity. | Can students use suitable graph format to display class results?<br><br>(This is an additional assessment opportunity for graphing – follow up from lesson 8). |
| 5 mins | Synthesizing phase / Debrief | | |
| 5 mins | Class discussion to identify characteristics of the most successful games.  Where there features in common?<br><br>Anticipated responses.<br><br>Minimum of stoppages.<br><br>All participants engaged. | | |

## Appendix 18 – Learning Experience Plan 11

| **Year Level:** | **Duration:** | **Focus/Topic:** |
|---|---|---|
| 5 | 40 minutes | Analysis of student games |

**Lesson Goal / Objective**

- Students will identify features of games that maximize physical activity in the shortest time span.
- Student teams will reflect on and modify their own games based on findings.

**Teacher Considerations / Teacher Notes:**

Graphing step results from games will allow students to see patterns in activity.

**Intended Learning Outcome/s:**

Students: <u>(declarative/know)</u>

Students: <u>(procedural/do)</u>

- Analyse their games and modify one variable to improve physical activity levels of participants.

| **All resources required for lesson:** | • Recording sheets.<br>• Calculators. |
|---|---|

| **Time** | **Learning Processes (eg. Teacher talk/methods & strategies/supporting diagrams, etc)** | **Teaching considerations &/or Resources for each activity** | **Assessment** |
|---|---|---|---|
| 5 mins | <u>Introduction / Orientation</u><br><br>Reflect with students on previous lessons; which games made you most active? What was it about these games that made you more active? (simple hypothesis).<br><br><u>Enhancing Phase</u><br><br><u>Activity 1</u> | | |

| Time | Learning Processes<br>(eg. Teacher talk/methods & strategies/supporting diagrams, etc) | Teaching considerations &/or<br>Resources for each activity | Assessment |
|---|---|---|---|
| 5 mins | Have groups tally up their steps taken for each of the games played. Organise this information into a table showing the steps taken by the entire class for each game.<br><br>Activity 2 | Step count sheets from previous lessons and calculator required. | |
| 5 mins | Organise table data into a graph to show increases/decreases/plateaus in activity across each game. Look for games which increased activity above a particular benchmark – this will vary. A plateau may indicate that two games equally affected activity. Setting a benchmark will allow both games to be considered.<br><br>Activity 3<br>Identify common features (variables) in these games which increased activity – play space shape, play space size, number of players, has elimination had an impact on student activity?<br><br>Activity 4 | | |
| 5 mins | As a group, come to some basic conclusions about features (variables) of games which most affected activity levels. As a group, write a statement about features which increase and decrease activity. | | |
| 5 mins | Eg; Based on our results, we have found that smaller rectangular play spaces allowed participants to be more active than larger square play spaces.<br><br>Activity 5<br>Using the conclusions made, have groups revisit their game and reflect upon how their game may incorporate only one of these variables and be modified to further increase the activity of participants. To ensure that testing is fair, games must not be | | |

| Time | Learning Processes<br>(eg. Teacher talk/methods & strategies/supporting diagrams, etc) | Teaching considerations &/or<br>Resources for each activity | Assessment |
|---|---|---|---|
| 5 mins | completely reinvented. Encourage students to incorporate a single change to their game.<br><br>Synthesizing Phase / Debrief<br><br>Students review game posters, modifying what they see as the most important variable. Students in their groups prepare to re-teach their games.<br><br>Games will be re-taught and re-played next lesson and results compared. | Depending upon time, teacher may decide to reduce the number of games to be re-taught by combining groups, and then allowing students choice as to which game to refine and teach. | Can groups analyse their games and modify one variable to improve physical activity levels of participants? |

## Appendix 19 – Learning Experience Plan 12

| Year Level: | Duration: | Focus/Topic: |
|---|---|---|
| 5 | 40 minutes | Game Presentation |

| Lesson Goal / Objective |
|---|
| For students to re-teach their game to peers to see if modification to selected variable has improved ‘step counts’. |

| Teacher Considerations / Teacher Notes: |
|---|
| This is the culminating lesson in a series of lessons that have sought to model the scientific investigation process through hypothesis making and testing, and controlling for variables. |

**Core Learning Outcome/s:**

- English OP 3.1 - When speaking students use logical sequence when organizing ideas.
- Health and Physical Education PA 3.2 Students observe rules and demonstrate an awareness of others in play and simple games.
- Smart Moves Integration within the curriculum.

**Intended Learning Outcome/s:**

| Students: <u>(declarative/know)</u> | Students: <u>(procedural/do)</u> |
|---|---|
| | • Explain rules of game and supervise.<br>• Observe rules and demonstrate an awareness of others in play and simple games. |

| All resources required for lesson: | |
|---|---|
| | • PE equipment as required for each game.<br>• Team Posters.<br>• Oval or indoor play area.<br>• Recording sheet. |

| Time | Learning Processes<br>(eg. Teacher talk/methods & strategies/supporting diagrams, etc) | Teaching considerations &/or<br>Resources for each activity | Assessment |
|---|---|---|---|
| 5 mins | <u>Introduction / Orientation</u><br><br>Remind students of the scientific investigation process that we have worked through over the past 3 lessons; i.e. Developed a game based upon experience of what you thought would meet the task demands. Devised a game and then tested its effect upon activity levels. Proposed a hypothesis that would allow the game to be further improved. Changed the game by modifying one variable only. Today is about collecting data to test the hypothesis.<br><br><u>Enhancing Phase</u><br><br>Have student groups present their revised game to their peers and clarify questions that may be posed by their colleagues. | | |
| 5 mins | Move to play space and activity to be supervised by students.<br><br>Recap game briefly, distribute step log tally sheets and reset pedometers prior to each game. Discuss predictions for participant activity during each game. | Team posters required. | Can students use logical sequence when organizing ideas to explain the rules of their game. |
| 20 mins | Each game to be of 4 minutes duration.<br><br>After each game, participants to record step counts.<br><br>Return to classroom to collate game 'step-count' total.<br><br>Graph class results for each modified game and graph against previous results. | Recording sheets. | Can students observe rules and demonstrate an awareness of others in play and simple games. |

| Time | Learning Processes<br>(eg. Teacher talk/methods & strategies/supporting diagrams, etc) | Teaching considerations &/or<br>Resources for each activity | Assessment |
|---|---|---|---|
| <br><br>10 mins<br><br><br><br><br><br>10 mins | Synthesizing phase / Debrief<br><br>Class discussion to identify evaluate the merits of the refined (version 2) game. Again, reconsider the nature or characteristics of the games that lent themselves to maximizing activity. Have we obtained the evidence to support or reject hypothesis? Were the initial hypotheses valid? How could we further develop the games to make them better? | | |

**Appendix 20 – Information and Consent Form to Parents**

School Letterhead + CQU Logo

Dear Parents / Caregivers,

Hello, my name is David Lapere and I am a lecturer in Health and Physical Education in the Faculty of Arts, Humanities and Education at Central Queensland University. I am writing to you to describe an innovative curriculum program that the Year 4/5 classes will undertake during the first six weeks of the third school term. I am also writing to request your approval and consent for (insert child's name) to complete research activities associated with the curriculum program.

Prior to describing the curriculum program, I would like to take the opportunity to briefly describe the background of this project. In 2001, a research consortium involving Queensland Health, local medical professionals and university academics developed a community health initiative called *10,000 Steps Rockhampton*. The aim of the project was to increase the physical activity level of adults living in Rockhampton using a range of health promotion strategies. One element of *10,000 Steps Rockhampton* that gained popular acceptance was the *10,000 Steps: - Workplace Walking Challenge*. The challenge involved workplace staff wearing personal pedometers to measure and record the number of steps taken each day. The aim was for each participant to walk at least 10,000 steps each day: - a figure that is associated with health benefits for adults. As part of the *10,000 Steps: - Workplace Walking Challenge*, employees were organised into teams to complete virtual walking challenges. For example, in one challenge workplace teams completed a virtual walk from Cooktown to Melbourne and their progress was tracked on an interactive website. Anecdotal feedback and evaluation studies of the *10,000 Steps: - Workplace Walking Challenges* revealed that they were, and continue to be, effective at increasing participants' physical activity.

In 2005, Queensland Health invited researchers from Central Queensland University to apply the core concepts of the workplace walking challenge to the primary school setting. Following this request, exploratory research was undertaken to determine how the Walking Challenge concept could be used to achieve the dual objectives of (i) increasing children's physical activity levels, and (ii) addressing core learning outcomes across all of the Key Learning Area syllabi. As a result of previous exploratory research and the input of the [redacted] Year 4 and 5 teachers, we have designed an innovative curriculum unit that has the following features:

- Children wear a personal pedometer to measure the number of steps that they take on a daily basis.
- Daily step count information will be used as ‘real-life’ data for learning experiences in a range of Key Learning Areas.
- Children will be organised into teams in order to complete a virtual walk of the Great Wall of China.
- An interactive website will track the progress of teams along the Great Wall of China and will provide educational activities and links to other websites.

We believe that this is an exciting curriculum initiative that will provide high quality learning experiences for the children which they will enjoy and find particularly interesting in the lead up to the Beijing Olympics.

My second purpose in writing this letter is to request your participation in research to determine the effectiveness of the curriculum program. The research requires that children are randomly selected from the Year 4/5 classes and are assessed for (i) physical activity and (ii) attitudes towards physical activity. Physical activity levels are assessed using a sophisticated instrument called an Actiheart Accelerometer, which measures heart rate and body acceleration over a 7-day period. It is a relatively unobtrusive device that is comfortably worn on the chest (see information sheet attached). The accelerometer simply needs to be placed on the chest at the earliest opportunity in the morning and removed as late as is feasible of an evening. The accelerometer should also be removed during showering and bathing, (or other aquatic activities) and during full contact sporting activities such as rugby league. Attitudes towards physical activity will be assessed using an 18-item questionnaire. The questionnaire will take approximately 20 minutes to complete and this will occur during scheduled class activities. In order to determine the effectiveness of the curriculum, it will be necessary to assess the children on three occasions; that is, before the curriculum program, immediately following the program and then again after 3-months has elapsed.

Participation in this research project is completely voluntary and all data that is collected will be treated in strict confidence and reported anonymously. The research data that is collected will only be viewed by the research team and will be stored in secure facilities at CQU. Data will be stored for five years in accordance with the CQU Code of Conduct for Research. The research findings will only be reported in aggregate form and no personally identifying information will be reported in the doctoral thesis, conference papers or journal publications that arise from the research. A Plain English statement of results will be available on the following website at the completion of the research: www.cqu.edu.au/research

On extremely rare occasions there may be some very minor skin irritation associated with wearing the Actiheart monitor as it is attached by two sticky pads. If your child experiences any discomfort associated with wearing the monitor they can be removed at any time and returned to the research team. Antihistamine medication can be used to relieve any residual skin irritation. Furthermore, in the unlikely event that your child experiences any negative outcome associated with participation counselling services are provided by Queensland Health by phone on 1800 177 833.

Neither parents nor child will be liable for any damages to either the pedometers or Actiheart Accelerometers that occurs as a result of their involvement in this research.

To further explain the research project, I will be conducting an information session on Wednesday (18/6) at 5.30 pm in [redacted] classroom (room 8). I invite you to attend should you have any queries or concerns in regards this research project. However, you can contact me at any time regarding any aspect of the research by phone on 4923 2868 or by email on d.lapere@cqu.edu.au. Additionally, please contact the CQU Office of Research (tel 0749 23 2607 or email research-enquiries@cqu.edu.au) should there be any concerns about the nature and/or conduct of this research project.

Finally, could you and (INSERT CHILD NAME) indicate your intention to either participate or withdraw from this research project by completing, signing and then returning the consent form attached in the stamped envelope that is supplied. You and your child's decision to participate is completely voluntary and you can withdraw at any time for any reason without prejudice.

Yours truly

David Lapere
Email:
d.lapere@cqu.edu.au
Phone:

This letter has been sent with the approval of the [redacted] Primary School administration team.

<< School Letterhead + CQU Logo >>

**RESEARCH TO INVESTIGATE THE EFFECTIVENESS OF A CLASS-BASED WALKING CHALLENGE TO ENHANCE ATTITUDES AND PHYSICAL ACTIVITY OF CHILDREN.**

**CONSENT FORM**

**I consent to participation in this research project and agree that:**

1. An Information Sheet has been provided to me that I have read and understood.
2. I have had any questions I had about the project answered to my satisfaction by the Information Sheet and any further verbal explanation provided.
3. I understand that I have the right to withdraw from the project at any time without penalty.
4. I understand the research findings will be included in the researcher's publication(s) on the project and this may include conferences and articles written for journals and other methods of dissemination stated in the Information Sheet.
5. I understand that to preserve anonymity and maintain confidentiality of participants that fictitious names may be used any publication(s).
6. I am aware that a Plain English statement of results will be available on the web address provided in the Information Sheet.
7. I agree that I am providing informed consent to participate in this project.

______________________________________ __ / ____ / _____

(parent / caregiver 1 signature) (date)

______________________________________ __ / ____ / _____

(parent / caregiver 2 signature) (date)

______________________________________ __ / ____ / _____

(child signature) (date)

I wish to have a Plain English statement of results posted to me at the address I provide below.

Postal Address: ________________________________________________________________

E-mail Address: ________________________________________________________________

**I DO NOT consent to participation in this research project**

| | |
|---|---|
| ______________________________________ | __ / ____ / _____ |
| (parent / caregiver 1 signature) | (date) |
| ______________________________________ | __ / ____ / _____ |
| (parent / caregiver 2 signature) | (date) |
| ______________________________________ | __ / ____ / _____ |
| (child signature) | (date) |

Thank you for taking the time to read the information form and complete the consent form.

**Appendix 21 – Pedometer 'Step Count' Diary.**

The purpose of the Pedometer 'Step Count' Diary is to record the number of steps taken for each day (4 day duration) and also to record when the pedometer was removed and for what purpose, especially if the removal is for an extended period of time. It is expected that the pedometer will be removed for bathing, swimming and other aquatic activities, and during full body contact activities such as Rugby League, AFL, Rugby Union, martial arts etc.

| | **Time Off** | **Time On** | **Duration Removed** | **Reason for Removal** | **Pedometer Steps for the Day.** |
|---|---|---|---|---|---|
| **Examples** | 2pm | 3pm | 60 mins. | Rugby League Match | |
| | 5pm | 5.45pm | 45 mins. | Swim Training. | |
| | | | | | Pedometer Reading - 13, 456 |
| | | | | | |
| **Day 1 Friday** | | | | | |
| | | | | | |
| | | | | | |
| | | | | | Pedometer Reading - |
| **Day 2 Saturday** | | | | | |
| | | | | | |
| | | | | | |
| | | | | | Pedometer Reading - |
| **Day 3. Sunday** | | | | | |
| | | | | | |
| | | | | | |
| | | | | | Pedometer Reading - |
| **Day 4. Monday** | | | | | |
| | | | | | |
| | | | | | |
| | | | | | Pedometer Reading - |

Please return to your class teacher on Tuesday morning. Thank you for your assistance

## Appendix 22 – Daily Physical Activity Diary

The purpose of the daily Physical Activity Diary is to record when the Actiheart Accelerometer and pedometer were removed and for what purpose, especially if the removal is for an extended period of time. It is expected that the Actiheart Accelerometer and pedometer will be removed for bathing, swimming and other aquatic activities, and during full body contact activities such as Rugby League, AFL, Rugby Union, martial arts etc. Please record the number of steps that were taken in day (pedometer reading) in the far right column.

| | **Time Off** | **Time On** | **Duration Removed** | **Reason for Removal** | **Pedometer Steps for the Day.** |
|---|---|---|---|---|---|
| **Examples** | 2pm | 3pm | 60 mins. | Rugby League Match | |
| | 5pm | 5.45pm | 45 mins. | Swim Training. | |
| | 7pm | 6am | 11 hours | Sleeping | 13, 456 |
| | | | | | |
| **Day 1 Thursday** | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| **Day 2 Friday** | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| **Day 3 Saturday** | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

| | Time Off | Time On | Duration Removed | Reason for Removal | Pedometer Steps for the Day. |
|---|---|---|---|---|---|
| **Examples** | 2pm | 3pm | 60 mins. | Rugby League Match | |
| | 5pm | 5.45pm | 45 mins. | Swim Training. | |
| | 7pm | 6am | 11 hours | Sleeping | 13, 456 |
| | | | | | |
| **Day 4 Sunday** | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| **Day 5 Monday** | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| **Day 6 Tuesday** | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| **Day 7 Wednesday** | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

**Appendix 22 – Actiheart Instruction Sheet**

Dear Parent and Volunteer,

Firstly, let me thank you for agreeing to take part in this project. The research will provide valuable information of the level and pattern of children's physical activity.

I would like you to wear a physical activity monitor for 7 days and one night. During this time, please carry on with all your normal activities as usual. The monitor is called an Actiheart Accelerometer. It is a small, lightweight, monitor and is a combined heart rate and movement sensor. It is used to measure physical activity levels and energy expenditure. The monitor is easy to apply and is attached to the chest with two small electrodes.

Please find enclosed in this package:

- 1 Actiheart monitor in box,
- 14 spare electrodes

Thank you for wearing an Actiheart. Below are instructions and frequently asked questions. Please take a few minutes to read through this sheet.

**What is the Actiheart?**

It is a heart rate monitor and movement sensor. There are two pieces, a round main piece and a little rectangular button, joined together by a wire. The two pieces clip on to ECG electrodes on your chest.

**When do I wear the Actiheart?**

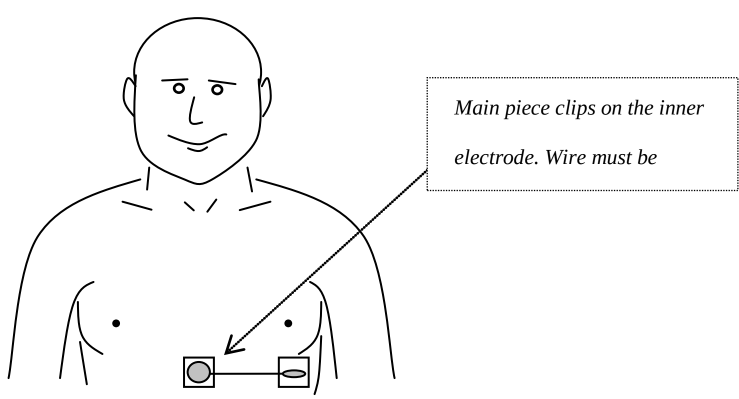
Please try and wear it at all the times during the day. Please wear for one night only during the measurement period. Whilst wearing the Actiheart, please carry on with all your normal activities as usual except for water based activities. Please DO NOT wear the Actiheart when showering or during other water based activities like swimming, or during full contact sports.

**How do I wear the Actiheart?**

The sensor is held to the skin by two sticky electrodes, which are safe to wear. These will be placed on the lower left side of your chest. Please do not use any skin creams, deodorant or perfume where the electrodes are placed. To attach the main piece and the small piece, you will need to press the little tabs on the edges of the pieces towards the centre and place it on the electrode. Females wear the Actiheart just below the bra, taking care to keep the wire straight (horizontal).

*The Actiheart* has 3 parts: You will see a large circular central piece with a heart on and a button on the top. A wire runs to a smaller side piece also with a button on the side. These two pieces clip on to the silver stud on the electrodes.

1. First, attach each of the two ends of the Actiheart monitor to two electrodes: Line up the hole on the back of the monitor with the silver stud on the electrode and press the small tabs on each of the pieces to connect them on.
2. **Skin preparation:** Take a clean dry towel or paper towel and give the skin a good rub in the position where the electrodes will be placed. The central piece will be placed just below the sternum (breastbone) and the smaller piece will be positioned horizontally across on the LEFT side of the chest (see diagram below). For adults, it may be advisable to shave any chest hair where the electrodes will be placed but this should not be necessary for children. You are now ready to position the monitor.



3. **Positioning the monitor:** There should be some slack in the wire so it is not pulled tight. You should not be able to feel the wire pull at any time.

   *NB: If you are having difficulty positioning the monitor it may be easier to look in a mirror or ask someone to assist you.*

   - Peel the film off the back of the electrode with the main circular part of the monitor connected to it. Stick this onto the skin just below the sternum (breastbone) as indicated in the diagram. Try to align it in the area marked by us when you were first fitted with the monitor.
   - Peel the film from the second electrode. Position this electrode on the skin so the 2 electrodes are in a horizontal position (at the same height).

The monitor will be collecting information from the moment you begin wearing it. Please note down the time you started wearing the monitor in the Daily Physical Activity Diary. This is attached. Please wear the monitor for one night whilst sleeping during the 7 days of measurement.

**Appendix 23 – Theory of Planned Behaviour Questionnaire**

**Date: ___ / ______ / 2008**

## Student Questionnaire

**Your Name** ______________________________________________

**I am a:** _____________ **Girl** ___________ **Boy**

**My Date of Birth:** __________ / ___________ / _________

**Day** **Month** **Year**

## Attitudes Towards Physical Activity Survey.

All questions in this questionnaire relate to you '**doing at least 60 minutes of moderate physical activity every day for the next week**'.

NB** The survey will be introduced to the participants with a discussion to clarify both the time and physical activity intensity elements. The class will be engaged in a discussion to work through the following questions.

- Question 1: What does the term 'physical activity' mean?
- Question 2: Are some types of physical activity harder than others?
- Question 3: What happens when we do hard physical activity? (i.e.- breathless, heart rate goes higher, start to sweat). Conclude with observation that physical activities can be grouped as light, moderate and vigorous depending upon "how hard" they are and how they make us feel.
- Question 4: Can you make a list of 5 light, 5 moderate and 5 hard physical activities?

Have children group the following set of activities as either light, moderate or vigorous.

| | |
|---|---|
| watching TV, | playing computer games |
| reading a book | playing chasey |
| playing netball | playing in the pool |
| playing soccer | playing AFL |
| playing Rugby League | doing swim training |
| training for gymnastics. | |

Discuss and group as a class.

** As a guide:

- Moderate physical activity is any form of activity that makes you feel the same as though you were going for a brisk walk, that is, 'a little bit breathless'.
- 60 minutes is about the time of two Physical Education lessons.

## Survey Response Information.

There are <u>NO right or wrong answers</u> for this questionnaire. Simply provide the answer that most accurately indicates what you believe or feel. There are 7 possible answers for each question and the number you circle shows the strength of your feeling or belief. You must circle the number that best indicates what you feel or believe. For example:

**Example questions.**

Do you like dogs?

| **Agree** | 1 | 2 | 3 | 4 | 5 | 6 | 7 | **Disagree** |
|---|---|---|---|---|---|---|---|---|
| | Very much like | Like a lot | Like a little | Neither like or dislike | Dislike a little | Dislike a lot | Very much dislike | |

If you absolutely loved dogs and thought they were fantastic you would circle 1. If you absolutely hated dogs you would circle 7. If you neither hated nor liked dogs you would answer 4. If you somewhat liked dogs you would circle 2 or 3 depending upon the strength of your feelings. Let's try two examples:

Do you think that the school holidays should be increased to 3 weeks?

| **Agree** | 1 | 2 | 3 | 4 | 5 | 6 | 7 | **Disagree** |
|---|---|---|---|---|---|---|---|---|
| | Absolutely Yes | Mostly Yes | A little bit Yes | Neither Yes or No | A little bit No | Mostly No | Absolutely Yes | |

Do you enjoy living in Rockhampton?

| **Disagree** | 1 | 2 | 3 | 4 | 5 | 6 | 7 | **Agree** |
|---|---|---|---|---|---|---|---|---|
| | Absolutely No | Mostly No | A little bit No | Neither Yes or No | A little bit Yes | Mostly Yes | Absolutely Yes | |

**Survey Response Questions.**

**Question 1:** For me, doing 60 minutes of moderate physical activity throughout each day for the next week will be:

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Harmful | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Beneficial |
| Good | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Bad |
| Pleasant | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Unpleasant |
| Worthless | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Useful |
| Fun | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Boring |
| Unenjoyable | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Enjoyable |

**Question 2:** During the next week I will do at least 60 minutes of moderate physical activity throughout every day.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Disagree | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Agree |

**Question 3:** Most people who are important to me think that I should do at least 60 minutes of moderate physical activity throughout each day for the next week.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Agree | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Disagree |

**Question 4:** I am confident that I can do at least 60 minutes of moderate physical activity throughout each day for the next week if I wanted to.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Disagree | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Agree |

**Question 5:** During the next week I plan to do at least 60 minutes of moderate physical activity throughout every day.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Agree | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Disagree |

**Question 6:** It is expected of me that I should do at least 60 minutes of moderate physical activity throughout each day for the next week.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Disagree | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Agree |

**Question 7:** During the next week I expect to do at least 60 minutes of moderate physical activity throughout every day.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Disagree | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Agree |

**Question 8:** For me to do at least 60 minutes of moderate physical activity throughout each day for the next week is easy.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Agree | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Disagree |

**Question 9:** The decision to do at least 60 minutes of moderate physical activity throughout each day for the next week is beyond my control.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Disagree | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Agree |

**Question 10:** Whether I do at least 60 minutes of moderate physical activity throughout each day for the next week is entirely up to me.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Agree | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Disagree |

**Question 11:** People who are important to me want me to do at least 60 minutes of moderate physical activity throughout each day for the next week.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Disagree | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Agree |

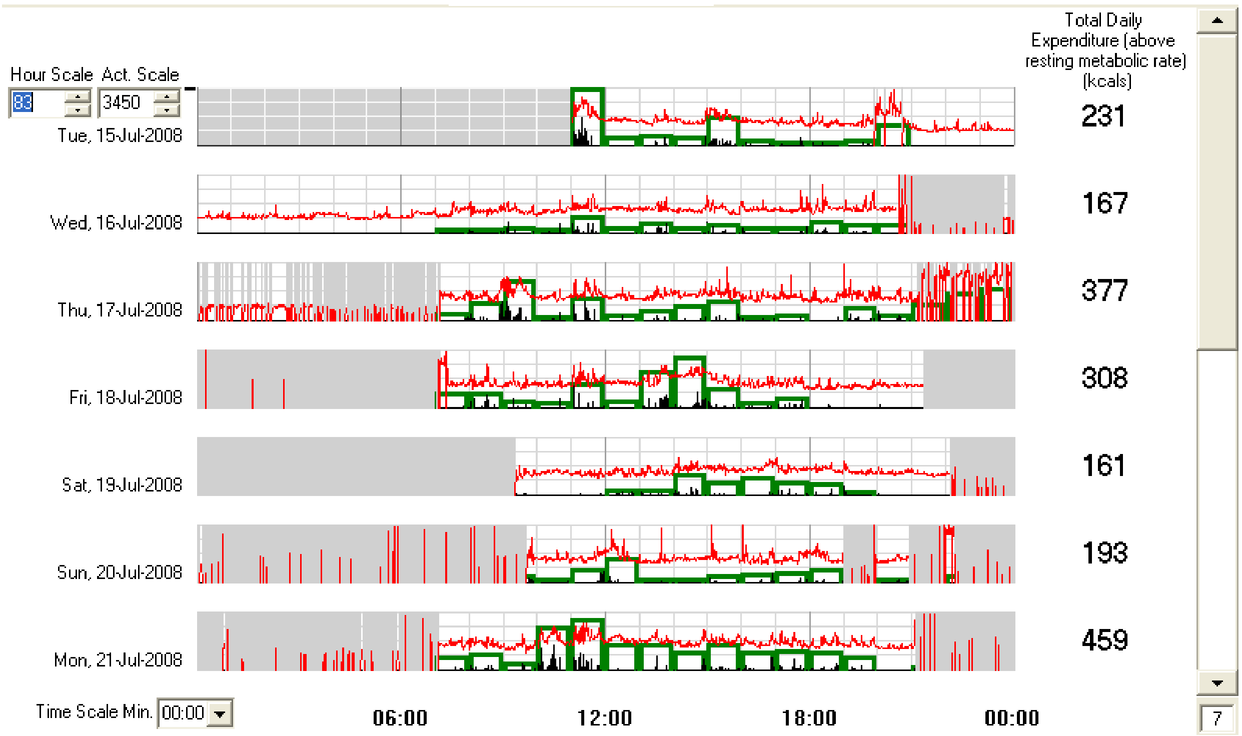
**Question 12:** During the next week I intend to do at least 60 minutes of moderate physical activity throughout every day.

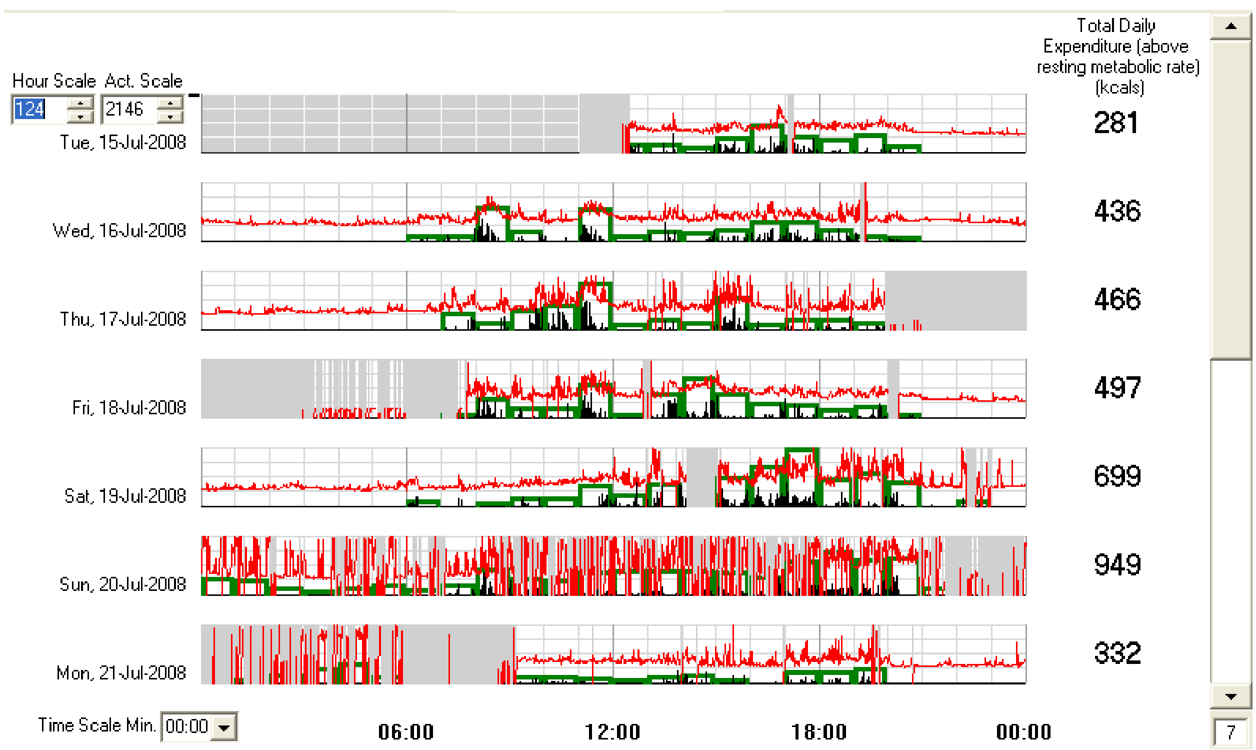
| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Agree | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Disagree |

**Question 13:** I feel under social pressure to do at least 60 minutes of moderate physical activity throughout each day for the next week.

Disagree 1 2 3 4 5 6 7 Agree

# Appendix 24 – Energy Expenditure Graph Derived from Actiheart Accelerometer Data




Note the ‘clutter’ on the bottom graph for Sun 20/7. The Actiheart accelerometer has been worn, however the read quality is poor, possibly due to poor placement and/or attachment to skin.