Investigating Physical Literacy Components in Primary School Children

by

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Declaration

I hereby certify that this material, which I now submit for assessment on the programme of study leading to the award of Doctor of Philosophy is entirely my own work, and that I have exercised reasonable care to ensure that the work is original, and does not to the best of my knowledge breach any law of copyright, and has not been taken from the work of others save and to the extent that such work has been cited and acknowledged within the text of my work.

Signed:

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To everybody who has been part of my life before or during my Ph.D., I owe all of you.

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Go Wildcats!

Abstract

Introduction*:* The physical literacy concept can serve as a guide to transform the focus on existing messages around physical activity participation. Although each individual component of physical literacy has been found to have a unique contribution to physical activity, understanding the connectivity between the components to support the development of physically literate children is needed. Novel analysis of components would allow for differentiation of children's physical literacy measurement and intervention.

Method*:* The Moving Well-Being Well project assessed 2,148 Irish primary school children's (5-12 years) physical literacy, with five core research measurements namely: i) Fundamental movement skill; ii) Physical activity motivation quality; iii) Perceived movement skill competence, iv) Physical self-efficacy and v) Physical activity levels. With subsequent development and evaluation of an empirically driven intervention seeking to positively impact children's physical literacy levels.

Results*:* Findings identified: i) Gender differences in regard to fundamental movement skills' relationship with different qualities of motivation; ii) Fundamental movement skills and perceived movement skill competency mediate the physical self-efficacy – physical activity relationship; and, iii) Four physical literacy-based profiles with significantly different physical activity levels. Findings allowed for the development and implementation of an exploratory trial to increase physical literacy components. Results from the intervention highlight using physical literacy as a theoretical framework is significant for developing children's fundamental movement skills and physical self-efficacy

Theoretical Contribution: The thesis supports the concept of physical literacy with empirical evidence that the components have a relationship that form children's physical activity. Moreover, the theoretical and practical contribution of differentiating children's physical literacy can guide future person-centred interventions.

Conclusion*:* Overall, this thesis highlights the importance of understanding how the components are connecting to develop a physically literate individual. Further longitudinal studies are needed to assess the impact of the Moving Well-Being Well intervention on behaviour change in regards to the physical literacy concept.

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CHAPTER 1

Introduction

Introduction to the thesis

Once upon a time, the young protagonist lived in a fairy-tale where everybody understood the benefits of being physically active. Like everybody he loved partaking in any form of physical activity that required energy expenditure via bodily movement produced by skeletal muscles (Caspersen, Powell, & Christenson, 1985). He listened to guidelines (Department of Health, 2013) and made sure he got at least one hour a day of moderate to vigorous intensity physical activity (MVPA). Results from the Fairy-tale Land Sport Participation and Physical Activity study showed that 100% of children, 100% of adolescents, and 100% of adults met these requirements (Fairy-tale, 2019 B.C.).

It was a normal day for the young protagonist of frolicking, cavorting, playing, dancing, and structured PA; until there was a knock on his fairy-tale door. It was the Wicked Witch of Westminster, she asked him to come be physically active one more time, but this PA was naughty…she convinced him to run through a field of wheat. This is a sin in Fairy-tale Land and the young protagonist was exiled to Ireland.

Irish fairy-tales might be fictitious, and it turns out Irish children's participation in PA is too! Results from the Children's Sport Participation and Physical Activity study in 2010 showed that only 19% of primary school children and 12% of adolescents met PA guidelines (Woods, Tannehill, Quinlan, Moyna, & Walsh, 2010). These proportions have decreased since 2010, with 17% children and 10% adolescents meeting the daily PA guidelines (CSPPA, 2018).

This low level of PA among children is not exclusive to Ireland, children and adolescents in Europe have been found to achieve the recommended levels of PA between only 5-47% (Van Hecke et al., 2016). This lack of PA is a concern considering there is significant evidence that PA promotes wellbeing, physical and mental health, prevents disease, improves quality of life and has economic, social and cultural benefits (Department of Health, 2016). Bearing in mind the health benefits of PA, plus the evidence that suggests children's PA tracks into adolescence and adulthood (Janz, Dawson, & Mahoney, 2000; Telama et al., 2005), there is an increasing need for solutions to change the low levels of PA.

Change to children's PA can be influenced from various directions, be that opportunities such as resources, or through motivation and capabilities (Michie & Abraham, 2004; Michie, van Stralen, & West, 2011) but targeting renowned determinants of childhood PA via the concept of physical literacy has gained traction this decade (Belton, Issartel, McGrane, Powell, & O'Brien, 2018; Dudley, Cairney, Wainwright, Kriellaars, & Mitchell, 2017; Edwards et al., 2018). Physical literacy is often defined as the *"motivation, confidence, physical competence, knowledge and understanding to value and take responsibility for engagement in physical activities for life"* (Cairney, Kiez, Roetert, & Kriellaars, 2019; Corbin, 2016; Whitehead, 2001, p, 127). Protagonists of the concept believe that physical literacy is the missing link that supports engagement in PA (Cairney, Kiez, et al., 2019; Corbin, 2016; Dudley et al., 2017; Whitehead, 2010). Common across all definitions is the core understanding that physical literacy is about having the necessary movement skills required to successfully participate in a range of PA. Each definition also acknowledges that mastery of a movement skill in itself does not necessarily promote a desire to be involved in PA, rather it is the rewarding satisfaction and belief generated from experience in movement that promotes prolonged involvement. Examining how these various components interact could be the key to understand what drives children to be active (Cairney, Dudley, Kwan, Bulten, & Kriellaars, 2019).

In childhood, competence in basic movement skills, commonly referred to as fundamental movement skills (FMS), can be seen as the foundations to more complex movements that are required to successfully participate in PA (Logan, Ross, Chee, Stodden, & Robinson, 2018). These FMS are classified into object control skills, locomotor skills, and stability skills (Gallahue, Ozmun, & Goodway, 2011). Object control skills require efficient throwing, striking, and catching movements; locomotor skills require fluid coordination movements of the body as the individual moves in one direction or another (Logan et al., 2018; Ulrich, 2017). Stability refers to the ability to gain and maintain balance during movement and/or stationary (Gallahue et al., 2011). There is a burgeoning link between FMS proficiency and increased PA (Jaakkola & Washington, 2013;Logan, Webster, Getchell, Pfeiffer, & Robinson, 2015; McGrane, Belton, Fairclough, Powell, & Issartel, 2018). Additionally, there is a belief that developing FMS in childhood determines PA during adolescence (Barnett et al., 2009; Hardy et al., 2013; Jaakkola et al., 2016; Stodden et al., 2008). Not the only determinant of PA, the theory of physical literacy builds upon competence in FMS, suggesting that the way in which movement is perceived impacts children's desire to be physically active.

Perceived movement competence refers to an individual's perception of their actual movement proficiency. Stodden and colleagues (2008) stipulated that the relationship between movement competence and PA is mediated by perceived movement competence across childhood. In fact, there is emerging evidence that perception of movement skill is just as important as FMS (De Meester, Stodden, et al., 2016). This is reasonable as children are more willing to engage and persist in activities when they feel they can apply their skills (Barnett et al., 2008; Harter, 1982). Some suppose that it could even be beneficial to foster perception of movement competence in children beyond their actual FMS (De Meester, Stodden, et al., 2016). For example, adolescents who overestimate their movement competence in comparison to their actual movement competence have higher PA than accurate estimators (De Meester, Maes, et al., 2016). Although, some have questioned if overestimation of the self is healthy over the long-term (Baumeister, Campbell, Krueger, & Vohs, 2003). In an effort to create physically literate children, it is essential that the concept of movement competency is wholly understood and defined in order to cultivate positive movement experience (Cairney, Clark, et al., 2019). If this positive movement experience is cultivated, according to the theory of physical literacy, satisfaction and belief will be generated for PA.

Satisfaction for PA and a feeling of competence derived from positive movement experience is considered key in physical literacy (Whitehead, 2001, 2013). Such intrinsic motivation for PA is considered the highest quality in self-determination theory (SDT) (Ntoumanis, 2001; Ryan & Deci, 2000). When considering motivations role in physical literacy, SDT is a consistent component within the existing theoretical literature, as both are multi-dimensional (Cairney, Kiez, et al., 2019; Corbin, 2016). Self-Determination Theory proposes a multidimensional conceptualisation of motivation in which the types of motivations are of different quality, with self-determined (or autonomous) motivation types considered to be higher quality than less self-determined (or controlling) types of motivation (Ryan and Deci, 2000). From a physical literacy perspective fostering intrinsic motivation is preferable but understanding and capturing different qualities of PA motivation in children is necessary to understand children's physical literacy.

Additionally, positive movement experience is predicted to foster a child's belief to engage in PA. Physical self-efficacy (PSE) is a key construct in social-cognitive theory, and is defined as belief in one's ability to complete a task in differing contexts

(Bandura, 1982). A positive assessment of one's ability to carry out PA is one of the strongest determinants for PA (Annesi, 2006). Physical self-efficacy has been found to have a significant direct association with PA in children, adolescents, and adults (McAuley et al., 2006; Van Der Horst, Paw, Twisk, & Van Mechelen, 2007). The consistency of PSE is important in regard to physical literacy, as physical literacy is not just about valuing PA in childhood, it is about building the foundations to be PA for life. Unfortunately, belief to be physically active is low in adolescents (McGrane, Belton, Powell, & Issartel, 2017).

Research in Ireland has indicated that individual components of physical literacy are low, be that physical competence (Bolger, Bolger, O'Neill, et al., 2018) or attitudes to PA (Belton et al., 2018; Belton, O' Brien, Meegan, Woods, & Issartel, 2014). Considering these poor levels of physical competence, motivation, and self-efficacy, the concept of physical literacy has been suggested as one that can offer a catalyst for a new emphasis in children. The school setting provides an ideal opportunity to do this (McKenzie & Lounsbery, 2009).

School policies and programmes have the opportunity to support and adopt physical literacy into children's lifestyle (Department of Health, 2016; McLennan, Nancy, Thompson, & Jannine, 2015; Woods et al., 2010). If delivered properly physical education provides children with the opportunity to develop motivation, confidence, physical competence, and understanding to value and take responsibility for engagement in physical activities for life (Cairney, Dudley, et al., 2019; Dudley et al., 2017). Physical education interventions in an adolescent population have been shown to stem the decline in PA (Belton, McCarren, McGrane, Powell, & Issartel, 2019), yet there are insufficient interventions that target younger children in Ireland. While physical education interventions have been shown to be effective for individual components of physical literacy, the interventions with multiple components are proven to be the most successful (Stull, Snyder, & Demark-Wahnefried, 2007). Programmes which contain components such as professional development for teachers (McKenzie et al., 2009), family involvement (Belton, O' Brien, Meegan, Woods, & Issartel, 2014), and active classrooms (Martin & Murtagh, 2017) are among those which have been seen to have a significant impact. Understanding the effective components from interventions that have been proven successful in increasing PA will help inform future intervention design and development.

Summary and justification for the research

This thesis aims to understand what drives children to be active by examining how the physical literacy components of competence, motivation and, self-efficacy interact. This will be done by analysing the relationship between motivation to be physically active and proficiency in FMS (Cairney, Dudley, et al., 2019). Building upon this there will be an investigation to how competence is contributing to the belief to be physically active, and its relationship with PA. Such knowledge starts to form a picture of physical literacy components and how this connects with PA. The thesis will investigate how the components of physical literacy are grouping in children and why some children are more physically active than others. Once a clearer picture of physical literacy has been established, an evidence-based intervention can be designed that considers differentiation. The final aim of this thesis is to evaluate the effectiveness of the Moving Well-Being Well exploratory trial in improving physical literacy components in children.

Aims and Objectives of the Thesis

The primary aim of this research was to explore the relationship between physical literacy components in children.

Objectives:

1. To investigate the relationship between quality of motivation for physical activity and fundamental movement skills *(Chapter 3)*.
2. To evaluate the role of physical self-efficacy in mediating the movement – physical activity relationship *(Chapter 4)*.
3. To identify physical literacy-based profiles in primary school children *(Chapter 5)*.
4. To examine differences in physical activity levels among children with different physical literacy-based profiles *(Chapter 5)*.
5. To evaluate the intervention effect of the Moving Well-Being Well professional development programme on components of physical literacy in children *(Chapter 6)*.

Research Questions

1. Does autonomous motivation for physical activity have a positive relationship with children's fundamental movement skills, and are the relationships the same for boys and girls?
2. Does controlling motivation for physical activity have a negative relationship with children's fundamental movement skills, and are the relationships the same for boys and girls?
3. Do fundamental movement skills and/or perception of movement skills mediate the relationship between PSE and physical activity?
4. Do different profiles based on the components of physical literacy exist in primary school children?
5. How do physical literacy-based profiles impact physical activity, and do they differ between groups?

6. Does the Moving Well-Being Well professional development intervention significantly affect the physical literacy components: fundamental movement skills, PSE, and autonomous motivation for physical activity?

Thesis Structure

The thesis consists of seven chapters. Following this introduction to the thesis, Chapter 2 will critically review the current literature on children's physical literacy components: motivation, self-efficacy, movement competence, perceived movement competence, and interventions incorporating these components. Chapter 3, 4, and 5 address the primary aim of this thesis consisting of studies assessing the relationship between quality of motivation for physical activity and movement proficiency, the mediating role of movement within the PSE – physical activity relationship, and how physical activity manifests based on physical literacy components. Chapter 6 evaluates the Moving Well-Being Well professional development intervention. The final chapter provides a general discussion of the findings, conclusion and recommendations.

My Role:

Alongside the other authors, I was the principal investigator responsible for all of the data collected (2017-2019). Data consisted of physical activity, physical literacy components, and body mass index. My specific focus was the psychological components of physical literacy. I was principally involved in the physical literacy data analysis. Regarding the design of the MWBW intervention, alongside Stephen Behan, Dr. Sarahjane Belton, and Dr. Johann Issartel, I was responsible for developing all the content and resources which are outlined in Chapter 6 and Appendix A.

Publications

Published

Moving Well-Being Well: Investigating the maturation of fundamental movement skill proficiency across sex in Irish children aged five to twelve. *Journal of Sports Science - accepted 16th July 2019, published online 5th August 2019.* Authors: Stephen Behan, Sarahjane Belton, Cameron Peers, Noel E O'Connor, & Johann Issartel

Under Review

How Children's Physical Activity Motivation Impacts Their Fundamental Movement Skills. *Journal of Motor Learning and Development. Submitted July 2019.* Authors: Cameron Peers, Johann Issartel, Stephen Behan, Noel E O'Connor, & Sarahjane Belton.

The Contribution of Competence to the Physical Self-Efficacy - Physical Activity Relationship. *Human Movement Science. Submitted April 2019.* Authors: Cameron Peers, Johann Issartel, Stephen Behan, Noel E O'Connor, & Sarahjane Belton.

Development of a refraction framework to underpin design of the Moving Well-Being Well physical literacy intervention. *International Journal of Behavioural Nutrition and Physical Activity. Submitted September 2019*. Authors: Johann Issartel, Jamie McGann, Stephen Behan, Cameron Peers, Noel E O'Connor, & Sarahjane Belton

CHAPTER 2

Literature Review

Physical Activity

The World Health Organization (WHO, 2017) have taken up the position that physical activity (PA) is defined as *"any bodily movement produced by skeletal muscles that require energy expenditure"* (Caspersen, Powell, & Christenson, 1985). There is significant evidence that PA of moderate intensity promotes wellbeing, physical and mental health, prevents disease, improves quality of life and has economic, social and cultural benefits (Department of Health, 2013). Categorised into PA that is of either light, moderate, vigorous or very vigorous intensity, and most health benefits have been associated with moderate to vigorous intensity (Haskell et al., 2007). A widely used definition of moderate and vigorous physical activity (MVPA) are provided by Prochaska et al. (2001) describing moderate PA as *"usually makes you breathe hard or feel tired some of the time"* and vigorous PA as *"usually makes you breathe hard or feel tired most of the time."* (p. 555).

Physical activity in youth

Irish and international guidelines are in consensus that all children and young people should be active, at a moderate to vigorous level, for at least 60 minutes every day (Physical Activity Guidelines Advisory Committee, 2008; Irish Department of Health and Children, 2009). The guidelines state that PA should include muscle-strengthening, flexibility, and bone strengthening exercises three times a week (Physical Activity Guidelines Advisory Committee, 2008; Irish Department of Health and Children, 2009).

A systematic review of PA in European children and adolescents found that only 5% to 47% of children and adolescents achieved the recommended levels of PA (Van Hecke et al., 2016). In Ireland, only 9% of primary aged children self-reported meeting the PA guideline of accumulating at least 60 minutes of MVPA daily (Woods, Moyna, Quinlan, & Walsh, 2010). Meanwhile objectively measured PA (accelerometer) in children and youth across ten countries found only 9% of boys and 2% of girls accumulated ≥60 minutes of MVPA on all measured days (≥ 3 days) (Van Hecke et al., 2016). Objective data from an Irish regional sample found 22% of 8 – 11 year olds (n = 830) accumulated ≥60 minutes of MVPA on all measured days (≥ 3 days) (Keane, Kearney, Perry, Browne, & Harrington, 2014).

Considering the health benefits of PA, plus the evidence that suggests children's PA tracks into adolescence and adulthood (Janz et al., 2000; Telama et al., 2005), there is an increasing need for enhanced solutions to address the low levels of PA. To promote lifelong PA, health professionals have sought original approaches to promote value toward PA. One such approach that has received increasing interest and critical debate is the concept of physical literacy (Whitehead, 2001)

The concept of Physical Literacy

Physical Literacy is commonly thought of as an academic 21st century term, but it can be traced back as far as the United States Army in the late 1800s where the term was used to capture movement quality in a specific social context (United States Army Corps of Engineers, 1884). During the 20th century academics used the term in response to lifestyle changes arising from the modernisation of mechanisation, the start of the electronic era, and more recently the commencement of the internet (Cairney, Kiez, et al., 2019). The use of the term physical literacy has gained popularity in recent years due to the increasing awareness of the impact of a sedentary lifestyle. To combat the growing issue of sedentary behaviour, there has been a substantial uptake of physical literacy as a worldwide ‘social movement’ (Cairney, Kiez, et al., 2019), to the point the WHO (2018) now includes physical literacy as an objective to creating an active society:

"Develop a national communications strategy for physical activity as part of, or aligned with, a national action plan on physical activity to raise awareness and knowledge of the health benefits of physical activity, promote behaviour change and increase health and physical literacy." (WHO, 2018, p.63)

Proponents of the concept believe that physical literacy is the missing link that supports engagement in PA (Corbin, 2016; Edwards et al., 2018; Edwards, Bryant, Keegan, Morgan, & Jones, 2017). There are, however, various definitions of physical literacy. Physical literacy is defined by the United Nations Educational, Scientific and Cultural Organization (UNESCO) as the ability, confidence, and motivation to engage in life-long PA. Mandigo and colleagues (2009) described physically literate people as *"individuals who… move with competence in a wide variety of physical activities that benefit the development of the whole person"* (Mandigo, Francis, Lodewyk, & Lopez, 2009, p. 2). A more philosophical definition of physical literacy comes from Margaret Whitehead's research (Whitehead, 2001, 2010). Whitehead theorises physical literacy as an entire embodied experience; this includes confident movement proficiency in a variety of environments, alongside a positive value and attitude towards PA that helps individuals achieve the highest quality of life (Whitehead, 2010). A commonly cited physical literacy consensus statement describes physical literacy as the *"motivation, confidence, physical competence, knowledge and understanding to value and take responsibility for engagement in physical activities for life"* (Cairney, Kiez, et al., 2019; Corbin, 2016, Whitehead, 2001, p. 127). Common across all definitions is the core understanding that physical literacy is about having the necessary movement skills required to successfully accomplish a range of PA, from everyday activities to participation in sport. Each definition also acknowledges that mastery of a movement skill in itself does not necessarily promote a desire to be involved in PA, rather it is the rewarding satisfaction and belief generated from experience in movement that promotes prolonged involvement.

Edwards and colleagues (2017) identified and labelled properties of physical literacy with a framework that focuses on the affective, physical, and cognitive domains. Edwards and colleagues (2017) define the affective domain as one's motivation and "confidence" in relation to PA. Physical capability is defined as one's ability to move with competence in a wide variety of activities. The cognitive domain of physical literacy concentrates on knowledge and understanding in a variety of activities (Edwards et al., 2017; Shearer et al., 2018). The interdisciplinary relationship between key theories and components within physical literacy renders it a complex concept, and much research is required to better understand the relationship between the physical literacy components. Not only are there different ways of defining physical literacy, there are also different theoretical positions used for concepts (e.g. motivation), thus detailing the theoretical associations is necessary in physical literacy research.

The Components of Physical Literacy

Previous components adopted under the 'affective' domain have included confidence and motivation in relation to PA. From a theoretical point of view, physical literacy considers that a confident child will exhibit certainty and a willingness to try new movements. Moreover, if children are provided with experiences that are rewarding and enjoyable, this will enhance the quality of their motivation when participating in PA (Prochaska, Sallis, Slymen, & McKenzie, 2003).

Motivation: Definition and conceptual elements

One influential component of a physically literate person is motivation for PA (Dudley et al., 2017; Edwards et al., 2017; Whitehead, 2010). Motivation is considered one's direction and intensity to perform a behaviour; what causes a person to want to learn and repeat a behaviour (Cortis et al., 2017; Ng et al., 2012; Teixeira, Carraça, Markland, Silva, & Ryan, 2012). Motivation has been deemed an important correlate and determinant of PA (Cortis et al., 2017; Ng et al., 2012; Teixeira et al., 2012).

Motivation can be conceptualized from varying theoretical positions. For example: Achievement Goal Theory explores achievement behaviours that motivates the way an individual approaches, participates, and reacts to tasks (Dweck & Leggett, 1988; Nicholls, 1984); Expectancy Value Theory, proposes motivation is dependent on an individual's judgment of how successfully they perform in a task (Eccles et al., 1983); and, Interest Theory, proposes motivation for an activity is due to pleasure (Hidi, 1990). From a physically literacy perspective, Whitehead suggests that physically literate individuals are physically active mostly for intrinsic reasons such as enjoyment, opportunity, and a sense of competence. Children should *"identify the intrinsic value of physical activity; overcome the need to justify physical activity as a means to other ends"* (Whitehead, 2010, p .5). Potentially this is idealistic, with research on children's PA motivation discussing the importance of various sources of motivation (Standage & Ryan, 2012).

Self-Determination Theory attempts to capture the various sources of motivation, as well as intrinsic value, and orders them as a continuum of different qualities (Deci & Ryan, 2002). Research has suggested that children's motivation is driven by intrinsic motivation (Owen, Smith, Lubans, Ng, & Lonsdale, 2014), however, other research based on SDT has demonstrated the possibility that children might adopt other sources of motivation such as valuing the benefits of PA, or external punishments such as reward or punishment to stay motivated in PA (Bryan & Solmon, 2007). There is a dearth of studies focusing on children's motivation, hence examining the relationship between children's motivation and PA is required to understand children's patterns of PA, this is particularly prevalent as children's PA habits tend to track into adulthood (Janz et al., 2000; Telama et al., 2005). From a physical literacy perspective fostering intrinsic motivation is preferable but understanding and capturing different qualities of PA motivation in children is necessary to understand children's physical literacy.

Quality of Motivation

When considering motivations role in physical literacy, SDT is a consistent component within the existing theoretical literature, as both are multi-dimensional and person-centred (Cairney, Kiez, et al., 2019; Corbin, 2016). Self-Determination Theory proposes a multidimensional conceptualisation of motivation in which the types of motivations are of different quality, with self-determined (or autonomous) motivation types considered to be higher quality than less self-determined (or controlling) types of motivation (Ryan and Deci, 2000). Six motivation types are arranged on the SDT continuum based on their degree of self-determination (Ryan & Deci, 2000): intrinsic motivation, integrated regulation, identified regulation, introjected regulation, external regulation and amotivation. Intrinsic motivation is considered the most autonomous form of motivation and involves pursuing an activity purely out of interest and/or enjoyment. Meanwhile, integrated, identified, introjected and external regulations are various extrinsic forms of motivation that refer to engaging in an activity to attain an outcome not directly associated with the activity itself. Integrated (i.e., an individual values PA and it is ingrained in their personality) and identified (i.e., personally valuing the benefits of being active) regulation are considered autonomous forms of extrinsic motivation. On the other hand, introjected regulation (i.e., PA participation is driven by internal pressures to avoid guilt or shame and to enhance or protect one's ego) and external regulation (i.e., being active to obtain performance-based rewards, comply with demands/expectations or avoid punishment) are considered controlling forms of extrinsic motivation (Ryan & Deci, 2000; Standage & Ryan, 2012). Lastly, amotivation is defined as the absence of motivation or unwillingness toward participation (Ryan & Deci, 2000). According to SDT, quality of motivation is vital as autonomous forms of motivation facilitate higher interest and greater effort (Ntoumanis, 2001). Such a theory aligns with the research objective of the current thesis as it looks to untangle the complex nature of children's motivation and position it within the concept of physical literacy. A framework such as SDT not only provides insights to what is motivating children, but has extensive research to the impact of these different qualities and their relationship with PA.

Motivation Quality and its Impact on PA

A review carried out by Owen and colleagues (Owen et al., 2014) identified 46 studies that have assessed the association between self-determined motivation and PA levels in children and adolescents, with a median age of n = 14.04. In this review, autonomous forms of motivation (i.e., intrinsic motivation and identified regulation) were found to have moderate, positive associations with PA (ρ=.27 to .38), whereas controlled forms of motivation (i.e., introjection and external regulation) were found to have weak, negative associations with PA (ρ=.03 to 17). Meanwhile, amotivation was shown to have a weak, negative association (ρ=.11 to 21) with PA (Owen et al., 2014).

Research from a range of countries has explored the relationship between quality of motivation for PA among adolescents, and provides collective evidence that more autonomous forms of PA motivation are positively related to PA, whereas controlled forms of motivation are largely negatively related (Aelterman et al., 2012; Bagøien & Halvari, 2005; Gillison, Standage, & Skevington, 2011; Hagger et al., 2009; Lonsdale, Sabiston, Raedeke, Ha, & Sum, 2009). There is a lack of studies, however, assessing children's self-determined motivation, with the youngest cohort from Owen and colleagues (Owen et al., 2014) review reporting a mean age of 10.03 (range of 7.84 to 11.09 years) (Sebire et al., 2013). This is potentially due to the fact that understanding and recognising feelings is difficult for children, thus measuring children's quality of PA motivation is particularly challenging. For example, introjection may be too abstract for children, relying on advanced cognitive / self-perception development, with research reporting low internal consistency of scales measuring introjected PA motivation among children (Sebire et al., 2013; Vierling, Standage, & Treasure, 2007).

Previous studies measuring motivation in children have combined introjected and external types into a single controlled motivation indicator (Guay et al., 2010; Gunnell et al., 2018). This can prove problematic when designing interventions to counteract these controlling motivations, as although both are negatively associated with PA, they are very different forms of regulation that require different intervention strategies to target (Silva et al., 2008; Teixeira et al., 2012). Ignoring differences between the qualities of motivation, and the diverse barriers to PA participation faced by children, could lead to interventions which may focus on only one need while being of very little assistance for the other.

There are two studies that have sought to design tools to measure quality of motivation in children, with both emphasising that quality of PA motivation is paramount to PA participation (Sebire et al., 2013; Vierling et al., 2007). Both studies have found that, in children aged 7 – 12, autonomous motivation positively predicts greater levels of PA and positive attitudes towards PA (Sebire et al., 2013; Vierling et al., 2007). With intrinsic motivation displaying a positive association with MVPA and sharing approximately 4% of the variance (Sebire et al., 2013) and 13% with pedometer step counts (Vierling et al., 2007). Sebire and colleagues (2013) study provides evidence for the psychometric properties of measures of motivation aligned with SDT among children. Although, measurement of introjected motivation found internal consistency was below accepted thresholds, this is similar to previous research in children (Vierling et al., 2007) and adolescents (Verloigne et al., 2011). Considering the aforementioned research, there are validated and reliable measurements, such as the Behavioural Regulation in Exercise Questionnaire – adapted, that capture the relationship between children's quality of motivation and PA (Sebire et al., 2013), application of this measurement tool from a physical literacy perspective will not only further knowledge of children's quality of motivation, but due to its multi-dimensional conceptualisation, enhance knowledge of how different qualities of PA motivation might be connecting with other components of physical literacy.

Yet, the BREQ-adapted limitations must be considered, foremost is that introjected motivation falls below the accepted threshold, therefore does it truly distinguish between the lower qualities of motivation. Moreover, amotivation is not included in the questionnaire, as such, the motivation measure assumes a presence of motivation, albeit of varying quality (i.e., self-determination) and does not represent children with low quantity motivation (i.e., amotivated). Central to scale consistency is the invariance of scale structures between different populations (e.g., children of different ages, genders, ethnicities). The current version has not been applied in Ireland; thus, future research should be thorough when using the BREQ-adapted

Gender Differences in Quality of Motivation

Little research has focused on children's quality of motivation (Owen et al., 2014), furthermore due to previous sample size of groups understanding gender differences is limited (Sebire et al., 2013). Children's PA habits, however, tend to track into adulthood (Janz et al., 2000; Telama et al., 2005). So, a systematic review (Teixeira et al., 2012) examining the relationship between key SDT-based constructs and PA in adults, noted that in the majority of studies gender differences are not reported, making it difficult to draw firm conclusions. A closer examination of all the studies that explored gender differences with respect to the association between adult's quality of motivation and PA, suggests that introjected regulation may be more positively associated with PA among females, whereas among males the association is negative or zero (Duncan, Hall, Wilson, & Jenny, 2010; Wilson, Rodgers, Fraser, & Murray, 2013). Meanwhile, in adolescent males, introjected regulation has been linked to social factors, such as avoiding social disapproval and receiving ego boosts (Gillison, Osborn, Standage, & Skevington, 2009). Yet, in the same study, adolescent females were found to rarely participate in PA with their friends, and their introjected regulation was due to guilt regarding health and fitness (Gillison et al., 2009). Tackling this controlling motivation, regardless of reasons it has manifested, is important as sustained introjected regulation can compromise autonomous forms of motivation over the long term (Gillison et al., 2009). Additionally, there is evidence to suggest that introjected regulation will not bode well for long-term behaviours (Gillison et al., 2009). Introjected regulation is deemed an unstable motivation, and effort can cease as soon as external factors are removed (Gillison et al., 2009). Drawing from gender differences in adolescence and adulthood, although not obviously critical for primary school children, an environment change that potentially removes these external controls is the transition from primary to post primary school (Britton, Belton, & Issartel, 2019). Thus, it is important to understand controlling motivation as early as possible; interventions should consider fostering an environment to be supportive of autonomy and promoting value, as introjected regulation can compromise autonomous motivations over the long term. Essentially, autonomous motivation toward PA that promotes a desire to be involved in PA and the rewarding satisfaction developed through positive movement experience is a key philosophy in physical literacy (Whitehead, 2001). According to physical literacy, these positive experiences in movement also generate belief to participate and remain involved in PA.

Physical Self-Efficacy

Another well-established PA determinant, from a different theoretical position, is that of self-efficacy (Craggs, Corder, Van Sluijs, & Griffin, 2011; Spence et al., 2010). Physical self-efficacy (PSE) is a key construct in social-cognitive theory, and is defined as belief in one's ability to complete a task in differing contexts (Bandura, 1982). Meanwhile, the current definition of confidence from a physical literacy perspective states that individuals who are physically literate demonstrate confidence in a wide variety of physically challenging situations (Cairney, Dudley, Kwan, Bulten, & Kriellaars, 2019). Confidence is included as a component of most physical literacy definitions (Cairney, Dudley, Kwan, Bulten, & Kriellaars, 2019; Dudley, Cairney, Wainwright, Kriellaars, & Mitchell, 2017; Mandigo et al., 2009; Whitehead, 2010). It is stated that a physically literate person has acquired an improved sense of self through their movement experiences. This would theoretically lead to confidence in engaging in a wide array of activities (Whitehead, 2010). Confidence however, as a construct, has certain limitations and can be problematic to assess, Bandura (1997) highlighted confidence is 'a catchword rather than a construct embedded in a theoretical system' (pp 382). Meanwhile, self-efficacy is a theory-based construct which can account for an individual's belief that they can achieve a given level of attainment (Bandura, 1997). Directed by Bandura's dialogue around self-efficacy and confidence, self-efficacy will be applied in place of confidence in this study.

Definition and Conceptual Elements of Physical Self-Efficacy

Grounded in social-cognitive theory, PSE encompasses a personal assessment of one's ability to carry out PA (Annesi, 2006). According to Bandura (2004), PSE is central to the decision-making process to participate in PA. Additionally, PSE is associated with one's ability to persevere with a task (Annesi, 2006). PSE levels are thought to determine how obstacles are viewed, with highly efficacious individuals perceiving barriers to PA as conquerable through increased effort (Bandura, 2004). Physical self-efficacy has shown positive associations with PA in children (O'Loughlin, Paradis, Kishchuk, Barnett, & Renaud, 1999; Trost, Kerr, Ward, & Pate, 2001). Such traits have also been found to have some of the strongest positive associations with PA for adolescents (Van Der Horst et al., 2007). In addition, PSE has been found to have a significant direct association ($\beta = .66$) with PA in adults (McAuley et al., 2006). Such results would suggest that to PSE is a PA determinants that tracks throughout the life course (Janz et al., 2000; Telama et al., 2005). One example of a school-based intervention that found significant improvements is a 36-week, three times a week dance intervention (Gao, Zhang, & Stodden, 2013), the result from their intervention targeting self-efficacy and PA as outcomes found significant improvements in self-efficacy; change score 0.52 (F 1.99 = 6.50, $p < 0.05$) and PA levels; change score 0.76 (F 1.99 = 4.69, $p < 0.05$). Furthermore, there is strong evidence of PSE acting as a one of the most effective working mechanisms in PA interventions (Lubans, Foster, & Biddle, 2008; van Stralen et al., 2011). Such knowledge is vital because it allows us as researchers to determine which components of an intervention contribute to behaviour change (Lubans et al., 2008). Although research has determined that targeting PSE is an efficient approach, regarding how to improve the psychological construct is still a knowledge gap (Bauman et al., 2012; Williams & French, 2011), such knowledge could contribute to understanding the relationship between physical literacy components, but the correct measurement tools are necessary.

Assessment of Physical Self-Efficacy

Self-efficacy has been identified as one of the primary correlates of PA participation in adults and adolescents (Lewis, Marcus, Pate, & Dunn, 2002), however, PSE has proven difficult to assess in children (Bartholomew, Loukas, Jowers, & Allua, 2006). The Physical Activity Self-Efficacy Scale (PASES) was an initial attempt to assess self-efficacy for PA in children (Saunders et al., 1997). The measurement originally used a three-factor model of self-efficacy for PA; assessing the subscales: barriers, support seeking, and positive alternatives, reliability coefficients ranged from 0.50 to 0.78 (Saunders et al., 1997). The barriers subscale relates to children's belief that they can overcome common barriers to be physically active (e.g. hot/cold weather). The support seeking subscale relates to children's belief that they can ask/find others (e.g. parents or friends to share in PA). The positive alternatives subscale relates to children's belief that they can choose PA over sedentary behaviours (e.g. television viewing). But, a confirmatory factor analysis to test the factorial validity and invariance of PASES failed to support the underlying factor structure of the full-length scale (Bartholomew et al., 2006). Item analyses revealed poor fit with a number of items (Motl et al., 2000). Thus, an 8-item, single factor scale was developed and has been successfully associated with PA in boys and girls, and has been found to remain stable across a 1-year study period, = .58 (Dishman et al., 2004). Moreover, the 8-item scale has highlighted differences in PSE between obese and non-obese children (Trost et al., 2001). In sum, although the developed 8-item PASES might not differentiate between the different factors accounting for PSE, it is the most appropriate means to assess PSE in children due to its statistical superiority (model fit and internal consistency reliability) and application to both genders.

Moreover, there is a lack of measurements applicable to children for PSE, previous work with adults have applied the Self-Efficacy for Exercise Behaviours Scale (McAuley, 1992; 1993) however this scale is exercise focused. A 13-item scale that focuses on self-efficacy expectations related to the ability to continue exercising in the face of barriers to exercise, this measure was developed initially for sedentary adults who participated in an outpatient exercise program including biking, rowing, and walking (McAuley, 1993). Adapted proxy versions have been implemented, with parents asked about their children's self-efficacy (Decker, 2010), although parental influence is important, this research wants to focus on children's own attitudes, thus proxy questionnaires do not capture the insight of children's physical literacy.

Gender Differences in Physical Self-Efficacy

When using the three-factor model of self-efficacy for PA, composite scores of PSE display similar means across gender (Bartholomew et al., 2006; Dishman et al., 2004; Trost, Pate, Ward, Saunders, & Riner, 1999). But there are gender differences in the subscale's relationship with PA, highlighting the need for health practitioners and physical educators to consider potentially important gender differences. For instance, boys with lower PA are found to demonstrate significantly lower support seeking efficacy (m = 2.1 ± 0.6) compared to boys with higher PA (m = 2.4 ± 0.5), but girls with low PA did not (Trost et al., 1999). Conversely, low efficacy to find positive alternatives (choosing PA over watching television and playing video games) was apparent in girls with low PA, but not boys. Over 70% of girls classified in the low PA group reported they would choose watching television and playing video games over PA (Trost et al., 1999).

When considering the 8-item PASES tool, PSE is significantly related to PA for both genders, but with conflicting findings regarding gender difference. For example, studies of adolescents have shown that the direct effect of PSE on PA is significantly greater for boys (β = 0.13) than for girls (Allison, Dwyer, & Makin, 1999; Chen, Dai, & Gao, 2019). Interestingly, multilevel analysis found the role of PSE is a significantly stronger correlate of PA for girls, with a gender x PSE interaction significantly predicting PA (β = .04). In the same study, however, boys (m = 2.99) had significantly higher PSE compared with girls (m = 2.79), which resulted in significantly more PA

(Spence et al., 2010). These conflicting findings warrant further investigation to better understand what is developing PSE and PA.

Physical Competence

Definition and Conceptual Elements of Physical Competence

The present definitions of physical literacy encourage the development of physical competence. An individual who is physically competent *"moves with poise, economy and confidence in a wide variety of physically challenging situations … anticipating movement needs or possibilities and responding appropriately to these, with intelligence and imagination"* (Whitehead, 2007, p. 287). Some physical literacy definitions have stated physical competence includes PA, body composition, and health-related fitness (Francis et al., 2015). This differs from Whitehead (2010) and others (Cairney, Dudley, et al., 2019; Dudley et al., 2017; Edwards et al., 2017) position, who have arranged PA as the basis to, but distinct from physical literacy. A recent empirical examination indicates that PA and body composition might not fit within the construct (Longmuir et al., 2015). Longmuir and colleagues found that items related to body composition (specifically body mass index) and PA did not meet the threshold for loading onto a factor analysis of a physical literacy assessment. Consistent with much of the conceptual work on physical literacy and the available evidence there is a current view that PA behaviours, body composition, and fitness are manifestations of physical literacy, rather than part of the construct itself (Cairney, Clark, Dudley, & Kriellaars, 2019). Meanwhile, skilful movement in a wide variety of physical activities aligns with the theory of physical literacy, and is an accepted core component of the PL construct in all definitions (Cairney, Dudley, et al., 2019; Dudley et al., 2017; Edwards et al., 2017; Shearer et al., 2018; Whitehead, 2013). Movement competence is purported to be the foundation of effective participation in PA (Barnett, van Beurden, Morgan, Brooks, & Beard, 2009; Okely, Booth, & Patterson, 2001), thus positive movement experience can be considered to provide the foundations to being physical literate. Research in the field of movement considers that in order to develop children to be physically active, they need to have competence in a wide range of skills that are required to participate in PA (Logan et al., 2018).

This wide range of skills is referred to as fundamental movement skills (FMS) and they are classified into object control skills, locomotor skills, and stability skills (Gallahue et al., 2011). Object control skills require efficient throwing, striking, and catching movements (e.g. Catch – the ability to catch a ball that has been tossed underhand), and locomotor skills require fluid coordination movements of the body as the individual moves in one direction or another (e.g. Run – the ability to advance steadily by springing steps so that both feet leave the ground for an instant with each stride) (Logan et al., 2018; Ulrich, 2017). Additionally, to wholly consider movement skill competence accurately, stability must also be factored (Rudd et al., 2015). Stability refers to the ability to gain and maintain balance during movement and/or stationary (Gallahue et al., 2011). These movement skills are the building blocks of more complex movements required to participate in games, sports or other context specific PA (Logan et al., 2018). Fundamental movement skills have been found to have a causal relationship with PA (Barnett et al., 2011). Movement skills are not completely maturational in nature (Newell, 1991), if children are not in a developmentally appropriate environment, that fosters learning and practice, and provides the opportunities to experience success early and frequently, a child will not flourish in terms of this domain (Gagen & Getchell, 2006).

Internationally children's level of FMS proficiency has been reported to be low (Bardid et al., 2016; Burrows, Keats, & Kolen, 2014; Cliff, Okely, Smith, & McKeen, 2009; Khodaverdi, Bahram, Stodden, & Kazemnejad, 2016). The FMS proficiency among 7- and 8-year-old Belgian children was found to be 'below average', with 37.4% scoring below average and only 6.9% scoring above average (Bardid, De Meester, et al., 2016). Similar findings are also reported in 6- to 10-year-old Canadian children (Burrows et al., 2014), who have poorly developed FMS, falling between 12th and 27th percentile of the overall motor proficiency score when considering age and gender. In consideration of the normative values (Ulrich, 2000) Australian boys FMS have been interpreted to be between the 16th and 25th percentile (Cliff et al., 2009). Meanwhile, 9-year-old Iranian girls were found to exhibit 'poor' FMS levels, falling into the bottom 9% with a mean raw score of 76.28 (Khodaverdi et al., 2016). From an Irish perspective, FMS levels among Irish adolescents are lower than international comparisons, overall only 11% of children scored as either mastering or near mastering for nine FMS (O' Brien, Belton, & Issartel, 2016). Only one participant possessed complete mastery level across all nine object-related and locomotor movement skills (O' Brien et al., 2016). Irish primary school children's FMS proficiency is again similar to international peers, with 6 year old boys (n = 195) scoring around the 37th percentile, again this is considered low (Bolger, Bolger, O'Neill, & Coughlan, 2018).

The often referred to conceptual model of Stodden and colleagues (2008) refers to the dynamic relationship between movement competence and PA, with much support for movement competence being the foundation of effective participation in PA (Barnett, van Beurden, Morgan, Brooks, & Beard, 2009; Okely, Booth, & Patterson, 2001). Yet, children's FMS proficiency has been reported to be low worldwide, suggesting that attempts to develop FMS might require more than just developing the skills. From a physical literacy perspective, it is not just movement, but the movement experience that is vital, thus research should look at how physical competence and the other components of physical literacy combine, such as motivation toward PA, and whether higher quality attitude fosters movement proficiency.

Assessment of Physical Competence

Assessment of physical competence from the physical literacy perspective is difficult as capturing quality of movement in applied settings is usually neglected. Many measurements of physical competence separate the domains of physical literacy, and measure physical competence in isolation rather than in a setting that involves authentic application (Edwards et al., 2018). There are limitations to all measurements, however, if administered in the correct manner with a child-centred focus that concentrates on individual ability and progress, measurements can be applied while still considering key philosophical underpinnings of physical literacy.

Gallahue, Ozmun, and Goodway (2012) classify movement competence within three distinct holistic categories: locomotion, object control and stability skills. Assessment tools have yet to capture quality of proficiency in one test, with the use of separate product and process movement competence measurements being questioned (Stodden et al., 2012). Product-oriented measurements record the result of an action, e.g. the speed the ball is kicked. The most commonly used product based assessments are the Korperkoodinations Test fur Kinder (KTK) (Kiphard and Shilling, 2007) and the Movement Assessment Battery for Children (MABC) (Henderson et al., 2007). The KTK is validated for children aged five to 14 (Cools et al., 2009) and consists of four subtests, that measures the outcome of; walking backwards, moving sideways, hopping for height, and jumping sideways (Vandorpe et al., 2011). The KTK, however, only records the overall FMS score, with no breakdown of the components. Meanwhile, the MABC-2 is advantageous over the KTK due to fact that it can be assessed separately when identifying impairments in FMS across the three skill categories: manual dexterity, aiming and catching, and balance (Henderson et al., 2007). The main limitation of the MABC-2, as is the case in all product based assessments, is the fact that it does not identify movement quality – i.e. if the components of a skill are correctly executed during their execution.

Process measurements provide a qualitative assessment of skill proficiency (i.e., whether a child does or does not demonstrate ability in the skill). Although process-oriented movement competence assessments such as the Test of Gross Motor Development (TGMD) do not measure the outcome of movement (i.e., number of jumps completed in a specific time), it is presumed that the quality in the skills is associated with successful outcomes. Previous findings suggest relationships between skill process and skill outcomes (Logan, Barnett, Goodway, & Stodden, 2017; True, Brian, Goodway, & Stodden, 2017). In children, a significant relationship was found between the product and process scores of a two-handed strike (correlations ranging from $r = .51$ to .66) (Miller, Vine, & Larkin, 2007). Additionally, comparison of the overarm throw has shown a significant relationship between product (ball velocity) and process of skill in primary school children (Roberton & Konczak, 2001). Both these studies provide evidence for a positive relationship between process and product FMS measures.

Process-oriented movement competence assessments such as the TGMD evaluates how locomotor and object control movement is performed and can measure individual ability and progress (Ulrich, 2013). Normative data for the TGMD was initially developed using data collected in 1997–1998 among a large cohort ($n = 1208$) of 3- to 10-year-old US children (Ulrich, 2000). Since then other editions of the TGMD have been modified, currently on the third edition, the TGMD-3 has been shown to be a valid and reliable tool when measuring FMS of children (Maeng, Webster, & Ulrich, 2017). The TGMD-3 captures movement quality of 13 FMS, subdivided into locomotor proficiency and object control proficiency. This is a direct observation, process-oriented skill assessment looking at 3-6 performance criteria per skill that reflect the most mature movement pattern. The TGMD may help teachers track children's' progress, identify areas for development, and plan interventions tailored to each child (Maeng et al., 2017; Ulrich, 2000).

To assess movement skill competence accurately some form of stability assessment must be included (Rudd et al., 2015), something the TGMD lacks. The balance subtest of the Bruininks-Oseretsky Test of Motor Proficiency 2 (BOT-2) Short Form is a movement skill competence battery consisting of two tasks, walking forward along a straight line, and standing on one leg on a balance beam with eyes open (Deitz, Kartin, & Kopp, 2007). In contrast to the TGMD-3, these tests are based on the outcome of the performance. The product-based assessment awards points on a scale from zero to four for each task, measuring the outcome of the skill rather than the performance (Deitz et al., 2007) and has proven validity and reliability in both genders (Deitz et al., 2007; Fransen et al., 2014).

Gender Differences in Physical Competence

Research has highlighted differences across genders in regards to FMS proficiency (Spessato et al., 2013). Males have consistently been reported to have higher levels of overall proficiency (Barnett et al., 2009; Lopes et al., 2011; O' Brien et al., 2016) and object control proficiency compared to females (Barnett, Van Beurden, Morgan, Brooks, & Beard, 2008; Breslin et al., 2012; O' Brien et al., 2016). Meanwhile, gender differences have not been found to be as pronounced in the locomotor skills. Some have found significant gender differences in locomotor skills, with females achieving higher proficiency in the locomotor skills (Cliff et al., 2012; Hardy et al., 2010), whereas others have found no significant differences between gender (Bardid et al., 2016; Kelly et al., 2018).

Barnett and colleagues found males were more proficient at performing movement skills with a maximum score available of thirty, males scored a mean of 19.0 (CI 18.2,19.8), compared with females with a mean of 16.2 (CI 15.4,17.0). Males were also more proficient at object control skills, 11.3 (CI 10.9,11.8), in comparison with females, 7.8 (CI 7.3,8.2). Furthermore, Irish research between genders has highlighted adolescent males scoring higher in overall FMS; $t(221) = 2.454$, $p < .05$ (McGrane et al., 2018). Also, an independent t-test showed that males have an overall higher object control score compared to females; $t(221) = 3.382$, $p < .01$. A gender gap was also found in children (7-8 years old) for specific skills such as the over-arm throw and kicking, with males again outperforming the girls (Breslin et al., 2012).

The gender gap is even an expectation that is reflected in the measurement tools available for FMS, with girls having a lower threshold to achieve "acceptable norms" (Deitz et al., 2007; Ulrich, 2017; 2000). Gabbard (2011), however, discusses that biological sex differences affecting FMS are negligible before puberty. If not addressed the gender difference in FMS is known to increase from early childhood to adolescence (Goodway, Robinson, & Crowe, 2010), potentially impacting individuals perception toward PA participation.

Perceived Competence

Perceived physical competence has been identified as an important determinant of PA in youth (Farmer, Belton, & O'Brien, 2017; Raudsepp, Liblik, & Hannus, 2002; Weiss & Amorose, 2005). In a recent review, perceived physical competence was found to have the strongest association with PA in youth compared to the other aspects of self-perception (Babic et al., 2014). Thus, it is important to investigate development of perceived physical competence in children.

Definition and Conceptual Elements of Perceived Competence

Perceived physical competence is one’s perception to make meaningful self-evaluations of their performance (Harter, 1982). Perceived physical competence is considered to be multi-dimensional as children can perceive movement skill competence differently to competence in other sorts of PA. Previously, in physical literacy literature, perceived physical competence has been classified under the domain of motivation (Edwards et al., 2017).

Approaching perceived physical competence from its original theoretical position is broad as the approach looks at how children perceive their athletic ability and their ability to learn sports skills (Harter, 1982; Harter & Pike, 1984). One such study, that takes this approach, highlights the importance of perceived physical competence using a cluster analysis allowing for the understanding of different profiles within children (age = 8.82 ± 0.66 years) (Bardid, De Meester, et al., 2016). The research suggested that children who have a combination of low actual movement competence, 16% below the population mean, and low perceived physical competence, 19% below the population mean, are less likely to be physically active (Bardid, De Meester, et al., 2016). Moreover, children in groups with low levels of perceived physical competence have been shown to have significantly lower autonomous motivation for sports than children in groups with high levels of perceived physical competence, this is regardless of actual movement competence levels (Bardid, De Meester, et al., 2016). These findings suggest that perceived physical competence may be even more crucial than actual movement competence in terms of autonomous motivation, and that children need to feel competent in order to be motivated to engage in sports and PA (Bardid, De Meester, et al., 2016). Such findings need to be considered in interventions as there is an agreement that in early childhood the overestimation of competence could be seen as an asset, as the positive perceptions are more likely to promote PA participation (LeGear et al., 2012). A possible limitation to such research examining associations between actual and perceived physical competence from this direction is the instrument to assess FMS perceived competence does not match the actual skills assessed (Barnett, Ridgers, Zask, & Salmon, 2015).

From a movement skill domain, there is a developing thought that perception of skill is just as important as actual movement competence (De Meester, Stodden, et al., 2016), and in the effort to create physically literate children, it is important that the concept of movement competency is wholly understood and defined (Cairney, Clark, et al., 2019). Drawing from the discipline of movement, perceived movement competence refers to an individual's perception of their actual movement proficiency. Stodden and colleagues (2008) stipulated that the reciprocal and developmentally dynamic relationship between movement competence and PA is mediated by factors such as perceived movement competence across childhood. From a pragmatic standpoint, this makes sense as children are more willing to engage and persist in activities, they feel they can apply their skills toward (Barnett et al., 2008; Harter, 1982). Some even argue that it would be advantageous to foster the perception of movement competence in children beyond their actual skill level (De Meester, Stodden, et al., 2016). For example, adolescents who overestimate their movement competence in comparison to their actual movement competence have higher PA than accurate estimators, however this is in low-proficient adolescents (De Meester, Maes, et al., 2016). Interestingly, comparative research in children found over-estimation led to the lowest MVPA (De Meester, Stodden, et al., 2016), however they used divergent methods to identify perceived and actual movement competence. Meanwhile, when using aligned measures in children, those who overestimate their locomotor skill competence engage in more PA than their accurate counterparts, with multiple comparisons showing over-estimators, as compared to the accurate children, spent significantly more hours in after-school sport ($t73 = -2.24$, $p = .01$) (Pesce, Masci, Marchetti, Vannozzi, & Schmidt, 2018). Caveat; overestimation of movement skill competence has negatives which must be taken into account. In childhood, injuries are linked to factors such as overestimation of physical ability, with boys being at higher risk than girls (Plumert, 1995). From a broader point of view, it is also questioned if overestimation of the self is healthy over the long-term (Baumeister et al., 2003). Future interventions should not just look at increasing the perception of movement competence but consider aligning children's perception to their actual movement competence (Schmidt, Valkanover, Roebers, & Conzelmann, 2013). With this in mind, research has developed specific measurements that align children's perception to their actual movement (Barnett et al., 2016; Harter & Pike, 1984).

Assessment of Perceived Competence

Harter and Pike (1984) designed the Pictorial Scale of Perceived Competence and Acceptance for Young Children to measure physical self-perceptions in children. While it assesses typical childhood actions (e.g. swinging on a swing), it does not assess movement in an empirical manner. Some instruments have been developed to more accurately measure perceived competence of the most common movement skills. The Children's Perception of Motor Competence Scale was developed and used in Spain (Pérez & Sanz, 2005) but this also failed to encompass common movement, neglecting to include common object control skills such as kicking and striking. One such skill specific measure of perceived movement competence, developed by Barnett et al (2015), utilizes a pictorial scale that has been validated in children 4-10 years old (Barnett, Ridgers, Zask, & Salmon, 2015; Lopes et al., 2016). The Pictorial Scale of Perceived Movement Skill Competence (PMSC) was developed with the purpose of aligning with the TGMD-3 when assessing FMS perception among children. The PMSC is a valid and reliable instrument with an internal consistency coefficient ranging from 0.60 to 0.81 and overall =.83 (Barnett et al., 2015). It is the first tool for young children that assesses perceptions in the same FMS skills that are commonly used to test actual FMS proficiency (Barnett et al., 2015). It utilizes the same format and item structure as previously established assessments of physical competence perception (Harter & Pike, 1984), but the PMSC aligns with common measurements movement skill (i.e., TGMD). The pictorial scale of PMSC assesses six locomotor (run, gallop, hop, skip, horizontal jump, and slide) and seven object proficiency skills (two-hand strike of a stationary ball, one-hand stationary dribble, kick, two-hand catch, overhand throw, forehand strike of a self-bounced ball, and underhand roll), based on the TGMD-3 (Ulrich, 2017). Administration of the pictorial scale of PMSC arranges cartoon pictures of children depicting a skill proficiently, opposite to an image of a child depicting a skill not so proficiently. Children either pick a cartoon portraying a child who is proficient at a skill or the cartoon portraying a child who is not so proficient at a skill. If children select the proficient cartoon they are asked: 'are you really good at …' (score of four) or 'pretty good at …' (score of three), if children pick the not so proficient cartoon, they are asked: are you 'not that good at (score of one) or sort of good at …' (score of two). The result is a four-point Likert scale response variable (range 1–4).

Gender Differences in Perceived Competence

While the research on FMS is quite consistent regarding gender differences, the research on perceived movement competence is inconclusive in this regard. A study of children, ages 3 to 6 years (n = 66), found no gender difference on children perceptions of movement competence (Famelia, Tsuda, Bakhtiar, & Goodway, 2018). Meanwhile, in another study, that comprised of 704 children (mean age 6.8 years) found boys had higher perception of movement competence than girls (Toftegaard-Stoeckel, Groenfeldt, & Andersen, 2010). Although important on its own, accuracy of perception is necessary as children have been found to under/over-estimate, with research again contrasting as one study found girls are more accurate than boys when perceiving their movement competence (LeGear et al., 2012). Meanwhile, one study of 136 Australian children (51% boys; M = 6.5 yr., SD = 1.1) found that only boy's perception of their movement competence is significantly related to their actual object control competence (Liong, Ridgers, & Barnett, 2015). Important developments from a Finnish study (Jaakkola et al., 2019) that aligned measurement of perceived and actual movement competence suggests the impact on PA levels is different for boys and girls (n=422, age =11.26 ± 0.31). Boys movement competence was directly associated with PA, meanwhile the indirect path through perceived movement competence was significant for only girls (Jaakkola et al., 2019), this finding contrasts with Babic and colleagues systematic review (Babic et al., 2014). This development highlights that alignment of perceived competence with actual competence needs further investigation because if positive self-perception and attitude toward PA engagement is contributing to children's PA then it needs to be considered and fostered in a holistic manner, alongside actual movement competence in interventions.

Physical Literacy

Physical literacy is often defined as the *"motivation, confidence, physical competence, knowledge and understanding to value and take responsibility for engagement in physical activities for life"* (Cairney, Kiez, et al., 2019; Corbin, 2016; Whitehead, 2001, p. 127). Advocates of the concept believe that physical literacy is the connection of PA determinants that support the participation in PA (Cairney, Kiez, et al., 2019; Corbin, 2016; Dudley et al., 2017; Whitehead, 2010). The principal of physical literacy is movement skill alone does not promote a desire to be involved in PA, rather it is the rewarding satisfaction and belief generated from experience and proficiency in movement that promotes prolonged involvement. Studying how the components of physical literacy interact could be the key to understand what drives children to be active (Cairney, Dudley, et al., 2019). Yet there is discrepancy on how to assess the concept (Edwards et al., 2018).

Assessment of Physical Literacy

At present, there are two assessment tools published in peer-reviewed journals that specifically identify as measures of physical literacy, the Canadian Assessment of Physical Literacy (CAPL) (Francis et al., 2016) and the Physical Literacy Assessment for Youth (PLAY) tool (Cairney et al., 2018). To progress the area empirically, testing and analysing physical literacy is important, particularly as attention for physical literacy has outpaced empirically valid measurement of the construct (Corbin, 2016; Dudley et al., 2017; Edwards et al., 2018).

The CAPL tool was designed to measure physical literacy of children aged 8 to 12, it uses a broad testing battery that assesses all the domains of the accepted physical literacy definition plus additional elements, such as body composition (Francis et al., 2016). Originally the CAPL comprised of 25 indicators chosen to align with the internationally accepted Canadian Consensus Statement definition of physical literacy

(Robinson & Randall, 2017). Criticism around the CAPL tool was focussed on the physical competence domain of the measure. The tool included movement competence, but also originally included outcomes of physical literacy such as PA participation and body composition as part of the physical competence domain. As mentioned, there is a current hypothesis that body composition is a manifestation of physical literacy, rather than part of the construct itself (Cairney, Dudley, et al., 2019; Whitehead, 2010). Recent physical literacy construct evaluation of the CAPL tool has confirmed issues with the inclusion of body composition within the physical competence domain, showing that body composition was the factor that loaded the most into the physical competence domain (Longmuir et al., 2015; Robinson & Randall, 2017). The CAPL has undergone extensive modifications to reflect advances in physical literacy theory and to account for results from investigations of score reliability and validity (Francis et al., 2016). Although, a recent Delphi process recommended that the CAPL be revised to represent the holistic nature of physical literacy by overlapping the components of physical literacy, such as physical competence and confidence (Longmuir et al., 2015). Other issues are due to the composite scoring system, where analysis of the CAPL results may be deceptive, a child may score high in the physical domain and low in the affective domain, yet a child with reverse results could have the same composite score (Corbin, 2016), thus not profiling children and their unique physical literacy.

The PLAY tools are another combination of assessments that were developed using the internationally accepted Canadian Consensus Statement definition of physical literacy (Cairney et al., 2018; Kilborn, Lorusso, & Francis, 2016). PLAY tools include: PLAYfun; an assessment of movement competence, confidence and comprehension; PLAYself; a self-assessment tool; PLAYinventory – a child's self-report of participation in activity; PLAYparent – a parental assessment of the child; PLAYcoach;

assessment of the child by the coach or PE teacher (Canadian Sport for Life Society, 2013).

Similar to the CAPL, PLAY is suitable for use with children 7 to 14 years of age (Canadian Sport for Life Society, 2013). The physical competence domain is assessed using the PLAYfun tool which assesses movement competence in 18 curriculum focussed tasks. The movement competence assessment in PLAYfun assesses tasks rather than skills so that it includes an evaluation of spatial awareness, skill proficiency, and selection in the competency evaluation. This assessment also uses a continuous criterion-referenced scale (0–100) that fit within four labelled categories: initial, emerging, competence, and proficient. Importantly the tool also assesses a child's confidence and comprehension to execute movement tasks, for example does the child seem apprehensive or need clarification of the terminology. PLAYfun is one tool from the PLAY collection of tools to measure physical literacy in children. PLAYfun encompasses 18 different movement tasks within five categories that assess different aspects of a child's movement skills. The five categories are as follows: 1) running, 2) locomotor, 3) object control—upper body, 4) object control—lower body, and 5) balance, stability, and body control. Factor structure has initially supported PLAYfun as a measure of movement competence (Cairney et al., 2018). The five-factor structure of the scale was found to have an acceptable fit to the data (root mean square error of approximation, 0.055; 90% confidence interval, 0.03–0.075; comparative fit index, 0.95; Tucker–Lewis Index, 0.94). Continued evaluation of the tool and other subscales of PLAY is required as the sample size was not as large as some recommended minimums for conducting confirmatory factor analysis (MacCallum, Widaman, Zhang, & Hong, 1999). Some suggest that the PLAYfun tools should not be used as the only assessment of movement competence (Stearns, Wohlers, McHugh, Kuzik, & Spence, 2019). Additionally, psychometric testing of the PLAY tools (PLAYself – the self-assessment tool, and PLAYinventory – the child's self-report of participation in activity) is needed before the overall PLAY tool can be accepted as an established physical literacy assessment.

Another approach to physical literacy, the pragmatic perspective, believes that using evidence-based measures that are compatible with physical literacy will promote change in current practices, such as curriculum and policy (Creswell, 2003; Higgs, 2010). The pragmatic perspective has tried to capture the sense of physical literacy by using a battery of previously validated measures, quantitative methods have included: monitoring devices (e.g., accelerometers); observations (e.g., of PA or movement proficiency); psychometrics (e.g., enjoyment, self-perceptions); performance measures (e.g., objective times/distances); and, anthropometric measurements.

Such a pragmatic approach, using the method which appears best suited to the research problem of measuring physical literacy has been implemented in children and adolescents in Ireland (Belton et al., 2018; McKee, Breslin, Haughey, & Donnelly, 2013). In Northern Ireland, physical literacy is defined as FMS applied with confidence, in settings which may lead to sustained involvement in sport and PA. The authors combined Henderson and Sugden's Movement Assessment Battery for Children, Bruininks-Oseretsky Test of Motor Proficiency, Brustad's Children's Attraction to Physical Activity, and Harter's Self- Perception Profile for Children to capture physical literacy (McKee et al., 2013)

Meanwhile, in adolescents, the Youth Physical Activity Towards Health (Y-PATH) programme used measures in consideration of several components of physical literacy in an Irish context, using the structure of the physical literacy domains presented in Longmuir and colleagues (Longmuir et al., 2015). Measuring PA via accelerometer and self-report (Prochaska, Sallis, & Long, 2001); physical competence via FMS (Ulrich, 2000) and body composition; and psychological correlates through self-efficacy (Garcia, Pender, Antonakos, & Ronis, 1998; Whitehead, 1995) and perceived benefits of PA (Rowe & Murtagh, 2012). Physical activity was considered the overall outcome of the Y-PATH programme, and by measuring variables that consistently correlate with MVPA, plus using the structure of physical literacy, data highlights that Irish adolescents lack basic movement skill proficiency, with 11% scoring mastery or near mastery across the 9 skills; are not physically fit, with self-report data showing only 33% meet the PA guidelines on all 7 days; have less than ideal BMI, with 21% of adolescents overweight, and 4% obese (Cole, Bellizzi, Flegal, & Dietz, 2000); and have low levels of self-efficacy, with comparisons showing children with "low PA" have significantly lower self-efficacy than "moderate" or "high PA" children. All these poor scores point to inadequate levels of physical literacy and insufficient PA.

A range of initiatives and programs have emerged from the pragmatic approach towards measuring physical literacy (Belton et al., 2018; Francis et al., 2016; Giblin, Collins, & Button, 2014), but some have been criticised for treating them as quite separate (Francis et al., 2016), and providing a disproportional focus on physical and movement competence (Giblin et al., 2014). Adopting a pragmatic approach, however, facilitates reliability, validity, and replicability in developing interventions. Moreover, a pragmatic perspective is important as it helps develop an understanding of physical literacy components, hence what should be targeted in interventions to achieve physically literate children.

Physical Literacy Interventions

Fostering physical literacy in children can promote physical and psychological benefits and considering the low levels of PA it seems apparent to address both from a more rounded approach. This section of the literature review will question the need to intervene and will reflect and consider the nature of the implementation of a physical literacy intervention.

How to intervene

According to the Medical Research Council, all interventions should be founded on relevant theory (Craig et al., 2008). Utilising relevant theory when developing interventions to change behaviour have been more successful than those that do not outline the process (Stull et al., 2007). Interventions with a theoretical framework can be evaluated and examined with ease, thus pinpointing ways in which the intervention can be improved (Michie & Abraham, 2004). A review of 19 frameworks theorises that behavioural changes come from an interaction between an individual's capability, opportunity and motivation to perform and carry out a behaviour (Michie et al., 2011). The Capability-Opportunity-Motivation Behaviour (COM-B) model theorises change is required in one or more of these conditions for any behavioural change to take place (Michie et al., 2011). While no framework contained all three conditions, they were synthesised into the Behavioural Change Wheel (BCW), and contain the COM-B model at its core (Michie et al., 2011).

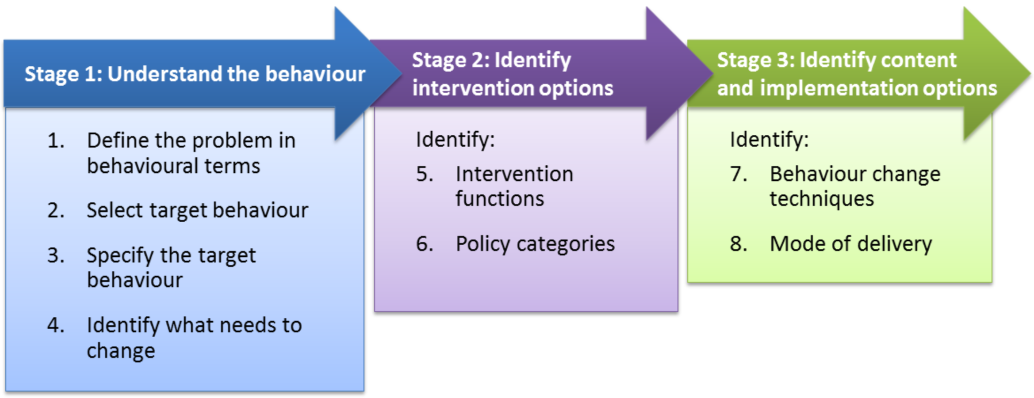

Figure 1. Behavioural Change Wheel Step by Step Method for Designing Behaviour Change Interventions (Michie et al., 2011)

Components of Physical Literacy Interventions

Reviews state that interventions targeting PA or PA determinants should be multi-component and not solely limited to one approach (Langford et al., 2015). Research suggests that multi-component school-based interventions not only support a rise in PA at school, but also increase levels outside of the school, which is vital if long-term behaviour change is to be achieved (Crutzen, 2010; Dobbins, Husson, Decorby, & Larocca, 2013; Salmon, Booth, Phongsavan, Murphy, & Timperio, 2007; Van Sluijs, McMinn, & Griffin, 2008). Moreover, incorporating influences, such as family, into the intervention also strengthens the potential for success (Kriemler et al., 2011). Furthermore, children with parents and/or siblings who regularly participate in PA have healthier PA patterns, possibly due to encouragement of sports participation and active transport, peer modelling, and an opportunity for someone to be physically active with (Murphy, Rowe, & Woods, 2016).

Considering that in Ireland only 35% of primary schools deliver the recommended minimum minute of PE per week (60 minutes), a reframing of how PA is viewed has been called for, suggesting that a FMS programme looking at alternative forms of activities to suit the age, development, and interests of children is needed in Ireland (Woods, Moyna, Quinlan, & Walsh, 2010). School policies and programmes have the opportunity to support and adopt physical literacy into children's lifestyle (Department of Health, 2016; McLennan, Nancy, Thompson, & Jannine, 2015; Woods et al., 2010). If delivered properly PE provides children with the opportunity to develop motivation, confidence, physical competence, and understanding to value and take responsibility for engagement in physical activities for life (Cairney, Dudley, et al., 2019; Dudley et al., 2017). For successful PA behaviour change to occur, the focus must encompass the development of children in a holistic manner to provide a solid foundation for physical literacy. Thus, physical literacy intervention frameworks should ensure all aspects of the theory are nurtured in a wide variety of physical activities, which in turn will allow for a significant contribution to children's quality of life.

Examples of interventions targeting physical literacy components

There is a consensus that intervening by targeting the components of physical literacy is vital as PA levels deteriorate (Dudley et al., 2017; Whitehead, 2010). By developing children to be physically literate they are more likely to not only participate, but value sport and PA for life which has many benefits (Dudley et al., 2017). In order to move the theory of physical literacy forward it is appropriate to consider empirical research on the concept of physical literacy and physical literacy components that have previously been evaluated in interventions. It is also important to consider that school-based efforts to promote PA were already under development before the calls for collective efforts to promote PA around the physical literacy concept (Roetert, 2013). Nevertheless, there are various programmes that have provided evidence and incorporated physical literacy into the development and support of school-based interventions that target an increase in PA, and/or the individual components of physical literacy (O'Brien, Belton, & Issartel, 2015).

Movement Competence Interventions

Movement competence interventions have produced significant improvements in movement proficiency and PA. For example, The Get Skill, Get Active research team (van Beurden, Zask, Barnett, & Dietrich, 2002a, 2002b) in Australia investigated the Move it Grove it program designed for children aged 7 to 10 over a 1 year duration (n = 1000). This intervention was utilised across the whole school, resulting in an improvement of 16.8% across movement skills. While these findings are positive, the intervention group only increased their MVPA by one minute. The 'Move it Groove it' intervention did increase FMS proficiency, but the intervention effect on PA is negligible. A recognised limitation to this study, and an important future direction, is the emphasis on FMS, and that the skill development was not transferred into PA. Future interventions should consider integrating FMS development into children-focused physical activities.

Similarly, a clustered RCT over 6 months (n = 709) in the USA using the SPARK interventional approach on children compared three groups; PE specialists, intervention teachers and control teachers (Sallis et al., 1997). At the time, movement competence of three object control skills (overhand throw, catch and kick) was the primary outcome (Sallis et al., 1997). Over the 6-month duration, the PE specialist group increased movement competence for these three skills by 21%, the intervention teacher group by 19% and the control teacher group increased by 13%. While the PE specialist was superior in the majority of outcomes compared to their intervention teacher counterparts, the intervention teachers achieved significantly greater results than the control teacher group. This result is of particular interest in an Irish context, as specialised PE teachers are sparse in Irish primary schools, highlighting that teacher training can also be effective in positively increasing children's PA (McKenzie, Sallis, & Rosengard, 2009).

A meta-analysis of movement competence interventions reported significant intervention effects with large effect sizes for overall movement proficiency and locomotor skill competency, and medium effect size for object control skill competency (Morgan et al., 2013). As previously mentioned, it is the experience of movement that is vital for children to actually value their competence and apply it to PA (Cairney, Dudley, et al., 2019), with research stating that children's learning and proficiency can be improved through a positive environment. An example of an intervention that nurtures positive movement experience is Martin and colleagues (Martin et al., 2009) two strand FMS intervention (n=64, mean age 5.55 years). One strand using a mastery motivational approach to teaching FMS and the other strand using a low autonomy approach to teaching FMS. A mastery motivational approach is suggested to encourage increased engagement and develops a positive attitude toward an activity (Ames, 1992). Participants in the mastery class achieved significant improvements in FMS from pre to post intervention (p=0.001), while the low autonomy version failed to elicit any significant change (Martin et al., 2009). These highlights, how movement interventions are delivered is important, movement proficiency alone is not the only determinant of PA, there are other approaches, such as development of attitude toward PA.

Affective Interventions

Few intervention studies have tested SDT in relation to PA. But, based on SDT some interventions have seen increases in autonomous motivation towards PA (Hagger et al., 2009; Vansteenkiste, Simons, Lens, Soenens, & Matos, 2005). A school-based intervention programme (Vansteenkiste et al., 2005), used tenets of SDT to promote PA participation. In accordance with principles of SDT, this study pointed out that autonomy-supportive environments enhanced pupils' autonomous motivation toward the fitness class they participated in. The intervention programme, however, was brief producing small to medium effect sizes, that explained between 2% and 21% of variance in PA participation. A similar study (Hagger et al., 2009) developed and evaluated the benefit of a school-based intervention to change adolescents' PA autonomous motivation and self-reported PA. Results indicated that adolescents who were taught in an autonomy-supportive environment participated in more PA than pupils in the control condition. What these interventions suggest is that SDT can provide a useful framework for the development of school-based interventions that can affect not only autonomous motivation to PA, but also PA participation. It is again important to consider that autonomous motivation interventions effects on PA are small, indicating that influencing multiple determinants during interventions could be the way forward (Heath et al., 2012; Langford et al., 2015).

Other interventions that have addressed characteristics of physical literacy, self-efficacy (Dishman et al., 2004; Khodaverdi et al., 2016; Lubans et al., 2008), have found that interventions that targeted PSE contributed to significant improvements in PA. The LEAP study (Dishman et al., 2004) was designed to increase PA in high school girls by enhancing self-efficacy via behavioural skills (e.g., goal setting, time management, and identifying/overcoming barriers). The intervention had statistically significant, but small direct effects on self-efficacy (R^2 =.07) and PA (R^2 =.10). Self-efficacy was also shown to have a statistically significant direct effect (R^2 =.08) on PA. Thus, the effect of the intervention on PA was partially mediated by self-efficacy (Dishman et al., 2004).

Similar attempts to increase self-efficacy through goal setting and PA planning have been made in Iranian girls (Khodaverdi et al., 2016). This study found that teaching the intervention group goal setting increased girl's commitment to planning for PA, which in turn mediated changes in PA. There is convincing evidence that targeting self-efficacy is an effective means of increasing PA, however, many intervention techniques for changing self-efficacy and thereby PA have yielded small effects (Lubans et al., 2008). There still remains a knowledge gap of what develops PSE (Ashford, Edmunds, & French, 2010; Williams & French, 2011), with an opportunity for research to investigate the relationship between components of physical literacy.

Toward a Physical Literacy Intervention

A school-based intervention to promote PA that has gone through years of development before the calls for collective efforts to promote PA around the physical literacy concept was the SPARK studies (McKenzie, Alcaraz, Sallis, & Faucette, 1998; Prochaska et al., 2003; Sallis et al., 1997). In brief, there was evidence of success with the following variables: (a) PA during PE (McKenzie et al., 1998); (b) physical fitness (Sallis et al., 1997); (c) movement skill development (McKenzie et al., 1998); and (d) student enjoyment of SPARK (Prochaska et al., 2003). Research has drawn considerably from SPARKs findings (McKenzie et al., 2009), but this review will focus on more recent and pertinent interventions.

Since the call to promote PA around the concept of physical literacy (Roetert, 2013), an intervention using the PLAY tools, examined the impact of circus arts instruction in PE ($n = 101$) on the physical literacy of children, compared to the traditional PE ($n = 110$) curriculum (Kriellaars et al., 2019). The physical literacy of the children was evaluated by the use of the PLAY tools (Cairney et al., 2018). There were significant improvements in movement competence for both groups, based upon overall mean movement competence, there were significant improvements for the standard curriculum of 2.9% and circus arts intervention of 7.8% ($p < .001$), with no average differences at baseline. Alongside the improvement in movement skills, increases were observed in the circus arts children's confidence and comprehension of movement terminology. Moreover, there was a significant difference in environmental participation across the contexts of participation (gym, water, ice, snow, outdoors, and playground) in the circus arts intervention schools than the standard PE schools at endpoint ($p = .02$). Correspondingly, based upon the total number activities participated in (PLAYinventory), at endpoint, the circus arts intervention schools revealed a significantly greater number of activities (26 vs. 20, $p = .05$) than the standard curriculum schools. The difference in movement competence for genders also significantly shortened in the intervention group, initially, the gender difference in movement competence was similar pre-intervention (2.5% circus vs. 3.6% standard), but at endpoint, the gender gap was magnified in the standard PE schools (5.4%) and was slightly decreased in the circus arts schools (1.95%). It must be noted that the entirety of the PLAY tools has not yet been validated (Stearns et al., 2019). A beneficial outcome of the PLAY tools is the categorisation of children, two categories: Developing or Acquired. Within the Developing category, children are classified as either Initial or Emerging, while under the Acquired category, children are classified as either Competent or Proficient. Such classification has allowed for tailored interventions, which considers children's different needs. In the context of physical literacy, there needs to be a consideration of differentiation in children's development, due to the complex and non-linear nature of physical literacy, yet accurate measurements are a necessity.

The Y-PATH intervention has components in line with the promotion of physical literacy in Irish adolescents, this was not due to a direct attempt to address physical literacy at the outset, but rather was developed as a response to the identified needs evident in Irish adolescent youth (Belton et al., 2014). The purpose of Y-PATH is to increase PA of adolescent youth, through targeting various components of physical literacy, namely health related activity knowledge and understanding, PA motivation, attitudes and self-efficacy, and movement competence (Belton et al., 2014; Belton, O'Brien, McGann, & Issartel, 2019). Applying a socio-ecological model, this intervention utilises a multi component approach, targeting the whole-school and home (through parents) also (Belton et al., 2014; Belton, O'Brien, et al., 2019). In an exploratory trial of Y-PATH the intervention group significantly increased daily PA by 7.2 minutes more than participants in the control group at the retention phase of the intervention (McGrane et al., 2018). The intervention and control groups both saw an improvement in FMS, however improvement in the intervention group was significantly greater (McGrane et al., 2018).

Considering a similar direction to the Y-PATH intervention, systematic reviews provide evidence that the more effective strategies involve multiple components and are not solely limited to what can be achieved in a PE lesson (Kriemler et al., 2011; Salmon et al., 2007; Timperio, Crawford, Telford, & Salmon, 2004). School-based interventions including an at home component found a positive effect on increased PA participation (Belton et al., 2014; De Meij et al., 2010; Murillo Pardo et al., 2013). Active classrooms have also gained traction in recent years to be included as a part of a whole school approach (Goh et al., 2014; Martin & Murtagh, 2015). The research around school-based interventions is clear and multi-component interventions are proven to be more effective, although the results do not always result in positive changes (Beets et al., 2016). One caveat, PA interventions frequently report small effect sizes, with a recent review stating that interventions have an average increase of four minutes on children's daily PA (Metcalf, Henley, & Wilkin, 2012). While the research supports the multi-component nature of these interventions, promoting PA via physical literacy should be considered for inclusion in any future interventions.

Drawing from the aforementioned physical literacy interventions, it is evident that approaching children's physical literacy in a way that considers differentiation (Cairney et al., 2018; Kriellaars et al., 2019) would be beneficial, as this aligns with the current pedagogy of differentiated teaching and learning. Building upon previous approaches, and bearing in mind that interventions should be based on a relevant theoretical framework (Craig et al., 2008), differentiated interventions should be developed via identification of needs. This is best done via a robust needs assessment utilising reliable and valid measurements, similar to that of Y-PATH (Belton et al., 2014). The Y-PATH intervention has been evaluated and refined and proven effective in improving physical literacy (Belton et al., 2018; O' Brien, Issartel, & Belton, 2013) and halting the decline in PA levels in adolescence (Belton, McCarren, et al., 2019), yet there are insufficient interventions that target younger children in Ireland. Previous research highlights low levels of PA and FMS levels in small samples of Irish children

(Bolger, Bolger, O'neill, et al., 2018; Keane et al., 2014), however a nationally generalizable sample has never been obtained to allow for a coherent national needs analysis, that could help the development of a physical literacy intervention for children (Michie & Abraham, 2004).

Conclusion

In this literature review, the components of physical literacy have been explored, with their importance to PA participation evident. Common to all physical literacy definitions is the core understanding that physical literacy is about having the motivation and belief to engage in wide array of activities, while having the essential movement skills to successfully participate in these sports and other physical activities (Cairney, Kiez, et al., 2019; Corbin, 2016; Dudley et al., 2017; Whitehead, 2010).

To gain a better understanding of physical literacy, and successfully develop and implement an intervention to address it, measuring the components of physical literacy is essential to allow analysis to highlight relationships between the components and generate differentiated profiles of children. Current research adopts diverse methodologies in measuring/assessing physical literacy (Edwards et al., 2018; Shearer et al., 2018). The choice of measurements is highly dependent on a researcher's philosophical approach, the specific intention and target of the research question, and moreover the validity and reliability of available measurement tools in children. From a pragmatic perspective, using measures that are valid and reliable, but also compatible with the theory of physical literacy, could provide evidence to the current development of children and their physical literacy.

As this review has shown, early childhood in the primary school period could be a critical period to establish the components of physical literacy (Whitehead, 2010). It is clear, with adolescents' low levels of physical literacy, that there is not only a need to assess physical literacy, but also a need for initiatives at an earlier age to prevent the decline. Primary school provides an excellent setting for intervention development and evaluation to target the components of physical literacy in children, however multi-component approaches must be considered to achieve behaviour change (Langford et al., 2015). There is a strong rationale to that interventions that also incorporate targeting broader influences, such as family, can provide positive results.

Finally, when developing interventions to change behaviour it is vital that there is consideration to what the behavioural target is, and what components need to be changed to achieve this. Understanding the relationship between the components of physical literacy in an Irish youth cohort, would allow for the development of an optimum intervention to target their needs. Such an approach has proven successful in targeting PA behaviour change in post primary aged Irish youth (Belton, McCarren, et al., 2019; Belton et al., 2014), and the need for a similar methodology to be employed to address the issue in Irish primary aged children is clear.

Purpose of the Current Study

The purpose of the current study is to explore physical literacy relationships, with a view to gaining a better understanding of how the components interact to promote PA in children. Considering the under-explored relationship of physical literacy components, an analysis of how children's PA motivation impacts their fundamental movement skills will be conducted to develop an understanding of how to promote FMS (Wick et al., 2017). Knowing how to promote FMS is helpful, but prior research has demonstrated that there are psychological components (e.g. PSE) that support development of a physically active lifestyle. Yet, regarding how to improve the psychological construct is still a knowledge gap. With a large majority of research to date championing improvements in PSE as the remedy to PA levels, understanding if

FMS is helping develop PSE would help further knowledge of physical literacy. Furthering this knowledge is pertinent as it is still unclear why some children are more physically active than others. Previous research has provided an overall picture of children's PA (Cortis et al., 2017; Craggs et al., 2011; Uijtdewilligen et al., 2011; Van Der Horst et al., 2007), however, such an approach provides very little specificity, as entire samples are described together. Current research notes that when children are differentiated according to their learning needs then they are more likely to develop (Gibbs & Simpson, 2004). Therefore, this research will explore whether different profiles in terms of physical literacy exist in primary school children and if this significantly impacts their PA. Finally, with a clearer picture of children's physical literacy needs, this research will develop an intervention, with a focus on teacher's physical education pedagogy to ensure differentiation in children's physical literacy development is considered.

CHAPTER 3

How Children's Physical Activity Motivation Impacts Their Fundamental Movement Skills

Abstract

Background: To understand the relationship between children's quality of physical activity motivation and proficiency of fundamental movement skills.

Methods: A purposive sample of 865 children (47.7% female, 10.9 ± 1.16 years) were recruited from thirty primary schools. Children completed an assessment for quality of physical activity motivation (Behavioural Regulation in Exercise Questionnaire adapted). Fundamental movement skill (object and locomotor) proficiency was measured using the TGMD-3 and was supplemented by the vertical jump. Separate hierarchical multiple regressions were employed to analyse the relationship between quality of physical activity motivation and fundamental movement skill proficiency for males and females.

Results: For males, the analyses yielded a significant positive relationship between identified physical activity regulation and overall (β = .21), object (β = .17), and locomotor (β = .21) fundamental movement skill proficiency. Meanwhile external physical activity regulation had a significant negative relationship across overall (β = -.21), object (β = -.13), and locomotor (β = -.18) fundamental movement skill proficiency for females. Sex differences occurred.

Conclusion: This study provides evidence for the need to decrease controlling regulations and at the same time stimulate an environment that promotes autonomous motivation when designing, testing and implementing fundamental movement skills interventions.

Globally, children do not participate in sufficient physical activity (PA) to develop and maintain good health (Andersen et al., 2016; Bauman et al., 2012). Although, various strategies to improve PA have been developed (Heath et al., 2012), PA levels are slow to improve and are worsening in some countries (Dumith, Hallal, Reis, & Kohl, 2011). Moreover, the gap between males and females PA levels is widening (Cortis et al., 2017). An important correlate and determinant of PA is fundamental movement skills (Barnett, Morgan, Ball, & Lubans, 2011; Lopes, Rodrigues, Maia, & Malina, 2011). There is an increasing recognition of the relationship between FMS and PA in childhood (Lubans, Morgan, Cliff, Barnett, & Okely, 2010; Stodden et al., 2012), with studies beginning to show a causal relationship between FMS and PA (Barnett et al., 2011; Jaakkola & Washington, 2013). A proficient FMS ability can be considered an important motivating force for children's prolonged engagement in PA (Kalaja, Jaakkola, Watt, Liukkonen, & Ommundsen, 2010; Stodden et al., 2012).

Yet, there is discrepancy between the sexes in regards to their FMS proficiency (Spessato et al., 2013). Males have consistently been reported to have higher levels of overall proficiency (Barnett et al., 2009; Breslin et al., 2012; Cantell et al., 2008; Lopes et al., 2011; O' Brien et al., 2016) and object proficiency compared to females (Barnett, van Beurden, Morgan, Brooks, & Beard, 2010; Barnett et al., 2008; Breslin et al., 2012; O' Brien et al., 2016). This expectation is even reflected in the measurement tools available for FMS (Ulrich, 2000, 2017; Deitz et al., 2007). However, Gabbard (2011) discusses that biological sex differences affecting FMS are negligible before puberty, thus it is pertinent for research to understand what is driving the gap between the sexes FMS proficiency.

Motivation is one's direction and intensity for a behaviour; what causes a person to want to learn and repeat a behaviour (Cortis et al., 2017; Ng et al., 2012; Teixeira et al., 2012). Studies to date have predominantly focused on the relationship between the quality of PA motivation and PA (Cortis et al., 2017; Sallis et al., 2000), however, there are a lack of studies that have investigated the relationship between quality of PA motivation and determinants of PA, such as FMS. Self-Determination Theory (SDT) proposes a multidimensional conceptualisation of motivation in which the types of motivations are of different quality, with self-determined (or autonomous) motivation types (intrinsic motivation and identified regulation) considered to be higher quality than less self-determined (or controlling) types of motivation (introjected and external regulation; Ryan and Deci, 2000). According to SDT, quality of motivation is vital as autonomous forms of motivation facilitate learning, performance, higher interest and greater effort. Meanwhile, controlling forms of motivation, in contrast, are negatively related to these outcomes (Grolnick and Ryan, 1987; Deci et al., 1996).

Despite the abundance of research highlighting that FMS lay the foundations for being physically active, there is low-quality evidence on how to promote FMS (Wick et al., 2017). Moreover, no studies have assessed why females are less proficient at FMS than males. With the above in mind, understanding if the relationship between children's quality of PA motivation and proficiency of FMS is congruent with previous SDT research will help contribute to the development of strategies for the promotion of FMS. Equally such awareness offers an explanation to why there is a gap between the sexes FMS. Thus, the primary purpose of the current study was to analyse if a positive relationship will be observed between autonomous motivation – intrinsic and identified – and FMS; in turn, a negative relationship between the controlling motivations and FMS. Additionally, it is hypothesised that the relationship between PA motivation and FMS will differ between sexes. Although there is no direct data to suggest that biological sex plays a role in motivation, the SDT framework would propose that the reason males FMS proficiency is consistently found to be higher than females (Barnett et al., 2009; Breslin et al., 2012; Cantell et al., 2008; Lopes et al., 2011; O' Brien et al., 2016) is due to outcomes of autonomous motivation (e.g. higher interest and greater effort; Grolnick and Ryan, 1987; Deci et al., 1996). Thus, it is predicted that males will have a stronger positive relationship between autonomous motivation and FMS than females. Respectively females controlling motivation will have a stronger negative relationship with FMS than males.

Methods

Participants and recruitment

Cross-sectional data were collected as part of a larger study entitled the 'Moving Well-Being Well' (MWBW) programme. Support in identifying schools was provided by gatekeepers (coaches) who were involved in the schools. The coaches were asked to recommend schools, after being provided with a purposive sampling criterion based on the Delivering Equality of Opportunity in Schools (DEIS) action plan for educational inclusion (Department of Education and Skills, 2017). The DEIS Plan (2017) identified 640 out of 3111 schools (20.6%) with levels of educational disadvantage. In order for generalisability, thirty schools were approached, of which eight (20%) were identified as schools with levels of educational disadvantage, all consented to participate. From the thirty selected schools, 1,104 children from third to sixth class were invited to participate, from which 1,053 (95.34%) volunteered to participate. Once participants with missing data were removed, the final sample consisted 865 children (47.7% female, 10.9 ± 1.16 years) - ie 78.35% of the invited children. Children completed assent forms, while parents provided signed informed consent forms to confirm they understood the purpose of the research and participation rights (e.g., voluntary participation, right of withdrawal, and confidentiality of the data). Data collection took place from February 2017 to June 2017. Ethical approval was granted by the Dublin City University Research Ethics Committee (DCUREC/2017/029).

Measures

A ratio of 1 researcher to 5 children was employed for all measures. Quality of PA motivation was measured using the Behavioural Regulation in Exercise Questionnaire which was adapted for primary school children (BREQ-adapted; Sebire et al., 2013). The BREQ-adapted's wording is modified from the original BREQ (Mullan, Markland, & Ingledew, 1997) to increase item clarity for the age group. Flesch-Kincaid Grade Level reading scores (based on average sentence length & number of syllables) indicates that the reading level of this survey is appropriate for the target age group (Sebire et al., 2013). Moreover, if assistance was required researchers had a scripted alternative. The BREQ-adapted is consistent with self-determination definitions (Deci and Ryan, 2000), and has been shown to have good psychometric properties in children (Sebire et al., 2013). The BREQ-adapted represents how motivation is multidimensional with 3 questions per each of the 4 subscales: intrinsic ($\alpha = .81$), identified ($\alpha = .73$), introjected ($\alpha =.56$) and external ($\alpha = .73$). The measurement of introjected regulation among children is challenging as it requires understanding and recognising feelings of guilt as a source of motivation. Expecting children to differentiate between introjected and external regulation might be too abstract for this age range (Harter, 1999). Previous research has also reported low internal consistency of scales measuring introjected PA regulation among children ($\alpha =.56$, Vierling et al., 2007; $\alpha =.59$, Sebire et al., 2013), but moderate correlation between introjected and external regulation suggests children can differentiate between the subscales. Items were scored using a 5-point likert-type scale: 1 (not true for me) to 5 (very true for me). The study was briefly explained, and instructions provided on how to complete the BREQ-adapted. Participants were encouraged to take their time, reflect on their answers, and to be as honest as possible. The BREQ-adapted was completed on tablets (8” display - The Alcatel PIXI 3) via ‘Survey Anyplace’ in class, with a unique ID number assigned to each participant.

Motor skill proficiency was measured using two motor competence tests. The TGMD-3 (Ulrich, 2017) evaluates FMS of typically developing children between 3 and 11 years of age. The TGMD-3 assesses 13 FMS, subdivided into two subscales: locomotor proficiency and object control proficiency. This is a direct observation, process-oriented skill assessment looking at 3-6 performance criteria per skill that reflect the most mature movement pattern. The TGMD-3 has been shown to be a valid and reliable tool when measuring children’s FMS (Maeng et al., 2017). To supplement the TGMD-3, an additional locomotor skill was measured: the vertical jump (Department of Education Victoria, 1996). These particular skills were assessed because they complement games and sports within the primary school curriculum and most have been measured in a secondary school population in Ireland (Belton et al., 2014). Prior to motor skill proficiency assessment all researchers were required to undergo formal training in order to ensure thorough understanding of the skill assessment process as well as consistency in assessing the test subjects. The team were required to meet a 95% inter-observer agreement on a pre-coded data set. This data set was pre-coded by the lead researcher and researchers were blind to the conditions of coding. Participants performed the skill on 3 occasions: 1 familiarisation practice and 2 performance trials (Department of Education Victoria, 1996; Ulrich, 2017). FMS proficiency was calculated to a single composite variable score of the TGMD-3 and vertical jump test.

Traditionally, live data from motor skill proficiency assessments are recorded initially using pen and paper, and then later inputted to a data base. This method can be time consuming, as well as providing double the opportunity for input error (initial recording then manual data entry). To counteract this, a unique app (Behan et al., 2017) was developed to collect the data. This app allowed the research team to assess the participants live using electronic tablets (iPad mini). User experience with the tablet is similar to the paper version (Ulrich et al. 2017) as the format, content, and usability of the paper version was replicated. The assessor checked a skill component box on the touchscreen when the skill criteria was fulfilled and left it blank if unfulfilled. When connected to a secure network, the tablet then sent the complete data set to a secure server based on the University campus. This database was then downloaded and analysed without the need for manual data entry. The system was approved by the University's Ethics committee and was fully compliant with the new general data protection regulation laws.

Statistical Analysis

Pearson correlations (Cohen, 1988) were computed between age, the BREQ-adapted subscales, and the motor skill proficiencies. A one way between-groups multivariate analysis of variance (MANOVA) was performed to investigate sex differences between the variables. The independent variable was sex (male or female). Seven dependent variables were used: intrinsic motivation, identified regulation, introjected regulation, external regulation, overall FMS, object control, and locomotor proficiency. When performing multiple analyses on the same dependent variable, the chance of committing a Type I error increases. To protect from a Type I error a Bonferroni correction is conducted. To get the Bonferroni corrected p value, the original α-value was divided by the seven analyses on the dependent variable (α altered =.05/7), thus a Bonferroni post-hoc adjustment alpha level of .007 for multiple analyses was assigned. Effect size was evaluated using Partial Eta Squared (Cohen, 1988). Hierarchical multiple regression, controlling for the influence of age was conducted for separate male and female analysis. Step two of the hierarchical multiple regression was used to assess the capacity of four measures (intrinsic motivation, identified, introjected and external regulations) and FMS proficiency. By doing so, it allowed the models to determine whether the theoretical constructs embedded in SDT accounted for additional variance in FMS proficiency between sexes, above and beyond the important demographic variable of age. Hierarchical regression analysis was also used to assess the capacity of the four measures on locomotor and object control proficiency. Preliminary analyses were conducted to ensure no violation of the assumptions of normality, linearity, multicollinearity and homoscedasticity. Statistical analyses were conducted using IBM SPSS Statistics 24.0 software and the significance threshold was set at .05.

Results

The relationship between PA motivation (intrinsic, identified, introjected and external) and the motor skill proficiencies (overall FMS, object control, and locomotor proficiency) was investigated using Pearson product-moment correlation coefficient (Cohen, 1988). For males, there was a small ($r=.10$ to $.29$), positive correlation between three variables of PA motivation (intrinsic, identified, and introjected) and all the motor skill proficiency variables, with high levels of these PA motivation qualities associated with higher levels of motor skill proficiency (see table 1)

Females had small, positive correlations between intrinsic motivation and two of the motor skill proficiency variables (overall FMS and locomotor proficiency). Additionally, for females, there was a small, negative correlation between external regulation and all the motor skill proficiency variables, with high external regulation associated with lower levels of motor skill proficiency (see table 2).

Results of the MANOVA revealed there was a statistically significant difference between males and females on the combined dependent variables ($F(7, 852) = 28.29$, $p < .001$; Wilks' Lambda = .81; partial eta squared = .189). Individually, the variables to reach statistical significance, using a Bonferroni adjusted alpha level of .007, was overall FMS ($F(1, 858) = 29.37$, $p < .001$, partial eta squared = .033) and object control proficiency ($F(1, 858) = 114.29$, $p < .001$, partial eta squared = .118). In view of these results, as well as the fact that the existing literature has split overall FMS proficiency into locomotor and object control, males and females were analysed separately. By doing so, it allowed the models to determine whether the theoretical constructs embedded in SDT accounted for additional variance in FMS proficiency between sexes.

Table 1. Males. Pearson correlations for age, each of the BREQ-adapted subscales, and the motor skill proficiencies.

		M	SD	1	2	3	4	5	6	7
1.	Age	10.46	1.18							
2.	Intrinsic Motivation	4.58	.64	-.081						
3.	Identified Regulation	4.29	.91	.009	.540**					
4.	Introjected Regulation	2.96	1.02	.005	.156**	.376**				
5.	External Regulation	2.17	1.10	-.105*	-.102*	.044	.498**			
6.	Overall FMS	96.94	13.55	.265**	.154**	.269**	.144**	-.097*		
7.	Locomotor Proficiency	47.17	7.72	.193**	.118*	.246**	.140**	-.092	.904**	
8.	Object Control Proficiency	42.85	6.76	.311**	.144**	.228**	.121*	-.058	.857**	.574**

*Note. N = 448. *p < .05. **p < .001.*

Table 2. Females. Pearson correlations for age, each of the BREQ-adapted subscales, and the motor skill proficiencies.

		M	SD	1	2	3	4	5	6	7
1.	Age	10.28	1.18							
2.	Intrinsic Motivation	4.61	.62	-.071						
3.	Identified Regulation	4.33	.70	-.051	.523**					
4.	Introjected Regulation	2.90	1.00	-.017	.149**	.363**				
5.	External Regulation	2.04	1.05	-.125*	-.036	.135**	.494**			
6.	Overall FMS	93.44	12.04	.122*	.113*	.107**	-.039	-.198**		
7.	Locomotor Proficiency	48.40	7.21	.028	.121*	.080	-.064	-.181**	.849**	
8.	Object Control Proficiency	37.93	6.70	.222**	.054	.091	-.024	-.142**	.804**	.392**

*Note. N = 412. *p < .05. **p < .001.*

Hierarchical Regression Analysis

Age was entered at Step 1 for both sexes, explaining 7% of the variance in FMS proficiency for males (Table 3), and only 1.5% for females (Table 4). After entry of the self-determined motivation variables at Step 2 the total variance explained by the models as a whole was 15.9% for males ($F(5, 442) = 16.71$, $p < .001$) and 7% for females ($F(5, 406) = 6.13$, $p < .001$). The four measures explained an additional 8.9% of the variance in FMS proficiency, after controlling for age, for males (R^2 change = .089, F change (4, 442) = 11.67, $p < .001$). Meanwhile, the four measures explained an additional 5.5% of the variance in FMS proficiency, after controlling for age, for females (R^2 change = .055, F change (4, 406) = 6.03, $p < .001$). In the final model for males three measures were statistically significant ($p < .05$), with identified regulation recording a higher beta value ($\beta = .21$), than external ($\beta = -.14$), and introjected ($\beta = .13$)

regulation also making a significant unique contribution to males FMS proficiency. Meanwhile, in the final model for females, only external regulation (β = -.21) made a significant unique contribution to FMS proficiency.

Hierarchical regression analysis was also used to assess the capacity of the four measures on locomotor and object proficiency. For males an additional 7.9% of variance in locomotor proficiency was explained by the four measures, after controlling for age (R^2 change = .079, F change (4, 442) = 9.93, $p < .001$). Once more, the four measures explained less additional variance (4.8%) on female's locomotor proficiency (R squared change = .048, F change (4, 442) = 5.12, $p < .001$). Along a similar trajectory as FMS proficiency, the final model for male's locomotor proficiency had three measures that were making a statistically significant unique contribution ($p < .05$), with identified regulation recording a higher beta value (β = .21), than external (β = -.16), and introjected (β = .14) regulation. Again, in the final model for females, only external regulation (β = -.18) made a significant unique contribution to locomotor proficiency.

The relationship between the four measures and object proficiency had notable differences to the other two results. Age was again entered at Step 1 for both sexes, explaining 10% of the variance in object proficiency for males and 5% for females. After entry of the self-determined motivation variables at Step 2, the total variance explained by the models as a whole was 15.6% for males ($F(5, 442) = 16.32$, $p < .001$) and 7.7% for females ($F(5, 406) = 6.73$, $p < .001$). The four measures explained an additional 5.9% of the variance in object proficiency, after controlling for age, for males (R^2 change = .059, F change (4, 442) = 7.72, $p < .001$). Meanwhile, the four measures explained an additional 2.7% of the variance in object proficiency, after controlling for age, for females (R^2 change = .027, F change (4, 406) = 3.01, $p < .05$). This time, the final model for males only had identified regulation as a statistically significant beta value ($\beta = .17$) making a unique contribution to object proficiency. Meanwhile, in the final model for females, external regulation ($\beta = -.13$) and identified regulation ($\beta = .12$) made significant unique contributions to object proficiency.

Table 3. Linear model of predictors of males FMS, locomotor and object proficiency.

	FMS Proficiency			Locomotor Proficiency			Object Proficiency		
Predictor	b	SE B	β	b	SE B	β	b	SE B	β
Step 1									
Age	3.04 (2.00, 4.21)	.55	.27**	1.26 (.65, 1.92)	.31	.19	1.80 (1.30, 2.30)	.27	.31
Step 2									
Intrinsic Motivation	.54 (-1.90, 2.80)	1.21	.03	-.22 (-1.72, 1.30)	.75	-.02	.64 (-.60, 1.80)	.60	.06
Identified Regulation	3.50 (1.41, 5.64)	1.10	.21**	2.00 (.72, 3.20)	.60	.21**	1.40 (.40, 2.40)	.51	.17**
Introjected Regulation	1.80 (.30, 3.30)	.73	.13*	1.10 (.30, 1.90)	.40	.14**	.54 (-.30, 1.30)	.37	.08
External Regulation	-1.80 (-3.10, -.40)	.70	-.14**	-1.20 (-1.90, -40)	.40	-.16**	-.42 (-1.12, .32)	.35	-.07
R^2 Change		.09**			.08**			.06**	

*Note. N = 448. *p < .05. **p < .001.*

Unstandardized beta (b). Standard error for the unstandardized beta (SE B). Standardized beta (β).

95% bias corrected, and accelerated confidence intervals reported in parentheses. Confidence intervals and standard errors based on 1000 bootstrap samples.

Table 4. Linear model of predictors of females FMS, locomotor and object proficiency.

	FMS Proficiency			Locomotor Proficiency			Object Proficiency		
Predictor	b	SE B	β	b	SE B	β	b	SE B	β
Step 1									
Age	1.25 (.18, 2.22)	.54	.12*	.17 (-.53, .82)	.33	.03*	1.26 (.67, 1.83)	.29	.22**
Step 2									
Intrinsic Motivation	1.08 (-.90, 3.20)	1.01	.06	.98 (-.34, 2.25)	.65	.08	.03 (-1.13, 1.21)	.59	.00
Identified Regulation	1.80 (.14, 3.52)	.88	.10	.67 (-.52, 1.94)	.62	.07	1.13 (.04, 2.17)	.55	.12*
Introjected Regulation	.22 (-1.20, 1.70)	.74	.02	-.08 (-.99, .86)	.47	-.01	.01 (-.69, .82)	.39	.00
External Regulation	-2.40 (-3.80, -1.04)	.71	-.21**	-1.22 (-2.06, -.39)	.43	-.18**	-.84 (-1.52, -.20)	.36	-.13*
R^2 Change	.06**			.05**			.03**		

*Note. N = 412. *p < .05. **p < .001.*

Unstandardized beta (b). Standard error for the unstandardized beta (SE B). Standardized beta (β).

95% bias corrected, and accelerated confidence intervals reported in parentheses. Confidence intervals and standard errors based on 1000 bootstrap samples.

Discussion

The results of the current research demonstrate the importance of PA motivation quality in understanding the variability in FMS proficiency for both sexes. Identified and introjected regulation were positively associated with FMS proficiency for males. Conversely, regression analysis showed, as hypothesised, external regulation had a negative relationship with FMS proficiency for both sexes. Subsequent regression analyses revealed sex differences in the relationship between PA motivation and the subcomponents of locomotor and object control proficiency.

When considering the qualities of motivation, it is important to consider them in terms of high quality – intrinsic and identified – and low quality – introjected and external. Despite being heralded as the highest quality motivation, intrinsic motivation did not have a significant independent relationship with overall, locomotor, or object control proficiency for either sex when controlling for age in the regression analyses. One might wonder whether it is worth trying to cultivate intrinsic motivation for FMS. With this in mind, concentrating on the facilitation of identified regulation could be more successful for FMS interventions. Developing FMS proficiency requires individuals to place value on the skills and to recognise the importance of FMS in terms of facilitating their participation and success in PA. Equally, identified regulation involves an individual's recognition and acceptance of the value and importance of a behaviour (e.g. FMS) and an integration of this into the self (Edmunds, Ntoumanis, & Duda, 2006). The development of identified regulation would also counteract the negative relationship between external regulation and overall FMS and locomotor proficiency that is apparent for both sexes. To counteract such controlling PA motivation, a focus for FMS interventions could be to help children understand the importance, contribution and enjoyment FMS has on their PA, all factors congruent with identified regulation. Such value and competence is theorised to enhance children's confidence and autonomous motivation to try physical activities and sports (Whitehead, 2010).

Considering sex differences, there is a negative relationship between female's external regulation and their object proficiency, and there is perhaps a more nuanced reason why only females have this significant negative relationship. Justification for sex differences in PA have focused on an assortment of reasons, comprising bias for sport, physical activity preferences, and an overarching bias towards specific sex roles in society (Spessato et al., 2013). Sociocultural explanations for sex differences could also be applicable in regard to female's external regulation and object control proficiency, as sex-role stereotypes continue to be reinforced through physical education classes (Paechter, 2003) and participation in extra-curricular physical activities differ (Woods, Moyna, Quinlan & Walsh, 2010). Such findings highlight the demand for promotion of autonomous motivation, but with slight differences between sexes highlighting how interventions are not 'one size fits all'.

Moreover, introjected regulation had a significant relationship with overall and locomotor proficiency for only males. Introjected regulation is a controlling form of motivation that is considered of poor quality within SDT. Despite its positive relationship with overall and locomotor proficiency in the current study, there is evidence to suggest that introjected regulation will not bode well for long-term behaviours (Gillison et al., 2009). Introjected regulation is deemed an unstable motivation, and effort can cease as soon as external factors are removed (Gillison et al., 2009). Although not obviously critical for this age group, an environment change that potentially removes these external controls is the transition from primary to post primary school. As males' introjected regulation has a significant relationship with overall and locomotor proficiency, interventions should be tackling this controlling motivation as early as possible; trying to foster an environment to be supportive of autonomy and promoting value, as introjected regulation can compromise autonomous motivations over the long term.

Considering the different relationships identified regulation and controlling regulations have on FMS proficiency, it seems prudent for FMS interventions to focus on not only increasing identified regulation but decreasing controlling regulations within children. The authors suggest that the best way to influence motivation quality is by considering the impact of social factors. In a physical education setting, Vallerand and Losier (1999) proposed that emphasis on self-improvement, cooperative learning, and perceived choice fosters conditions that promote higher autonomous motivation. The emphasis teachers place on children's self-referenced improvement is vital when considering the relationship between controlling motivation and FMS. A motivational environment which focuses on improvement of individual performance levels should foster identified regulation as it promotes in each participant a sense of value for the skills, meanwhile it should reduce the controlling nature of interpersonal comparison, something particularly prevalent in those motivated by introjected regulation. Creating an environment that avoids comparison but does promote cooperation is challenging. Cooperation makes an activity inherently more interesting; if a teacher can foster an environment that emphasises cooperation, then this will bring children together to help each other learn and improve (Ames, 1992). Peer feedback provides children opportunities to learn from each other, particularly prevalent in FMS as children can be at very different stages of mastery (Lubans et al., 2010). Finally, the perception of choice would go some way to reducing external regulation, if a teacher was to provide choice of FMS tasks and encourage cooperative leadership children's basic need for autonomy would flourish.

Understanding the sequence of processes that foster and/or undermine autonomous motivation holds great practical implication. Thus, future work on motivation and FMS would benefit from measuring the social factors and basic psychological needs that contribute to quality of motivation, thus FMS. It is essential to emphasise the fact that the current research is cross-sectional in design. To remedy this limitation longitudinal research would allow for an understanding of the changing dynamic of motivation and its relationship with FMS. Such as, does introjected regulation still maintain a positive relationship with FMS across the school transition, and what impact does this have on children's physical activity. Despite the presented limitations, the understanding of how motivation quality influences FMS proficiency and the impact of sex is necessary for interventions to be successful. Thus, the findings from this paper can contribute to the theoretical base of interventions aimed at increasing and sustaining levels of FMS.

Link Section Chapter 3 to 4

The results shown in chapter 3 provide the researchers with an overall picture of quality of motivation for PA and FMS proficiency. The relationship between FMS and controlling motivation for both genders gives cause for concern given the purported links between FMS proficiency and future PA participation. Higher quality of motivation is well established with increased PA participation (Mandigo, Holt, Anderson, & Sheppard, 2008). This chapter promotes development of movement, as it highlights FMS proficiency has an association with the autonomous qualities of motivation. There is, however, a need to understand the way in which movement is perceived and how this impacts children's desire to be PA. There is emerging evidence that perception of movement skill is just as important as FMS (De Meester, Stodden, et al., 2016). It is important to form a comprehensive view of movement and how it influences other physical literacy components, such as PSE, and children's PA.

Previous research has repeatedly shown PSE predicts PA (Lubans et al., 2008), yet, what explains the relationship is still required (Williams & French, 2011). Chapter 4 investigates whether PSE mediates the relationship between movement competence and PA in children. Bandura (1986) indicated that self-efficacy will only determine a behaviour when the necessary skills are in place. Engaging in PA requires PSE, this has been well established (Cortis et al., 2017; Craggs et al., 2011), yet what skills are developing this belief is a knowledge gap (Ashford et al., 2010; Williams & French, 2011). Enactive mastery experience is the proficiency or perception of proficiency of a behaviour, and is proposed as a way to promote self-efficacy (Bandura, 1977). In PA, enactive mastery experience, be it proficiency or perception could be important (Williams & French, 2011). This aligns with the concept of physical literacy and the thought that movement experience drives belief to be active (Dudley et al., 2017; Whitehead, 2010). Therefore, it seems pertinent to understand if FMS proficiency and PMSC levels are explaining the development of psychological determinants that support children in engaging and maintaining PA.

CHAPTER 4

Contribution of Competence to the Physical Self-Efficacy - Physical Activity Relationship

Abstract

Background: The purpose of this paper was to investigate whether physical self-efficacy mediates the relationship between movement competence (fundamental movement skills and perceived movement skill competence) and physical activity in children.

Methods: A purposive sample of 860 children (47.7% female, 10.9 ± 1.16 years) were recruited and completed assessments for physical self-efficacy (Physical Activity Self-Efficacy Scale), fundamental movement skills (Test of Gross Motor Development-3), perceived movement skill competence (Pictorial Scale of Perceived Movement Skill Competence), and physical activity (PACE+). A bootstrap mediation analysis was employed using movement competence as the predictor variable and physical activity as the outcome variable, and physical self-efficacy as the potential mediator of the relationship.

Results: The results from a bootstrap mediation analysis yielded a statistically significant mediation effect for physical self-efficacy, with the entire model explaining approximately 10.3% of the variance of physical activity. The indirect effect of perceived movement skill competence through physical self-efficacy was significantly larger than the indirect effect of fundamental movement skills through physical self-efficacy. Neither sex nor age acted as a covariate.

Conclusion: Movement competence (fundamental movement skills and perceived movement skill competence) acts as a source of information for children's physical self-efficacy, moreover physical self-efficacy mediates the movement competence – PA relationship. Findings highlight the need for interventions to target and improve movement competence as a whole for children.

Regular physical activity (PA) is beneficial to the maintenance of good physical and psychological health (Cortis et al., 2017). Research has enhanced the understanding of correlates and determinants for PA, such as physical self-efficacy (PSE) (Mcauley & Blissmer, 2000) and movement competence (Barnett, Morgan, Ball, & Lubans, 2011; Lubans, Morgan, Cliff, Barnett, & Okely, 2010). Yet, across the life-course people are not participating in enough PA to actually maintain good health (Andersen et al., 2016; Bauman et al., 2012).

A consistent correlate of PA for children is PSE (Bauman et al., 2012; Mcauley & Blissmer, 2000; Sallis, Prochaska, & Taylor, 2000). PSE is a key construct in social-cognitive theory (SCT), and is defined as belief in one's competency to complete a task in differing contexts (Bandura, 1982). PSE encompasses a personal assessment of one's competency to carry out PA (Annesi, 2006). According to Bandura (2004), PSE is central to the decision-making process to participate in PA. PSE levels are thought to determine how obstacles are viewed, with highly efficacious individuals perceiving barriers to PA as conquerable through increased effort (Bandura, 2004). Such traits have been found to be one of the strongest positive associations with PA for children (Van Der Horst, Paw, Twisk, & Van Mechelen, 2007).

Targeting PSE is an efficient approach, as promotion of PSE has been repeatedly shown to predict PA. Yet, regarding how to improve the psychological construct is still a knowledge gap. Moreover, knowing what sources of information are helping to explain the PSE – PA relationship is paramount (Bauman et al., 2012; Williams & French, 2011). Bandura (1977) proposed that self-efficacy is the consequence of four sources of information: enactive mastery experience, vicarious experience, verbal persuasion, and physiological arousal. Enactive mastery experience refers to competence of a behaviour/perception of competency, which ought to boost PSE (Bandura, 1977). Vicarious experience refers to observing a peer/role model performing physical activity, such an observation can generate a belief that an individual can also perform PA. Verbal persuasion is where others convey belief in the individual's capabilities, although verbal influence is aimed mainly at raising outcome expectations rather than at enhancing self-efficacy. Physiological arousal, depending on the circumstances, might have informative value concerning ability to perform, although there is very little research into the impact of arousal on one's PSE. Of these four sources of information, enactive mastery experience has been identified to produce the highest levels of self-efficacy (Ashford, Edmunds, & French, 2010). While there is previous research highlighting enactive mastery experience as a source of information that increases PSE, there still remains an insufficient understanding of what focus the source of information should be, with no research investigating movement competence as a potential explaining source of information for PSE (Ashford et al., 2010).

Bandura (1986) indicated that self-efficacy will only determine a behaviour when the necessary skills are in place. Fundamental movement skills (FMS) are stated to be necessary to children's psychological and physical development, with studies beginning to show a causal relationship between FMS and PA (Barnett et al., 2011). FMS consists of object control skills that require efficient throwing, striking, and catching movements (e.g. Catch – the ability to catch a ball that has been tossed underhand), and locomotor skills that require fluid coordination movements of the body as the individual moves in one direction or another (e.g. Run – the ability to advance steadily by springing steps so that both feet leave the ground for an instant with each stride) (Logan, Ross, Chee, Stodden, & Robinson, 2018; Ulrich, 2017). These movement skills are the building blocks of more complex movements required to participate in games, sports or other context specific PA (Logan et al., 2018). A relationship between FMS and PA has been established, and as such FMS can be considered key for developing physically active individuals. There is, however, more at play than just FMS directly explaining PA levels. Prior research has demonstrated that there are psychological components that support development of a physically active lifestyle, with literature highlighting that FMS has a positive relationship with such factors (Bardid et al., 2016). Therefore, it seems pertinent to understand if FMS are not only the building blocks to movement and PA but are the sources of information for psychological determinants that support children in developing and maintaining a physically active life, such as PSE.

Although competence of a behaviour can raise self-efficacy, the extent to which people enhance their efficacy also depends on perception of competence (Ashford et al., 2010; Bandura, 1977). Perceived movement skill competence (PMSC) is an individual's perception of their basic capability of carrying out a skill (e.g. running or kicking a ball). In this regard, PMSC is considered important as it has been found to have a relationship with PA, and as children mature into adulthood it has been shown to drive confidence to try new physical activities (Bauman et al., 2012; Barnett et al., 2011; 2008; Lubans et al., 2010). Considering this from a SCT framework, while an individual may objectively be competent in completing a skill, their perception of their competency to complete the skill is also helping explain one's belief to participate and engage in PA (Bandura, 1982; Annesi, 2006).

The theory that more skilful children may increase their time in PA and persist with activities is congruent with PSE (Bandura, 2004). Moreover, Bandura (1986) indicates that self-efficacy will only determine a behaviour when the necessary skills are in place. When considering competence of movement skills, perception and competence are inextricably linked dimensions of our movement experience (Cairney, Dudley, Kwan, Bulten, & Kriellaars, 2019; Cairney, Clark, Dudley, & Kriellaars, 2019; Giblin, Collins, & Button, 2014). Therefore, this study looks at incorporating PMSC alongside FMS in an effort to capture movement experience and determine how this might contribute to PSE. With this in mind, this study will identify if the process that underlies the relationship between movement competence and PA is via the inclusion of PSE. Rather than a direct relationship between movement competence and PA, the study proposes that movement competence will influence PSE, which in turn will influence PA. Thus, does PSE serve to clarify the nature of the relationship between movement and PA.

Methods

Sample

Cross-sectional data were collected as part of a larger study entitled the 'Moving Well-Being Well' (MWBW) programme. Support in identifying schools was provided by gatekeepers (coaches) who were involved in the schools. The coaches were asked to recommend schools, after being provided with a purposive sampling criterion based on the Delivering Equality of Opportunity in Schools action plan for educational inclusion (Department of Education and Skills, 2017). Thirty schools were approached, and all consented to participate. Children from third to sixth class were invited to participate; 1,053 children from a possible 1,104 volunteered, after participants with missing data were removed the final sample consisted of 860 children (47.7% female, 10.9 ± 1.16 years). Children completed assent forms, meanwhile parents signed informed consent forms to confirm they understood the purpose of the research and participation rights (e.g., voluntary participation, right of withdrawal, and confidentiality of the data). Data collection took place from February 2017 to June 2017. Ethical approval was granted by the Dublin City University Research Ethics Committee (DCUREC/2017/029)

Procedures and materials

A ratio of 1 researcher to 5 children was employed for all measures. The questionnaire was completed on tablets (8" display; The Alcatel PIXI 3) via 'Survey Anyplace' in class. Children were encouraged to take their time, reflect on their answers, and to be as honest as possible. Children were provided with a definition (PA is any activity that increases your heart rate and makes you get out of breath some of the time) and examples of common physical activities. To measure physical activity, children completed the PACE+ (Prochaska, Sallis, & Long, 2001), a validated and reliable measure for this age (Murphy, Rowe, Belton, & Woods, 2015). The first item asked them to report the number of days (0–7) they were physically active for at least 60 minutes per day in the past seven days. The second item asked the same question with respect to a typical or usual week. An average value of the two items yielded a score of days per week that participants accumulated 60 minutes of moderate-to-vigorous physical activity (MVPA). Spearman correlations between self-reported PA levels and accelerometery derived minutes of MVPA per day are small (r = 0.27; seven valid days). This low correlation is consistent with findings in the literature (Dumith, Gigante, Domingues, & Kohl, 2011). Test-retest reliability has been conducted on the instrument, where it was found to have acceptable reliability with intraclass correlation coefficients (ICC) ranging from 0.6 to 0.8 (Vuori et al., 2005).

To assess barriers, support seeking and positive alternatives in PA, a modified version of the original Physical Activity Self-Efficacy Scale (PASES) (Mullan, Markland, & Ingledew, 1997) was used. Originally developed as a three-factor model, the PASES has been adapted for primary school children into an 8-item single factor scale (Bartholomew, Loukas, Jowers, & Allua, 2006) and is consistent with self-efficacy definitions (Bandura, 1977, 1982, 1997), having shown good psychometric properties in children (Bartholomew et al., 2006). An example item of the PASES is: "I have the skills I need to be physically active". Items were scored using a 3-point likert-type scale with "No" (0), "Not Sure" (1), and "Yes" (2) as the three choices. Cronbach's alpha coefficient for PASES was good (α = .88).

The pictorial scale of PMSC for young children aligned with the Test of Gross Motor Development-3 (TGMD-3) was administered (Barnett, Ridgers, Zask, & Salmon, 2015; Ulrich, 2017). The pictorial scale of PMSC assesses six locomotor (run, gallop, hop, skip, horizontal jump, and slide) and seven object competency skills (two-hand strike of a stationary ball, one-hand stationary dribble, kick, two-hand catch, overhand throw, forehand strike of a self-bounced ball, and underhand roll), based on the TGMD-3. Administration of the pictorial scale of PMSC replicated the process of Barnett and colleagues (2015), where an extensive protocol is provided. To summarise, skills on the pictorial scale of PMSC were arranged in an order so that a cartoon picture of a child depicting a skill competently was opposite to an image of a child depicting a skill not so competently. Children either pick a cartoon portraying a child who is competent at a skill or the cartoon portraying a child who is not so competent at a skill. If children select the competent cartoon they are asked: 'are you really good at …' (score of four) or 'pretty good at …' (score of three), if children pick the not so competent cartoon, they are asked: are you 'not that good at (score of one) or sort of good at …' (score of two). The result is a four-point Likert scale response variable (range 1–4). The test-retest, internal reliability, face validity (Barnett et al., 2015) and construct validity (Barnett et al., 2016) of the pictorial scale of PMSC has previously been established. Cronbach's alpha coefficient for PMSC was good (α = .70). Some of the skills required further description beyond the visual picture provided. For instance, during development of the PMSC children previously requested a demonstration of the gallop and the slide (Barnett et al., 2015), thus to remain consistent all children in this study were provided with a physical demonstration of the skills by a trained researcher.

Once the questionnaire was completed FMS were assessed using the TGMD-3 (Ulrich, 2017), the TGMD-3 evaluates FMS of typically developing children between 3 and 11 years of age. With consideration of developmental ability incorporated into the scoring and interpretation. The TGMD-3 assesses 13 fundamental movement skills, subdivided into two subscales: Locomotor competency and object control competency. This is a direct observation, process-oriented skill assessment looking at 3-6 performance criteria per skill that reflect the most mature movement pattern, with consideration of developmental ability incorporated into the scoring and interpretation. The subtest scores were then summed to give an overall gross motor quotient (GMQ) score (maximum possible score = 100). The TGMD-3 has been shown to be a valid and reliable tool when measuring children's FMS (Ulrich, 2017). Prior to motor skill competency assessment, a data set was pre-coded by the lead researcher with researchers' blind to the conditions of coding. Inter-rater and intra-rater reliability of the TGMD-3 were assessed using the ICC and corresponding 95% confidence intervals. Researchers (n = 22) were required to reach a minimum of 90% intra-rater, and 95% inter-rater agreement for all of the skills, such results are similar to percent agreement in reliability assessments of the TGMD-3 (Rintala, Sääkslahti, & Iivonen, 2017). Furthermore, the ICC reliability coefficients demonstrated excellent level of significance for inter-rater 0.91, 95% CI (0.80, 0.96) and intra-rater 0.95, 95% CI (0.84, 0.98). Participants performed the skill on 3 occasions: 1 familiarisation practice and 2 performance trials (Ulrich, 2017). Assessment of the TGMD-3 repeated Behan and colleagues (Behan, Belton, Peers, O'Connor, & Issartel, 2019), where an extensive protocol is provided

Statistical Analysis

Means, standard deviations and bivariate correlations were calculated for all variables. Statistical analyses were conducted using IBM SPSS Statistics 24.0 software and the macro PROCESS; significance threshold was set at .01. PROCESS is a logistic regression path analysis modelling tool for SPSS used for estimating direct and indirect effects in single and multiple mediator models. Mediation is when the strength of the relationship between two variables is reduced by involving another variable.

This approach tests the indirect effects of mediators and uses bootstrapping to estimate 95% bias corrected unstandardized confidence intervals (CI). First, the mediating assumption was tested by assessing the separate pathways a) the direct relationship between FMS and PA, by excluding PSE and PMSC, b) the direct relationship between PMSC and PA, by excluding PSE and FMS, c) The direct relationship between movement competence and PA, by excluding PSE, c) the first pathways in mediation by using PSE as the dependent variable, and d) the second pathway in mediation by using PSE as the predictor variable and self-reported PA as the dependent variable. Finally, PROCESS was used to test the full model that incorporates the direct relationship between movement competence and self-reported PA, plus the indirect relationship: PSE mediating between the movement competence – PA relationship (Hayes, 2013). Sex and age were entered into the model as a covariate.

Results

Table 1 provides descriptive statistics and correlations of the variables. Self-reported PA was significantly ($p < .01$) and positively associated with PSE, FMS, and PMSC. All assumptions were met with FMS having a direct positive relationship with self-reported PA ($R^2 = .03$, $p < .001$) and PSE ($R^2 = .05$, $p < .001$). Additionally, PMSC to self-reported PA ($R^2 = .06$, $p < .001$) and PSE ($R^2 = .09$, $p < .001$) met assumptions with direct positive relationships. Also, FMS and PMSC (movement competence) in the same model had a direct positive relationship with PSE ($R^2 = .12$, $p < .001$) and self-reported PA ($R^2 = .07$, $p < .001$). Thus, a model to test whether PSE mediates the relationship between movement competence and self-reported PA was justified.

Table 1: Means, Standard Deviations, and Bivariate Correlations (N = 860)

Variable	M	SD	1	2	3
Physical Self-Efficacy (0 – 2 scale)	1.66	.28	–		
Self-Reported PA (0 – 7 days)	4.83	1.68	.26**	–	
Fundamental Movement Skills (0 – 100 scale)	78.73	11.10	.23**	.17**	–
Perceived Movement Skill Competence (1 – 4 scale)	50.85	5.82	.31**	.24**	.29**

Note: ** Correlation is significant at the 0.01 level (2-tailed)

There was a significant indirect effect of FMS on self-reported PA through PSE, *b* = .008, 99% BCa CI [.004, .013], with the individual direct relationship from FMS to self-reported PA explaining 3% of the variance (R^2= .03). Meanwhile, there was a significant individual indirect effect of PMSC on self-reported PA through PSE, *b* = .018, 99% BCa CI [.010, .030], with the individual direct relationship from PMSC to self-reported PA explaining 6% of the variance (R^2= .06). In the overall model, the three direct pathways to PA were significant (Table 2). Neither sex, *b* = -.13, 99% BCa CI [-.416, .155], or age, *b* = .04, 99% BCa CI [-.050, .136], were found to be a statistically significant covariates and thus were removed in the final model. Also, there was a significant indirect effect of movement competence (FMS and PMSC) on self-reported PA through PSE, *b* = .015, 99% BCa CI [.007, .025]. The direct relationship from movement competence to self-reported PA explained 7% of the variance (R^2= .07). PSE as a mediating variable helped to explain 10% of variance of overall self-reported PA (R^2 = .10) as demonstrated in Figure 1.

Table 2: *Direct, indirect, individual, and total effects (and 99% bootstrapped confidence intervals) of movement competence on physical activity*

	Direct β	Direct b	LLCI	ULCI	Indirect β	Indirect b	LLCI	ULCI	Total β	Total b	LLCI	ULCI
Overall Model	.16**	.045	.019	.071	.05**	.015	.007	.025	.21**	.059	.034	.085
Fundamental Movement Skills	.03**	.018	.005	.031	–	–	–	–	.08**	.026	.013	.039
Perceived Movement Skill Competence	.06**	.050	.025	.076	–	–	–	–	.10**	.070	.044	.093
Physical Self-Efficacy	.05**	1.171	–	–	.05**	.015	.007	.025	–	–	–	–

Abbreviations: β = Beta – standardised coefficients; *b* = Beta – unstandardized coefficients; LLCI & ULCI = lower & upper levels for confidence interval. *Note:* The confidence interval for the indirect effect is a BCa bootstrapped CI based on 10,000 samples. * p < 0.05 **p < 0.001

Breakdown of the model showed the direct effect between movement competence and PSE was stronger than the direct effect between movement competence and self-reported PA. Additionally, the direct effect between FMS and PSE was stronger than the direct effect between FMS and self-reported PA. Similarly, the direct effect between PMSC and PSE was stronger than the direct effect between PMSC and self-reported PA.

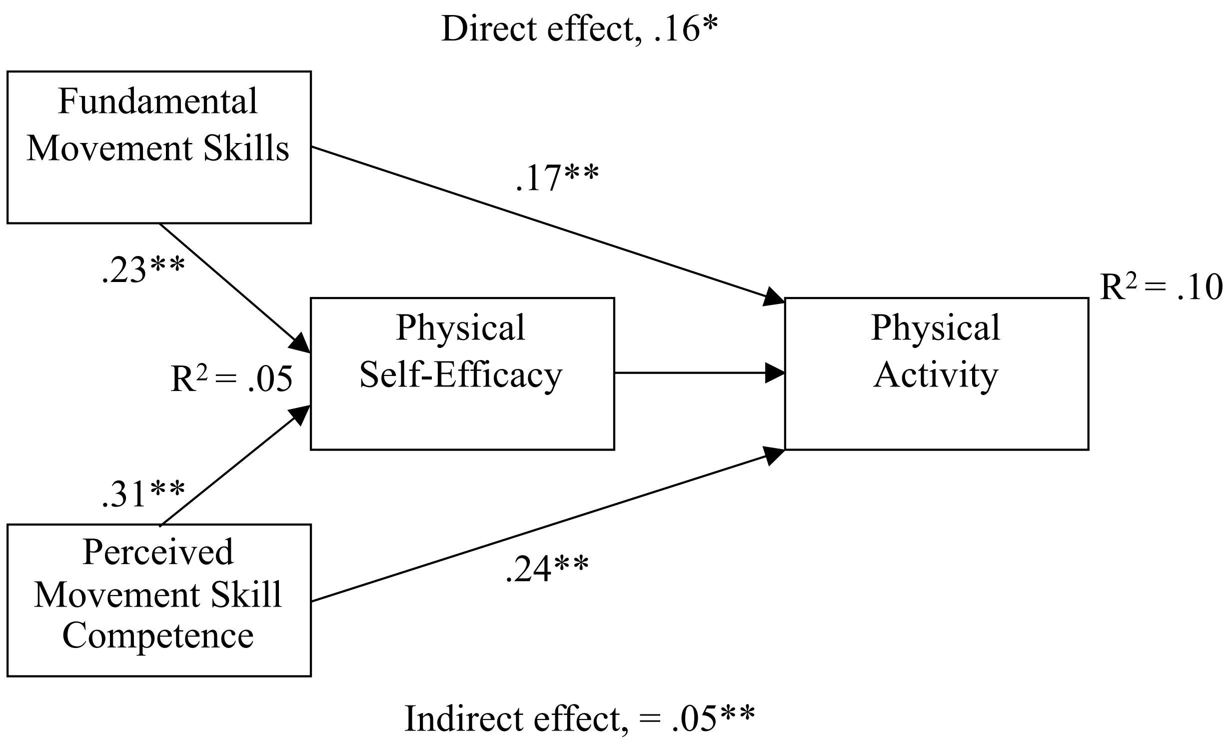

Figure 1: Model of fundamental movement skills and perceived movement skill competence as predictors of self-reported physical activity, mediated by physical self-efficacy. The confidence interval for the indirect effect is a BCa bootstrapped CI based on 10,000 samples.

* $p < 0.05$ ** $p < 0.001$

Discussion

This is the first study to demonstrate that PSE mediates the movement competence – PA relationship. The model explained 10% of the variance, such results reflect previous studies in the PSE (Annesi, 2006) and movement domains (Holfelder & Schott, 2014). The direct relationship between movement competence and PA is weak, yet PSE is significantly impacting the movement competence – PA relationship. Moreover, the direct relationship between movement competence and PSE is stronger than the movement competence – PA relationship. This article has taken the first steps in acknowledging that for children there are mediating sources of information that help to explain the movement competence – PA relationship. This can be via enactive mastery experience such as FMS or PMSC. The current study, from a movement paradigm, has applied Bandura's (1986) theory that self-efficacy will only determine a behaviour when the necessary skills are in place, with results indicating that movement competence's determination of PA is partially explained by movement competence's determination of PSE.

In fact, when breaking down movement competence, the direct effect of PMSC and the indirect effect through PSE is significantly larger than FMS. These findings support past research in that PMSC is playing a critical role in increasing PA, even more critical than FMS (Bardid et al., 2016), underlining that children need to perceive competence in order to be efficacious to carry out PA in differing circumstances. The current research is compatible with similar work that has analysed the contribution of FMS and PMSC on autonomous motivation (Bardid et al., 2016). Bardid and colleagues (2016) point out that the 'underestimation' of competence is unfavourable, with low PMSC having a negative impact on children's autonomous PA motivation regardless of FMS ability. This study furthers the advocacy of PMSC, by suggesting that children's perception of competence in their movement is the greater explanation for confidence to interact with peers in physical activities or choosing to be physically active over sedentary behaviours, key tenets of PSE.

Although PMSC is important individually, it is important to consider movement competence as a whole construct; it seems reasonable to consider that FMS competency and perception of FMS competency is contributing to determinants of participation in PA. As research assesses FMS and PMSC together and their explanation of determinants of PA it will allow for intervention design and evaluation to take into consideration how fostering and assessing more than just FMS is important. This research highlights FMS is an important foundation to build upon, but other key components such as PMSC are helping promote children's confidence that they can be physically active. Accuracy of children's PMSC is proposed to increase with age and cognitive development, this leads to them drawing upon past experiences of skill difficulty and social comparisons, these perceptions reinforce interactions in PA setting (Bolger, Bolger, O'Neill, & Coughlan, 2018). The direct relationship with PSE highlights the importance of movement competence as a whole construct. Thus, interventions need to focus on not only the physical building blocks required to participate in games, but for children to receive feedback, directions and encouragement regarding their movement that will develop their 'belief building blocks' to participate.

This study is not without limitations. For instance, when using self-report measures of PA children can have problems identifying frequency, duration, and intensity of PA, as well as response bias which usually leads to overestimation of physical activity (Hidding, Chinapaw, van Poppel, Mokkink, & Altenburg, 2018; J. Sallis & Saelens, 2000). Although, the PACE+ has strong percentage of agreement with accelerometers (Murphy et al., 2015; Hidding et al., 2018), plus self-report avoids the increased costs and the logistics of fitting accelerometers to a large sample of children. The large sample size and the use of validated and tested FMS, PMSC, and PSE measures add to the strength of this study. There are many studies demonstrating that movement and perception of movement are significant variables linked to PA engagement (Bolger, Bolger, O'Neill, et al., 2018; Famelia, Tsuda, Bakhtiar, & Goodway, 2018; Pesce, Masci, Marchetti, Vannozzi, & Schmidt, 2018). The relationship between movement and the psychological benefits, however, have remained uncertain. Clearing these uncertainties will advance evidence on the benefits associated with movement (Lubans et al., 2010). Similar to the relationship between PMSC, FMS, and motivation for PA (Bardid et al., 2016), the main strength of this work is the inclusion of PSE from a movement paradigm, as there is a lack of certainty between movement variables and this important determinant of PA.

Conclusion

This research among primary school children revealed that both FMS and PMSC act as sources of information for PSE, that mediates the movement competence – PA relationship. In addition, the results showed the direct and indirect effect of PMSC through PSE is significantly larger than the effect of FMS. These findings emphasise that fostering children's PMSC is just as crucial to improving their PSE and PA. As Bardid and colleagues (2016) found targeting movement competence as a whole improves motivation toward PA, this study also champions movement competence as a form of enactive mastery experience when trying to nurture PSE. Application of results from previous research and the current study can help build perspectives of how to inform future interventions in terms of goals and instructional approach. Additionally, future movement skill research should consider FMS and PMSC's position when contributing to the dynamic relationship between the various components of an individual which support them in developing and maintaining a physically active life.

Link Section Chapter 4 to 5

The results presented in chapter 4 suggest that PSE is important in explaining the movement competence – PA relationship. While this has been documented in previous research (Barnett et al., 2011), it is the first time that PSE has been investigated alongside combined movement measurements of proficiency and perception. The findings show that developing perception of movement is perhaps more crucial when trying to develop belief to be PA.

So far, this thesis has discussed the link between PA determinants and PA, and the results outlined in chapters 3 and 4, along with previous research, provides a developing picture of physical literacy. Previous research, however, does not indicate whether, and to what extent, children's PA levels differ due to the core physical literacy components (Edwards et al., 2018; Francis et al., 2016). Understanding how different physical literacy component scores impact PA will promote theory development as it allows for identification of differing dynamics in children. The purpose of chapter 5 is to identify whether different physical literacy profiles exist in primary school children, and if and how various physical literacy-based profiles differently relate to PA.

CHAPTER 5

Identifying Profiles Of Physical Literacy Among Children: Associations With Physical Activity

Abstract

Background: Positive associations between components of physical literacy and physical activity have been identified by means of variable-centred analyses. To expand the understanding of these associations, this study used a person-centred approach to investigate whether different combinations (i.e., profiles) of physical literacy exist (Aim 1) and to examine differences in physical activity levels among children with different physical literacy-based profiles (Aim 2).

Methods: A purposive sample of 860 children (47.7% female, 10.9 ± 1.16 years) were recruited and completed assessments for physical self-efficacy (Physical Activity Self-Efficacy Scale), quality of motivation for PA (Behavioural Regulation in Exercise Questionnaire adapted), perceived movement skill competence (Pictorial Scale of Perceived Movement Skill Competence), fundamental movement skills (Test of Gross Motor Development-3), and physical activity (PACE+). Cluster analyses (Aim 1) and MANOVAs (Aim 2) were used to analyse the data.

Results: The analysis generated four groups in total. Two predictable groups: one group displaying relatively high levels in the physical literacy components and one group with relatively low levels in the components. Two groups were characterised by dissonant levels of physical literacy. Children in the group displaying relatively high levels in the physical literacy components reported significantly higher physical activity than the other groups. Children in the dissonant levels of physical literacy groups reported no significant difference in their physical activity.

Conclusion: A combination of high physical literacy components is related to higher physical activity. Moreover, the physical literacy profiles emphasise the need for differentiated interventions when trying to promote physical activity.

Physical activity enhances quality of life (Shoup, Gattshall, Dandamudi, & Estabrooks, 2008) despite this knowledge, just 16% of children (Peers et al., under review) and 14% of adolescents (Woods, Moyna, & Quinlan, 2010) engage in the recommended one hour per day of moderate to vigorous physical activity. Understanding physical activity through the physical literacy concept has received increasing awareness, with physical literacy being positioned as the foundation for children of all levels to form lifelong participation in physical activity (Cairney, Dudley, et al., 2019; Dudley et al., 2017; Whitehead, 2010). Physical literacy has been defined as the *"…motivation, confidence, physical competence, knowledge and understanding to value and take responsibility for engagement in physical activities for life*" (Whitehead, 2001, p. 127) Although approaches to the construct are debated, be they grounded in philosophy (Whitehead, 2010) or from a more pragmatic approach (Belton et al., 2018; Dudley et al., 2017).

From a pragmatic approach, there is evidence for a lack of physical competence in children (Behan et al., 2019) and adolescents (Belton et al., 2014); low levels of PSE (Peers et al., under review; Belton, Issartel, McGrane, Powell, & O'Brien, 2018; McGrane, Belton, Fairclough, Powell, & Issartel, 2018); and, children's quality of motivation is poor (Peers et al., under review). All these poor scores point to inadequate levels of physical literacy, thus low physical activity.

With this in mind, it is still unclear why some children are more physically active than others. Previous research has provided an overall picture of children's physical activity that explains relationships between components of physical literacy in children (Cortis et al., 2017; Craggs et al., 2011; Uijtdewilligen et al., 2011; Van Der Horst et al., 2007), however, such an approach provides very little specificity, as entire samples are described together. Current research notes that when children are provided with instruction and assessment that is differentiated according to their learning needs then they are more likely to develop (Gibbs & Simpson, 2004). Physical literacy is no different, it is a complex and multifaceted concept that poses challenges to researchers on how it is best operationalized, with much research required to better elucidate why some children are more physically active.

Children vary in physical literacy, therefore providing alternative paths to enable all children to reach their potential is vital. Recently, there has been a demand for more creative approaches to assess/apply physical literacy from a more holistic perspective (Cairney, Dudley, et al., 2019; Edwards et al., 2018; Robinson & Randall, 2017). Physical literacy components, however, have been heavily studied with the more traditional pragmatic variable-centred approach. This variable-centred approach does not identify groups of children who share similar physical literacy levels and how this impacts their physical activity. A person-centred approach to physical literacy would allow for this holistic assessment, and also promote theory development as it allows for identification of differing dynamics in children. Such an approach could also offer the chance to progress the theory into practice as teachers would be aware of differing physical literacy groupings as they plan the curriculum, pedagogy, and assessment of children. Moreover, by considering these varied physical literacy needs, teachers could develop differentiated instruction so that all children can learn effectively.

The first aim of the current study was to use a person-centred approach to explore whether different profiles in terms of physical literacy exist in primary school children. Based on the theory of physical literacy (Whitehead, 2010) and previous studies (Corbin, 2016; Edwards et al., 2018; Francis et al., 2016) there was an expectation to find several different profiles characterized by different combinations in levels of motivation, confidence, and physical competence (actual and perceived). The second aim was to explore if and how various physical literacy-based profiles differently relate to physical activity. It was hypothesized that children with profiles characterized by relatively high levels of all physical literacy components would participate in more physical activity than children with relatively low levels of all physical literacy. Meanwhile, although physical literacy is described as a multidimensional concept, there is a scarcity of research examining the combination of the components, thus children with dissonant physical literacy components were examined in a more explorative fashion.

Methods

Participants

A convenience sample was used to recruit children. Assistance in identifying schools was provided by gatekeepers who were working closely with the schools at the time through their role as games development officers with a large sport's national governing body (Gaelic Athletic Association). Coaches suggested schools via a purposive sampling criterion established on the Department of Education and Skills report (2017). The report identified 640 out of 3111 schools (20.6%) with levels of educational disadvantage. In order for generalisability, thirty schools across the country were approached, of which eight (20%) were identified as schools with levels of educational disadvantage, all consented to participate. From the thirty selected schools, 1,104 children from third to sixth class were invited to participate, from which 1,053 (95.34%) volunteered to participate. Once participants with missing data were removed, the final sample consisted of 860 children (47.9% female, 10.37 ± 1.18 years) – ie 77% of the invited. Assent was granted by the children. A written informed consent was provided for each child by a parent or legal guardian.

Data collection took place from February 2017 to June 2017. Ethical approval was granted by the Dublin City University Research Ethics Committee (DCUREC/2017/029).

Procedure

Children completed questionnaires on the psychological components of physical literacy (PSE, quality of motivation, perceived movement skill competence) and physical activity. The questionnaire battery was completed on tablets (8" display - The Alcatel PIXI 3) via 'Survey Anyplace' in class, with a unique ID number assigned to each participant. The administration of the questionnaire was verbally guided by the lead researcher to ensure that children understood each item. The movement skill proficiency assessment was completed subsequently in the school sports hall. Throughout the questionnaire and assessment, a ratio of 1 researcher to 5 children was employed. Full details on all measures are given in the subsections below.

Measures: Cluster Variables

Self-efficacy:

Confidence as a construct has certain limitations and can be problematic to assess, Bandura (1997) highlighted confidence is '*a catchword rather than a construct embedded* *in a theoretical system*' (pp 382). Directed by Bandura's dialogue around self-efficacy and confidence, self-efficacy will be applied in place of confidence in this research. Self-efficacy is a theory-based construct which can account for an individual's belief that they can achieve a given level of attainment (Bandura, 1997). The Physical Activity Self-Efficacy Scale (PASES) was employed in this study. This scale was adapted for primary school children into an 8-item single factor scale (Bartholomew et al., 2006), and is consistent with self-efficacy definitions (Bandura, 1977, 1982, 1997), having shown good psychometric properties in children (Bartholomew et al., 2006). Items were scored using a 3-point likert-type scale with "No" (0), "Not Sure" (1), and "Yes" (2) as the three choices. Cronbach's alpha (Cronbach, 1951) coefficient for PASES in this study was good ($\alpha = .88$).

Autonomous Motivation:

Children's quality of motivation was measured using two subscales of the Behavioural Regulation in Exercise Questionnaire which was adapted for primary school children (BREQ-adapted; Sebire et al., 2013). The BREQ-adapted is consistent with SDT definitions (Deci and Ryan, 2000), and has been shown to have good psychometric properties in children (Sebire et al., 2013). The BREQ-adapted represents how motivation is multidimensional with 3 questions per motivation subscale: intrinsic ($\alpha = .81$) and identified ($\alpha = .73$). Items were scored using a 5-point likert-type scale: 1 (not true for me) to 5 (very true for me).

Perceived Movement Skill Competence

The pictorial scale of perceived movement skill competence for young children aligned with the Test of Gross Motor Development-3 (TGMD-3) was administered (Barnett, Ridgers, Zask, & Salmon, 2015; Ulrich, 2017). The pictorial scale of perceived movement skill competence assesses six locomotor (run, gallop, hop, skip, horizontal jump, and slide) and seven object proficiency skills (two-hand strike of a stationary ball, one-hand stationary dribble, kick, two-hand catch, overhand throw, forehand strike of a self-bounced ball, and underhand roll), based on the TGMD-3. Delivery of the pictorial scale of perceived movement skill competence replicated the process of Peers and colleagues (2019), with the extensive protocol available in Barnett et al. (2015). To synopsise, children either choose a cartoon portraying a child who is competent at a skill or the cartoon portraying a child who is not so competent at a skill. If children choose the competent cartoon they are asked: 'are you really good at …' (score of four) or 'pretty good at …' (score of three), if children select the not so competent cartoon, they are asked: are you 'not that good at (score of one) or sort of good at …' (score of two). The result is a four-point Likert scale response variable (range 1–4). The test-retest, internal reliability, face validity (Barnett et al., 2015) and construct validity (Barnett et al., 2016) of the pictorial scale of perceived movement skill competence has previously been established. Cronbach's alpha coefficient for perceived movement skill competence was good for this study sample (α = .70).

Movement Skill Competence

The TGMD-3 evaluates 13 fundamental movement skills, subdivided into two subscales: locomotor proficiency and object control proficiency of typically developing children between 3 and 11 years of age. This is a direct observation, process-oriented skill assessment looking at 3-6 performance criteria per skill that reflect the most mature movement pattern. The TGMD-3 has been shown to be a valid and reliable tool when measuring children's fundamental movement skills (Maeng et al., 2017). To supplement the TGMD-3, the vertical jump complementing the process-based assessment (Department of Education Victoria, 1996). These tools assess the performance of skill criteria, rather than assessing the outcome or product of the skill. Both the TGMD-3 (Ulrich, 2017) and the vertical jump (Cools, Martelaer, Samaey, & Andries, 2009) tools have been shown to be a valid and reliable when measuring children's fundamental movement skills. To assess movement skill competence accurately some form of stability assessment must be included (Rudd et al., 2015), thus the balance subtest of the Bruininks-Oseretsky Test of Motor Proficiency 2 (BOT-2) Short Form was included. The BOT-2 is a movement skill competence battery consisting of two tasks, walking forward along a straight line, and standing on one leg on a balance beam with eyes open. In contrast to the TGMD-3, these tests are based on the outcome of the performance. The product-based assessment awards points on a scale from zero to four for each task, measuring the outcome of the skill rather than the performance (Deitz et al., 2009) and has proven validity and reliability (Deitz, Kartin, & Kopp, 2009; Fransen et al., 2014).

Measures: Outcome Variables

Physical Activity:

To measure physical activity children completed the PACE+ (Prochaska et al., 2001), a validated and reliable measure for this age (Murphy, Rowe, Belton, & Woods, 2015). Children were given a definition (PA is any activity that increases your heart rate and makes you get out of breath some of the time) and examples of common physical activities. Children were asked how many days in the past week and in a normal week they were physically active (cumulative activity including sports, playing with friends, and walking to school, however excluding physical education class) for 60 min or more. As suggested by these authors the average number of days from the past week and typical week was used as an index of PA participation (Prochaska et al., 2001).

Statistical Analysis

Statistical analyses were conducted using IBM SPSS Statistics 24.0 software. Means, standard deviations and bivariate correlations were calculated for all variables. significance threshold was set at .01. Cluster analysis was conducted to examine whether groups could be identified based on children's components of physical literacy: PSE, quality of motivation, perceived movement skill competence, and fundamental movement skills. The components were standardised to Z-scores (mean = 0, SD = 1) to equalise the contribution of each variable in the cluster analysis. Univariate outlier analysis was conducted and as recommended (Hair & Black, 2000) observations on each clustering variable that exceeded 3.29 standard deviations from the mean were deleted (n = 20, 2.4%). Using the Mahalanobis distance measure multivariate outliers were also identified and deleted (n = 8, 0.9%). Following this process, data from 822 children remained available for analysis- 74.4% of the original sample.

A two-step cluster analysis procedure was applied (Gore, 2000; Blashfield & Aldenderfer; Hair & Black, 2000). First, Ward's hierarchical clustering method was conducted to obtain initial cluster groupings (Ward, 1963; Everitt, Landau, & Leese, 2001), this was employed as Ward's minimum variance method tends to derive more equally sized groups (Jain, Murty, & Flynn, 2000). In addition, squared Euclidean distance was used to measure the distance between the individual observations on the clustering variables. The number of clusters was selected based on the rescaled distances evident in the hierarchical cluster dendrograms, the percentage change in agglomeration coefficients at each step of the cluster analysis, and theoretical considerations (Hair & Black, 2000) resulting in two-, three-, and four-cluster solutions. The explained variance in all the clustering variables of each cluster solution was at least 50% (Milligan & Cooper, 1985). In the second stage of the cluster analysis, the cluster means from the hierarchical analysis were independently analysed through a non-hierarchical, k-means cluster analysis to refine the initial cluster solution, and to decrease the risk of cluster misallocation that is typical with hierarchical cluster methods (Asendorpf, Borkenau, Ostendorf, & Van Aken, 2001). These new clusters were then matched for agreement with the original hierarchical clusters via a Cohen's kappa (K). The two subsequent kappa's were averaged and a Cohen's kappa of at least 0.60 (good agreement) was deemed acceptable. Stability and replicability were deemed acceptable for only the four-cluster solution (.61) and explained 57% in quality of motivation, 65% in PSE, 82% in fundamental movement skills, and 56% in perceived movement skill competence respectively, thus the four-cluster solution was analysed for further interpretation. Chi-square analysis were calculated in order to assess representation of the clusters based on gender. Finally, comparisons of the clusters' variables and physical activity levels were made using one-way analysis of variance (ANOVA) and eta squared effect size, with post-hoc Bonferroni's test.

Results

The means and standard deviations of the variables as well as the correlation coefficients among these variables, are presented in Table 7. Participants demonstrated means of 95.71 for fundamental movement skills (SD = 12.72), 1.67 for PSE (SD = .27), 4.47 for autonomous motivation (SD = .57), and 50.90 for perceived movement skill competence (SD = 5.80

Table 5. Descriptive statistics and correlations among variables.

		M	*SD*	Min	Max	1	2	3	4	5
1.	Physical Self-Efficacy (0-2 scale)	1.66	.28	0	2					
2.	Autonomous Motivation (1-5 scale)	4.45	.61	1.5	5	.496*				
3.	Perceived Movement Competence Skill (13-52 scale)	43.96	5.22	20	52	.293*	.293*			
4.	Fundamental movement skills (0-120)	78.73	11.06	15	85	.229*	.178*	.271*		
5.	Self-Reported Physical Activity (days of week)	4.83	1.68	0	7	.263*	.287*	.221*	.171*	
6.	Age (years)	10.17	1.18	8	13	.035	-.052	.004	.237*	.058

Note. $N = 822$. $^{*}p < .05$. $^{**}p < .001$.

Identifying Clusters

As shown in Figure 3, four clusters could be retained based on cluster analyses. Cluster 1 (n = 370; 45%) was characterized by children who had, relative to children belonging to the other clusters, high levels of all constructs and was labelled the 'Leonardo' cluster. Cluster 2 (n = 87; 10.6%) was characterized by children who had, relative to children belonging to the other clusters, low levels of all constructs and was labelled the 'Michelangelo' cluster. Cluster 3 (n = 195; 23.7%) was characterized by children who had, relative to children belonging to the other clusters, average levels of fundamental movement skills and perceived movement skill competence but low levels of PSE and autonomous motivation and was labelled the 'Donatello' cluster. Finally, Cluster 4 (n = 170; 20.7%) was characterized by children who had, relative to students belonging to the other clusters, average levels of PSE and autonomous motivation, but low levels of fundamental movement skills and perceived movement skill competence and was labelled the 'Raphael' cluster. Chi-square analyses revealed a proportionate sex representation within the clusters ($x^2[3]=16.15$; p = < 0.001).

Significant differences were found between the four clusters in PSE (F^2, 818 = 359.677, $p < 0.001$), autonomous motivation (F^2, 818 = 384.782, $p < 0.001$), perceived movement skill competence (F^2, 818 = 249.548, $p < 0.001$), and fundamental movement skills (F^2, 818 = 142.904, $p < 0.001$). Tests of the four a priori clusters were conducted using Bonferroni adjusted alpha levels of .0125 per test (.05/4). Results indicated significant differences in PSE and autonomous motivation levels between all four clusters. Meanwhile for fundamental movement skills and perceived movement skill competence there were significant differences between the 'Leonardo' cluster and the other three clusters, and between the 'Donatello' cluster and the other three clusters. The pairwise comparison of the fundamental movement skills and perceived movement skill competence variables was non-significant between the ‘Michelangelo’ and ‘Raphael’ clusters (see Table 8).

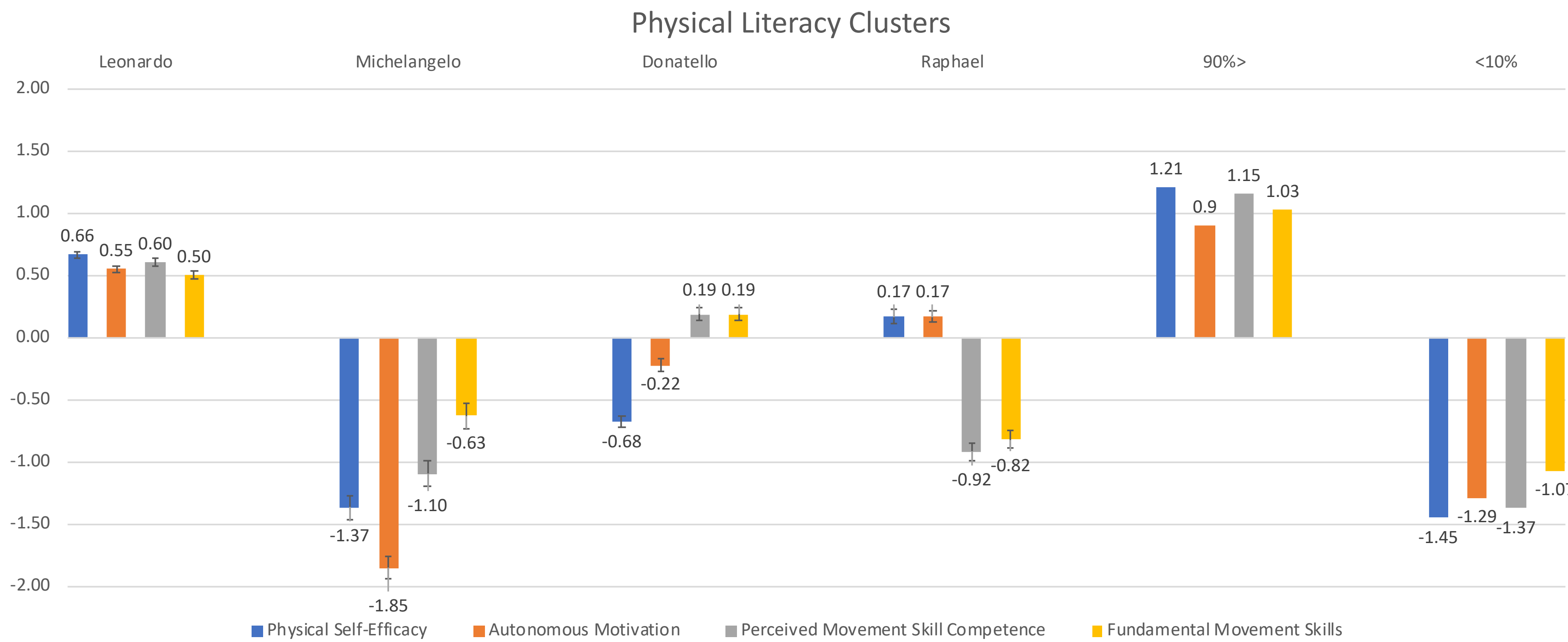

Figure 2. Four cluster solution based on z-scores for physical literacy constructs. Normative values from Issartel and colleagues (Appendix) included for a comparison

Differences between clusters self-reported physical activity.

Significant differences in physical activity levels between the physical literacy clusters were also found (F^2, 818 = 28.233, $p < 0.001$; eta squared .09). Cohen (1988) classifies .01 as a small effect, .06 as a medium effect and .14 as a large effect. Once more a priori analysis using Bonferroni adjusted alpha levels of .0125 per test (.05/4) revealed children in the Leonardo cluster (M = 5.35, SD = 1.49) displayed significantly higher levels of PA levels than children in the other three clusters. On the other hand, the Michaelangelo cluster (M = 3.81, SD = 1.75) displayed significantly lower levels of PA than the other three clusters. Meanwhile, the pairwise comparison of PA levels was non-significant between the Donnatello (M = 4.57, SD = 1.58) and Raphael (M = 4.61, SD = 1.70) clusters.

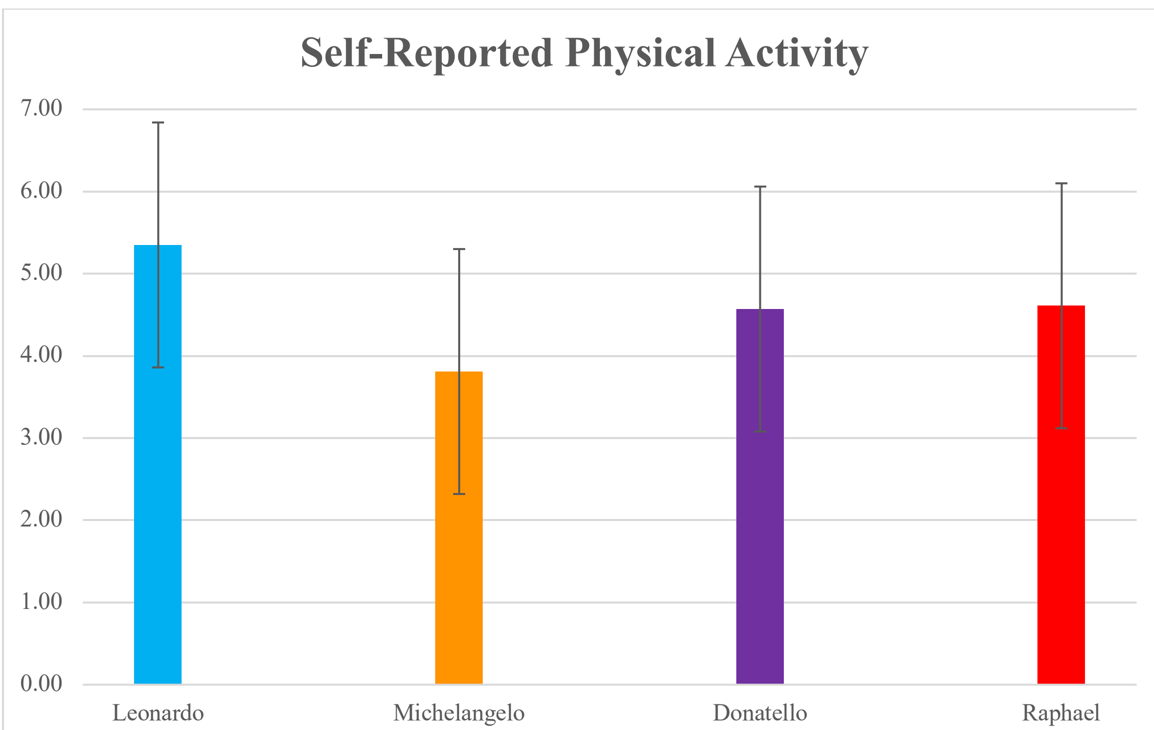

Figure 3. Mean differences of physical activity levels between clusters. Error bars represent standard deviation.

Table 6. Mean scores and cluster comparisons for the four Clusters (N = 822)

Variable	**Cluster**			
	Cluster 1: Leonardo N = 370 (**45%**) 202 boys, 168 females	Cluster 2: Michelangelo N = 87 (**10.6%**) 45 boys, 42 females	Cluster 3: Donatello N = 195 (**23.7%**) 116 boys, 79 females	Cluster 4: Raphael N = 170 (**20.7%**) 67 boys, 103 females
Cluster dimensions (z-scores)				
Physical Self-Efficacy	.67 (.02)[a]	-1.37 (.10)[b]	-.68 (.05)[c]	.17 (.05)[d]
Autonomous Motivation	.55 (.02)[a]	-1.85 (.09)[b]	-.22 (.05)[c]	.17 (.05)[d]
Perceived Movement Skill Competence	.60 (.03)[a]	-1.10 (.10)[b]	.19 (.05)[c]	-.92 (.07)[b]
Fundamental Movement Skills	.55 (.04)[a]	-.63 (.10)[b]	.19 (.05)[c]	-.82 (.07)b
Physical Activity	.31 (.05)[a]	-.61 (.11)[b]	-.15 (.07)[c]	-.13 (.08)[c]
Cluster dimensions (raw scores)				
Physical Self-Efficacy	1.85 (.01)[a]	1.27 (.03)[b]	1.47 (.01)[c]	1.71 (.02)[d]
Autonomous Motivation	4.79 (.01)[a]	3.32 (.05)[b]	4.32 (.03)[c]	4.55 (.03)[d]
Perceived Movement Skill Competence	3.61 (.01)[a]	2.97 (.04)[b]	3.45 (.02)[c]	3.02 (.03)[b]
Fundamental Movement Skills	101.80 (.46)[a]	87.07 (.1.31)[b]	97.67 (.64)[c]	84.62 (.90)[b]
Self-Reported Physical Activity	5.35 (.07)[a]	3.81 (.19)[b]	4.57 (.11)[c]	4.60 (.13)[c]

Note. Values in parentheses are standard errors. A cluster mean is significantly different from another mean if they have different superscripts. Different superscripts between parentheses indicate a trend to significance

Discussion

The aim of the current study was twofold: to investigate whether different physical literacy profiles exist among primary school children by using a person-centred approach and to explore how children with different physical literacy-based profiles might differ in terms of physical activity.

Cluster analyses identified four physical literacy-based profiles: two groups were characterized by corresponding levels of physical literacy components with approximately one tenth of all children (10.6%) having relatively low levels of all physical literacy components and almost half (45%) having relatively high levels of all physical literacy components. In addition, two groups with dissonant levels of physical literacy were identified. A group of children (23.7%) had relatively high levels of actual and perceived motor competence but low levels of self-efficacy and motivation towards physical activity, while another group (20.7%) displayed a combination of relatively low levels of self-efficacy and motivation, and high levels of actual and perceived motor competence.

Considering the individual groups, none bode well when considering children's' physical literacy, consequently PA. The Michelangelo group in comparison to normative values (Issartel, Appendix) has similar results in regard to PSE and perceived movement skill competence, with the autonomous motivation well into what would be the classed as the bottom 10% (Issartel, Appendix). The only redeeming factor for the group is that children's fundamental movement skills is above the 10^{th} percentile of normative values, however even this is well below expected scores (Issartel, Appendix). Considering physical activity is a manifestation of physical literacy, it is no surprise that the low-low group has inadequate physical activity levels as all components have been shown to be determinants. When considering the other clusters, the Leonardo group highlights that even moderately better physical literacy contributes to significantly different physical activity levels, however this cluster leaves much to be desired as the physical literacy scores are well below that of optimum normative values (Issartel, Appendix). But, the positive scores of this group highlights that maintenance, with a little development, could advance children to not only meet physical activity guidelines, but maintaining purposeful physical pursuits/activities throughout the life course (Cairney, Clark, et al., 2019; Whitehead, 2010).

The interesting groups are the two dissonant groups, as both the Donatello and Raphael group are lacking in all components of physical literacy. They have significantly different physical literacy scores yet have correlated physical activity levels. When contemplating the dissonant physical literacy-based profiles and comparing them to normative values it is interesting how even a development of one domain, such as competence can increase physical activity levels, even though the 'Donatello' group in comparison to normative values would fall in the 50th percentile (Issartel, Appendix). Conversely, the 'Raphael' cluster lacks core components of physical literacy, but even a moderately low score in the affective domain (PSE and motivation) contributes to significantly higher physical activity than the Michelangelo group. Clearly interventions should be striving to have all children achieve their full potential, if the high cluster has significantly higher physical activity than the other three clusters, envisage the health benefits if all children were reaching physical literacy levels of the top 10% (Issartel, Appendix).

Theoretical Implications

Theory integration has been advocated to progress physical activity as it can apply strengths of each theory as well as reduce weaknesses (Noar & Zimmerman, 2005). Both SDT and self-efficacy theory hold a strong link with physical activity, with autonomous motivation found in SDT (Deci & Ryan, 2002) and self-efficacy focusing on one's confidence to participate in physical activity (Bandura, 1997). Both autonomous motivation and PSE explained significant variance in the clusters and research consistently highlights both as predictors of physical activity (Cortis et al., 2017; Craggs et al., 2011; Uijtdewilligen et al., 2011; Van Der Horst et al., 2007). Although not to the same methodological rigor as previous research (Sweet, Fortier, Strachan, & Blanchard, 2012), this study highlights how theory integration is essential from a physical literacy perspective as interdisciplinary research teams build a multi-theoretical understanding of physical activity. Theory integration and its application to this pragmatic person-centred approach to physical literacy can help explain why some children are more physically active than others, such knowledge can then be applied to physical literacy interventions.

Practical Implications

This person-centred analysis highlights the need for a tailored intervention. The risk taken, when targeting physical literacy, is the misrepresentation of children leading to potential limited (or negative) impacts. Analysis of physical literacy in this holistic manner removes the 'one size fits all' intervention (Keegan, 2019) and lowers the chance of misrepresentation. With this in mind, future intervention development should consider curriculum, teaching, learning and assessment when trying to foster physical literacy in all children. Currently, the curriculum does not consider differentiation of children's physical literacy, and without a policy change the same inadequacies in physical literacy and consequently physical activity will remain.

Physical literacy is complex and non-linear in nature, this research helps paint a clearer picture for interventions, highlighting that teachers should consider the different aspects of physical literacy. Future interventions should therefore adopt a broad-spectrum assessment when targeting physical literacy as this will enable differentiated teaching and child-centred learning.

Limitations and Strengths

The strength of this study is the person-centred approach that has classified similar children into unique physical literacy groupings and the exploratory objective toward physical literacy, generating hypotheses for further research, rather than testing for statistical inference. Moreover, the person-centred approach begins to explain why some children are more physically active than others, with various physical literacy-based profiles differently relating to physical activity.

A number of limitations also need to be noted in the present study, with the most evident being the self-reported physical activity which is predisposed to social desirability and recall bias. Furthermore, this research has adopted a pragmatic approach to physical literacy, while trying to keep as true to its holistic philosophy as possible, a different interpretation of physical literacy could lead to different cluster outputs. Moreover, stability and replicability were only just acceptable for the four-cluster solution that potentially caused the unequal distribution of the sample.

Conclusion

This study among primary school children identified two physical literacy profiles with corresponding levels of physical literacy components and two dissonant profiles. In addition, the results showed that children with different types of physical literacy-based profiles differ in terms of physical activity. These findings emphasise the benefits of theory integration when explaining why some children are more physically active than others. Moreover, the physical literacy profiles emphasise the need for differentiated interventions when trying to promote physical activity. To achieve such an outcome will require successful integration and alignment of the curriculum, teaching and learning, and assessment; consideration of these pedagogical aspects is essential to support physical literacy and promote physical activity.

Link section Chapter 5 - 6

Chapter 5 sought to identify whether different profiles in terms of physical literacy exist in primary school children. The paper then ascertained whether physical literacy-based profiles have significantly different PA. Cluster analysis retained four physical-literacy profiles: two groups were characterized by corresponding levels of physical literacy components. The corresponding levels of physical literacy components support previous variable-centred approaches, in that good scores equate to more PA, and vice versa for poor scores. (Cortis et al., 2017; Craggs et al., 2011; Van Der Horst et al., 2007) Two groups with dissonant levels of physical literacy highlight the need for empirically designed interventions that consider differentiation when trying to promote PA and physical literacy overall.

The design and development process of the Moving Well-Being Well (MWBW) intervention is outlined in Appendix A as the author made a significant contribution to the design and development of the intervention, as well as a contribution to co-authoring. It is included in the Appendix so that the reader can consult as desired, to get further depth of information relating to the MWBW intervention programme.

In Chapter 6, the purpose is to explore the impact of a the MWBW professional development programme, as part of a multi component school-based intervention, on physical literacy of children. Utilising the Gaelic Athletic Association (GAA), one of the largest external providers in the primary physical education, the professional development programme will use GAA coaches to administer on the job professional development to teachers. The focus will be on how to deliver differentiated teaching that will foster autonomous motivation and PSE toward PA via positive movement experience.

CHAPTER 6

Moving Well-Being Well (MWBW) Physical Literacy Intervention: Results of an Exploratory Trial

Abstract

Background: Professional development programmes in physical education can play a considerable role in upskilling teachers to positively influence children's movement experience. The purpose of this study was to explore the impact of a professional development programme, as part of a multi component school-based intervention, on physical literacy of children.

Method: Children (n = 389, 52% female, mean age 7.6 ± 0.66 years) from ten schools (n= 5 intervention group) participated, and fundamental movement skills, physical self-efficacy, and autonomous motivation were measured at baseline, post-intervention, and at six-month retention. The intervention group received the Moving Well-Being Well eight-week intervention, with the remaining schools continuing with usual care.

Results: Results of a multilevel regression analysis confirmed that there was a significant time*intervention effect for fundamental movement skills. Results also show the intervention group significantly increased PSE from baseline to retention, whereas the control did not. No significant change in autonomous motivation was observed.

Conclusion: The Moving Well-Being Well intervention has the potential to improve FMS and PSE of primary school children.

Promoting PA in youth has received increasing attention over the past 20 years (Cortis et al., 2017), with physical literacy being positioned by many as the foundation for children of all levels to form lifelong habits of participation in PA (Cairney, Dudley, et al., 2019). Taking a holistic view of the individual, physical literacy provides a theoretical framework to investigate physical activity in relation to many factors including proficiency in fundamental movement skills (FMS), and the self-efficacy and motivation to be physically active which are developed through positive movement experiences (Cairney, Dudley, et al., 2019).

When considering the individual components of physical literacy there is evidence that FMS proficiency positively impacts increased participation in PA (Barnett et al., 2016; McGrane, Belton, Powell, & Issartel, 2017). It is understood that proficiency in FMS provides the building blocks for more complex movements required to participate in PA, and it is considered pertinent therefore to create opportunities to further develop FMS (Barnett, van Beurden, Morgan, Brooks, & Beard, 2009; McGrane, Belton, Fairclough, Powell, & Issartel, 2018). The theory of physical literacy, however, suggests that the way in which FMS is improved is important. If a child does not develop a sense of efficacy or motivation to be physically active from the movement experience, it is unlikely that FMS will be valued and therefore practiced, thus impacting participation in PA (Whitehead, 2001). As such, targeting not only improving FMS, but doing so through a positive movement experience is necessary (Cairney, Dudley, et al., 2019; Whitehead, 2010).

It is stated that a physically literate person has acquired an improved sense of belief to be physically active through their movement experiences (Cairney, Dudley, et al., 2019; Whitehead, 2010). This sense of belief to be physically active in theory will lead to children engaging in a wide array of activities (Whitehead, 2010). Physical self-efficacy (PSE) is a theory-based construct, that refers to an individual's belief in their skills to carry out PA and is central to the decision-making process to participate in PA (Annesi, 2006; Bandura, 2004). When considering PA determinants, PSE has been shown to be a consistent positive determinant of PA in children, and importantly, this tracks into adolescence and adulthood (Bauman et al., 2012).

Previous research has also explored the relationship between quality of motivation for PA among children and provides evidence that autonomous forms of PA motivation are positively related to PA, whereas controlled forms of motivation are largely negatively related (Sebire et al., 2013; Vierling et al., 2007). From a physical literacy perspective, Whitehead (2001, 2013) proposes that physically literate children are motivated to be physically active predominantly for intrinsic reasons such as satisfaction, opportunity, and a sense of competence derived from positive movement experience.

Considering the known interplay between individual physical literacy components and PA (Bauman et al., 2012), the emphasis of Irish primary school PE curriculum on providing movement experiences that enable children to experience enjoyment and develop confidence (Department of Education, 1999) is to be welcomed. While a focus on movement experience does exist in the peripherals of this curriculum (Department of Education, 1999), recent findings have demonstrated Irish primary school children have low levels of FMS (Behan et al., 2019), low levels of PSE (Peers, Issartel, Behan, O'Connor, & Belton, under review), and poor quality of motivation (Peers, Issartel, Behan, O'Connor, & Belton, under review). Collectively this data points to inadequate levels of physical literacy and subsequent PA participation in Irish young people (Belton et al., 2018). Consequently, physical literacy interventions targeting movement experience in Irish primary school children are required.

Professional development programmes in physical education can play a considerable role in developing primary school teachers pedagogy and reducing self-doubt toward teaching physical education (Harris, Cale, & Musson, 2012). Yet, professional development programmes, due to time and monetary constraints, can have a tendency to be fleeting workshops that occur away from the school environment (Jess, McEvilly, & Carse, 2017). Often, physical education professional development programmes, particularly in primary schools, focus on upskilling teachers' pedagogy through resource materials alone, however, resource-driven professional development programmes do not sufficiently deliver teachers with an in-depth awareness of physical education pedagogy (Armour & Yelling, 2004). Research has suggested that by collaboratively working with teachers, external providers can offer support in physical education pedagogy (Kaldor & Deutsch, 2013) and movement skills (Lucertini et al., 2013). A recent study has recommended increased communication and involvement with external providers in Ireland, in an effort to change the existing dynamic in which the teacher views the external provider as the expert (Ni Choinin et al., 2019). Considering children's levels of physical literacy in Ireland, the fact that movement experience should be a core focus when teaching primary school PE, and effective professional development in physical education. The Moving Well Being Well (MWBW) program is an example of an intervention which attempts to address this issue by providing support to both the external expert and the class teacher to work together.

The purpose of this paper was to evaluate the intervention effect of the MWBW tailored professional development programme on children's physical literacy components. The main research question was broken down to examine if the intervention groups would demonstrate a significant increase in levels of physical literacy components i) FMS, ii) PSE, and iii) autonomous motivation over time when compared to the control group.

Methods

Participants

This non-randomised controlled trial was conducted as part of the MWBW research programme. For this 6-month exploratory study a convenience sample of Irish children (n = 389, 52% female, mean age 7.6 ± 0.66 years) enrolled in 1st and 2nd year primary schools (n= 10) in County Dublin (Ireland) were invited to take part in the study. Schools were pair matched prior to baseline testing, based on the following criteria: socioeconomic status (disadvantaged and non-disadvantaged), gender, and size. One school from each pair was then allocated to the control group (and the other to the intervention group) using a manual number generator in blocks of 1:1. Ten schools (n = 389 children) completed all measures at two time points (pre-intervention, and post-intervention). Eight of these schools (n = 4 intervention group) agreed to a follow-up data collection six months post-intervention (n = 138 children). Children completed assent forms, meanwhile parents signed informed consent forms to confirm they understood the purpose of the research and participation rights (e.g., voluntary participation, right of withdrawal, and confidentiality of the data). Data collection took place from February 2018 to October 2018. Ethical approval was granted by the Dublin City University Research Ethics Committee (DCUREC/2017/029).

Intervention

The Behavioural Change Wheel (BCW) framework (Michie, van Stralen, & West, 2011) for developing and evaluating a tailored intervention states following a specific and relevant theoretical framework allows for interventions to be effectively evaluated, and also highlights ways in which the intervention can be improved. The BCW outlines an eight-step evidence-based approach that sit within three stages (Michie et al., 2011). This research represented phase two on the method for designing behaviour change interventions - identifying intervention functions (Michie et al., 2011). The MWBW intervention is a multicomponent, primary school intervention incorporating the following components: 1) The child: FMS as the vehicle for physical literacy development, foster children's movement experience, 2) The coach component: coach undergoes training in administering the physical education professional development programme to support the teacher, 3) The teacher component: generalist teacher receives on the job professional development on how to deliver differentiated teaching that will foster autonomous motivation and PSE toward PA via positive movement experience, 4) Active classroom component: interactive whiteboard resources are provided for five minute active breaks in the classroom, 5) Parental component: home activity resources are made available to encourage parents to be active, and support their children's physical literacy development.

The MWBW intervention is a professional development programme founded on physical literacy development implemented by both specialised sports coaches (community based professional GAA coaches) and primary school teachers. Although resource material is provided, the focus of the intervention was to provide teachers with an in-depth knowledge of physical education pedagogy. The intervention upskills teachers' pedagogical practice in physical education to ensure the professional development programme is student focused. This is achieved by embedding the content of the professional development programme alongside primary school teachers' current duties and responsibilities into structured, twice weekly 30-minute developmental lessons for the participating children. Pre- to post-intervention, the intervention group received two physical literacy-based lessons a week, the first lesson is guided by the coach accompanied by the teacher. The teacher would then exclusively run the second lesson of the week, along with daily active classroom activities, and weekly home activities (Issartel et al., under review). The control group continued with their usual PE programme and did not receive any specialised sports coaching for the duration of the study. Further detail on the MWBW intervention development and structure is shown in previously published work (Issartel et al., under review).

Measures

Measurements were taken at three time points: March 2018 (pre-intervention), May 2018 (post-intervention), and November 2018 (retention six-month follow-up). Children completed questionnaires on the psychological components of physical literacy (PSE and autonomous motivation). The questionnaire battery was completed on tablets (8” display - The Alcatel PIXI 3) via ‘Survey Anyplace’ in class, with a unique ID number assigned to each participant. The administration of the questionnaire was verbally guided by the lead researcher to ensure that children understood each item. The movement skill proficiency assessment was completed subsequently in the school sports hall. Throughout the questionnaire and assessment, a ratio of 1 researcher to 5 children was employed. Full details on all measures are given in the subsections below.

Fundamental Movement Skills

Fundamental movement skills were primarily assessed through the Test of Gross Motor Development-3rd Edition (TGMD-3). The TGMD-3 is comprised of locomotor (run, skip, gallop, slide, hop, and horizontal jump) and object-control (catch, overhand throw, underhand roll, kick, two handed strike, one handed strike, and stationary dribble) skill subtests (D. Ulrich, 2017). Also included was an additional locomotor skill test, the vertical jump, from the Victorian Fundamental Motor Skills manual (Department of Education Victoria, 1996, *Fundamental Motor Skills: A Manual for Classroom Teachers*, Melbourne: Education Department of Victoria), and the balance subtest from the Bruininks-Oseretsky Test of Motor Proficiency 2 (BOT-2) Short Form (Bruininks, 2005). All measures have established validity (Temple & Foley, 2017) and reliability in this age cohort (Cools et al., 2009; Yee, Wong, & Cheung, 2010), with the combined locomotor, object control and balance subtests in this study giving good internal consistency reliability ($\alpha = 0.80$).

Physical Self-Efficacy

The Physical Activity Self-Efficacy Scale (PASES) was employed in this study. This scale was adapted for primary school children into an 8-item single factor scale (Bartholomew et al., 2006), and is consistent with self-efficacy definitions (Bandura, 1977, 1982, 1997), having shown good psychometric properties in children (Bartholomew et al., 2006). Items were scored using a 3-point likert-type scale with "No" (0), "Not Sure" (1), and "Yes" (2) as the three choices. Cronbach's alpha (Cronbach, 1951) coefficient for PASES in this study was good ($\alpha = .76$).

Autonomous Motivation

Children's autonomous motivation for PA was measured using two subscales from the Behavioural Regulation in Exercise Questionnaire which was adapted for primary school children (BREQ-adapted; Sebire et al., 2013). The BREQ-adapted is consistent with SDT definitions (Deci and Ryan, 2000), and has been shown to have good psychometric properties in children (Sebire et al., 2013). The BREQ-adapted represents how motivation is multidimensional with 3 questions per autonomous motivation subscale: intrinsic ($\alpha = .79$) and identified ($\alpha = .71$). Items were scored using a 5-point likert-type scale: 1 (not true for me) to 5 (very true for me). Autonomous motivation was scored as a composite score of intrinsic and identified motivation.

Statistical Analysis

Separate multilevel linear regression analysis was used to examine the effect of the MWBW intervention on the physical literacy components: FMS, PSE, and autonomous motivation. A three level multilevel structure was proposed with random intercepts, where time (Level one), children (Level two) and schools (Level three) served as the grouping variables, time was treated as a fixed effect in the models but was also incorporated as a random slope effect (repeated measure) in the residual component. All fixed effect interactions were examined. The repeated measures component was analysed for identity, unstructured, unstructured heterogeneous, autoregressive, autoregressive heterogeneous and compound symmetry variance structures.

Regression coefficients for the group variables (where '0' indicated Control schools, and '1' indicated Intervention schools) reflected average differences in the outcome variable over time adjusted for baseline outcome values, timing of follow-up measures, and gender over 3 time periods. To determine the time points at which any intervention effects occurred at (T1, T2, or T3), post-hoc stratified analyses comparing the estimated marginal means of the interaction variables were performed for the Intervention and Control groups, and comparisons were made with t-tests using Satterwhaite degrees of freedom. Random Intercepts were assessed for significance using the Wald statistic with statistical significance set at $p < 0.05$. The covariance structure of the mixed model was evaluated by assessing the Akaike (AIC) information criterion and Bayesian information criterion (BIC). Analyses were performed using SPSS software version 24 (IBM Corporation).

Results

A total of 389 (n = 209, intervention group) participants from 10 schools were involved in this research at pre-intervention (T1). Participant retention ranged from 100% at post-intervention (T2) to 31.7% at retention follow up (T3), in the control group. The intervention group's retention ranged from 100% at post-intervention to 42.6% at retention follow up (Table 9). Participation levels were reduced significantly at the retention follow up as only a subsample of the original participants was tested due to logistical issues. Intervention and control groups physical literacy components (FMS, PSE, and autonomous motivation) across the three time points are given in Table 9. Fundamental movement skill is shown graphically by gender and intervention groups in Figure 5. Physical self-efficacy (Figure 6) and autonomous motivation (Figure 7) are shown graphically by intervention groups.

For FMS an Identity (ID) covariance structure was found to have the lowest AIC and BIC. The random intercept for School was found to be non-significant (3.593, $p=0.090$, Wald $Z=1.697$), but the ID repeated measures (39.020, $p<0.001$, Wald $Z=18.676$) of the error term was found to be significant. In this model the intercept term at a school level was excluded, as between-school variation was not significantly determining FMS variance.

For PSE, an Identity (ID) covariance structure was also found to have the lowest AIC and BIC. The random intercept for School was found to be non-significant (.0005, $p=0.345$, Wald $Z=.944$), but the ID repeated measures (.914, $p<0.001$, Wald $Z=21.213$) of the error term was found to be significant. In this model the intercept term at a school level was excluded, as between-school variation was not significantly determining PSE variance.

For autonomous motivation a multilevel linear regression did not converge. Baseline autonomous motivation significantly predicted the dependant variable of autonomous motivation, $F(1, 2770.398) = 1033.561$ $p < 0.001$, but intervention group did not significantly predict dependent variable autonomous motivation, $F(1, 1226.443) = .900$ $p = .343$, and the interaction effect between intervention and baseline autonomous motivation was also not significant, $F(1, 2770.398) = 1.509$ $p = .219$.

The final parameter estimates for the main fixed effects of the final FMS and PSE model choices are shown in Table 10 and 13, and similarly the Type III test effects for the final interaction effects for FMS and PSE are shown in Table 11 and 14. Post hoc analysis on the group comparisons of the intervention interaction with time are outlined in Table 11.

Table 7. Sample size, fundamental movement skill and physical self-efficacy (mean ± standard deviation) at each time point by gender and intervention group.

	Baseline				Post-intervention				Retention Follow-up			
Group	**n**	**FMS**	**PSE**	**Autonomous Motivation**	**n**	**FMS**	**PSE**	**Autonomous Motivation**	**n**	**FMS**	**PSE**	**Autonomous Motivation**
Intervention Male	88	76.65 (15.58)	1.51 (.32)	4.36 (.75)	88	88.34 (11.08)	1.59 (.38)	4.51 (.74)	37	92.84 (8.32)	1.53 (.34)	4.53 (.70)
Intervention Female	121	72.82 (12.87)	1.51 (.32)	4.43 (.58)	121	84.82 (10.15)	1.62 (.32)	4.70 (.38)	44	91.25 (8.67)	1.63 (.30)	4.68 (.44)
Intervention Overall	209	74.43 (14.17)	1.51 (.32)	4.40 (.66)	209	86.36 (10.70)	1.61 (.35)	4.61 (.57)	81	91.98 (8.50)	1.59 (.32)	4.61(.57)
Control Male	91	81.21 (13.37)	1.63 (.26)	4.53 (.63)	91	79.85 (11.86)	1.55 (.21)	4.70 (.61)	27	88.32 (12.87)	1.52 (.30)	4.59 (.51)
Control Female	89	74.06 (11.57)	1.52 (.32)	4.43 (.82)	89	71.27 (12.63)	1.46 (.48)	4.49 (.70)	30	76.97 (12.01)	1.59 (.30)	4.69 (.35)
Control Overall	180	77.67 (12.98)	1.59 (.29)	4.47 (.75)	180	75.47 (12.96)	1.49 (.40)	4.57 (.67)	57	81.93 (13.35)	1.53 (.30)	4.64 (.43)

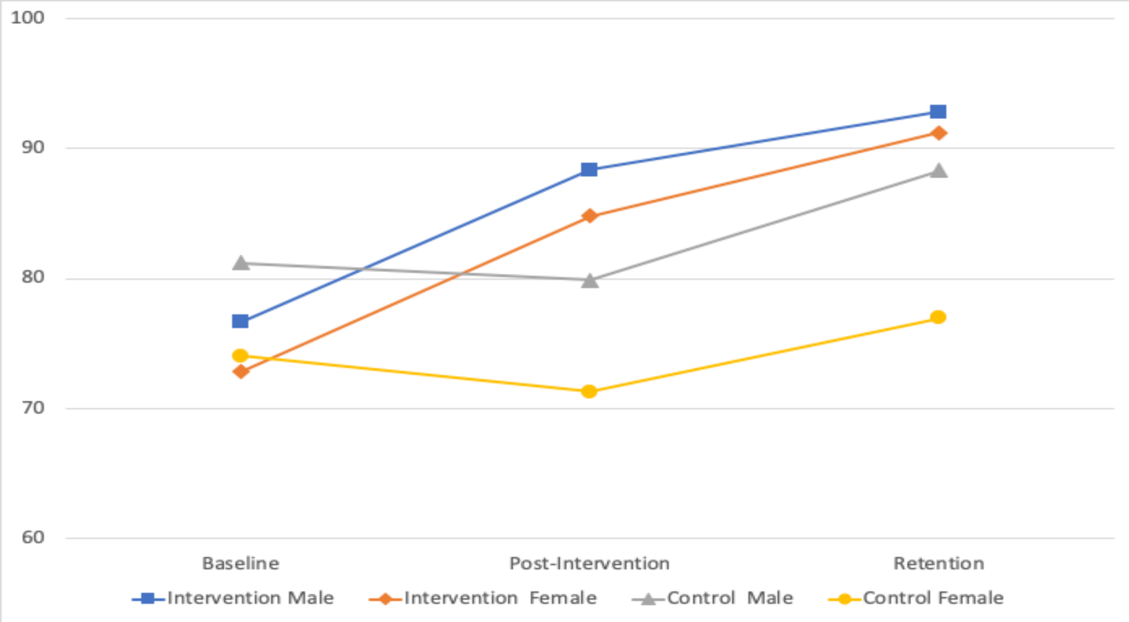

Figure 4. Overall fundamental movement skill across time and gender for control and intervention group

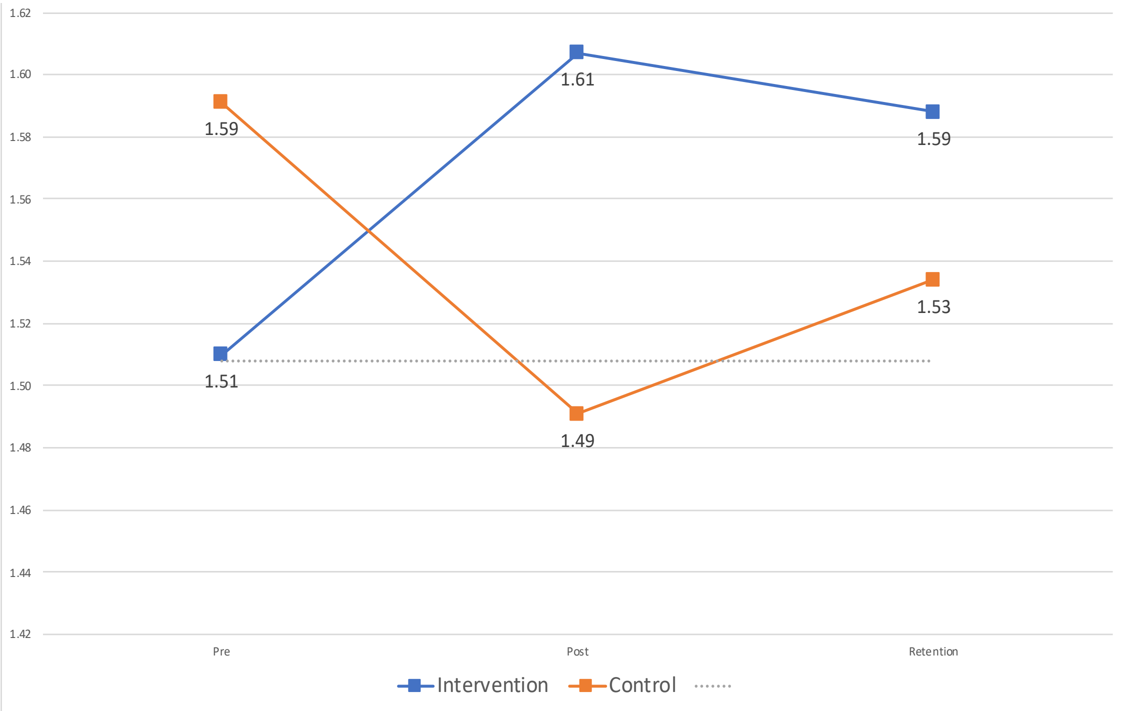

Figure 5. Physical Self-Efficacy across time for control and intervention groups.

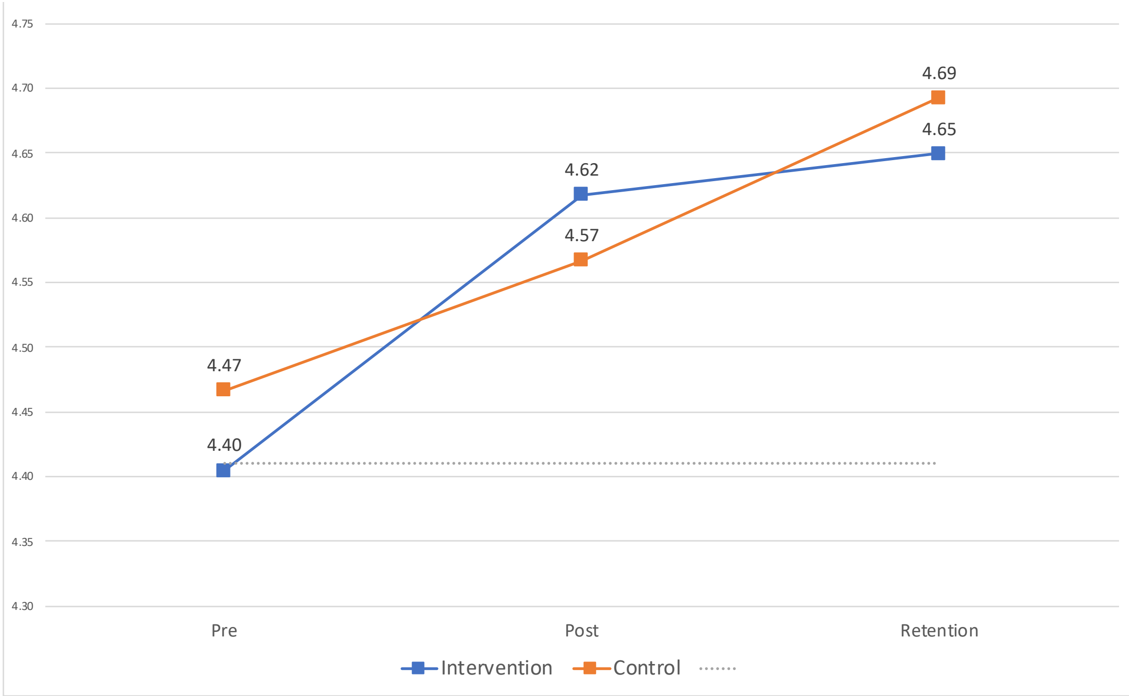

Figure 6. Autonomous motivation across time for control and intervention groups.

Table 8. Parameter estimates of fundamental movement skill main fixed effects

Parameter	Estimate	S.E.	df	t	C.I.
Intercept	35.257	2.298	283.101	15.343**	(30.733, 39.780)
Time					
Time (1v2)	-14.500	1.459	704.399	-9.943**	(-17.379, -11.641)
Time (1v3)	-0.987	1.49	703.655	-0.662	(-3.912, 1.939)
Gender (M/F)	0.751	1.607	698.856	0.467	(-2.405, 3.907)
Intervention	-17.648	3.689	345.618	-4.784**	(-24.903, -10.393)
Gender*Intervention	-6.233	2.637	701.312	-2.363*	(-11.410, -1.055)
Time*Intervention					
Time 1*Male	-1.325	1.886	702.805	-0.703	(-5.028, 2.378)
Time 3*Male	-3.698	1.921	701.366	-1.925	(-7.469, 0.073)
Time*Intervention					
Time 1*Control	9.686	2.126	705.991	4.371**	(5.335, 14.036)
Time 3*Control	-7.048	2.256	705.955	-3.125**	(-11.476, -2.620)
Gender*Intervention* Time					
Time 1*Male*Control	5.474	3.007	705.638	1.82	(-0.430, 11.379)
Time 3*Male*Control	7.625	3.052	705.783	2.499*	(1.633, 13.617)
Baseline FMS	0.723	0.023	705.991	4.371**	(0.678, 0.767)
Intervention*Baseline FMS	0.122	0.036	703.076	3.4008	(0.052, 0.192)

Implies significance at the α = .05*   * Implies significance at the α = .001*

Table 9. Fundamental movement skill Type III analysis of interaction effects

Parameter	**F**	**df**	**p**
Time*Intervention	124.622	(2, 681.971)	0.000**
Gender*Intervention	2.341	(1, 700.018)	0.119
Gender*Time	0.974	(2, 701.945)	0.378
Gender*Intervention*Time	3.138	(2, 701.945)	0.044*
Baseline Fundamental Movement Skill *Intervention	11.612	(1, 703.076)	0.001**

**Implies significance at the α = .05   ** Implies significance at the α = .01*

Table 10. Fundamental movement skill and physical self-efficacy post hoc contrast test analysis for significant interaction effects.

	Fundamental Movement Skills				Physical Self-Efficacy			
Comparison	**Estimated Difference**	**d**	**p**	**C.I.**	**Estimated Difference**	**d**	**p**	**C.I.**
Baseline Control vs Baseline Intervention	-8.341	.238	0.007**	(-14.367, -2.316)	-.184	.262	.052	(-369, .002)
Retention Control vs Retention Intervention	20.764	.898	0.000**	(-27.294, -14.235)	.280	.193	.011*	(.065, .494)
Baseline Control vs Retention Control	2.745	.324	0.024*	(-5.123, -0.367)	.024	.203	.662	(-.084, .133)
Baseline Intervention vs Retention Intervention	15.168	1.502	0.000**	(-17.073, -13.262)	.072	.250	.048*	(.001, .143)
Retention Female Control vs Retention Female Intervention	17.648	1.363	0.000**	(24.903, -10.393)	.208	.133	.037*	(.013, .403
Retention Male Control vs Retention Male Intervention	23.303	.417	0.000**	(-29.295, -17.312)	.160	.031	.110	(.035, .353

Table 11. Parameter estimates of physical self-efficacy main fixed effects

Parameter	Estimate	S.E.	df	t	C.I.
Intercept	.911	.073	900	12.4**	(.766, 1.06)
Time					
Time (1v2)	-.019	.053	900	-.349	(-.123, .086
Time (1v3)	.045	.053	900	.834	(-.060, .150)
Gender (M/F)	.082	.060	900	1.383	(-.034, .197)
Intervention	-.276	.131	900	-2.099*	(-.534, -.018)
Gender*Intervention	-.007	.116	900	-.058	(-.235, .222)
Time*Gender					
Time 1*Male	-.106	.072	900	-1.463	(-.248, .036)
Time 3*Male	-.068	.072	900	-.933	(-.210, .075)
Time*Intervention					
Time 1*Control	.068	.103	900	.658	(-.134, .269
Time 3*Control	.065	.103	900	.637	(-.136, 267)
Gender*Intervention*Time					
Time 1*Male*Control	.056	.132	900	.428	(-.203, 315
Time 3*Male*Control	-.038	.132	900	-.284	(-.296, .222)
Baseline FMS	.416	.039	900	10.688**	(.340, .493)
Intervention*Baseline FMS	.119	.059	900	2.00	(.002, .235)

**Implies significance at the α = .05   ** Implies significance at the α = .001*

Table 12. Physical Self-Efficacy Type III analysis of interaction effects

Parameter	F	df	p
Time*Intervention	1.278	(2, 900)	0.279
Gender*Intervention	<0.001	(1, 900)	0.993
Gender*Time	0.887	(2, 900)	0.412
Gender*Intervention*Time	0.576	(2, 900)	0.563
Baseline PSE*Intervention	3.998	(1, 900)	0.046*

**Implies significance at the α = .05*

Figure 5 graphically presents the trends in FMS across gender and time for control and intervention groups. The upward trend in FMS (Figure 5) over time is apparent for all groups, with the biggest increase evident for females in the intervention groups, where the lowest level of FMS at baseline was observed. Results of the mixed model analysis showed a significant time*intervention effect for FMS. The post hoc analysis, shown in in Table 12, demonstrates how the interaction between time and intervention occurs. This data shows a significant difference between control and intervention groups at baseline, with the control group demonstrating significantly higher FMS levels at baseline than the intervention group ($p = 0.007$, $d = 0.238$). At retention, however, there is a significant difference evident between the control and intervention in favour of the intervention group ($p < 0.001$, $d = 0.898$). Post hoc results from the multilevel analysis show the intervention group significantly increases FMS proficiency from baseline (74.43) to retention (91.98) in overall FMS ($p < 0.001$, $d = 1.502$).

Figure 6 graphically presents the trends in PSE across time for control and intervention groups. The upward trend in PSE (Figure 6) over time is apparent for the intervention group, (where the lowest level of PSE at baseline was observed). Results of the mixed model analysis show a significant Baseline PSE*intervention effect. With this in mind, post hoc results from the multilevel analysis show the intervention group significantly increases PSE from baseline to retention ($p = .048$, $d = .250$), meanwhile the control group do not (Table 12). Of note, there was no significant difference between control and intervention at baseline, but a significant difference is evident between the control and intervention at 6-month follow-up ($p = .011$, $d = .193$).

Discussion

The purpose of this study was to explore the effect of the MWBW intervention on primary school children's physical literacy components (FMS proficiency, PSE, and autonomous motivation). Study findings provide some support for the effectiveness of the MWBW intervention. After six months, the intervention was effective in developing FMS and PSE components. Meanwhile control participants FMS levels also significantly improved, their PSE did not significantly change. Considering baseline autonomous motivation, there were no significant changes for either the intervention or control groups. The findings suggest that implementing the MWBW intervention in primary schools may have positive impacts on children leading to development of their physical literacy.

Separating the individual components of physical literacy is stated to negate the holistic underpinnings of the concept (Whitehead, 2013). Separation during analysis and discussion, however, is important to specify how and what the intervention approach achieved and/or lacked. With this in mind, there were significant improvements in FMS over time for both school settings, the extent of change for the intervention group was markedly greater and was corresponding with an increase in PSE. The FMS results are similar to movement competence interventions that use professional development of teachers (McKenzie et al., 2009). Previous research has found that teachers trained in movement can elicit significantly greater improvements in children's FMS than teachers who are not (McKenzie et al., 2009).

This study builds and illustrates that the pedagogical methods used in the delivery of the intervention is a strong facilitator of children's FMS and PSE. Current research notes that when children are differentiated according to their learning needs then they are more likely to develop (Gibbs & Simpson, 2004). The substantive improvement in FMS and PSE, that remained at 6-month follow up, may be due to the upskilling of physical education pedagogy that used differentiated teaching to foster PSE via positive movement experience (Cairney, Dudley, et al., 2019). Additionally, although not causal, the intervention groups increase in FMS score from post-intervention (86.36) to retention (91.98) potentially highlights that if a child does develop a sense of efficacy to be PA from the movement experience, FMS will be valued and therefore practiced. In comparison to previous FMS interventions the magnitude of change is in line with percentage increase from baseline to retention, but previous studies only assessed 3 FMS (McKenzie et al., 2009), whereas this intervention saw a 17% increase in 15 skills across overall FMS: object control, locomotor, and balance.

By providing positive movement experience that suit children's interests and ability the intervention may have remediated the self-belief issues that have been identified in primary school children in previous research (Cairney et al., 2012). Previous research has focused on behavioural skills (e.g. goal-setting) to develop PSE (Dishman et al., 2004; Khodaverdi et al., 2016), but interventions applying such skills for changing PSE and thereby PA have yielded small effects (Lubans et al., 2008). Although similar effects, the current study is preliminary and if other intervention techniques were to be incorporated into the MWBW then optimal PSE could be achieved.

Autonomous motivation, however, did not significantly increase across the intervention or at follow-up. Physical education has been shown to facilitate children's autonomous motivation for PA through the support of physical competence, relatedness and autonomy (Deci & Ryan, 2000; Ng et al., 2012). There are different reasons why autonomous motivation may not have significantly increased across the current intervention: a clear focus on development of physical competence as a primary aim. This intervention may have isolated or overly emphasised competence support as the delivery focused on feedback and skill belief. Ryan and Deci (2000) maintain that the support of competence, relatedness, and autonomy in unison needs is required in order to shift from controlled to more autonomous motivation. Autonomy-supportive interventions have led to positive outcomes such as enjoyment for PA (Mandigo et al., 2008). Being more flexible with children (Mandigo et al., 2008) and providing opportunities for choice (Ward, Wilkinson, Graser, & Prusak, 2008) or self-initiative (Murcia, Lacárcel, & Álvarez, 2010) are examples of how to support autonomy, future iterations of MWBW should look to include such techniques. It is important to note also that the current intervention was quite structured as it took a mastery-approach, this could have impacted children's relatedness as teachers focused on the individualised ability and progress, rather than fostering connectedness (Gillison et al., 2011). Future interventions should look to measure competence, relatedness, and autonomy, as well as incorporating the aforementioned techniques to achieve optimal autonomous motivation.

Strengths

In line with cross-sectional studies looking at the relationship between PSE and FMS, the findings presented here suggest that improvement of FMS via a positive movement can also positively impact PSE. The fact that the positive results were retained six months later at the retention stage is a notable strength, as there is limited research which report retention testing of interventions targeting PA (Van Sluijs et al., 2008). Upskilling physical education pedagogy and instilling confidence toward PE in generalist teachers via a continuous professional development programmes can play a considerable role, in comparison to fleeting workshops; this is highlighted in the current studies baseline to retention FMS and PSE scores (Harris et al., 2012). This strength is emphasised in the long-term impact of the intervention as FMS from post-intervention to retention increased. Additionally, the use of multi-level analysis, which took into account the nested nature of the data, further supports the strength of the intervention as it impacted children regardless of school.

Limitations

The main limitation of this paper is the linear approach to physical literacy, in that it does not account for the complexity of the interaction between the various components of physical literacy (Edwards et al., 2018). Advanced analysis using multi-level models that outline the interaction effects between the components will help shape an understanding of children's physical literacy. Measurement that considers the multi-dimensional (autonomous and controlling) nature of motivation would also further understanding, with attention to the different qualities helping future interventions appreciate how they are impacting children's physical literacy. Moreover, there are problems with the connections between FMS, FMS assessment tools, and physical literacy, as FMS are classified into object control skills, locomotor skills, and stability skills (Gallahue et al., 2011). This perspective gives the impression that all movement experiences in primary school years should be based on these three categories. Whilst important, FMS do not reflect the broad diversity of movement competency utilised in PA pursuits across the lifespan (e.g. swimming and cycling) (Hulteen, Morgan, Barnett, Stodden, & Lubans, 2018).

Conclusions

The inadequate levels of physical literacy in children and adolescents (Behan et al., 2019; Belton et al., 2014) emphasise the need for interventions targeting movement experience in primary school children. Using physical literacy as a theoretical framework for developing children's FMS and PSE through positive movement experience is imperative as it equips children with the proficiency and belief to engage in a wide array of PA, and this is hopefully the beginnings of encouraging PA for life (Cairney, Dudley, et al., 2019; Whitehead, 2010). This school-based professional development programme shows the impact collaboration between teacher and external provider can have on children's movement experience and physical literacy when facilitated with multiple components, however further consideration to autonomous motivation in future studies is desirable.

CHAPTER 7

Discussion and Conclusions

Thesis General Discussion

Irish children are not meeting the physical activity (PA) guidelines of at least 60 minutes of moderate to vigorous physical activity, only 19% of primary school children meet these guidelines (Woods, Tannehill, Quinlan, Moyna, & Walsh, 2010). These proportions have decreased since 2010, with 17% of children meeting the daily PA guidelines (CSPPA, 2018).

To address the low levels of PA in children, the MWBW study first explored the determinants of PA via the physical literacy concept. Physical literacy as a concept takes a multi-dimensional approach to the determinants of PA and is commonly defined as the motivation, confidence, physical competence, knowledge and understanding to be physically active for life (Edwards, Bryant, Keegan, Morgan, & Jones, 2017; Shearer et al., 2018; Whitehead, 2001). Importantly, physical literacy provides a theoretical framework to explore how positive movement experiences can foster the motivation and belief to be physically active (Cairney, Dudley, Kwan, Bulten, & Kriellaars, 2019).

Using a sound theoretical framework and empirical evidence base when developing PA interventions has been shown to be a successful strategy (Stull et al., 2007). With this in mind, and the lack of physical literacy studies in children, the main objective of this research was to ascertain an empirical understanding of the nature and level of connectivity between the components of physical literacy in an Irish context.

Chapter 3, the first study in this thesis, analysed the relationship between children's quality of PA motivation and proficiency of fundamental movement skills (FMS). Both components are well supported determinants of PA (Bauman et al., 2012). With evidence that FMS proficiency positively impacts PA (Barnett et al., 2016; McGrane, Belton, Powell, & Issartel, 2017). Moreover, the relationship between quality of motivation for PA among children has provided evidence that autonomous forms of PA motivation are positively related to PA, whereas controlled forms of motivation are largely negatively related (Sebire, Jago, Fox, Edwards, & Thompson, 2013; Vierling, Standage, & Treasure, 2007). From a physical literacy perspective, this research question was established through the supposed process that higher quality of motivation for PA (intrinsic and identified) supports learning, performance, higher interest and greater effort. A proficient FMS ability has been considered an important motivating force for girls and boys prolonged engagement in PA (Kalaja, Jaakkola, Watt, Liukkonen, & Ommundsen, 2010; Stodden et al., 2012), but there is a gap between the genders FMS abilities, with few studies assessing why girls are less proficient at FMS than boys. This is noticeable in this study, as a positive relationship between FMS proficiency and identified PA regulation was observed for boys. Meanwhile, FMS proficiency and external PA motivation had a negative relationship in females. According to SDT, the actual quality of motivation is important as autonomous forms of motivation promote learning, performance, higher interest and greater effort (Chatzisarantis & Hagger, 2009; Ntoumanis, 2001). Controlling forms of motivation, in contrast, are negatively related to these outcomes (Grolnick and Ryan, 1987; Deci et al., 1996). The findings in chapter 3 reinforce these findings, with proficiency in FMS being associated with identified motivation for boys, meanwhile external motivation has a negative relationship with FMS for both genders. Regardless of direction in the relationship, not only concentrating on the facilitation of identified regulation, but counteracting controlling motivation could be an important focus for future FMS interventions. Developing and maintaining FMS proficiency requires individuals to place value on the skills, and to recognise the importance of FMS in terms of facilitating their participation and success in PA (Cairney et al., 2019). The results highlight that valuing the benefits of PA has a relationship with children's FMS, in theory this will lead to greater participation, thus greater opportunities to practice

FMS. Chapter 3 emphasises that quality of motivation continues to consistently hold a strong link with behaviours in the PA domain, such as FMS (Pan et al., 2009). Although quality of motivation has strong associations with FMS, there have been recommendations to explore other theories to further explain PA (Hagger & Chatzisarantis, 2008).

Chapter 4, examines whether movement competence is a source of information for PSE and PA. The PSE – PA relationship is well established, however identifying how to improve PSE remains less clear. Knowing what can improve PSE would also contribute to better understanding the PSE – PA relationship (Bauman et al., 2012; Williams & French, 2011). It is stated that a physically literate person has acquired an improved sense of belief in their ability to be physically active through their movement experiences (Cairney et al., 2019; Whitehead, 2001). This study incorporated perceived movement skill competence (PMSC), alongside FMS proficiency, in an effort to capture the movement experience and determine how this might explain the PSE – PA relationship. Although proficiency of movement goes some way to explaining why belief to be physically active is leading to engagement in PA, there is more than just proficiency playing a role. How children perceive their movement skill is vital to the PSE – PA relationship. According to the PSE, enactive mastery experience, be it mastery of proficiency or perception of mastery is important (Bandura, 1977; Williams & French, 2011). This aligns with physical literacy and the thought that movement experience drives belief to be active (Whitehead, 2001). The results of the current studies mediation model go some way to explaining that, not only development of FMS, but how children perceive their proficiency in FMS as significant to children's belief and PA participation. The theme throughout chapter 3 and 4 centres on understanding how FMS associates with self-efficacy and motivation. Notably chapter 4 aligns FMS proficiency with FMS perceived ability in an effort to capture movement experience more broadly, and investigate how this impacts children's PA.

Previous research has provided an overall picture of PA determinants and their relationship with children's PA (Bauman et al., 2012; Cortis et al., 2017). With this in mind, it is still unclear why some children are more physically active than others. Chapters 3 and 4 have looked to explain relationships between PA determinants as framed by physical literacy, but this approach provides very little specificity, as entire samples are described together. Hence, chapter 5 looked to interpret why some children are more physically active through a person-centred approach to understanding physical literacy. Chapter 5 used cluster analysis to identify four physical literacy-based profiles: two groups were characterized by corresponding levels of physical literacy components. The purpose of this was to identify groups of children who share similar physical literacy components and investigate how this impacts their PA participation levels. The corresponding levels of physical literacy components (e.g. high in all) support previous variable-centred approaches, in that good scores across the components generally equate to increased PA levels, and vice versa for poor scores. Of particular interest are the two groups with dissonant levels of physical literacy, the groups that despite displaying differing physical literacy component scores share similar physical activity levels. When contemplating the dissonant physical literacy-based profiles and comparing them to normative values (Issartel et al., Appendix), it is interesting to consider how positive scores in one domain (such as competence for example) can increase PA levels. Clearly interventions should be striving to develop all physical literacy components and have all children achieve their full potential. If the 'high' cluster (high on all PL components measured) has significantly higher PA than the other three clusters, envisage the health benefits if all children were reaching physical literacy levels of the top 10% (Issartel et al., Appendix). The physical literacy profiles emphasise the need for interventions that consider differentiation when trying to promote PA. To achieve such an outcome will require successful integration and alignment of the curriculum, teaching and learning, and assessment; consideration of these pedagogical aspects is essential to support physical literacy and promote physical activity.

The Moving Well-Being Well (MWBW) intervention outlined in chapter 6, took the aforementioned pedagogical aspects into consideration. The overall intervention is made up of multiple components, including teacher training, active classrooms and external provider components. The purpose of this study was to explore the impact of a professional development programme, as part of the multi component school-based intervention, on physical literacy of children. Utilising the Gaelic Athletic Association (GAA), one of the largest external providers in the primary physical education space in Ireland, the professional development programme used GAA coaches to administer 'on-the-job' professional development to generalist primary classroom teachers. The focus of the programme was delivering differentiated teaching to target fostering autonomous motivation and PSE toward PA via positive movement experience. There were significant improvements in FMS over time for both school settings, the extent of change for the intervention group was markedly greater and was matched with an increase in PSE. it is hypothesised that by providing positive movement experiences that suited the children's interests and ability, the intervention may have remediated the self-belief issues that have been identified in primary school children in previous research (Cairney et al., 2012); this supports the effectiveness the MWBW intervention. Autonomous motivation, however, did not significantly increase across the intervention or at follow-up. This intervention perhaps isolated competence support, as the delivery focused on feedback and skill belief. Ryan and Deci (2000) maintain that the support of all three needs, autonomy, related and competence is required in order to shift from controlled to more autonomous motivation. This school-based professional development programme demonstrates the impact collaboration between teacher and external provider can have on children's movement experience and physical literacy.

Research Strengths

This thesis explored numerous physical activity determinants through the lens of physical literacy. Findings increase awareness and address gaps that exist between theory and practice. That is to say, the thesis contributes to our understanding of why some children are physically active while others are not, and how the different physical literacy components connect to promote PA. Understanding the relationship between determinants of PA adds to the existing literature, as we look to build a detailed representation of children and their PA behaviours.

A pragmatic approach to physical literacy strengthens our understanding as measures that are valid and reliable, but also compatible with the theory of physical literacy, provides a comprehensive evidence base as a starting point from which to consider intervention programmes. A major strength of this study was the large cross-sectional data set (n= 860) that encompassed almost the complete primary school age cohort. Additionally, while analysing physical literacy as a construct is complex, a significant strength throughout the thesis is the statistical analyses employed.

Research Limitations

The main limitation of this thesis is the linear approach to physical literacy, in that such an approach does not always account for the complexity of the interaction between the various components of physical literacy (Edwards et al., 2018). Future research and analysis should look to capture all components of physical literacy. Furthermore, measuring the social factors, and basic psychological needs, that contribute to these physical literacy components would expand knowledge as we look to further understand children's behaviour. With this in mind, the samples used in the studies described in chapters 3-5, while large, are cross-sectional, and as such cannot be used to confirm causal behaviour. Future longitudinal research would clarify if the results depicted here hold true over time.

Applying current measurement tools to physical literacy is problematic. The connections between FMS, FMS assessment tools, and physical literacy being one- as FMS are classified exclusively into object control skills, locomotor skills, and stability skills (Gallahue, Ozmun, & Goodway, 2011). This perspective gives the impression that all movement experiences in primary school years should be based on these three categories. Whilst important, FMS do not reflect the broad diversity of movement competency utilised in PA pursuits across the lifespan (e.g. swimming and cycling) (Hulteen, Morgan, Barnett, Stodden, & Lubans, 2018).

Future Directions for Moving Well-Being Well

The MWBW exploratory trial presented in chapter 6, supports that MWBW is an effective intervention at improving some physical literacy components (FMS and PSE) in primary school children. Future assessment and analysis should examine the interaction between all physical literacy components and how the determinants interlink to influence children's PA. Future studies building on the current iteration of MWBW would be advised to incorporate additional assessments that consider children's psychological needs as satisfying basic psychological needs is important when creating positive movement experiences, and ultimately, engagement in PA over time.

To strengthen the MWBW intervention (e.g. motivation), future studies should consider building on the findings presented here during the exploratory trial. The MWBW intervention has to date only taken place in urban schools. In order to ensure it is effective in all school types, future studies must measure its impact in all primary school settings in Ireland. The next iteration of the MWBW intervention should take into account the limitations outlined in this thesis. Future studies around the MWBW program should entail the expansion and appropriate scaling of the intervention to a randomised control trial (RCT), ensuring that robust intervention fidelity measures are implemented. In addition, a thorough process evaluation should be carried out on any future intervention, in order to make the MWBW intervention sustainable for national dissemination. An deireadh.

Reference List

Aelterman, N., Vansteenkiste, M., Keer, H. Van, Van Den Berghe, L., De Meyer, J., & Haerens, L. (2012). *Students' Objectively Measured Physical Activity Levels and Engagement as a Function of Between-Class and Between-Student Differences in Motivation Toward Physical Education*. *Jour nal of Sport & Exercise Psychology* (Vol. 34).

Allison, K. R., Dwyer, J. J. M., & Makin, S. (1999). Perceived Barriers to Physical Activity among High School Students. *Preventive Medicine*, *28*(6), 608–615. https://doi.org/10.1006/PMED.1999.0489

Ames, C. (1992). Achievement goals and the classroom motivational climate. In *Student Perceptions in the Classroom* (pp. 327–348).

Andersen, L. B., Mota, J., Di Pietro, L., Lee, I., Shiroma, E., Lobelo, F., … Andersen, L. (2016). Update on the global pandemic of physical inactivity. *The Lancet*, *388*(10051), 219–229. https://doi.org/10.1016/S0140-6736(16)30960-6

Annesi, J. J. (2006). Relations of physical self-concept and self-efficacy with frequency of voluntary physical activity in preadolescents: Implications for after-school care programming. *Journal of Psychosomatic Research*, *61*(4), 515–520. https://doi.org/10.1016/j.jpsychores.2006.04.009

Armour, K., & Yelling, M. (2004). Continuing Professional Development for Experienced Physical Education Teachers: Towards Effective Provision. *Sport, Education and Society*, *9*(1), 95–114. https://doi.org/10.1080/1357332042000175836

Asendorpf, J., Borkenau, P., Ostendorf, F., & Van Aken, M. (2001). Carving personality description at its joints: Confirmation of three replicable personality prototypes for both children and adults. *European Journal of Personality*, *15*(3), 169–198. https://doi.org/10.1002/per.408

Ashford, S., Edmunds, J., & French, D. P. (2010). What is the best way to change self-efficacy to promote lifestyle and recreational physical activity? A systematic review with meta-analysis. *British Journal of Health Psychology*, *15*(2), 265–288. https://doi.org/10.1348/135910709X461752

Babic, M., Morgan, P., Plotnikoff, R., Lonsdale, C., White, R., & Lubans, D. (2014). Physical Activity and Physical Self-Concept in Youth: Systematic Review and Meta-Analysis. *Sports Medicine*, *44*(11), 1589–1601. https://doi.org/10.1007/s40279-014-0229-z

Bagøien, T. E., & Halvari, H. (2005). Autonomous Motivation: Involvement in Physical Activity, and Perceived Sport Competence: Structural and Mediator Models. *Perceptual and Motor Skills*, *100*(1), 3–21. https://doi.org/10.2466/pms.100.1.3-21

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review*, *84*(2), 191–215. https://doi.org/10.1037/0033-295X.84.2.191

Bandura, A. (1982). *Self-efficacy mechanism in human agency. American Journal of Psychology*. https://doi.org/10.1037/0003-066X.37.2.122

Bandura, A. (1997). Self-efficacy. *Encyclopedia of Human Behavior*, *4*(1994), 1–65. https://doi.org/10.1002/9780470479216.corpsy0836

Bandura, A. (2004). Health promotion by social cognitive means. *Health Education and Behavior*. https://doi.org/10.1177/1090198104263660

Bardid, F., De Meester, A., Tallir, I., Cardon, G., Lenoir, M., & Haerens, L. (2016). Configurations of actual and perceived motor competence among children: Associations with motivation for sports and global self-worth. *Human Movement Science*, *50*, 1–9. https://doi.org/10.1016/j.humov.2016.09.001

Bardid, F., Huyben, F., Lenoir, M., Seghers, J., De Martelaer, K., Goodway, J. D., & Deconinck, F. J. A. (2016). Assessing fundamental motor skills in Belgian children aged 3-8 years highlights differences to US reference sample. *Acta Paediatrica, International Journal of Paediatrics*, *105*(6), e281–e290. https://doi.org/10.1111/apa.13380

Barnett, L. M., Stodden, D., Cohen, K. E., Smith, J. J., Lubans, D. R., Lenoir, M., … Morgan, P. J. (2016). Fundamental Movement Skills: An Important Focus. *Journal of Teaching in Physical Education*, *35*(3). https://doi.org/10.1123/jtpe.2014-0209

Barnett, L. M., van Beurden, E., Morgan, P. J., Brooks, L. O., & Beard, J. R. (2009). Childhood Motor Skill Proficiency as a Predictor of Adolescent Physical Activity. *Journal of Adolescent Health*, *44*(3), 252–259. https://doi.org/10.1016/j.jadohealth.2008.07.004

Barnett, L. M., Vazou, S., Abbott, G., Bowe, S. J., Robinson, L. E., Ridgers, N. D., & Salmon, J. (2016). Construct validity of the pictorial scale of Perceived Movement Skill Competence. *Psychology of Sport & Exercise*, *22*, 294–302. https://doi.org/10.1016/j.psychsport.2015.09.002

Barnett, L., van Beurden, E., Morgan, P., Brooks, L., & Beard, J. (2010). Longitudinal evidence for the importance of motor skill proficiency to physical activity. *Journal of Science and Medicine in Sport*, *12*, e70–e71. https://doi.org/10.1016/J.JSAMS.2009.10.145

Barnett, L, Morgan, P., Van Beurden, E., Ball, K., & Lubans, D. (2011). A Reverse Pathway? Actual and Perceived Skill Proficiency and Physical Activity. *Med Sci Sports Exerc*, *43*(5), 898–904. https://doi.org/10.1249/MSS.0b013e3181fdfadd

Barnett, Lisa, Morgan, P., van Beurden, E., & Beard, J. (2008). Perceived sports competence mediates the relationship between childhood motor skill proficiency and adolescent physical activity and fitness: A longitudinal assessment. *International Journal of Behavioral Nutrition and Physical Activity*, *5*(1), 40. https://doi.org/10.1186/1479-5868-5-40

Barnett, Lisa, Ridgers, N., Zask, A., & Salmon, J. (2015). Face validity and reliability of a pictorial instrument for assessing fundamental movement skill perceived competence in young children. *Journal of Science and Medicine in Sport*, *18*(1), 98–102. https://doi.org/10.1016/j.jsams.2013.12.004

Barnett, Lisa, Van Beurden, E., Morgan, P., Brooks, L., Beard, J., Van Beurden, E., … Beard, J. (2008). Does childhood motor skill proficiency predict adolescent fitness? *Medicine and Science in Sports and Exercise*, *40*(12), 2137–2144. https://doi.org/10.1249/MSS.0b013e31818160d3

Bartholomew, J. B., Loukas, A., Jowers, E. M., & Allua, S. (2006). Validation of the Physical Activity Self-Efficacy Scale: Testing Measurement Invariance between Hispanic and Caucasian Children. *Journal of Physical Activity and Health*, *3*(1), 70–78. https://doi.org/10.1123/jpah.3.1.70

Bauman, A. E., Reis, R. S., Sallis, J. F., Wells, J. C., Loos, R. J., Martin, B. W., … Sarmiento, O. L. (2012). Correlates of physical activity: Why are some people physically active and others not? *The Lancet*, *380*(9838), 258–271. https://doi.org/10.1016/S0140-6736(12)60735-1

Baumeister, R., Campbell, J., Krueger, J., & Vohs, K. (2003). Does High Self-Esteem Cause Better Performance, Interpersonal Success, Happiness, or Healthier Lifestyles? *Psychological science in the public interest*, *4*(1).

Beets, M., Okely, A., Weaver, R., Webster, C., Lubans, D., Brusseau, T., … Cliff, D. (2016). The theory of expanded, extended, and enhanced opportunities for youth physical activity promotion. *International Journal of Behavioral Nutrition and Physical Activity*, *13*(1), 120. https://doi.org/10.1186/s12966-016-0442-2

Behan, S., Belton, S., Peers, C., O'Connor, N. E., & Issartel, J. (2019). Moving Well-Being Well: Investigating the maturation of fundamental movement skill proficiency across sex in Irish children aged five to twelve. *Journal of Sports Sciences*, 1–9. https://doi.org/10.1080/02640414.2019.1651144

Belton, S., Issartel, J., McGrane, B., Powell, D., & O'Brien, W. (2018). The Y-PATH programme: A consideration for physical literacy in Irish youth, and implications for physical education in a changing landscape. *Irish Educational Studies*. https://doi.org/10.1080/03323315.2018.1552604

Belton, S., McCarren, A., McGrane, B., Powell, D., & Issartel, J. (2019). The Youth-Physical Activity Towards Health (Y-PATH) intervention: Results of a 24 month cluster randomised controlled trial. *PLOS ONE*, *14*(9), e0221684. https://doi.org/10.1371/journal.pone.0221684

Belton, S., O' Brien, W., Meegan, S., Woods, C., & Issartel, J. (2014). Youth-Physical Activity Towards Health: evidence and background to the development of the Y-PATH physical activity intervention for adolescents. *BMC Public Health (2014) 14(1)*, *14*(1). https://doi.org/10.1186/1471-2458-14-122

Belton, S., O'Brien, W., Mcgann, J., & Issartel, J. (2019). Bright spots physical activity investments that work: Youth-Physical Activity Towards Health (Y-PATH) BAckground To THe ProgrAmme. *Br J Sports Med*, *53*(4). https://doi.org/10.1136/bjsports-2018-099745

Bolger, L., Bolger, L., O'neill, C., & Coughlan, E. (2018). Age and Sex Differences in Fundamental Movement Skills Among a Cohort of Irish School Children Project Spraoi View project Pedagogical Cases in Physical Education and Youth Sport View project. https://doi.org/10.1123/jmld.2017-0003

Bolger, L., Bolger, L., O'Neill, C., Coughlan, E., O'Brien, W., Lacey, S., & Burns, C. (2018). Accuracy of Children's Perceived Skill Competence and its Association With Physical Activity. *Journal of Physical Activity and Health*, *16*(1), 29–36. https://doi.org/10.1123/jpah.2017-0371

Breslin, G., Murphy, M., McKee, D., Delaney, B., & Dempster, M. (2012). The effect of teachers trained in a fundamental movement skills programme on children's self-perceptions and motor competence. *European Physical Education Review*, *18*(1), 114–126. https://doi.org/10.1177/1356336X11430657

Britton, Ú., Belton, S., & Issartel, J. (2019). Small fish, big pond: The role of health-related fitness and perceived athletic competence in mediating the physical activity-motor competence relationship during the transition from primary to secondary school. *Journal of Sports Sciences*, *37*(22), 1–11. https://doi.org/10.1080/02640414.2019.1647041

Bryan, C., & Solmon, M. (2007). Self-determination in physical education: Designing class environments to promote active lifestyles. *Journal of Teaching in Physical Education*, *26*(3), 260–278. https://doi.org/10.1123/jtpe.26.3.260

Burrows, J., Keats, M., & Kolen, A. (2014). Contributions of After School Programs to the Development of Fundamental Movement Skills in Children. *International Journal of Exercise Science*, *7*(3), 236–249.

Cairney, Dudley, D., Kwan, M., Bulten, R., & Kriellaars, D. (2019). Physical Literacy, Physical Activity and Health: Toward an Evidence-Informed Conceptual Model. *Sports Medicine*. https://doi.org/10.1007/s40279-019-01063-3

Cairney, J, Veldhuizen, S., Graham, D., Rodriguez, C., Bedard, C., Bremer, E., & Kriellaars, D. (2018). A Construct Validation Study of PLAYfun. *Medicine & Science in Sports & Exercise*, *50*(4), 855–862. Retrieved from doi: 10.1249/MSS.0000000000001494.

Cairney, John, Clark, H., Dudley, D., & Kriellaars, D. (2019). Physical literacy in children and youth-a construct validation study. *Journal of Teaching in Physical Education*, *38*(2), 84–90. https://doi.org/10.1123/jtpe.2018-0270

Cairney, John, Kiez, T., Roetert, E. P., & Kriellaars, D. (2019). A 20th-Century Narrative on the Origins of the Physical Literacy Construct. *Journal of Teaching in Physical Education*, *38*(2), 79–83. https://doi.org/10.1123/jtpe.2018-0072

Cairney, Kwan, M., Velduizen, S., Hay, J., Bray, S. R., & Faught, B. E. (2012). Gender, perceived competence and the enjoyment of physical education in children: A longitudinal examination. *International Journal of Behavioral Nutrition and Physical Activity*, *9*(1), 26. https://doi.org/10.1186/1479-5868-9-26

Canadian Sport for Life Society. (2013). Physical Literacy Assessment for Youth (PLAY): Fun workbook, 44. Retrieved from http://physicalliteracy.ca/wp-content/uploads/2016/08/PLAYbasic_workbook.pdf

Cantell, M., Crawford, S. G., & (Tish) Doyle-Baker, P. K. (2008). Physical fitness and health indices in children, adolescents and adults with high or low motor competence. *Human Movement Science*, *27*(2), 344–362. https://doi.org/10.1016/j.humov.2008.02.007

Caspersen, C. J., Powell, K. E., & Christenson, G. M. (1985). Physical Activity, Exercise, and Physical Fitness: Definitions and Distinctions for Health-Related Research Synopsis. *Public Health Rep*, *100*(2), 195–202.

Caspersen, C., Powell, K., & Christenson, G. (1985). Physical activity, exercise, and physical fitness: definitions and distinctions for health-related research. *Public Health Reports (Washington, D.C. : 1974)*, *100*(2), 126–131. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/3920711

Chatzisarantis, N., & Hagger, M. (2009). Effects of an intervention based on self-determination theory on self-reported leisure-time physical activity participation. *Psychology & Health*, *24*(1), 29–48. https://doi.org/10.1080/08870440701809533

Chen, H., Dai, J., & Gao, Y. (2019). Measurement invariance and latent mean differences of the Chinese version physical activity self-efficacy scale across gender and education levels. *Journal of Sport and Health Science*, *8*(1), 46–54. https://doi.org/10.1016/J.JSHS.2017.01.004

Cliff, D. P., Okely, A. D., Morgan, P. J., Jones, R. A., Steele, J. R., & Baur, L. A. (2012). Proficiency Deficiency: Mastery of Fundamental Movement Skills and Skill Components in Overweight and Obese Children. *Obesity*, *20*(5), 1024–1033. https://doi.org/10.1038/oby.2011.241

Cliff, D. P., Okely, A. D., Smith, L. M., & McKeen, K. (2009). Relationships between Fundamental Movement Skills and Objectively Measured Physical Activity in Preschool Children. *Pediatric Exercise Science*, *21*(4), 436–449. https://doi.org/10.1123/pes.21.4.436

Cole, T., Bellizzi, M., Flegal, K., & Dietz, W. (2000). Establishing a standard definition for child overweight and obesity worldwide: International survey. *British Medical Journal*, *320*(7244), 1240–1243. Retrieved from https://www.bmj.com/content/320/7244/1240.full-text

Cools, W., Martelaer, K. De, Samaey, C., & Andries, C. (2009). Movement skill assessment of typically developing preschool children: a review of seven movement skill assessment tools. *Journal of Sports Science & Medicine*, *8*(2), 154–168. https://doi.org/10.1016/S0031-9406(05)66164-0

Corbin, C. B. (2016). Implications of Physical Literacy for Research and Practice: A Commentary. *Research Quarterly for Exercise and Sport*, *87*(1), 14–27. https://doi.org/10.1080/02701367.2016.1124722

Cortis, C., Puggina, A., Pesce, C., Aleksovska, K., Buck, C., Burns, C., … Boccia, S. (2017). Psychological determinants of physical activity across the life course: A "DEterminants of DIet and Physical ACtivity" (DEDIPAC) umbrella systematic literature review. *PLOS ONE*, *12*(8). https://doi.org/10.1371/journal.pone.0182709

Craggs, C., Corder, K., Van Sluijs, E., & Griffin, S. (2011). Determinants of change in physical activity in children and adolescents: A systematic review. *American Journal of Preventive Medicine*. https://doi.org/10.1016/j.amepre.2011.02.025

Craig, P., Dieppe, P., Macintyre, S., Michie, S., Nazareth, I., Petticrew, M., … Petticrew, M. (2008). Developing and evaluating complex interventions : new guidance. *BMJ (Clinical Research Ed.)*, *337*, a1655. https://doi.org/10.1136/bmj.a1655

Creswell, J. (2003). Creswell, J.W. (2003). Chapter One, “A Framework for Design.”

Research Design Qualitative Quantitative and Mixed Methods Approaches, 3–26. https://doi.org/10.3109/08941939.2012.723954

Cronbach LJ. (1951). Coefficient alpha and the internal structure of tests. *PSYCHOMETRIKA*, *16*(3), 297–334. https://doi.org/10.1007/BF02310555

Crutzen, R. (2010). Adding effect sizes to a systematic review on interventions for promoting physical activity among European teenagers. *International Journal of Behavioral Nutrition and Physical Activity*. https://doi.org/10.1186/1479-5868-7-29

CSPPA, Woods, C., Powell, C., Saunders, J., O'Brien, W., Murphy, M., … Belton, S. (2018). *The Children's Sport Participation and Physical Activity Study 2018*. Retrieved from https://www.sportireland.ie/Research/CSPPA Final Report.pdf

De Meester, A., Maes, J., Stodden, D., Cardon, G., Goodway, J., Lenoir, M., & Haerens, L. (2016). Identifying profiles of actual and perceived motor competence among adolescents: associations with motivation, physical activity, and sports participation. https://doi.org/10.1080/02640414.2016.1149608

De Meester, A., Stodden, D., Brian, A., True, L., Cardon, G., Tallir, I., & Haerens, L. (2016). Associations among elementary school children's actual motor competence, perceived motor competence, physical activity and BMI: A cross-sectional study. *PLoS ONE*, *11*(10), e0164600. https://doi.org/10.1371/journal.pone.0164600

De Meij, J., Chinapaw, M., Kremers, S., Van Der Wal, Jurg, M., & Van Mechelen, W. (2010). Promoting physical activity in children: The stepwise development of the primary school-based JUMP-in intervention applying the RE-AIM Evaluation framework. *British Journal of Sports Medicine*, *44*(12), 879–887.

https://doi.org/10.1136/bjsm.2008.053827

Deci, E. L., Ryan, R. M., & Williams, G. C. (1996). Need satisfaction and the self-regulation of learning. *Learning and Individual Differences*, *8*(3), 165–183. https://doi.org/10.1016/S1041-6080(96)90013-8

Deci, E., & Ryan, R. (2002). *Handbook of Self-Determination Research* (Vol. 23). University of Rochester Press.

Decker, Jonathan W., "A New Measure Of Parental Self-efficacy For Enacting Healthy Lifestyles In Their Children" (2010). Electronic Theses and Dissertations. 1523.

Deitz, J. C., Kartin, D., & Kopp, K. (2007). Review of the Bruininks-Oseretsky Test of Motor Proficiency, Second Edition (BOT-2). *Physical & Occupational Therapy In Pediatrics*, *27*(4), 87–102. https://doi.org/10.1300/J006v27n04_06

Department of Education and Skills. (2017). *DEIS Identification Process*. Retrieved from https://www.education.ie/en/Schools-Colleges/Services/DEIS-Delivering-Equality-of-Opportunity-in-Schools-/DEIS-Identification-Process.pdf

Department of Education Victoria. (1996). Fundamental Motor Skills: A Classroom Manual for Teachers. *Department of Education, Victoria*.

Department of Health. (2013). *A framework for improved health and wellbeing 2013 – 2025*. *Department of Health.* (Vol. Healthy Ir). https://doi.org/http://www.dohc.ie/publications/Healthy_Ireland_Framework.html

Department of Health. (2016). *Get Ireland Active! Journal of Physical Activity and Health* (Vol. 6). Retrieved from https://health.gov.ie/wp-content/uploads/2016/01/Get-Ireland-Active-the-National-Physical-Activity-

Plan.pdf

Dishman, R., Motl, R., Saunders, R., Felton, G., Ward, D., Dowda, M., & Pate, R. (2004). Self-efficacy partially mediates the effect of a school-based physical-activity intervention among adolescent girls. *Preventive Medicine*, *38*(5), 628–636. https://doi.org/10.1016/J.YPMED.2003.12.007

Dobbins, M., Husson, H., Decorby, K., & Larocca, R. (2013, February 28). School-based physical activity programs for promoting physical activity and fitness in children and adolescents aged 6 to 18. *Cochrane Database of Systematic Reviews*. https://doi.org/10.1002/14651858.CD007651.pub2

Dudley, D., Cairney, J., Wainwright, N., Kriellaars, D., & Mitchell, D. (2017). Critical Considerations for Physical Literacy Policy in Public Health, Recreation, Sport, and Education Agencies. *Quest*, *69*(4), 436–452. https://doi.org/10.1080/00336297.2016.1268967

Dumith, S. C., Hallal, P. C., Reis, R. S., & Kohl, H. W. (2011). Worldwide prevalence of physical inactivity and its association with human development index in 76 countries. *Preventive Medicine*, *53*(1–2), 24–28. https://doi.org/10.1016/j.ypmed.2011.02.017

Duncan, L. R., Hall, C. R., Wilson, P. M., & Jenny, O. (2010). Exercise motivation: a cross-sectional analysis examining its relationships with frequency, intensity, and duration of exercise. *International Journal of Behavioral Nutrition and Physical Activity*, *7*(1), 7. https://doi.org/10.1186/1479-5868-7-7

Dweck, C., & Leggett, E. (1988). A Social-Cognitive Approach to Motivation and Personality. *Psychological Review*, *95*(2), 256–273. https://doi.org/10.1037/0033-295X.95.2.256

Eccles, J., Adler, T., Futterman, R., Goff, S., Kaczala, C., Meece, J., & Midgley, C. (1983). Expectancies, Values, and Academic Behaviors. *Achievement and Achievement Motivation*. Freeman. https://doi.org/10.1207/s15327752jpa8502

Edmunds, J., Ntoumanis, N., & Duda, J. L. (2006). A test of self-determination theory in the exercise domain. *P*, *36*(9), 2240–2265. https://doi.org/10.1111/j.0021-9029.2006.00102.x

Education, D. of. (1999). Physical Education Primary School Curriculum Curaclam na Bunscoile.

Edward L. Deci, & Richard M. Ryan. (2000). The "What" and "Why" of Goal Pursuits: Human Needs and the Self-Determination of Behavior. *Psychological Inquiry*, *11*(4), 227–268. Retrieved from https://www.jstor.org/stable/pdf/1449618.pdf

Edwards, L. C., Bryant, A. S., Keegan, R. J., Morgan, K., Cooper, S.-M., & Jones, A. M. (2018). ‘Measuring’ Physical Literacy and Related Constructs: A Systematic Review of Empirical Findings. *Sports Medicine*, *48*(3), 659–682. https://doi.org/10.1007/s40279-017-0817-9

Edwards, L. C., Bryant, A. S., Keegan, R. J., Morgan, K., & Jones, A. M. (2017). Definitions, Foundations and Associations of Physical Literacy: A Systematic Review. *Sports Medicine*, *47*(1), 113–126. https://doi.org/10.1007/s40279-016-0560-7

Famelia, R., Tsuda, E., Bakhtiar, S., & Goodway, J. D. (2018). Relationships among perceived and actual motor skill competence and physical activity in Indonesian preschoolers. *Journal of Motor Learning and Development*, *6*(s2), S403–S423. https://doi.org/10.1123/jmld.2016-0072

Farmer, O., Belton, S., & O'Brien, W. (2017). The Relationship between Actual Fundamental Motor Skill Proficiency, Perceived Motor Skill Confidence and Competence, and Physical Activity in 8–12-Year-Old Irish Female Youth. *Sports*, *5*(4), 74. https://doi.org/10.3390/sports5040074

Field, A. (2013). *Discovering Statistics using IBM SPSS Statistics - Cluster Analysis*. *Discovering Statistics using IBM SPSS Statistics*. Sage. https://doi.org/10.1016/B978-012691360-6/50012-4

Francis, C., Longmuir, P., Boyer, C., Andersen, L., Barnes, J., Boiarskaia, E., … Tremblay, M. S. (2016). The Canadian Assessment of Physical literacy: Development of a model of children's capacity for a healthy, active lifestyle through a Delphi process. *Journal of Physical Activity and Health*, *13*(2), 214–222. https://doi.org/10.1123/jpah.2014-0597

Fransen, J., D'Hondt, E., Bourgois, J., Vaeyens, R., Philippaerts, R. M., & Lenoir, M. (2014). Motor competence assessment in children: Convergent and discriminant validity between the BOT-2 Short Form and KTK testing batteries. *Research in Developmental Disabilities*, *35*(6), 1375–1383. https://doi.org/10.1016/j.ridd.2014.03.011

Fundamental Motor Skills: A Manual for Classroom Teachers. (1996). State of Victoria.

Gabbard, C. (2011). *Lifelong Motor Development*.

Gagen, L. M., & Getchell, N. (2006). Using 'Constraints' to Design Developmentally Appropriate Movement Activities for Early Childhood Education. *Early Childhood Education Journal*, *34*(3), 227–232. https://doi.org/10.1007/s10643-006-0135-6

Gallahue, Ozmun, & Goodway. (2011). *Understanding Motor Development: Infants,* *Children, Adolescents, Adults*. Retrieved from https://jms4p0pil01.storage.googleapis.com/MDA3MTI0NDQ0MQ==01.pdf

Gao, Z., Zhang, T., & Stodden, D. (2013). Children's physical activity levels and psychological correlates in interactive dance versus aerobic dance. *Journal of Sport and Health Science*, *2*(3), 146–151. https://doi.org/10.1016/j.jshs.2013.01.005

Garcia, A., Pender, N., Antonakos, C., & Ronis, D. (1998). Changes in Physical Activity Beliefs and Behaviors of Boys and Girls Across the Transition to Junior High School. *Journal of Adolescent Health*, *22*(5), 394–402. https://doi.org/10.1016/S1054-139X(97)00259-0

Gibbs, G., & Simpson, C. (2004). Learning and Teaching in Higher Education. *Learning and Teaching in Higher Education*, *1*(1), 3–130. https://doi.org/10.1080/03075079812331380502

Giblin, S., Collins, D., & Button, C. (2014, September 5). Physical literacy: Importance, assessment and future directions. *Sports Medicine*. https://doi.org/10.1007/s40279-014-0205-7

Gillison, F., Osborn, M., Standage, M., & Skevington, S. (2009). Exploring the experience of introjected regulation for exercise across gender in adolescence. *Psychology of Sport and Exercise*, *10*(3), 309–319. https://doi.org/10.1016/j.psychsport.2008.10.004

Gillison, F., Standage, M., & Skevington, S. (2011). Motivation and Body-Related Factors as Discriminators of Change in Adolescents' Exercise Behavior Profiles. *Journal of Adolescent Health*, *48*(1), 44–51. https://doi.org/10.1016/J.JADOHEALTH.2010.05.006

Goh, T., Hannon, J., Webster, C., Podlog, L., Brusseau, T., & Newton, M. (2014).

Effects of a classroom-based physical activity program on children's physical activity levels. *Journal of Teaching in Physical Education*, *33*(4), 558–572. https://doi.org/10.1123/jtpe.2014-0068

Goodway, J. D., Robinson, L. E., & Crowe, H. (2010). Gender Differences in Fundamental Motor Skill Development in Disadvantaged Preschoolers From Two Geographical Regions. *Research Quarterly for Exercise and Sport*, *81*(1), 17–24. https://doi.org/10.1080/02701367.2010.10599624

Grolnick, W. S., & Ryan, R. M. (1987). Autonomy in Children's Learning: An Experimental and Individual Difference Investigation. *Journal of Personality and Social Psychology*, *52*(5), 890–898. https://doi.org/10.1037/0022-3514.52.5.890

Guay, F., Chanal, J., Ratelle, C. F., Marsh, H., Larose, S., & Boivin, M. (2010). Intrinsic, identified, and controlled types of motivation for school subjects in young elementary school children. *British Journal of Educational Psychology*, *80*(4), 711–735. https://doi.org/10.1348/000709910X499084

Gunnell, K., Longmuir, P., Woodruff, S., Barnes, J., Belanger, K., & Tremblay, M. (2018). Revising the motivation and confidence domain of the Canadian assessment of physical literacy. *BMC Public Health*, *18*(S2), 1045. https://doi.org/10.1186/s12889-018-5900-0

Hagger, M., & Chatzisarantis, N. (2008). Self-determination Theory and the psychology of exercise. *International Review of Sport and Exercise Psychology*, *1*(1), 79–103. https://doi.org/10.1080/17509840701827437

Hagger, M., Chatzisarantis, N. L. D., Hein, V., Soós, I., Karsai, I., Lintunen, T., & Leemans, S. (2009). Teacher, peer and parent autonomy support in physical education and leisure-time physical activity: A trans-contextual model of motivation in four nations. *Psychology & Health*, *24*(6), 689–711. https://doi.org/10.1080/08870440801956192

HARDY, L. L., BARNETT, L., ESPINEL, P., & OKELY, A. D. (2013). Thirteen-Year Trends in Child and Adolescent Fundamental Movement Skills. *Medicine & Science in Sports & Exercise*, *45*(10), 1965–1970. https://doi.org/10.1249/MSS.0b013e318295a9fc

Hardy, L. L., King, L., Farrell, L., Macniven, R., & Howlett, S. (2010). Fundamental movement skills among Australian preschool children. *Journal of Science and Medicine in Sport*, *13*(5), 503–508. https://doi.org/10.1016/j.jsams.2009.05.010

Harris, J., Cale, L., & Musson, H. (2012). The predicament of primary physical education: A consequence of “insufficient” ITT and “ineffective” CPD? *Physical Education and Sport Pedagogy*, *17*(4), 367–381. https://doi.org/10.1080/17408989.2011.582489

Harter, S. (1999). *The construction of the self: A developmental perspective.* New York: Guildford Press. Retrieved from https://psycnet.apa.org/record/1999-02441-000

Harter, Susan. (1982). The Perceived Competence Scale for Children. *Child Development*, *53*(1), 87. https://doi.org/10.2307/1129640

Harter, Susan, & Pike, R. (1984). The Pictorial Scale of Perceived Competence and Social Acceptance for Young Children. *Child Development*, *55*(6), 1969–1982. https://doi.org/136.206.121.217

Haskell, W., Lee, I. M., Pate, R., Powell, K., Blair, S., Franklin, B., … Bauman, A. (2007, August). Physical activity and public health: Updated recommendation for adults from the American College of Sports Medicine and the American Heart Association. *Medicine and Science in Sports and Exercise*.

https://doi.org/10.1249/mss.0b013e3180616b27

Hayes, A. (2013). Introduction to Mediation, Moderation, and Conditional Process Analysis: A Regression-Based Approach. New York, NY: The Guilford Press. *Journal of Educational Measurement*, *51*(3), 335–337. https://doi.org/10.1111/jedm.12050

Heath, G. W., Parra, D. C., Sarmiento, O. L., Andersen, L. B., Owen, N., Goenka, S., … Wells, J. C. (2012). Evidence-based intervention in physical activity: Lessons from around the world. *The Lancet*, *380*(9838), 272–281. https://doi.org/10.1016/S0140-6736(12)60816-2

Hidding, L., Chinapaw, M., van Poppel, M., Mokkink, L., & Altenburg, T. (2018). An Updated Systematic Review of Childhood Physical Activity Questionnaires. *Sports Medicine*, *48*(12), 2797–2842. https://doi.org/10.1007/s40279-018-0987-0

Hidi, S. (1990). Interest and Its Contribution as a Mental Resource for Learning. *Review of Educational Research*, *60*(4), 549–571. https://doi.org/10.3102/00346543060004549

Higgs, C. (2010). Physical literacy–Two approaches, one concept. *Quest*. Retrieved from http://search.proquest.com/openview/f7faef2c15ec6497c69070dd9c45c9a7/1?pq-origsite=gscholar&cbl=42913

Hulteen, R., Morgan, P., Barnett, L., Stodden, D., & Lubans, D. (2018). Development of Foundational Movement Skills: A Conceptual Model for Physical Activity Across the Lifespan. *Sports Medicine*, *48*(7), 1533–1540. https://doi.org/10.1007/s40279-018-0892-6

Jaakkola, T, Yli-Piipari, S., Huotari, P., Watt, A., & Liukkonen, J. (2016). Fundamental movement skills and physical fitness as predictors of physical activity: A 6-year follow-up study. *Scandinavian Journal of Medicine & Science in Sports*, *26*(1), 74–81. https://doi.org/10.1111/sms.12407

Jaakkola, Timo, Huhtiniemi, M., Salin, K., Seppälä, S., Lahti, J., Hakonen, H., & Stodden, D. F. (2019). Motor competence, perceived physical competence, physical fitness, and physical activity within Finnish children, *29*(7), 1013–1021. https://doi.org/10.1111/sms.13412

Jaakkola, Timo, & Washington, T. (2013). The relationship between fundamental movement skills and self-reported physical activity during Finnish junior high school. *Physical Education & Sport Pedagogy*, *18*(5), 492–505. https://doi.org/10.1080/17408989.2012.690386

Jain, A., Murty, M., & Flynn, P. (2000). *Data Clustering: A Review*. Retrieved from http://eprints.iisc.ernet.in/273/1/p264-jain.pdf

Janz, K., Dawson, J., & Mahoney, L. Tracking physical fitness and physical activity from childhood to adolescence: the Muscatine study, 32 § (2000). https://doi.org/10.1097/00005768-200007000-00011

Jess, M., McEvilly, N., & Carse, N. (2017). Moving primary physical education forward: start at the beginning. *Education 3-13*, *45*(5), 645–657. https://doi.org/10.1080/03004279.2016.1155072

Kalaja, S., Jaakkola, T., Watt, A., Liukkonen, J., & Ommundsen, Y. (2010). European Physical Education Review European Physical Education Review On behalf of: North West Counties Physical Education Association can be found at: European Physical Education Review Additional services and information for. https://doi.org/10.1177/1356336X09364714

Kaldor, A., & Deutsch, J. (2013). Making a Case for Having a Physical Education Specialist. *Strategies*, *26*(6), 9–12. https://doi.org/10.1080/08924562.2013.839426

Keane, E., Kearney, P. M., Perry, I. J., Browne, G. M., & Harrington, J. M. (2014). Diet, Physical Activity, Lifestyle Behaviors, and Prevalence of Childhood Obesity in Irish Children: The Cork Children's Lifestyle Study Protocol. *JMIR Research Protocols*, *3*(3), e44. https://doi.org/10.2196/resprot.3140

Kelly, L., O'Connor, S., Harrison, A. J., & Ní Chéilleachair, N. J. (2018). Does fundamental movement skill proficiency vary by sex, class group or weight status? Evidence from an Irish primary school setting. *Journal of Sports Sciences*, 1–9. https://doi.org/10.1080/02640414.2018.1543833

Khodaverdi, Z., Bahram, A., Stodden, D., & Kazemnejad, A. (2016). The relationship between actual motor competence and physical activity in children: mediating roles of perceived motor competence and health-related physical fitness. *Journal of Sports Sciences*, *34*(16), 1523–1529. https://doi.org/10.1080/02640414.2015.1122202

Kilborn, M., Lorusso, J., & Francis, N. (2016). An analysis of Canadian physical education curricula. *European Physical Education Review*, *22*(1), 23–46. https://doi.org/10.1177/1356336X15586909

Kriellaars, D., Cairney, J., Bortoleto, M., Kiez, T., Dudley, D., & Aubertin, P. (2019). The Impact of Circus Arts Instruction in Physical Education on the Physical Literacy of Children in Grades 4 and 5. https://doi.org/10.1123/jtpe.2018-0269

Kriemler, S., Meyer, U., Martin, E., Van Sluijs, E., Andersen, L., & Martin, B. (2011). Effect of school-based interventions on physical activity and fitness in children and adolescents: A review of reviews and systematic update. *British Journal of Sports*

Medicine, *45*(11), 923–930. https://doi.org/10.1136/bjsports-2011-090186

Langford, R., Bonell, C., Jones, H., Pouliou, T., Murphy, S., Waters, E., … Campbell, R. (2015). The World Health Organization's Health Promoting Schools framework: a Cochrane systematic review and meta-analysis. *BMC Public Health*, *15*(1), 130. https://doi.org/10.1186/s12889-015-1360-y

LeGear, M., Greyling, L., Sloan, E., Bell, R. I., Williams, B.-L., Naylor, P.-J., & Temple, V. A. (2012). A window of opportunity? Motor skills and perceptions of competence of children in Kindergarten. *International Journal of Behavioral Nutrition and Physical Activity*, *9*(1), 29. https://doi.org/10.1186/1479-5868-9-29

Lewis, B. A., Marcus, B. H., Pate, R. R., & Dunn, A. L. (2002). Psychosocial mediators of physical activity behavior among adults and children. *American Journal of Preventive Medicine*, *23*(2 Suppl), 26–35. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/12133735

Liong, G. H. E., Ridgers, N. D., & Barnett, L. M. (2015). Associations between Skill Perceptions and Young Children's Actual Fundamental Movement Skills. *Perceptual and Motor Skills*, *120*(2), 591–603. https://doi.org/10.2466/10.25.PMS.120v18x2

Logan, S. W., Barnett, L. M., Goodway, J. D., & Stodden, D. F. (2017). Comparison of performance on process- and product-oriented assessments of fundamental motor skills across childhood. *Journal of Sports Sciences*, *35*(7). https://doi.org/10.1080/02640414.2016.1183803

Logan, S. W., Ross, S. M., Chee, K., Stodden, D. F., & Robinson, L. E. (2018). Fundamental motor skills: A systematic review of terminology. *Journal of Sports Sciences*, *36*(7), 781–796. https://doi.org/10.1080/02640414.2017.1340660

Logan, S., Webster, K., Getchell, N., Pfeiffer, K., & Robinson, L. (2015). Relationship Between Fundamental Motor Skill Competence and Physical Activity During Childhood and Adolescence: A Systematic Review. *Kinesiology Review*, *4*(4), 416–426. https://doi.org/10.1123/kr.2013-0012

Longmuir, P., Boyer, C., Lloyd, M., Yang, Y., Boiarskaia, E., Zhu, W., & Tremblay, M. (2015). The Canadian Assessment of Physical Literacy: Methods for children in grades 4 to 6 (8 to 12 years). *BMC Public Health*, *15*(1), 767. https://doi.org/10.1186/s12889-015-2106-6

Lonsdale, C., Sabiston, C. M., Raedeke, T. D., Ha, A. S. C., & Sum, R. K. W. (2009). Self-determined motivation and students' physical activity during structured physical education lessons and free choice periods. *Preventive Medicine*, *48*(1), 69–73. https://doi.org/10.1016/J.YPMED.2008.09.013

Lopes, V., Barnett, L., Saraiva, L., Gonçalves, C., Bowe, S., Abbott, G., & Rodrigues, L. (2016). Validity and reliability of a pictorial instrument for assessing perceived motor competence in Portuguese children. *Child: Care, Health and Development*, *42*(5), 666–674. https://doi.org/10.1111/cch.12359

Lopes, V. P., Rodrigues, L. P., Maia, J. A. R., & Malina, R. M. (2011). Motor coordination as predictor of physical activity in childhood. *Scandinavian Journal of Medicine & Science in Sports*, *21*(5), 663–669. https://doi.org/10.1111/j.1600-0838.2009.01027.x

Lubans, D., Morgan, P., Cliff, D., Barnett, L., & Okely, A. (2010). Fundamental movement skills in children and adolescents: review of associated health benefits. *Sports Medicine (Auckland, N.Z.)*, *40*(12), 1019–1035. https://doi.org/10.2165/11536850-000000000-00000

Lubans, D. R., Foster, C., & Biddle, S. J. H. (2008). A review of mediators of behavior in interventions to promote physical activity among children and adolescents. *Preventive Medicine*, *47*(5), 463–470. https://doi.org/10.1016/J.YPMED.2008.07.011

Lucertini, F., Spazzafumo, L., de Lillo, F., Centonze, D., Valentini, M., & Federici, A. (2013). Effectiveness of professionally-guided physical education on fitness outcomes of primary school children. *European Journal of Sport Science*, *13*(5), 582–590. https://doi.org/10.1080/17461391.2012.746732

MacCallum, R., Widaman, K., Zhang, S., & Hong, S. (1999). Sample size in factor analysis. *Psychological Methods*, *4*(1), 84–99. https://doi.org/10.1037/1082-989X.4.1.84

Maeng, H. J., Webster, E. K., & Ulrich, D. (2017). Reliability for the Test of Gross Motor Development-Third Edition (TGMD-3). *Research Quarterly for Exercise and Sport*, *87*.

Mandigo, J., Francis, N., Lodewyk, K., & Lopez, R. (2009). Physical Literacy for Educators. *Sport Research Intelligence Sportive*, 27–30. https://doi.org/http://books.scholarsportal.info/viewdoc.html?id=678422

Mandigo, J., Holt, N., Anderson, A., & Sheppard, J. (2008). Children's motivational experiences following autonomy-supportive games lessons. *European Physical Education Review*, *14*(3), 407–425. https://doi.org/10.1177/1356336X08095673

Martin, E., Rudisill, M., & Hastie, P. (2009). Motivational climate and fundamental motor skill performance in a naturalistic physical education setting. *Physical Education & Sport Pedagogy*, *14*(3), 227–240. https://doi.org/10.1080/17408980801974952

Martin, R., & Murtagh, E. (2015). Preliminary findings of Active Classrooms: An intervention to increase physical activity levels of primary school children during class time. *Teaching and Teacher Education*, *52*, 113–127. https://doi.org/10.1016/j.tate.2015.09.007

McAuley, E. (1993). Self-efficacy and the maintenance of exercise participation in older adults. *Journal of Behavioral Medicine, 16*(1), 103-113.

Mcauley, E., & Blissmer, B. (2000). Self-efficacy determinants and consequences of physical activity. *Exercise and Sport Sciences Reviews*, *28*(May), 85–88. https://doi.org/0091-6631/2802/85-88

McAuley, E., Konopack, J., Motl, R., Morris, K., Doerksen, S., & Rosengren, K. (2006). Physical activity and quality of life in older adults: Influence of health status and self-efficacy. *Annals of Behavioral Medicine*, *31*(1), 99–103. https://doi.org/10.1207/s15324796abm3101_14

McGrane, B., Belton, S., Fairclough, S., Powell, D., & Issartel, J. (2018). Outcomes of the Y-PATH randomized controlled trial: Can a school-based intervention improve fundamental movement skill proficiency in adolescent youth? *Journal of Physical Activity and Health*, *15*(2), 89–98. https://doi.org/10.1123/jpah.2016-0474

McGrane, B., Belton, S., Powell, D., & Issartel, J. (2017). The relationship between fundamental movement skill proficiency and physical self-confidence among adolescents. *Journal of Sports Sciences*, *35*(17), 1709–1714. https://doi.org/10.1080/02640414.2016.1235280

McKee, M., Breslin, G., Haughey, T., & Donnelly, P. (2013). Research Assessing Physical Literacy in Northern Ireland. *Journal of Sport Science and Physical Education*, *65*, 284–289. Retrieved from http://uir.ulster.ac.uk/28780/

McKenzie, T., Alcaraz, J., Sallis, J., & Faucette, N. (1998). Effects of a physical education program on children's manipulative skills. *Journal of Teaching in Physical Education*, *17*(3), 327–341. https://doi.org/10.1123/jtpe.17.3.327

McKenzie, T. L., Sallis, J. F., & Rosengard, P. (2009). Beyond the Stucco Tower: Design, Development, and Dissemination of the SPARK Physical Education Programs. *Quest*, *61*(1), 114–127. https://doi.org/10.1080/00336297.2009.10483606

McLennan, Nancy, Thompson, & Jannine. (2015). *QUALITY PHYSICAL EDUCATION (QPE) GUIDELINES FOR POLICY-MAKERS Social and Human Sciences Sector United Nations Educational, Scientific and Cultural Organization*. Retrieved from http://www.unesco.org/open-access/

Metcalf, B., Henley, W., & Wilkin, T. (2012). Effectiveness of intervention on physical activity of children: systematic review and meta-analysis of controlled trials with objectively measured outcomes (EarlyBird 54). *BMJ (Clinical Research Ed.)*, *345*, e5888. https://doi.org/10.1136/bmj.e5888

Michie, S., & Abraham, C. (2004). Interventions to change health behaviours: evidence-based or evidence-inspired? *Psychology & Health*, *19*(1), 29–49. https://doi.org/10.1080/0887044031000141199

Michie, S., van Stralen, M., & West, R. (2011). The behaviour change wheel: A new method for characterising and designing behaviour change interventions. *Implementation Science*, *6*(1), 42. https://doi.org/10.1186/1748-5908-6-42

Miller, J., Vine, K., & Larkin, D. (2007). The Relationship of Process and Product Performance of the Two-Handed Sidearm Strike. *Physical Education and Sport Pedagogy*, *12*(1), 61–76. Retrieved from https://www.learntechlib.org/p/101864/

Morgan, P., Barnett, L., Cliff, D., Okely, A., Scott, H., Cohen, K., & Lubans, D. (2013). Fundamental Movement Skill Interventions in Youth: A Systematic Review and Meta-analysis. *Pediatrics*, *132*(5), e1361–e1383. https://doi.org/10.1542/PEDS.2013-1167

Motl, R. W., Dishman, R. K., Trost, S. G., Saunders, R. P., Dowda, M., Felton, G., … Pate, R. R. (2000). Factorial Validity and Invariance of Questionnaires Measuring Social-Cognitive Determinants of Physical Activity among Adolescent Girls. *Preventive Medicine*, *31*(5), 584–594. https://doi.org/10.1006/PMED.2000.0735

Mullan, E., Markland, D., & Ingledew, D. K. (1997). A graded conceptualisation of self-determination in the regulation of exercise behaviour: Development of a measure using confirmatory factor analytic procedures. *Personality and Individual Differences*, *23*(5), 745–752. https://doi.org/10.1016/S0191-8869(97)00107-4

Murcia, J., Lacárcel, J., & Álvarez, F. (2010). Search for autonomy in motor task learning in physical education university students. *European Journal of Psychology of Education*, *25*(1), 37–47. https://doi.org/10.1007/s10212-009-0008-7

Murillo Pardo, B., Bengoechea, E. G., Lanaspa, E. G., Bush, P. L., Casterad, J. Z., Julián Clemente, J. A., & González, L. G. (2013, June 1). Promising school-based strategies and intervention guidelines to increase physical activity of adolescents. *Health Education Research*. https://doi.org/10.1093/her/cyt040

Murphy, M. H., Rowe, D. A., & Woods, C. B. (2016). Sports Participation in Youth as a Predictor of Physical Activity: A 5-Year Longitudinal Study. *Journal of Physical Activity and Health*, *13*(7), 704–711. https://doi.org/10.1123/jpah.2015-0526

Murphy, M., Rowe, D. A., Belton, S., & Woods, C. (2015). Validity of a two-item physical activity questionnaire for assessing attainment of physical activity guidelines in youth. *BMC Public Health*, *15*(1), 1080. https://doi.org/10.1186/s12889-015-2418-6

Newell, K. M. (1991). *MOTOR SKILL ACQUISITION. Annu. Rev. Psychol* (Vol. 42). Retrieved from www.annualreviews.org/aronline

Ng, J. Y. Y., Ntoumanis, N., Thøgersen-Ntoumani, C., Deci, E. L., Ryan, R. M., Duda, J. L., & Williams, G. C. (2012). Self-Determination Theory Applied to Health Contexts: A Meta-Analysis. *Perspectives on Psychological Science*, *7*(4), 325–340. https://doi.org/10.1177/1745691612447309

Nicholls, J. (1984). Achievement motivation: Conceptions of ability, subjective experience, task choice, and performance. *Psychological Review*, *91*(3), 328–346. Retrieved from https://psycnet.apa.org/record/1984-28719-001

Noar, S., & Zimmerman, R. (2005, June 1). Health Behavior Theory and cumulative knowledge regarding health behaviors: Are we moving in the right direction? *Health Education Research*. https://doi.org/10.1093/her/cyg113

Ntoumanis, N. (2001). A self-determination approach to the understanding of motivation in physical education. *British Journal of Educational Psychology*, *71*(2), 225–242. https://doi.org/10.1348/000709901158497

O' Brien, W., Belton, S., & Issartel, J. (2016). Fundamental movement skill proficiency amongst adolescent youth. *Physical Education and Sport Pedagogy*, *21*(6), 557–571. https://doi.org/10.1080/17408989.2015.1017451

O' Brien, W., Issartel, J., & Belton, S. (2013). Evidence for the Efficacy of the Youth-Physical Activity towards Health (Y-PATH) Intervention. *Advances in Physical Education*, *03*(04), 145–153. https://doi.org/10.4236/ape.2013.34024

O'Brien, W., Belton, S., & Issartel, J. (2015). Promoting physical literacy in Irish adolescent youth: the Youth-Physical Activity Towards Health (Y-PATH) intervention. *MOJ Public Health*, *2*(6), 41. https://doi.org/10.15406/mojph.2015.02.00041

O'Loughlin, J., Paradis, G., Kishchuk, N., Barnett, T., & Renaud, L. (1999). Prevalence and correlates of physical activity behaviors among elementary schoolchildren in multiethnic, low income, inner-city neighborhoods in Montreal, Canada. *Annals of Epidemiology*, *9*(7), 397–407. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/10501407

Okely, A., Booth, M., & Patterson, J. (2001). Relationship of physical activity to fundamental movement skills among adolescents, *33*(11). https://doi.org/10.1097/00005768-200111000-00015

Owen, K., Smith, J., Lubans, D. R., Ng, J. Y. Y., & Lonsdale, C. (2014). Self-determined motivation and physical activity in children and adolescents: A systematic review and meta-analysis. *Preventive Medicine*, *67*, 270–279. https://doi.org/10.1016/J.YPMED.2014.07.033

Paechter, C. (2003). Power, Bodies and Identity: How different forms of physical education construct varying masculinities and femininities in secondary schools. *Sex Education*, *3*(1), 47–59. https://doi.org/10.1080/1468181032000052153

Pesce, C., Masci, I., Marchetti, R., Vannozzi, G., & Schmidt, M. (2018). When children's perceived and actual motor competence mismatch: Sport participation and gender differences. *Journal of Motor Learning and Development*, *6*(s2), S440–S460. https://doi.org/10.1123/jmld.2016-0081

Planinšec, J., & Fošnarič, S. (2005). Relationship of Perceived Physical Self-Concept and Physical Activity Level and Sex among Young Children. *Perceptual and Motor Skills*, *100*(2), 349–353. https://doi.org/10.2466/pms.100.2.349-353

Plumert, J. (1995). Relations Between Children's Overestimation of Their Physical Abilities and Accident Proneness. *Developmental Psychology*, *31*(5), 866–876. https://doi.org/10.1037/0012-1649.31.5.866

Prochaska, J. J., Sallis, J. F., & Long, B. (2001). A physical activity screening measure for use with adolescents in primary care. *Archives of Pediatrics and Adolescent Medicine*, *155*(5), 554–559. https://doi.org/10.1001/archpedi.155.5.554

Prochaska, J., Sallis, J., Slymen, D., & McKenzie, T. (2003). A longitudinal study of children's enjoyment of physical education. *Pediatric Exercise Science*, *15*(2), 170–178. https://doi.org/10.1123/pes.15.2.170

Raudsepp, L., Liblik, R., & Hannus, A. (2002). Children's and Adolescents' Physical Self-Perceptions as Related to Moderate to Vigorous Physical Activity and Physical Fitness. *Pediatric Exercise Science*, *14*, 97–106.

Rintala, P., Sääkslahti, A., & Iivonen, S. (2017). Reliability Assessment of Scores From Video-Recorded TGMD-3 Performances. *Journal of Motor Learning and Development*, *5*(1), 59–68. https://doi.org/10.1123/jmld.2016-0007

Roberton, M. A., & Konczak, J. (2001). Predicting children's overarm throw ball velocities from their developmental levels in throwing. *Research Quarterly for Exercise and Sport*, *72*(2), 91–103. https://doi.org/10.1080/02701367.2001.10608939

Robinson, D. B., & Randall, L. (2017). Marking Physical Literacy or Missing the Mark on Physical Literacy? A Conceptual Critique of Canada's Physical Literacy Assessment Instruments. *Measurement in Physical Education and Exercise*

Science, *21*(1), 40–55. https://doi.org/10.1080/1091367X.2016.1249793

Robinson, L. E., Stodden, D. F., Barnett, L. M., Lopes, V. P., Logan, S. W., Rodrigues, L. P., & D'Hondt, E. (2015). Motor Competence and its Effect on Positive Developmental Trajectories of Health. *Sports Medicine*, *45*(9), 1273–1284. https://doi.org/10.1007/s40279-015-0351-6

Roetert, P. (2013). Physical literacy in the United States. In *Physical Literacy across the World* (pp. 200–214). https://doi.org/10.4324/9780203702697-14

Rowe, D., & Murtagh, S. (2012). *The FifeActive Study. Physical activity participation in Fife school children: Research report of current levels, modes, contexts, preferences and determinants*. Retrieved from https://www.researchgate.net/publication/259398343

Rudd, J. R., Barnett, L. M., Butson, M. L., Farrow, D., Berry, J., & Polman, R. C. J. (2015). Fundamental Movement Skills Are More than Run, Throw and Catch: The Role of Stability Skills. *PloS One*, *10*(10), e0140224. https://doi.org/10.1371/journal.pone.0140224

Ryan, R. M., & Deci, E. L. (2000). Intrinsic and Extrinsic Motivations: Classic Definitions and New Directions. *Contemporary Educational Psychology*, *25*(1), 54–67. https://doi.org/10.1006/ceps.1999.1020

Sallis, J. F., Prochaska, J. J., & Taylor, W. C. (2000). A review of correlates of physical activity of children and adolescents. *Medicine and Science in Sports and Exercise*, *32*(5), 963–975. Retrieved from http://www.msse.org

Sallis, J, McKenzie, T., Alcaraz, J., Kolody, B., Faucette, N., & Hovell, M. (1997). The effects of a 2-year physical education program (SPARK) on physical activity and fitness in elementary school students. Sports, Play and Active Recreation for Kids.

American Journal of Public Health, *87*(8), 1328–1334. https://doi.org/10.2105/ajph.87.8.1328

Sallis, James, & Saelens, B. (2000). Assessment of physical activity by self-report: Status, limitations, and future directions. *Research Quarterly for Exercise and Sport*, *71*, 1–14. https://doi.org/10.1080/02701367.2000.11082780

Salmon, J., Booth, M., Phongsavan, P., Murphy, N., & Timperio, A. (2007). Promoting physical activity participation among children and adolescents. *Epidemiologic Reviews*. https://doi.org/10.1093/epirev/mxm010

Saunders, R. P., Pate, R. R., Felton, G., Dowda, M., Weinrich, M. C., Ward, D. S., … Baranowski, T. (1997). Development of Questionnaires to Measure Psychosocial Influences on Children's Physical Activity. *Preventive Medicine*, *26*(2), 241–247. https://doi.org/10.1006/PMED.1996.0134

Schmidt, M., Valkanover, S., Roebers, C., & Conzelmann, A. (2013). Promoting a functional physical self-concept in physical education: Evaluation of a 10-week intervention. *European Physical Education Review*, *19*(2), 232–255. https://doi.org/10.1177/1356336X13486057

Sebire, S. J., Jago, R., Fox, K. R., Edwards, M. J., & Thompson, J. L. (2013). Testing a self-determination theory model of children's physical activity motivation: a cross-sectional study. *British Journal of Educational Psychology*. https://doi.org/10.1186/1479-5868-10-111

SG, T., RR, P., DS, W., Saunders, R., & Riner, W. (1999). Research papers. Determinants of physical activity in active and low-active, sixth grade African-American youth. *Journal of School Health*, *69*(1), 29–34. https://doi.org/10.1111/j.1746-1561.1999.tb02340.x

Shearer, C., Goss, H. R., Edwards, L. C., Keegan, R. J., Knowles, Z. R., Boddy, L. M., … Foweather, L. (2018). How is Physical Literacy Defined? A Contemporary Update. *Journal of Teaching in Physical Education*, *37*(3), 237–245.

Shoup, J. A., Gattshall, M., Dandamudi, P., & Estabrooks, P. (2008). Physical activity, quality of life, and weight status in overweight children. *Quality of Life Research*, *17*(3), 407–412. https://doi.org/10.1007/s11136-008-9312-y

Silva, M. N., Markland, D., Minderico, C. S., Vieira, P. N., Castro, M. M., Coutinho, S. R., … Teixeira, P. J. (2008). A randomized controlled trial to evaluate self-determination theory for exercise adherence and weight control: Rationale and intervention description. *BMC Public Health*, *8*(1), 234. https://doi.org/10.1186/1471-2458-8-234

Spence, J. C., Blanchard, C. M., Clark, M., Plotnikoff, R. C., Storey, K. E., & McCargar, L. (2010). The Role of Self-Efficacy in Explaining Gender Differences in Physical Activity Among Adolescents: A Multilevel Analysis. *Journal of Physical Activity and Health*, *7*(2), 176–183. https://doi.org/10.1123/jpah.7.2.176

Spessato, B. C., Gabbard, C., Valentini, N., & Rudisill, M. (2013). Gender differences in Brazilian children's fundamental movement skill performance. *Early Child Development and Care*, *183*(7), 916–923. https://doi.org/10.1080/03004430.2012.689761

Standage, M., & Ryan, R. M. (2012). Self-determination theory and exercise motivation: facilitating self-regulatory processes to support and maintain health and well-being. In *Advances in motivation in sport and exercise, 3rd edition* (pp. 233–270). Human Kinetics. Retrieved from https://researchportal.bath.ac.uk/en/publications/self-determination-theory-and-exercise-motivation-facilitating-se

Stearns, J. A., Wohlers, B., McHugh, T.-L. F., Kuzik, N., & Spence, J. C. (2019). Reliability and Validity of the PLAY *fun* Tool with Children and Youth in Northern Canada. *Measurement in Physical Education and Exercise Science*, *23*(1), 47–57. https://doi.org/10.1080/1091367X.2018.1500368

Stodden, D. F., Goodway, J. D., Langendorfer, S. J., Roberton, M. A., Rudisill, M. E., Garcia, C., & Garcia, L. E. (2012). A Developmental Perspective on the Role of Motor Skill Competence in Physical Activity: An Emergent Relationship. *Quest*, *60*(2), 290–306. https://doi.org/10.1080/00336297.2008.10483582org/10.1080/00336297.2008.10483582

Stull, V., Snyder, D., & Demark-Wahnefried, W. (2007). Lifestyle Interventions in Cancer Survivors: Designing Programs That Meet the Needs of This Vulnerable and Growing Population. *The Journal of Nutrition*, *137*(1), 243S-248S. https://doi.org/10.1093/jn/137.1.243S

Sweet, S., Fortier, M., Strachan, S., & Blanchard, C. (2012). Testing and integrating self-determination theory and self-efficacy theory in a physical activity context. *Canadian Psychology*, *53*(4), 319–327. https://doi.org/10.1037/a0030280

Teixeira, P., Carraça, E., Markland, D., Silva, M., & Ryan, R. Exercise, physical activity, and self-determination theory: A systematic review, 9 International Journal of Behavioral Nutrition and Physical Activity § (2012). BioMed Central. https://doi.org/10.1186/1479-5868-9-78

Telama, R., Yang, X., Viikari, J., Välimäki, I., Wanne, O., & Raitakari, O. (2005). Physical activity from childhood to adulthood: A 21-year tracking study. *American*

Journal of Preventive Medicine, *28*(3), 267–273. https://doi.org/10.1016/J.AMEPRE.2004.12.003

Temple, V., & Foley, J. (2017). A Peek at the Developmental Validity of the Test of Gross Motor Development...: EBSCOhost. *Journal of Motor Learning and Development*, *5*, 5–14.

Timperio, A., Crawford, D., Telford, A., & Salmon, J. (2004). Perceptions about the local neighborhood and walking and cycling among children. *Preventive Medicine*, *38*(1), 39–47. https://doi.org/10.1016/j.ypmed.2003.09.026

Toftegaard-Stoeckel, J., Groenfeldt, V., & Andersen, L. B. (2010). Children's self-perceived bodily competencies and associations with motor skills, body mass index, teachers' evaluations, and parents' concerns. *Journal of Sports Sciences*, *28*(12), 1369–1375. https://doi.org/10.1080/02640414.2010.510845

Trost, S., Kerr, L., Ward, D., & Pate, R. (2001). Physical activity and determinants of physical activity in obese and non-obese children. *International Journal of Obesity*, *25*(6), 822–829. https://doi.org/10.1038/sj.ijo.0801621

True, L., Brian, A., Goodway, J., & Stodden, D. (2017). Relationships Between Product- and Process-Oriented Measures of Motor Competence and Perceived Competence. *Journal of Motor Learning and Development*, *5*(2), 319–335. https://doi.org/10.1123/jmld.2016-0042

Uijtdewilligen, L., Nauta, J., Singh, A. S., Van Mechelen, W., Twisk, J., Van Der Horst, K., & Chinapaw, M. J. M. (2011). Determinants of physical activity and sedentary behaviour in young people: A review and quality synthesis of prospective studies. *British Journal of Sports Medicine*. https://doi.org/10.1136/bjsports-2011-090197

Ulrich, D. (2017). The Test of Gross Motor Development-3 (TGMD-3): Administration, Scoring, & International Norms. *Hacettepe Journal of Sport Sciences*, *24*(2), 27–33. Retrieved from http://dergipark.gov.tr/download/article-file/151209#page=35

Ulrich, D. A. (2000). TGMD 2–Test of gross motor development examiner's manual.

van Beurden, E., Zask, A., Barnett, L., & Dietrich, U. (2002a). Fundamental movement skills--how do primary school children perform? The "Move it Groove it" program in rural Australia. *Journal of Science and Medicine in Sport*, *5*(3), 244–252. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/12413042

van Beurden, E., Zask, A., Barnett, L. M., & Dietrich, U. (2002b). Fundamental movement skills - How do primary school children perform ? The 'Move it Groove it' program in rural Australia,. *Journal of Science and Medicine*, *5*(3), 244–252.

Van Der Horst, K., Paw, M. J. C. A., Twisk, J. W. R., & Van Mechelen, W. (2007). A brief review on correlates of physical activity and sedentariness in youth. *Medicine and Science in Sports and Exercise*, *39*(8), 1241–1250. https://doi.org/10.1249/mss.0b013e318059bf35

Van Hecke, L., Loyen, A., Verloigne, M., van der Ploeg, H. P., Lakerveld, J., Brug, J., … Deforche, B. (2016). Variation in population levels of physical activity in European children and adolescents according to cross-European studies: a systematic literature review within DEDIPAC. *International Journal of Behavioral Nutrition and Physical Activity*, *13*(1), 70. https://doi.org/10.1186/s12966-016-0396-4

Van Sluijs, E., McMinn, A., & Griffin, S. (2008). Effectiveness of interventions to promote physical activity in children and adolescents: Systematic review of controlled trials. *British Journal of Sports Medicine*, *42*(8), 653–657. https://doi.org/10.1136/bmj.39320.843947.BE van Stralen, M. M., Yildirim, M., Velde, S. te, Brug, J., van Mechelen, W., & Chinapaw, M. J. M. (2011). What works in school-based energy balance behaviour interventions and what does not? A systematic review of mediating mechanisms. *International Journal of Obesity*, *35*(10), 1251–1265. https://doi.org/10.1038/ijo.2011.68

Vansteenkiste, M., Simons, J., Lens, W., Soenens, B., & Matos, L. (2005). Examining the Motivational Impact of Intrinsic Versus Extrinsic Goal Framing and Autonomy-Supportive Versus Internally Controlling Communication Style on Early Adolescents' Academic Achievement. *Child Development*, *76*(2), 483–501. https://doi.org/10.1111/j.1467-8624.2005.00858.x

Verloigne, M., De Bourdeaudhuij, I., Tanghe, A., D'Hondt, E., Theuwis, L., Vansteenkiste, M., & Deforche, B. (2011). Self-determined motivation towards physical activity in adolescents treated for obesity: an observational study. *International Journal of Behavioral Nutrition and Physical Activity*, *8*(1), 97. https://doi.org/10.1186/1479-5868-8-97

Vierling, K. K., Standage, M., & Treasure, D. C. (2007). Predicting attitudes and physical activity in an "at-risk" minority youth sample: A test of self-determination theory. *Psychology of Sport and Exercise*, *8*(5), 795–817. https://doi.org/10.1016/J.PSYCHSPORT.2006.12.006

Ward, J., Wilkinson, C., Graser, S., & Prusak, K. (2008). Effects of choice on student motivation and physical activity behavior in physical education. *Journal of Teaching in Physical Education*, *27*(3), 385–398. https://doi.org/10.1123/jtpe.27.3.385

Weiss, M. R., & Amorose, A. J. (2005). Children's Self-Perceptions in the Physical

Domain: Between- and Within-Age...: EBSCOhost. *JOURNAL OF SPORT & EXERCISE PSYCHOLOGY*, *27*, 226–244.

Welk, G. J., & Schaben, J. A. (2004). Psychosocial correlates of physical activity in children-A study of relationships when children have similar opportunities to be active. *Measurement in Physical Education and Exercise Science*, *8*(2), 63–81. https://doi.org/10.1207/s15327841mpee0802_2

Whitehead, M. (2001). The Concept of Physical Literacy. *European Journal of Physical Education*, *6*(2), 127–138. https://doi.org/10.1080/1740898010060205

Whitehead, M. (2007). Physical literacy: Philosophical considerations in relation to developing a sense of self, universality and propositional knowledge. *Sport, Ethics and Philosophy*, *1*(3), 281–298. https://doi.org/10.1080/17511320701676916

Whitehead, M. (2010). *Physical literacy; throughout the lifecourse. - ProQuest*. https://doi.org/http://search.proquest.com.proxy.bib.uottawa.ca/docview/733799374?accountid=14701

Whitehead, M. (2013). *Definition of Physical Literacy and Clarification of related Issues*.

WHO. (2018). The global action plan on physical activity 2018 - 2030. Retrieved August 13, 2019, from https://www.who.int/ncds/prevention/physical-activity/gappa/action-plan

Wick, K., Leeger-Aschmann, C. S., Monn, N. D., Radtke, T., Ott, L. V., Rebholz, C. E., … Kriemler, S. (2017). Interventions to Promote Fundamental Movement Skills in Childcare and Kindergarten: A Systematic Review and Meta-Analysis. *Sports Medicine*, *47*(10), 2045–2068. https://doi.org/10.1007/s40279-017-0723-1

Williams, S. L., & French, D. P. (2011). What are the most effective intervention techniques for changing physical activity self-efficacy and physical activity behaviour - And are they the same? *Health Education Research*, *26*(2), 308–322. https://doi.org/10.1093/her/cyr005

Wilson, P. M., Rodgers, W. M., Fraser, S. N., & Murray, T. C. (2013). Research Quarterly for Exercise and Sport Relationships between Exercise Regulations and Motivational Consequences in University Students. https://doi.org/10.1080/02701367.2004.10609136

Woods, C., Moyna, N., Quinlan, A., & Walsh, J. (2010). *The children's sport participation and physical activity study (CSPPA study).*

Woods, C., Moyna, N., & Quinlan, A. (2010). The Children's Sport Participation and Physical Activity Study (CSPPA Study). *The Irish Sports Council*.

Woods, Tannehill, Quinlan, Moyna, & Walsh. (2010). The Children's Sport Participation and Physical Activity Study (CSPPA). Research Report No 1. *School of Health and Human Performance, Dublin City University and The Irish Sports Council, Dublin, Ireland*.

Yee, K., Wong, A., & Cheung, S. Y. (2010). Confirmatory Factor Analysis of the Test of Gross Motor Development-2. *Measurement in Physical Education and Exercise Science*, *14*, 202–209. https://doi.org/10.1080/10913671003726968

Appendix A: Development of a 'refraction' framework to underpin design of the Moving Well-Being Well physical literacy intervention

Physical literacy (PL) is a multifaceted construct viewed as a crucial to engagement in physical activity over a life course. In recent years, there have been increased calls to support development of PL and its components in the school setting, however, design and development of a PL intervention requires careful consideration. That is, in order to be effective, a PL intervention must be, 1) evidence-based, framed around the discrepancy between what is currently in place and what should be in place and 2) underpinned by relevant theoretical framework(s). Given the paucity of empirical evidence concerning PL, this paper incorporates results from a cross sectional study utilising valid and robust assessment of PL and its components in Irish children (n = 2098, age range 5 – 12 years, 47% girls). This provides a greater understanding of Irish children's PL and, of the Irish PL landscape. Results are utilised as inputs to inform an evidence-based intervention design. Results also yield normative values capable of supporting our understanding of intervention impact and learner progress over time. From a theoretical standpoint, the study outlines design of an underpinning 'refraction framework' which marries the Theory of Constraints (TOC), Self-Determination Theory (SDT) and 'mapping functions' associated with the Behavioural Change Wheel (BCW), with the intention of changing the direction of PL outcomes in Irish children by supporting more positive movement experiences. Overall, the holistic approach to intervention design presented in this study is potentially best placed to facilitate a positive change in movement behaviours in Irish school communities.

Manuscript submitted as: Development of a refraction framework to underpin design of the Moving Well-Being Well physical literacy intervention

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Introduction

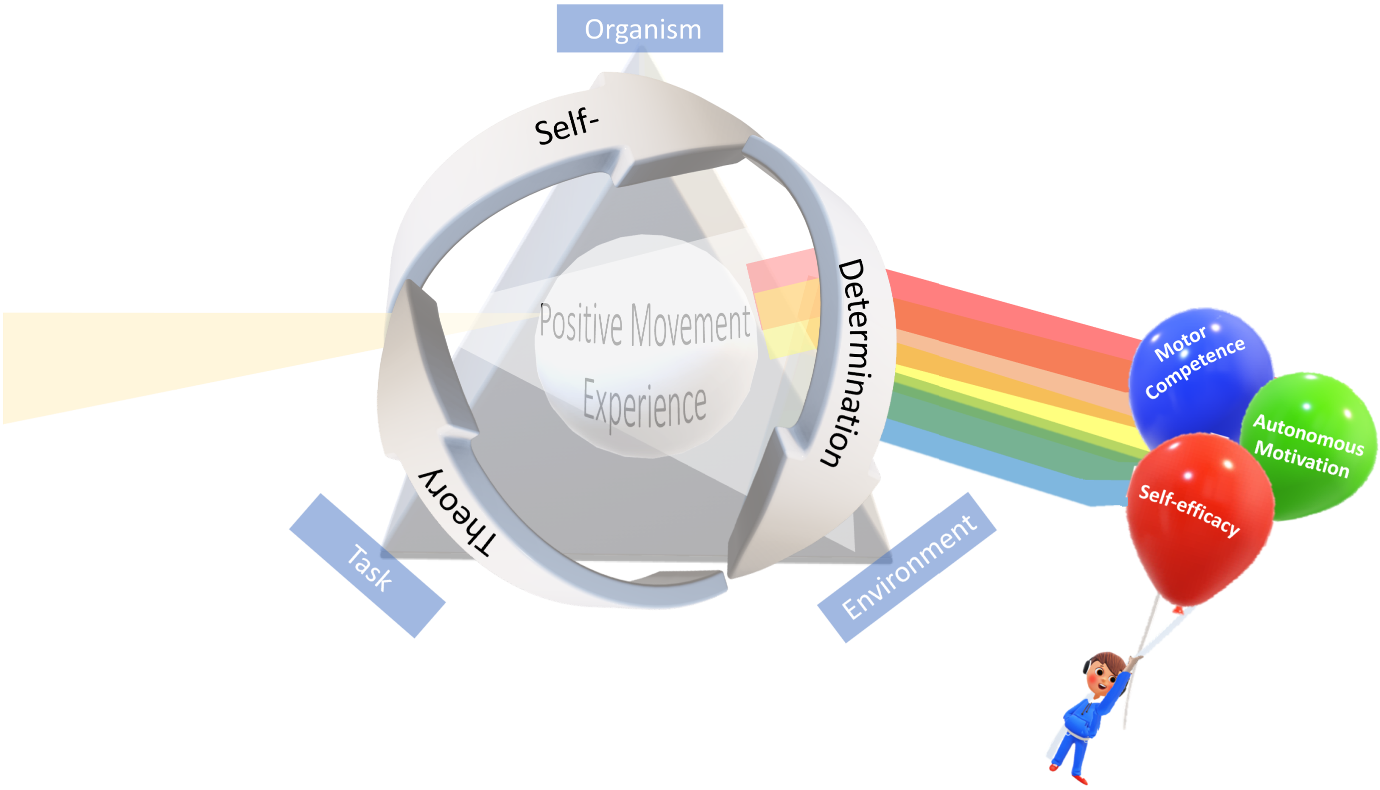
Utilisation of the term Physical Literacy has grown exponentially in the last 10 years discussed in small community groups, schools, universities, up to policy makers with unprecedented societal impact. The term Physical Literacy has now been introduced by the United Nations Educational, Cultural, and Scientific Organization (2015) as a core tenet in the physical education framework. The definition and conceptualisation of physical literacy still requires clarity, as there are various perspectives (Shearer et al., 2018; Edwards, Bryant, Keegan, Morgan & Jones, 2017). UNESCO define physical literacy as the ability, confidence, and motivation to engage in life-long PA, however there is a more commonly accepted consensus statement in academic literature that expands physical literacy to the "motivation, confidence, physical competence, knowledge and understanding to value and take responsibility for engagement in physical activities for life". At the core of physical literacy is an acknowledgement that movement skill is not enough. That is, a physically literate person also has the motivation and confidence to engage in a wide array of physical activities, which foster enjoyment and an improved sense of self through movement experiences.

The term Physical Literacy is now 'in vogue' and resonates well in the research community whilst also having a growing impact 'on the ground' with practitioners. The increased popularity of this construct amongst researchers, coaches and teachers seems to indicate that a variety of people potentially grasp its meaning, opening the door for its manipulation and implementation. However, physical literacy is a complex construct and as such, there is a risk of misinterpretation and misrepresentation of its nature leading to potentially limited (or negative) impact on targeted groups. Essentially, teachers, coaches etc., require support and guidance to foster physical literacy 'on the ground' in an applied way. The construct of physical literacy, as a holistic approach to tackle a given potential problem, is appealing. However, when choosing this approach, caution needs to prevail at each point, from -A- the onset of a given project when choosing the measurement to objectively capture the needs (Barnett, van Beurden, Morgan, Brooks, & Beard, 2009) to -Z- the implementation of the proposed solution (Keegan et al., 2019). This article is concerned with mapping the design, development and implementation of a physical literacy intervention starting from the first aspect: measurement. Indeed, the measurement of physical literacy determinants facilitates a pathway to understanding how to develop the intervention to maximise its efficiency (Gilmore & Campbell, 2005). This approach is embedded in the socio ecological model providing evidence that "*determinants are causally related to the behaviour and environmental conditions*" (Bartholomew, Loukas, Jowers, & Allua, 2006, p231). The proposition is to consider i) what are the components a learner needs to work on? ii) how should they be measured? And, iii) what is the interrelationship between the individual and their environment? These questions are to be followed by a decision on how to intervene. Several research groups have debated how to best measure physical literacy and its components, with questions still arising as to what might constitute an appropriate method of collecting empirical data for the study of physical literacy (Cairney, Veldhuizen, et al., 2018; Corbin, 2016; Edwards et al., 2017). Previous pragmatic approaches have attempted to capture and measure physical literacy, but have prioritised the physical domain (Tremblay, Longmuir, et al., 2018). Other measure/assessment attempts have adopted simplistic and linear methods that do not capture the concept of physical literacy (Edwards, 2017). In contrast, the PLAY tools (Physical Literacy Assessment in Youth), prove more promising, but while novel and aligned with the physical literacy consensus statement, it requires further psychometric testing. Given the paucity of empirical evidence concerning physical literacy, this study proposes incorporating validated measurements that align with the holistic philosophy of physical literacy as a more suitable method of assessment, the results of which could be utilised to inform physical literacy intervention design.

To that end, the assessment required in the context of this intervention development should be framed around the discrepancy between what is currently in place and what should be in place (Gilmore & Campbell, 2005). Such an exercise has never been conducted in the primary school setting in Ireland. Indeed, there is a dearth of understanding of Irish children's physical literacy levels, particularly at a component level. The approach taken in this study is to implement a formative evaluation of physical literacy components in order to better understand the determinants of health behaviour. This included a gathering of information about the participants, covering all components of the physical literacy construct. Gathering of information about the targeted population is essential (see method section) but not enough. That is, in order to have an impact on a child's behaviour we also need to consider the environment around them and, the nature of the tasks they can avail in their environment. Interactions between these three levels of constraints marry well with the Theory of Constraints proposed by Newell (1986) which highlights that behavioural change, including the movement behavioural change, occurs from the interplay between the task, the individual and his/her environment. The dynamical interaction between these three constraints effectively shape a change in movement quality and efficiency. This ecological dynamics approach takes into account all ingredients affecting the performer within his/her environment. It must be highlighted that Newell (1986) named the person the "organism" as the functional and structural properties embodied in the person.

This terminology echoes well the "organismic psychology" (Ryan, 1995) angle of the self-determination theory where the performers are viewed as active organisms. Self-determination theory presents as another crucial 'recipe' or framework for behavioural change. It proposes a multidimensional conceptualisation of motivation in which the types of motivations are of different quality, with self-determined (or autonomous) motivation types (intrinsic motivation and identified regulation) considered to be higher quality than less self-determined (or controlling) types of motivation (introjected and external regulation; Ryan & Deci, 2000). According to SDT, the quality of motivation is vital, with more autonomous forms of motivation facilitating learning, performance, higher interest and greater effort (Grolnick and Ryan, 1987; Kasser & Ryan, 1996). To foster said autonomous motivation three psychological needs are required: competence (i.e., self-belief in one's development of mastery), autonomy (i.e., choice is available in one's actions), and relatedness (i.e., a feeling of meaningful interaction with others). Interestingly, these psychological needs are also impacted by constraints, relating to the task and the environment. Thus, we propose the foundations of *positive movement experiences* and a positive change in behaviour potentially lie in a marriage between the TOC and, SDT where constraints relating to the organism (learner, performer etc.), the task (activity, etc.) and environment (equipment, feedback, instruction) are adapted, specifically in line with learner needs and their surrounding context. Moreover, when we get this adaption right, we can change the direction or 'refract' a learner's movement experiences towards more positive movement experiences and, more positive outcomes associated with physical literacy, including motor competence, autonomous motivation and self-efficacy. This crucial interplay between a Theory of Constraints and SDT is outlined in Figure 1.

Figure 1. 'Refracting' movement experiences and physical literacy outcomes by marrying Theory of Constraints and Self-Determination Theory



In an applied sense, this means that a physical literacy intervention could consider 1) adapting constraints relating to learner (organism), task and environment with the intention of supporting a motivational climate and positive movement experiences, leading to improved outcomes associated with physical literacy (e.g. motor competence, self-efficacy, autonomous motivation) and ultimately, impactful behavioural change over time. In this study we propose identifying constraints of the learner, at local level, by measuring psychological and physiological components associated with physical literacy whilst also identifying constraints of the local context, and school community. Results are to be utilised as inputs to inform design and development of an evidence-based intervention that aims to bridge the gap between research and practice and improve physical literacy levels of Irish children.

Both TOC and SDT will be considered as core pillars supporting the overall development of this intervention whilst also being underpinned by the intervention mapping framework (Michie, van Stralen, & West, 2011). This mapping framework should be viewed as a list of 'ingredients' guiding good practice (in an applied way) at a micro level, whereas the TOC and SDT should be viewed as supporting the overall rational informing the development, implementation and future evaluation of the intervention.

Intervention Mapping Framework

The National Institute for Health and Care Excellence (NICE) (2014) reports behavioural changes come from an interaction between three core components; an individual's capability, opportunity and motivation to perform and carry out that behaviour. At a macro level, this is in line with TOC and SDT as it considers the importance of the Individual's physical and psychological capability as well as opportunities afforded to them, including opportunities associated with the task and environment. This specific behaviour change framework is known as the Capacity-Opportunity-Motivation Behaviour (COM-B) model. A recent review of behavioural change literature identified 19 frameworks associated with behavioural change. These frameworks were then evaluated in relation to their coherence, comprehensiveness and links to models of behaviour (Michie et al., 2011). As no framework contained all three criteria, they were synthesised into the 'Behavioural Change Wheel' (BCW), with a COM-B model at its core (Michie et al., 2011). Crucially, the BCW offers a list of intervention 'functions' mapped onto behaviour change taxonomy and applied techniques to guide design of interventions aimed at changing behaviours (further outlined in the discussion). These functions essentially provide designers with a micro set of ingredients to inform development of evidenced-based interventions that carefully map, evaluate and foster both the task and environmental conditions in order to best support an individual's behavioural needs over time.

Accordingly, this paper discusses the design of an evidence-based physical literacy intervention, which, at a macro level, is underpinned by TOC and SDT. Determinants of physical literacy and, intervention functions of the behavioural change wheel are utilised to tackle constraints relating to the learner, the task and the environment with the explicit intention of supporting the development of physical literacy in children. More specifically, the intervention takes an evidence-based approach, grounding its content on the needs of Irish children, on the realities and constraints of an Irish context/environment and the school community setting. Results relating to the learner and context were identified via a cross-sectional study which evaluated Irish children and their surrounding environment through the lens of physical literacy. Thus, arming us with a significant amount of information to map out an optimum structure of the intervention.

This study's intervention design is significantly supported by the construct of physical literacy which points us to a list of determinants (motivation, confidence, knowledge & understanding) that require evaluation and development. In a first instance, it is essential to measure these core components and consider them in relation to the intervention functions so that we can evaluate and develop effective change over time. The intervention mapping framework, through the lens of the BCW, will support the development process, however it is the marriage between the TOC and SDT that i) supports the overall design and implementation of the intervention, ii) guides the interpretation of the results and iii) assists the reflection and future directions of the intervention.

Methods

Local context informing the structure of the intervention

In Ireland, as in most countries internationally, generalist primary school teachers are responsible for delivery of PE content (Fletcher and Mandingo, 2012). It is often cited that primary school teachers feel poorly prepared to teach PE programmes in a way that is truly meaningful to pupils, and positively impact lifelong participation in PA (Fletcher and Mandingo, 2012). While the generalist teacher is unquestionably best placed to deliver curricular content to their class in a child centred and integrated manner (Coulter, Marron, Murphy, Cosgrave, Sweeney, & Dawson, 2009), a difficulty arises when insufficient time for PE is available on an overcrowded initial teacher training curriculum to allow all primary teachers develop confidence and competence in delivering PE. Identifying, developing and implementing strategies to help improve generalist classroom teacher's confidence and competence in teaching PE is recommended as a feasible avenue for improving the quality of PE experiences at primary level (Fletcher & Mandingo, 2012).

Murphy and O'Leary (2012), highlight some of the issues faced by primary generalise teachers when exposed to traditional CPD. While an initial boost in motivation for teaching PE, and trying new things, is experienced following the traditional 'seminar day' of CPD, this motivation is subsequently washed out as teachers fall back into the daily challenges of school life (Murphy & O'Leary, 2012). In Ireland there is an acknowledged increasing trend towards the use of external providers in the physical education space in primary schools (Ní Chróinín & O'Brien, 2019). It is accepted that there is benefit in terms of 'added value' of external providers contributing to aspects of children's learning in PE at primary schools (Ní Chróinín & O'Brien, 2019), however the way in which this external provision is structured is critical if maximum benefit is to be obtained.

Research conducted by Ní Chróinín & O'Brien (2019) highlight that there is limited authentic partnership development and engagement between the primary school teacher and the external provider currently in Ireland. The classroom teacher generally views the external provider as 'the expert', and as a result, takes a 'back seat' when the external provider is delivering content- engaging and communicating minimally (Ní Chróinín & O'Brien, 2019).The classroom teacher without doubt can be considered the expert in the child, and generating a child centred and integrated class room experience (Coulter et al., 2009). Harnessing the primary school teacher's belief in their own expertise in child centred pedagogy, as matching that of an external provider's expertise in the subject specific content, may well provide a new opportunity for professional development in primary school physical education. Increased communication and involvement in pedagogical decision making with external providers have been highlighted as areas to be addressed when *'reconceptualising the relationship between classroom teachers and external providers'* in Ireland (Ni Choinin & O'Brien, 2019, pp 329).

Participants

Cross-sectional data were collected as part of a national physical literacy study 'Moving Well-Being Well'. In all, 50 schools were approached with 44 agreeing to participate. Participants (n=2098, 47% girls, ranging from 5-12 years of age, mean age 9.2 ±2.04) were recruited from these schools across twelve counties (56% rural, 44% urban) in Ireland. Data from typically developing children were collected March through June 2017 across the full primary school cycle. Ethical approval was obtained from the Research Ethics Committee of the institution (DCU/REC/2017/029). Parental consent and participant assent were obtained, and participants were assigned a unique ID code to ensure anonymity. Age and sex were collected through consent forms and questionnaires administered in the classroom. Full details of participants can be found in previously published work (Behan, Belton, Peers, O'Connor & Issartel, 2019).

Data Collection

FMS proficiency were measured using the Test of Gross Motor Development, 3rd edition (TGMD-3) (Ulrich, 2013), with the vertical jump from the Victorian Fundamental Motor Skills manual (Department of Education Victoria, 1996, *Fundamental Motor Skills: A Manual for Classroom Teachers*, Melbourne: Education Department of Victoria), and the balance subtest from the Bruininks-Oseretsky Test of Motor Proficiency 2 (BOT-2) Short Form added to the assessment battery. All procedures described in the literature were fully adhered to (outlined further in Behan et al., 2019).

The pictorial scale of perceived movement skill competence for young children (Barnett, Ridgers, Zask, & Salmon, 2015), which aligned with TGMD-3, was also administered. The pictorial scale of perceived movement skill competence assesses six locomotor (run, gallop, hop, skip, horizontal jump, and slide) and seven object proficiency skills (two-hand strike of a stationary ball, one-hand stationary dribble, kick, two-hand catch, overhand throw, forehand strike of a self-bounced ball, and underhand roll), based on the TGMD-3. Delivery of the pictorial scale of perceived movement skill competence replicated the process of Peers, Belton, Behan, O'Connor & Issartel (2019, *in press*), with the extensive protocol available in Barnett et al. (2015).

The quality of children's motivation was measured using two subscales of the Behavioural Regulation in Exercise Questionnaire which was adapted for primary school children (BREQ-adapted; Sebire, Jago, Fox, Edwards, & Thompson, 2013). The BREQ-adapted is consistent with self-determination theory definitions (Ryan & Deci, 2000), and has been shown to have good psychometric properties in children (Sebire et al., 2013). The BREQ-adapted captures multidimensional components of motivation with 3 questions per motivation subscale: intrinsic (α = .81) and identified (α = .73). Items were scored using a 5-point Likert-type scale: 1 (not true for me) to 5 (very true for me). Full details are outlined previously in Peers et al. (2019, *in press*).

Self-efficacy was assessed using the Physical Activity Self-Efficacy Scale (PASES) was employed in this study. This scale was adapted for primary school children into an 8-item single factor scale (Bartholomew et al., 2006), and is consistent with self-efficacy definitions (Bandura, 1977, 1982, 1997), having shown good psychometric properties in children (Bartholomew et al., 2006). Items were scored using a 3-point Likert-type scale with "No" (0), "Not Sure" (1), and "Yes" (2) as the three choices. Cronbach's alpha (Cronbach, 1951) coefficient for PASES in this study was good (α = .88).

To measure physical activity, children completed the PACE+ (Prochaska, Sallis, & Long, 2001), a validated and reliable measure for this age (Murphy, Rowe, Belton, & Woods, 2015). Children were given a definition (PA is any activity that increases your heart rate and makes you get out of breath some of the time) and examples of common physical activities. Children were asked how many days in the past week and in a normal week they were physically active (cumulative activity including sports, playing with friends, and walking to school, however excluding physical education class) for 60 min or more. As suggested by these authors the average number of days from the past week and typical week was used as an index of PA participation (Prochaska et al., 2001).

An additional form of PA measurement was undertaken on a subsample using pedometers. A Yamex pedometer with proven validity was utilised. All participants wore the pedometer on the right hip during waking hours for a period of 9 days. The first and last day were discarded to give a seven-day step measurement. Participants were asked to note on a diary sheet any times (and reasons) during each of the 9 days they had to remove the pedometer. Participants noted each evening the number of steps they took before resetting the device in advance of the following day.

It should be noted that while FMS and PC were measured across all participants, it was not possible to measure self-efficacy, motivation, and self-reported PA assessments in a younger cohort (5 – 8 years) as tools have yet to be validated for this age group. As such, the sample size for these parameters is smaller, with 860 children/participants (47.9% female, 10.37 ±1.18 years).

Results

Results presented in Tables 1,2,3 & 4 illustrate the changes over time, for each measurement, carried out in a cross-sectional study. Beginning with PA levels (Table 1), the 50th percentile range, in terms of steps counts, is higher than the minimum 10,000 recommended steps for children. Of note is the fact that children in the lowest percentile range tend to do less and less over time, whilst children in the highest percentile range do more and more, explaining a widening of the gap in PA engagement over time.

From the perspective of FMS, previous findings from the same sample have identified a distinct lack of mastery among Irish children (Behan et al., 2019). Indeed, results showed just over half of the participants (n = 2098, age range 5 – 12 years, 47% girls) had mastery or near mastery in locomotor skills (52.8%) and object control skills (54.8%), while 60.6% had achieved mastery or near mastery in balance skills. Table 2 presents proposed normative values of FMS and its subtests, locomotor, object control and balance, in the same sample. Values have been yielded for the entire primary school age range.

Table 3 presents proposed normative values of perceived competence (PC) in Irish children. Notably, there seems to be no ceiling effect in the PC scores. There is no change in the 50th percentile from age nine to twelve, with 50% of the sample still seven points off the top score achievable. Another point of interest is the wide spectrum of scores for each age group, with the difference from the 10th to 90th percentile ranging between 11 and 17.8 points. The PC locomotor subset shows a decline in the 90th percentile with age, and again the 50th percentile remains the same from the age of nine. The PC object control subset shows the score needed to achieve 50th percentile status remains the same from age six all the way through to twelve, with nearly all age brackets reporting the 90th percentile as the maximum score achievable.

Table 1. Proposed normative values per age for Irish children for average daily steps measured using a pedometer and average PA measured using the self-report scale.

	Age							
	5	**6**	**7**	**8**	**9**	**10**	**11**	**12**
n	0	29	39	43	41	25	26	17
Average Daily Steps								
10th	n/a	7440.8	8222.3	7200.5	6705.2	9311.5	8177.8	6501
25th	n/a	9484.4	10449.9	8616.9	10001.1	11457.3	10286.2	8434.8
50th	n/a	12925.5	11894.4	12004.8	12778.3	13157.5	14264.4	11729.4
75th	n/a	17193.7	15723.3	15347.8	14698.5	15591.3	18704.1	14583.8
90th	n/a	18933	19703.3	18797.5	19352	17150.1	23955.8	21324.1

	Age							
	5	**6**	**7**	**8**	**9**	**10**	**11**	**12**
n	**n/a**	**n/a**	**n/a**	**n/a**	271	232	230	153
Average PA (Self Report – number of days meeting the 60min/day of MVPA)								
10th	n/a	n/a	n/a	n/a	2.5	3	2.1	3
25th	n/a	n/a	n/a	n/a	3.5	3.5	4	4
50th	n/a	n/a	n/a	n/a	5.5	5	5	5
75th	n/a	n/a	n/a	n/a	6.5	6	6	6
90th	n/a	n/a	n/a	n/a	7	7	7	7

Table 2. Proposed normative values per age for Irish children of overall FMS, locomotor, object control and Balance

	Age							
	5	**6**	**7**	**8**	**9**	**10**	**11**	**12**
n	116	244	312	298	334	247	256	171
Overall FMS Percentiles, max score = 120								
10th	50.7	56	54	65	70.3	80.4	82	83
25th	59.25	65	71	76	83	90	89	89
50th	67	75	82	87	92	97	98	98
75th	75	85	92	95.5	100	104	106	105
90th	86.3	92	99	105	105	110	111.5	111
Locomotor Percentiles, max score = 58								
10th	23.6	26	27	33	34	39	39	37.2
25th	31	35	36	40	42	45	44	44
50th	36	41	43	45.5	48	49	49	49
75th	43	46	48	50	52	53	53	52
90th	46	50	52	54	55	56	56	56
Object Control Percentiles, max score = 54								
10th	17	17	17	22	27	29	33	33
25th	21	23	25.5	29	32	35	38	38
50th	26	29	33	34	38	41	43	43
75th	31	35	39	41	42	46	47	46
90th	37.3	41	43	47	46	48	50	49.7
Balance Percentiles, max score = 8								
10th	2	2	2	3	4	5	4	4
25th	3	4	4	5	6	7	6	6
50th	5	6	6	7	8	8	8	8
75th	6	7	8	8	8	8	8	8
90th	8	8	8	8	8	8	8	8

Table 3. Proposed normative values per age for Irish children of perceived competence, including locomotor and object control subtests.

	Age							
	5	**6**	**7**	**8**	**9**	**10**	**11**	**12**
n	116	244	312	298	334	247	256	171
Total Perceived Competence Percentiles, Max Score = 52								
10th	31.1	34	35	35	36	38	37	34.4
25th	34.8	37	39	39	40	41	41	40
50th	39	41.5	43	42	45	45	45	45
75th	45	46	46	46	48	47	48	48
90th	48.9	49	49	49	50	49	50	50
Locomotor Perceived Competence Percentiles, Max Score = 24								
10th	15	15	15	16	16	17	16	16
25th	15	17	17	17	18	19	18	18
50th	18	19	19	20	20	20	20	20
75th	21	21	21	21	22	22	22	22
90th	24	24	24	24	24	23	23	23
Object Control Perceived Competence Percentiles, Max Score = 28								
10th	16	17	18.4	17.8	19	20	19	18.4
25th	18	19	21	21	22	22	23	21
50th	21.5	23	23	23	25	25	25	24
75th	25	25	25	25	27	27	27	27
90th	27.9	28	28	28	28	28	28	28

Finally, Table 4 proposes normative values for physical self-efficacy and autonomous motivation in Irish children. Both tools use considerably smaller scales than FMS and PC, but still have notable differences between the percentiles. Physical self-efficacy from age nine to twelve appears to remain consistent, regardless of percentile. Despite the small scale for physical self-efficacy, the difference from the 10th to 90th percentile is considerable across all ages. The 90th percentile demonstrate the maximum score available for physical self-efficacy across all the ages. Meanwhile, autonomous motivation for the top 25% have encountered a ceiling effect, this remains consistently high from age nine to twelve. Autonomous motivation appears to decline in the 10th percentile with age. Considering the scale, the 50th percentile is relatively high in regard to autonomous motivation.

Table 4. Proposed normative values per age for Irish children of self-efficacy and autonomous motivation, using the Physical Activity Self Efficacy Scale (PASES) and Behavioural Regulation and Exercise Questionnaire (BREQ) – Adapted measurement tool.

	AGE			
	9	**10**	**11**	**12**
n	235	202	214	138
Self-Efficacy Percentiles				
10th	1.25	1.375	1.25	1.3625
25th	1.50	1.50	1.50	1.50
50th	1.63	1.75	1.75	1.75
75th	1.88	1.88	1.88	1.88
90th	2.00	2.00	2.00	2.00
Motivation Percentiles				
10th	3.83	3.67	3.50	3.50
25th	4.33	4.17	4.00	4.17
50th	4.67	4.67	4.50	4.67
75th	5.00	5.00	4.83	5.00
90th	5.00	5.00	5.00	5.00

Ultimately, results presented by Behan and colleagues (2019) pertaining to the poor levels of PA and low levels of FMS mastery essentially frame the discrepancy between what is currently in place and what should be in place, in an Irish PE context. That is, Irish children are lacking in movement competence, and thus, valuable components of what it means to be physically literate. Furthermore, proposed normative values outlined in our results relating to PC, self-efficacy and autonomous motivation, essentially provide designers, researchers, teachers and practitioners with a veritable list of physical literacy components, associated with Irish primary children, that require attention. Crucially, normative values just presented, also offer a point of reference to measure and compare progress over time. Ultimately, results are used as inputs to inform intervention design. The next step of this design process is to examine these results through 'mapping functions' associated with Behaviour Change Wheel.

Input of results through the behaviour change wheel

The BCW uses an eight-step process to design interventions (Figure 1). The first three steps are to assist researchers identify the specific behaviour(s) they wish to change.

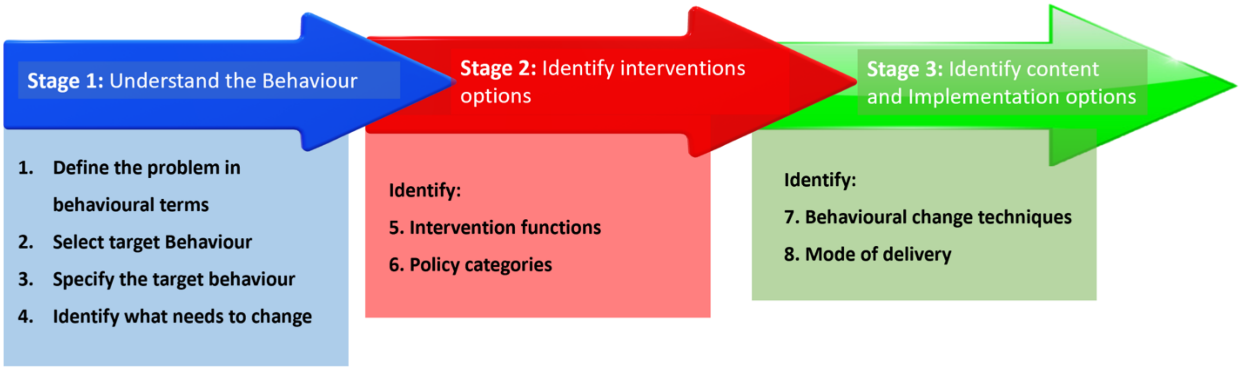


Figure 1. Behavioural Change Wheel Step by Step Method for Designing Behaviour Change Interventions (Michie et al., 2014)

When we input our results through these BCW steps, we come to the following outcomes:

Starting with **stage one**, and the first step, the behavioural problem is that children are not getting enough PA (see Table 1). This increased sedentary lifestyle can cause negative health outcomes as a child, such as obesity, etc. Children with poor levels of PA at a young age tend to be less active throughout life and, with that, the negative health outcomes become more pronounced increasing risk of cardiovascular disease, obesity, diabetes, etc. The need to improve PA levels seems clear, however previous initiatives attempting this feat have fallen short. A fresh approach is needed. This research chooses to target the behaviours which drive PA, through the lens of PL. That is, research indicates that increased PL levels in children will foster an increase in confidence and motivation to be active, as well as the physical competence to partake in a range of activities (Whitehead, 2013). By developing PL, children are more likely to be active throughout life and thus benefit from the positive health outcomes associated with increased PA levels.

This brings us to the **second step** of the BCW - selecting the target behaviour – which we believe should be an overarching focus of increasing PL in children. **Step three** recommends that the target behaviour be specified. This is particularly important when the target is PL as we know that many practitioners 'on the ground' lack a clear understanding of the construct. Researchers define PL as the motivation, confidence, physical competence, knowledge and understanding to be active for life. Using this definition, the components of PL can be extracted: confidence, motivation, physical competence, knowledge and understanding. Table 5 completes the first stage of the BCW process by providing a detailed summary of components considered as target behaviours, and what exactly needs to change (**step 4**), as deciphered through the lens of the COM-B model. Table 5 also depicts the unit of measurement proposed in order to measure the efficacy of the intervention and the specific components of the Physical literacy construct that need to be changed.

Table 5. Links between the components of the COM-B model of behaviour to physical literacy and the measures employed to assess each domain

COM-B FEATURES	PHYSICAL LITERACY DOMAIN TARGET	IDENTIFY WHAT NEEDS TO CHANGE	UNIT OF MEASUREMENT
CAPABILITY			
PHYSICAL	Physical Competence	Low levels of FMS proficiency in children Teachers ability to assess motor competence	Test of Gross Motor Development 3rd Edition
PSYCHOLOGY	Motivation Confidence	Low levels of autonomous motivation towards PA in children Low levels of self-efficacy towards PA in children Low levels of perceived FMS competence in children	Physical Activity Self Efficacy Scale (PASES) Behavioural Regulation and Exercise Questionnaire (BREQ) – Adapted Pictorial Scale of Perceived Movement Skill Competence for Young Children
OPPORTUNITY			
SOCIAL	Motivation Confidence	Lack of opportunity to practice skills with peers and parents. Lack of opportunity to be instructed in FMS by a more knowledgeable other	Physical Activity Self Efficacy Scale (PASES) Behavioural Regulation and Exercise Questionnaire (BREQ) – Adapted Pictorial Scale of Perceived Movement Skill Competence for Young Children
PHYSICAL	Physical Competence	Lack of PA time in schools Lack of opportunities to practice physical skills in a safe environment	Test of Gross Motor Development 3rd Edition
MOTIVATION			
AUTOMATIC	Physical Competence Knowledge & Understanding	Lowly skilled children feeling insecure in practicing physical skills with their peers. Lack of understanding in how to perform skills, and the importance these skills have in being active.	Test of Gross Motor Development 3rd Edition MWBW Knowledge & Understanding Scale
REFLECTIVE	Knowledge & Understanding	Lack of understanding in the benefits of being active	MWBW Knowledge & Understanding Scale

Discussion and Intervention Design

The leitmotif of this article is to describe all characteristics leading to development of a PL intervention, entitled 'Moving Well-Being Well'. According to the BCW, Stage 2, Step 5 requires the identification of intervention functions through review of the evidence. We propose that it is crucial to consider evidence-based findings from the literature to guide this identification. In this study, we are well placed to effectively map intervention functions against actual findings from our cross-sectional study. In this way, the intervention is essentially personalised to meet the needs of Irish children in an Irish school community context.

Systematic reviews of school-based interventions provide evidence that the more effective strategies involve multiple components and are not solely limited to what can be achieved in a PE lesson (S. Kriemler et al., 2011; S Kriemler et al., 2011; Murillo Pardo et al., 2013; Salmon et al., 2007; Timperio et al., 2004)

To that end, school-based interventions offering a *family* component are cited as having positive effects on increased PA participation (Belton et al., 2014; Murillo Pardo et al., 2013). Interventions that include a *community* component are also deemed effective, with the suggestion that community organisations have the capacity to facilitate provision of activities in schools that are particularly attractive to students (Acker et al., 2011). Interventions that integrate activity breaks in the classroom (i.e., *Active classrooms*) as part of a whole school approach, have also gained traction in recent years and prove effective in increasing PA across the school day (Goh, Hannon, Webster, Podlog, Brusseau, & Newton, 2014; Martin & Murtagh, 2015).

Conversely, an examination of interventions targeting PA in children provides strong evidence that these programmes have only had a small effect (approximately 4 additional minutes) on children's overall activity levels, i.e. PA in and outside of school

(Metcalf, Henley & Wilkin, 2012). Thus, in order to change behaviours and see an increase in Leisure Time PA (LTPA) we need to consider additional intervention components.

As previously mentioned, FMS development in children is widely reported to increase PA participation later in life (Barnett et al., 2009). Accordingly, we propose that an emphasis on skill development presents as a crucial 'ingredient' of behavioural change and note that, FMS can be targeted effectively as part of rounded PE programme (David Stodden et al., 2008). In summary, a multi-component intervention is required to facilitate real change in PL (S. Kriemler et al., 2011; Murillo Pardo et al., 2013; Salmon et al., 2007; Timperio et al., 2004). This includes a targeted effort to improve FMS, particularly in the PE setting, in order to equip children with the confidence and basic skill levels needed to partake in PA beyond the school setting and ultimately, throughout the life course (Stodden et al., 2008). Interventions should include components targeting active breaks, active classrooms, structured and focused PE, as well as engaging the family and the community (Acker et al., 2011). However, whilst research suggest that these components are an ideal, some may not currently be feasible in an applied sense 'on the ground'. We propose that it is crucial for interventions to be evidence-based and consider barriers that require negotiation as well as available facilitators, in order to bridge the gap between research and practical application.

Ultimately, the BCW framework provides an effective lens with which to view design and develop of an evidence-based intervention. It proposes a number of intervention functions to consider including: education, persuasion, training, enablement, and environmental restructuring outlined in more detail in Table 6. Accordingly, features of an evidence-based intervention include a continuous professional development (CPD) module, development of resources, and collaboration with professional bodies. Further, the BCW framework identifies overarching ‘observable, replicable and irreducible’ components known as behavioural change techniques (Michie et al., 2011a). These are considered the ‘active ingredients’ utilised to change behaviour. Active ingredients implemented in the Moving Well-Being Well intervention are outlined in Table 6 (Michie et al., 2011a).

Table 6. ‘Active Ingredients’ of the Moving Well-Being Well Intervention: Intervention functions mapped onto behaviour change taxonomy and applied techniques (i.e. Stage 3, Step 7)

INTERVENTION FUNCTIONS	**DEFINITION**	**PHYSICAL LITERACY FRAMEWORK INTERVENTION**
EDUCATION	Increasing knowledge or understanding	Coaches provided with information intervention need and delivery Teachers provided with information on benefits of FMS and bes practice on how to develop confident movement via a mastery/SDT framework. Children provided with information about the benefits of PA, looking to develop the belief, value and responsibility for physical activity via FMS and quality motivation

		Family invited to engage in the intervention
PERSUASION	Using communication to induce positive or negative feelings or stimulate action	SDT structure for delivery of intervention to develop motivation, self-efficacy, and competence for physical activities Instructions provided to negotiate challenges as children begin to master skill Variation used to adapt skills that are too challenging at the beginning Feedback on behaviour by inviting children to demonstrate technique, highlight competence to stimulate confidence in skills
TRAINING	Imparting skills	Coaches trained in the fidelity of implementation Non-disruptive in-service training of games-based teaching of FMS. Demonstration of behaviour from the coaches to the teachers, followed by instruction of how to deliver the session. Feedback from coaches Self-monitoring via lesson notes (what went well, what could be improved...) Additional opportunities for practice without supervision FMS development in a games-based mastery approach - use of mastery and constraints to fuel competence and motivation of children
ENABLEMENT	Increasing means/reducing barriers to increase capability or opportunity	Social support (family), Problem solving, Restructuring the environment (social and time) - homework
ENVIRONMENTAL RESTRUCTURING	Changing the physical or social context	Coaches provided with information of how intervention will change how the social context is perceived Restructuring the social comparison to a more mastery/SDT focused approach Children guided towards focus on development of skills via a mastery/SDT approach Once children begin to master technique add challenges (e.g. alternate throwing hand)

To unpack these intervention functions further let us first consider the importance of *the education function* as a way of keeping the child at the centre of the learning whilst also considering all actors (organisms) that have an impact on the learning (e.g., coaches, teachers, parents etc.). According to the TOC, consideration for all organisms around the child maximises efficiency of the intervention in terms of skills acquisition as the emerging behaviour comes from the interplay between all constraints. At this level, the constraints around the organism provide the child with all necessary ingredients to acquire the skills the best way possible in the given context.

Next, *the persuasion function* is utilised to address the child's needs from the content perspective and choice of pedagological approach. Consideration is also given to the environment of the learners so that a motivational climate is fostered and supported.

This calls for the teacher taking into account specifics relating to the class, school and social context that surrounds the children.

The training function then, specifically considers the nature of the learning to takes place for all actors of this intervention. Upskilling children is the primary objective, but this can only take place once the organims around the children are themseves equiped with all necessary tools and competency to model and educate them effectively. For these reasons, both coaches and teachers require a training phase as part of the intervention with a view to give confidence and all necessary competence to address the needs of the children.

Similarly, *the enablement function* echoes the training function making specific recommendations in terms of CPD training. Careful consideration is given to the content of the intervention so that we change direction of existing environmental barriers from both a psychological and logistical perspective. In that instance, the TOC and SDT shed some light on the important of a holistic approach in this context demonstrating that all elements around the child are intertwined. This leads us to highlight particularly strong pedagological tools in the CPD that empower coaches and teachers with the skills to differentiate all aspect of the learning process so that it is not "a one size fits all" intervention but an intervention geared towards a personnalised behavioural change.

Lastly, *The environmental restructuring function*, indirectly discussed above, is an ideal match with TOC, a crucial philosophy that underpins the intervention. This includes modifying the physical context to alter the task, modifying the environment around the child, and modifying the social context in order promote efficient and long term learning that ultimately, changes the direction of current physical literacy trends associated with Irish children.

To that end, the term ‘refraction’ refers to a change in direction of a wave (e.g. light) as it moves through a medium, realising its true colours and, true potential. In the same way, we propose that the PL design framework outlined in this study could be described as a physical literacy ‘Refraction Framework’, marrying TOC, SDT and mapping functions associated with Behavioural Change Wheel, in order to change the direction of a learner’s movement behaviours, moving them through positive movement experiences in order to realise their true potential. In these *positive movement experiences*, the ‘positive’ component refers to a motivational climate as associated with SDT, the ‘movement’ component relates to TOC and dynamics associated with refined motor coordination outcomes, whilst the ‘experience’ component refers to a multifaceted intervention (the Moving Well-Being Well intervention) where all environmental characteristics around the child are considered. Crucially, a physical literacy refraction framework uses crucial components of physical literacy (specific to Irish learners and the Irish context) as inputs to map design and development of what constitutes an ‘evidence-based’ intervention, which we believe, is best placed to get physical literacy education ‘off the ground’ in Ireland and enable Irish children to ‘reach for the physical literacy stars’ and realise their true potential. The over-arching recipe for the Moving Well-Being Well intervention is outlined in Figure 2 below.

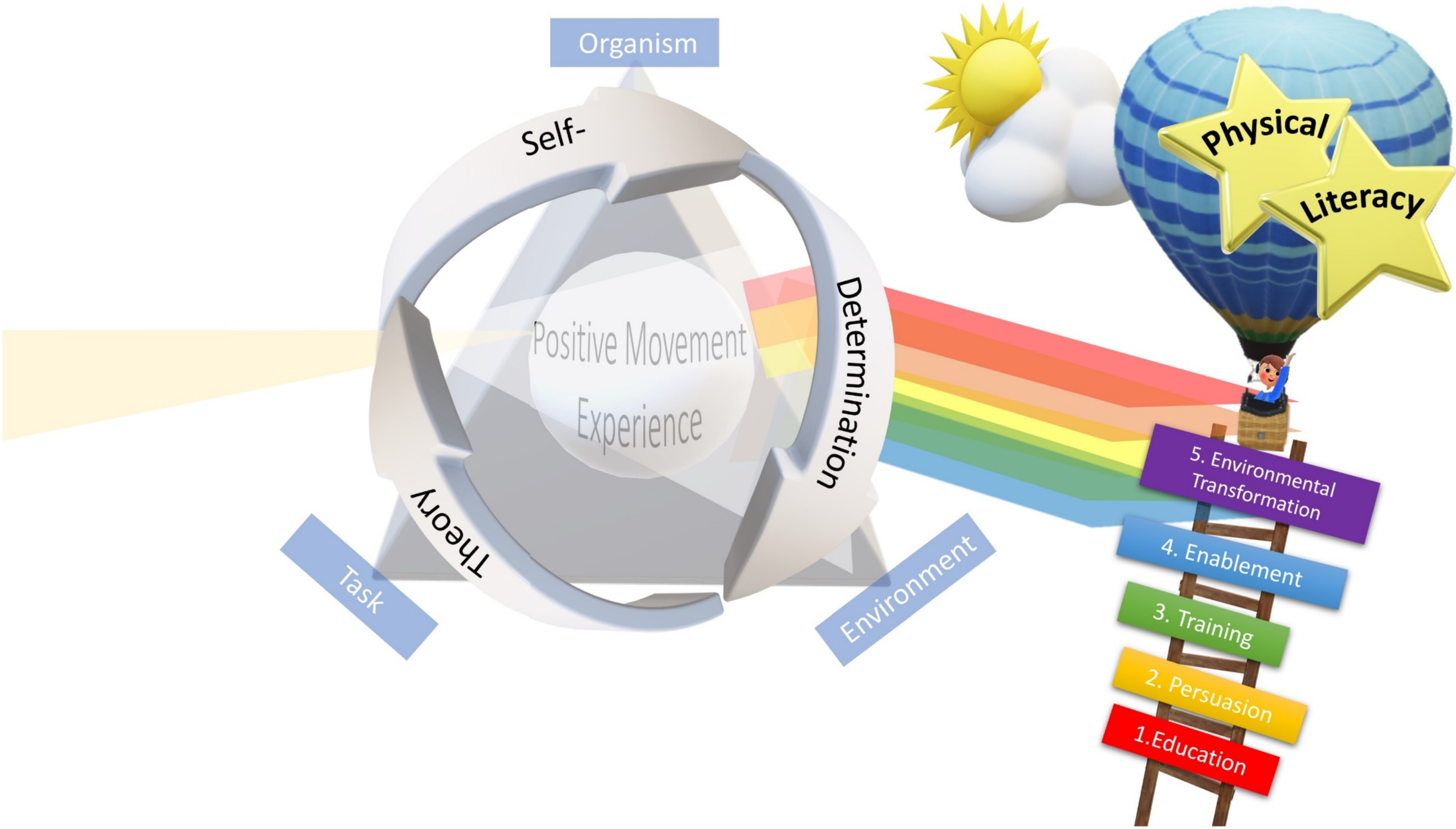


Figure 2. Physical Literacy 'Refraction Framework': Seeking to change the nature of movement experiences and the direction of physical literacy outcomes, in Irish school communities

Moving Well-Being Well in a nutshell and future directions

In the design of this intervention, the existing landscape of PE in Ireland was considered. While there are several resources and initiatives on offer to primary schools, most are sport specific and very few are aligned to the curriculum. One such resource, the Move Well, Move Often programme, seeks to develop physical literacy through FMS and was developed by the Professional Development Services for Teachers Physical Education (PDST-PE). The PDST-PE were approached and agreed to collaborate on this project, which led to the FMS lesson content of the Moving Well-Being Well intervention being made up of extracts from their Move Well, Move Often resource.

As discussed previously, external providers are often used in primary schools to support PE in primary schools. The Moving Well-Being Well project is in partnership with the Gaelic Athletic Association (GAA). The GAA is Ireland's largest sporting organisation and promotes indigenous Gaelic games such as Gaelic football, hurling, camogie, handball and rounders (GAA, 2019). The GAA are the largest external provider in primary schools, providing specialised sport specific support through their community based GAA coaches. Through this partnership, it is envisioned the pilot intervention will be deployed through a network of trained GAA coaches.

The intervention will be delivered to participants in three components: FMS lessons, active classroom activities, and home activities (Stage 3 Step 8). Tailored, 30-minute FMS specific lessons will be delivered by the GAA coach for six weeks. These classes will be delivered in a holistic manner, with a focus on creating a mastery environment. While providing these lessons, the GAA coach will also upskill the teacher in how to deliver an FMS based class. The teacher will have delivered each lesson to their class in the same week before the GAA coach returns to deliver the next lesson. After week six, the teacher must deliver the last two weeks of the intervention without the support of the GAA coach. The intervention aspires to not only improve the FMS levels of the participating children, but also to develop the teacher's ability to deliver an FMS based lesson effectively. In this manner, through the restructuring of the external provision to a more professional development approach, it is hoped to increase the teacher's belief in their own expertise in primary school PE.

Active classrooms have been shown to be an important component to effective, multicomponent interventions in a school setting (Martin & Murtagh, 2015). As part of the Moving Well-Being Well intervention, an interactive whiteboard resource has been designed for each day of the program. These include simple, easy to follow activities for the participants to partake in the classroom for approximately five minutes a day. Through this, the intention is to increase children's PA, develop knowledge and understanding components through the activities, and increase teacher confidence in engaging in active classroom activities.

The final component is the once weekly home activity. The aim is two-fold, to encourage the participants to be active with a parent/guardian and to develop knowledge and understanding.

Throughout the intervention, there will be a focus on just three locomotor skills: hop, skip and jump, and three object control skills: catch, kick and throw. These skills did not all emerge from the national cross-sectional data collection as the weakest, but it is important to note that none are close to mastery (Behan et al., 2109). The designers of the intervention chose these skills for two reason: i) they are easily implementable in any school regardless of amenities available and any equipment required is inexpensive and readily available, ii) these skills, once mastered, will give any individual an excellent foundation to acquire more complex skills used in sport or PA.

Moving Well-Being Well Physical Literacy intervention is an 8 week programme that will be evaluated through a pre-post assessment, with a follow up retention testing after six months. This study was granted ethical approval by the institution Research Ethics committee (DCU/REC/2017/029). Schools will be invited to take part from a selection of primary schools in the targeted study region. Pending a school's recruitment, written consent will be required from school principals, teachers, parents and participants. Participating schools will be matched as best as possible on key demographics including: socioeconomic status, size, ethos and gender. The resulting pairs will make up the intervention and control groups, with each pair having a school in either group. Those schools included in the intervention group will receive the intervention over an eight-week period. All participants will receive baseline testing in week one with follow up assessments in week ten, and retention testing after six months. The primary outcome will be the change in PL components over time.

Overall, the holistic approach to intervention design presented in this study supports the interventionist in targeting a change in PL of Irish children, taking into consideration their motivation and surrounding environmental context. Initial implementation of the intervention will focus on a young cohort so that a preventive medicine approach can be taken to tackle and 'refract' existing weaknesses and needs.

References

Acker, R. Van, De Bourdeaudhuij, I., De Martelaer, K., Seghers, J., Kirk, D., Haerens, L., … De, K. (2011). A Framework for Physical Activity Programs Within School-Community Partnerships. *Quest*, *63*(3), 300–320. https://doi.org/10.1080/00336297.2011.10483683

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review*, *84*(2), 191–215. https://doi.org/10.1037/0033-295X.84.2.191

Bandura, A. (1982). *Self-efficacy mechanism in human agency. American Journal of Psychology*. https://doi.org/10.1037/0003-066X.37.2.122

Bandura, A. (1997). Self-efficacy. *Encyclopedia of Human Behavior*, *4*(1994), 1–65. https://doi.org/10.1002/9780470479216.corpsy0836

Barnett, L. M., van Beurden, E., Morgan, P. J., Brooks, L. O., & Beard, J. R. (2009a). Childhood Motor Skill Proficiency as a Predictor of Adolescent Physical Activity. *Journal of Adolescent Health*, *44*(3), 252–259. https://doi.org/10.1016/j.jadohealth.2008.07.004

Barnett, L. M., van Beurden, E., Morgan, P. J., Brooks, L. O., & Beard, J. R. (2009b). Childhood Motor Skill Proficiency as a Predictor of Adolescent Physical Activity. *Journal of Adolescent Health*, *44*(3), 252–259. https://doi.org/10.1016/j.jadohealth.2008.07.004

Bartholomew, J. B., Loukas, A., Jowers, E. M., & Allua, S. (2006). Validation of the Physical Activity Self-Efficacy Scale: Testing Measurement Invariance between Hispanic and Caucasian Children. *Journal of Physical Activity and Health*, *3*(1), 70–78. https://doi.org/10.1123/jpah.3.1.70

Belton, S., O' Brien, W., Meegan, S., Woods, C., & Issartel, J. (2014). Youth-Physical Activity Towards Health: evidence and background to the development of the Y-PATH physical activity intervention for adolescents. *BMC Public Health*, *14*(1), 122. https://doi.org/10.1186/1471-2458-14-122

Cairney, J., Veldhuizen, S., Graham, J. D., Rodriguez, C., Bedard, C., Bremer, E., & Kriellaars, D. (2018). A Construct Validation Study of PLAYfun. *Medicine and Science in Sports and Exercise*, *50*(4), 855–862. https://doi.org/10.1249/MSS.0000000000001494

Corbin, C. B. (2016). Implications of Physical Literacy for Research and Practice: A Commentary. *Research Quarterly for Exercise and Sport*, *87*(1), 14–27. https://doi.org/10.1080/02701367.2016.1124722

Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika*, *16*(3), 297–334. https://doi.org/10.1007/BF02310555

De Meij, J. S. B., Chinapaw, M. J. M., Kremers, S. P. J., Van Der Wal, M. F., Jurg, M. E., & Mechelen, W. Van. (2010). Promoting physical activity in children: the stepwise development of the primary school-based JUMP-in intervention applying the RE-AIM evaluation framework. *Br J Sports Med*, *44*, 879–887. https://doi.org/10.1136/bjsm.2008.053827

Edward L. Deci, & Richard M. Ryan. (2000). The "What" and "Why" of Goal Pursuits: Human Needs and the Self-Determination of Behavior. *Psychological Inquiry*, *11*(4), 227–268.

Edwards, L. C., Bryant, A. S., Keegan, R. J., Morgan, K., & Jones, A. M. (2017). Definitions, Foundations and Associations of Physical Literacy: A Systematic Review. *Sports Medicine*, *47*(1), 113–126. https://doi.org/10.1007/s40279-016-0560-7

Fundamental Motor Skills: A Manual for Classroom Teachers. (1996). State of Victoria.

Goh, T. L., Hannon, J., Webster, C. A., Podlog, L. W., Brusseau, T., & Newton, M. (2014). Chapter 7 Effects of a Classroom-Based Physical Activity Program on Children's Physical Activity Levels. *Journal of Teaching in Physical Education*, *33*(4), 558–572. https://doi.org/10.1123/jtpe.2014-0068

Kriemler, S., Meyer, U., Martin, E., van Sluijs, E. M. F., Andersen, L. B., & Martin, B. W. (2011a). Effect of school-based interventions on physical activity and fitness in children and adolescents: a review of reviews and systematic update. *British Journal of Sports Medicine*, *45*(11), 923–930. https://doi.org/10.1136/bjsports-2011-090186

Kriemler, S., Meyer, U., Martin, E., van Sluijs, E. M. F., Andersen, L. B., & Martin, B. W. (2011b). Effect of school-based interventions on physical activity and fitness in children and adolescents: a review of reviews and systematic update. *British Journal of Sports Medicine*, *45*(11), 923–930. https://doi.org/10.1136/bjsports-2011-090186

Martin, R., & Murtagh, E. M. (2015). Preliminary findings of Active Classrooms: An intervention to increase physical activity levels of primary school children during class time. *Teaching and Teacher Education*, *52*, 113–127. https://doi.org/10.1016/J.TATE.2015.09.007

Metcalf, B., Henley, W., & Wilkin, T. (2012). Effectiveness of intervention on physical activity of children: systematic review and meta-analysis of controlled trials with objectively measured outcomes. *BMJ (Clinical Research Ed.)*, *345*, e5888. https://doi.org/10.1136/bmj.e5888

Michie, S., van Stralen, M. M., & West, R. (2011). The behaviour change wheel: A new method for characterising and designing behaviour change interventions. *Implementation Science*, *6*(1), 42. https://doi.org/10.1186/1748-5908-6-42

Murillo Pardo, B., Garcia Bengoechea, E., Generelo Lanaspa, E., Bush, P. L., Zaragoza Casterad, J., Julian Clemente, J. A., & Garcia Gonzalez, L. (2013). Promising school-based strategies and intervention guidelines to increase physical activity of adolescents. *Health Education Research*, *28*(3), 523–538. https://doi.org/10.1093/her/cyt040

Murphy, M., Rowe, D. A., Belton, S., & Woods, C. B. (2015). Validity of a two-item physical activity questionnaire for assessing attainment of physical activity guidelines in youth. *BMC Public Health*, *15*(1), 1080. https://doi.org/10.1186/s12889-015-2418-6

Peers, C., Issartel, J., Behan, S., O'Connor, N., & Belton, S. (2001). Contribution of Competence to the Physical Self Efficacy. *Human Movement Science*, *under review*.

Prochaska, J. J., Sallis, J. F., & Long, B. (2001). A physical activity screening measure for use with adolescents in primary care. *Archives of Pediatrics and Adolescent Medicine*, *155*(5), 554–559. https://doi.org/10.1001/archpedi.155.5.554

Ryan, R. M., & Deci, E. L. (2000). Intrinsic and Extrinsic Motivations: Classic Definitions and New Directions. *Contemporary Educational Psychology*, *25*(1), 54–67. https://doi.org/10.1006/ceps.1999.1020

Salmon, J., Booth, M. L., Phongsavan, P., Murphy, N., & Timperio, A. (2007). Promoting Physical Activity Participation among Children and Adolescents. *Epidemiologic Reviews*, *29*(1), 144–159. https://doi.org/10.1093/epirev/mxm010

Sebire, S. J., Jago, R., Fox, K. R., Edwards, M. J., & Thompson, J. L. (2013). Testing a self-determination theory model of children’s physical activity motivation: a cross-sectional study. *British Journal of Educational Psychology*. https://doi.org/10.1186/1479-5868-10-111

Stodden, D., Goodway, J. D., Langendorfer, S. J., Roberton, M. A., Rudisill, M. E., Garcia, C., & Garcia, L. E. (2008). A Developmental Perspective on the Role of Motor Skill Competence in Physical Activity: An Emergent Relationship. *Quest*, *60*(2), 290–306. https://doi.org/10.1080/00336297.2008.10483582

Timperio, A., Salmon, J., & Ball, K. (2004). Evidence-based strategies to promote physical activity among children, adolescents and young adults: review and update. *Journal of Science and Medicine in Sport*, *7*(1), 20–29. https://doi.org/10.1016/S1440-2440(04)80274-3

Tremblay, M. S., Longmuir, P. E., Barnes, J. D., Belanger, K., Anderson, K. D., Bruner, B., … Woodruff, S. J. (2018). Physical literacy levels of Canadian children aged 8-12 years: descriptive and normative results from the RBC Learn to Play-CAPL project. *BMC Public Health*, *18*(1036). https://doi.org/10.1186/s12889-018-5891-x

Whitehead, M. (2013). *Definition of Physical Literacy and Clarification of related Issues*. Retrieved from http://www.icsspe.org/sites/default/files/bulletin65_0.pdf#page=29

Appendix B: Examples of FMS Specific Lesson Plans from the Moving Well-Being Well Intervention Resources

Moving Well Being Well

Lesson 3

Skills Focus

Skipping
Catching
Throwing
Jumping

This pack contains activities from the PDST Move Well, Move Often Resource.

The other side of this card contains a teacher aid that should accompany this lesson. This aid is aimed at assisting a teacher delivering the lesson.

Equipment required

Cones
Beanbags
Tennis Balls
Balls of various sizes

DCU

Insight

This project is being run by the School of Health and Human Performance in Dublin City University, in collaboration with the Insight Centre for Data Analytics

Supported by

GAA

ÁTH CLIATH

Teachers Notes:

FREEZE

DANCE GYMNASTICS

Description of Activity

Pupils find a space in the playing area. Invite them to skip freely around the playing area. On a signal, or when the teacher calls 'freeze', pupils must perform a balance and hold it for a count of five. After they reach the number five, they continue skipping freely around the space. Balancing prompts may include: balance on one foot, balance on two body parts, balance on a large body part, balance on one hand and one foot etc. Pupils perform a different balance each time.

Variations

- Vary the locomotor skill used to move around the area, e.g. hopping, side stepping.
- As the activity progresses introduce partner work and group balances.
- Arrange pupils in pairs, with one skipping and the other watching. Give them clear guidelines to provide each other with feedback on their skipping technique. The observing pupils provide the suggestions for each balance. Alternate roles each time.

Equipment

An open playing area

- Explore a theme for each balance, e.g. animals, superheroes etc.
- Pause the activity at intervals to focus on the specific teaching points for skipping in the lesson. Invite a pupil to demonstrate correct technique, allow pupils to practise in isolation and then return to the activity. Provide feedback to individuals while they perform the skipping action during the activity.

- In your PE journal, create a new game that involves skipping. Show your friends how to play it in the yard.

scipeáil • reoigh • cothromaíocht • baill choirp

PDST Resources from the PDST PE Resource 'Move Well, Move Often'

BOUNCE PASS

ATHLETICS GAMES

Description of Activity

Arrange pupils in pairs and invite them to find a space in the playing area where they are not in contact with other pupils. Pupils face each other, approximately five metres apart and place a spot marker on the floor in the middle, equidistant from each pupil. Pupil A bounces the ball on or near the spot for their partner to catch. Pupil B then repeats the action.

Variations

- Alternate the hands used to bounce and catch e.g. bounce with two hands and catch with one or bounce with one hand and catch with the other.
- Vary the size or shape of the ball.

Equipment

A hard playing surface, spot markers, balls of various sizes including tennis balls

- Ensure pairs are evenly spaced and that pupils are not throwing across the path of another pair.
- At regular intervals pause the activity and discuss today's teaching points for catching. Invite a pupil to demonstrate correct technique, invite pupils to practise in isolation and then return to the activity.

- In your PE journal, draw a picture of a game that involves catching.

preabphas • gabháil agus caitheamh • spás le dromchla crua • ag obair i mbeirteanna • liathróid a phreabadh • malartaigh na lámha • forleathnú

Resources from the PDST PE Resource 'Move Well, Move Often'

CATCH THE LEADER

ATHLETICS GAMES GYMNASTICS

Description of Activity

Arrange pupils in groups of eight to ten and invite them to form a circle. The leader stands in the centre of the circle with a ball. The leader throws their ball to a pupil in the circle, who throws it back to them, and this action continues around the circle in a clockwise direction until every pupil has had a turn. After the last turn, the leader gives the ball to the next pupil and the activity continues until each pupil has had a turn as leader.

Variations

- Pupils balance on one leg after throwing the ball back to the leader.
- Pupils complete three jumps for height after they have thrown the ball back to the leader.
- Invite two leaders to stand back to back in the centre of the circle. The game continues as before, but now the passes must be completed at a faster pace.
- Increase or decrease the size of the circle.
- Vary the manipulative skill used to move the object, eg. kicking, striking with an implement, striking with the hand etc.

Equipment

An open playing area, balls of various sizes

- Pupils awaiting a turn should extend their hands outwards in anticipation of the ball.
- Pause the activity at intervals to focus on the specific teaching points for throwing in the lesson. Invite a pupil to demonstrate correct technique, and then return to the activity. Provide feedback to individual pupils as they practise throwing during the activity.
- Emphasise the importance of teamwork and cooperation - a good throw is necessary for a good catch!

- Practise throwing at home using a teddy bear. Investigate whether this is easier or more difficult than throwing a ball.

ochtar nó deichniúr • beirt cheannaire • ciorcal • droim le droim • ag caitheamh na liathróide

PDST

Resources from the PDST PE Resource 'Move Well, Move Often'

DISCOVER JUMP

ATHLETICS DANCE GAMES GYMNASTICS

Description of Activity

Give each pupil a spot marker, and invite them to find a space in the playing area where they are not in contact with anyone else. Each pupil places their spot marker on the floor and stands on the spot. Invite pupils to practise jumping onto and off their spot using some of the following instructions:

- Jump very fast or slow
- Jump like a giant or a frog
- Jump with stiff legs and arms
- Jump up and down keeping your arms out from your side
- Jump on and off your spot with legs apart and land with feet apart
- Start on your spot and jump three times forward in a straight line
- Start on your spot and jump around in a wide circle until you return to your spot

Variations

- Invite pupils to create their own different types of jump actions.
- Invite pupils to work in pairs to create a jump sequence.
- Add a low object to jump over e.g. rope, cone, beanbag.

Equipment

An open playing area, spot markers, ropes, cones, beanbags

- **Ensure there is adequate space between pupils to allow them to jump on and off their spot without crossing the path of another pupil.**
- **Pause the activity at intervals to focus on the specific teaching points for jumping in the lesson. Provide feedback to individuals while they perform the jumping action during the activity.**

- **In your PE journal, draw a picture of you jumping.**

ag seasamh ar spota • léim tapaidh • léim mall • ciúin • glórach • lámha amach

PDST

Resources from the PDST PE Resource 'Move Well, Move Often'

Lesson Notes:

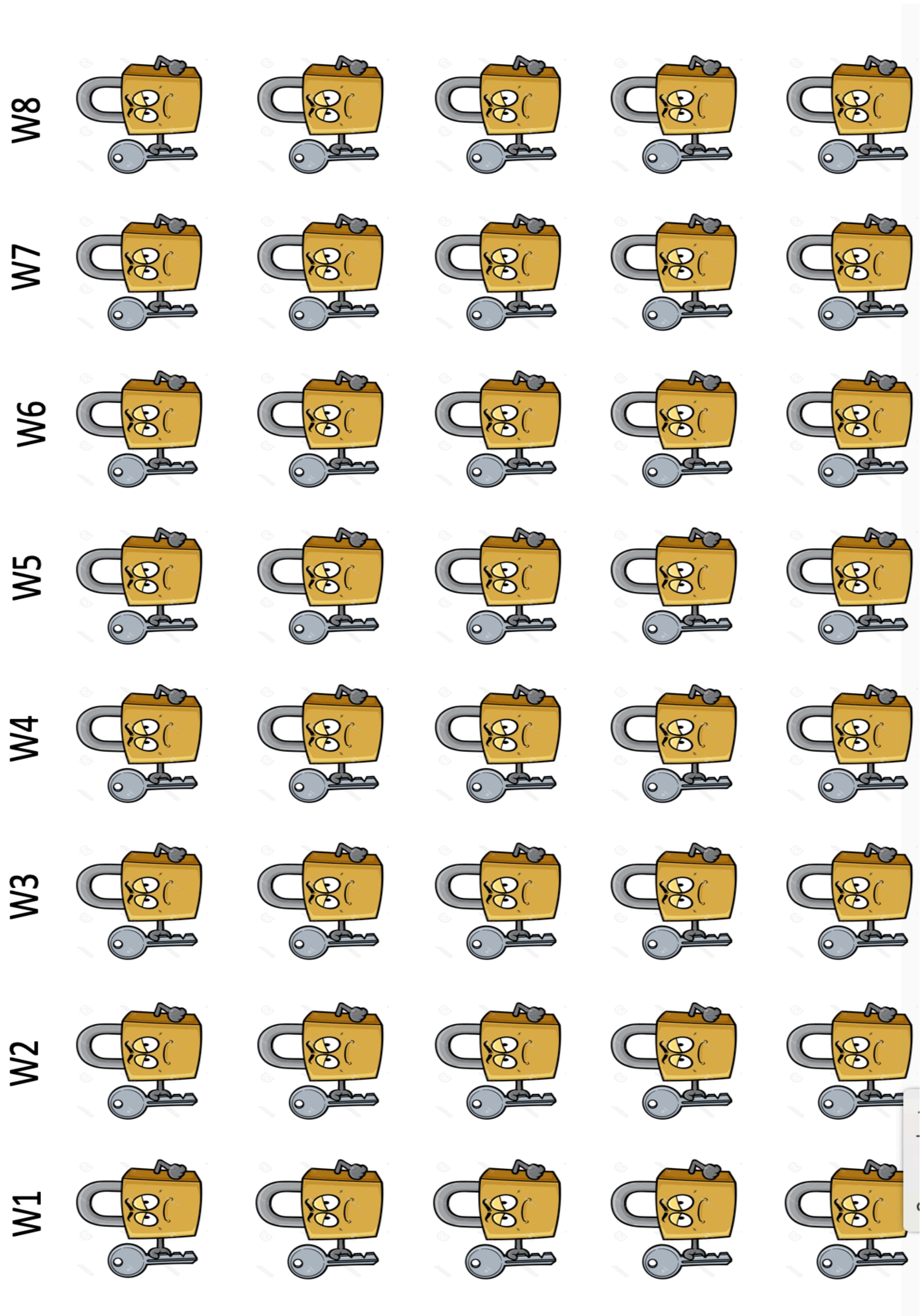
What went well:

What didn't work so well:

Targets for next lesson:

LESSON 3 - FREEZE
5 MINS
Learning Intention:
Child is learning to skip in a fluid motion through swinging the opposite leg forward for momentum
Key Questions:
What type of balance could we do?
Can you hold for more than 5 seconds?
FMS Differentiation and Success Criteria
STEPS & HOPS ON ONE FOOT
OPPOSITE ARM TO LEG
SWINGS LEG FOR MOMENTUM
ALTERNATES ARMS AND LEGS FLUID SKIPPING
Step 1
Step 2
Step 3
Step 4
LESSON 3 - CATCH THE LEADER
10 MINS
Learning Intention:
Child is learning to co-operate within a group and identify that their throw can go further if they rotate their torso when throwing
Key Questions:
How can we improve our throw?
FMS Differentiation and Success Criteria
THROW STARTS OVER SHOULDER
STEPS WITH OPPOSITE FOOT TO THROW
ROTATES TORSO AND ARM EXTENDS BEHIND
ARM LAGS WHEN THROWING
Step 1
Step 2
Step 3
Step 4
LESSON 3 - BOUNCE PASS
10 MINS
Learning Intention:
Child is learning to adjust their body to reach hands out to catch a bouncing ball
Key Questions:
Can you make it easier/harder for your partner?
Can you use a different ball?
FMS Differentiation and Success Criteria
CATCHES INTO CHEST
CATCHES WITH JUST HANDS
ADJUSTS FEET & HANDS TO CATCH
CATCHES WITH EITHER HAND
Step 1
Step 2
Step 3
Step 4
LESSON 3 - DISCOVER JUMP
5 MINS
Learning Intention:
Child is learning to appreciate that bending knees before jumping off two feet can help them go further
Key Questions:
Which is the easiest jump to do?
Can you bend your knees before jumping?
FMS Differentiation and Success Criteria
JUMP WITH BOTH FEET AT SAME TIME
CROUCHES BEFORE JUMPING
ARMS SWING BEHIND BEFORE JUMP
ARMS SWING FORWARD, LEGS FULLY EXTEND
Step 1
Step 2
Step 3
Step 4

Appendix C: **Examples of the Active Learning classroom component from the Moving Well-Being Well Intervention Resources**



Frog Hunches

- Start standing up straight
- Hunch down like a frog , bending your knees and touching the floor with your hands
- Go from standing to hunched position and back 10 times

Starfish Jumping Jacks

- Stand feet together
- Jump and spread your feet apart, move your hands out and overhead like the starfish
- Jump again , bring feet together and arms back to side

- Do it for 20 seconds
    - What happens to your chest? Why does this happen?

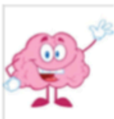
Appendix D: **Examples of the Home Activity component from the Moving Well-Being Well Intervention Resources**

ACTIVITY - JUMPING

DESCRIPTION OF ACTIVITY

Ask someone at home to join in

1. Stand with your feet together and jump as high as you can. Be sure to land with both of your feet at the same time
2. Does crouching down before you jump help you jump higher?
3. Does using your arms help with your jump?
4. Ask mammy and daddy to do it too, who has the highest jump?
5. Can you think up any high jumping games? Play for 1 minute with someone at home



BRAINY BITS

How many minutes each day should you and other children do physical activities?

This is anything that makes your heart beat faster or makes you breath faster, like walking fast or running.

Use the clock and draw your answer in

Sometimes children watch television, play video games or play on the computer and on a phone.

What is the most time that children should look at a screen each day?

Do not count the time that you have to look at a screen to do your homework.

Use the clock and draw your answer in

JUMPING

Moving Well Being Well

ACTIVITY - HOPPING

DESCRIPTION OF ACTIVITY

Ask someone at home to join in

1. Stand on one foot and hop around the room.
2. Can you do it on the other foot? Which foot is the best?
3. Does using your arms help with your hop?
4. Ask someone to try it too, can they hop well on both feet?

BRAINY BITS

Physical activity is about making friends and fun. Fill in the blanks

Should not ***Stop*** ***Should*** ***Keep going***

If someone falls in front of you while running a race and they are hurt, you should ______________________and check if they are alright.

When playing sport, you cannot win all the time. If you lose, the important thing is to ____.

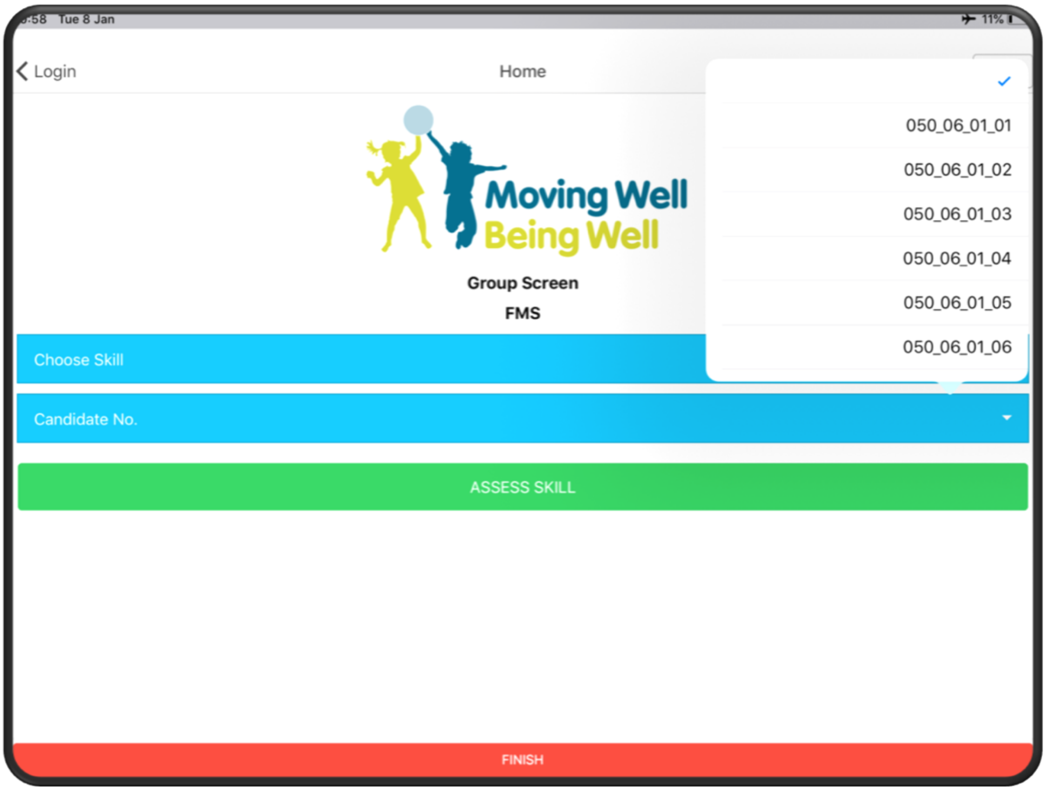
Everyone makes mistakes. If you see someone make a mistake, you ________ go over and see if there is any way that you could help.

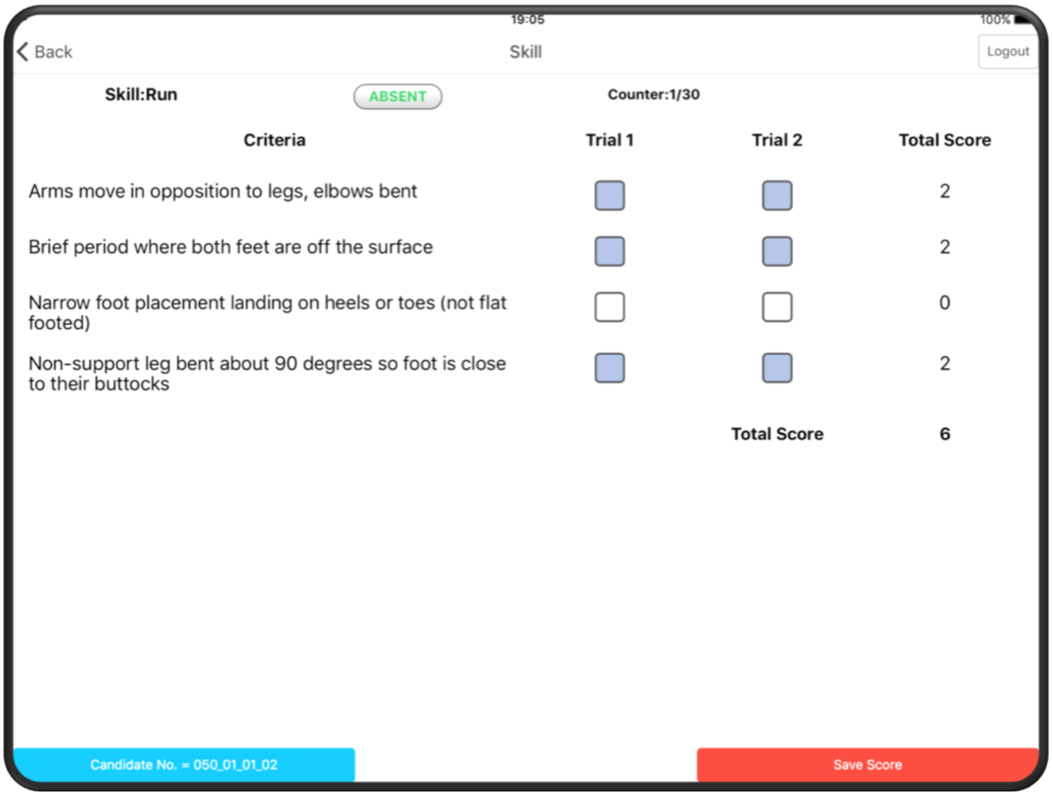
Winning is nice. Remember when you win that you ___________________ laugh at the losers.

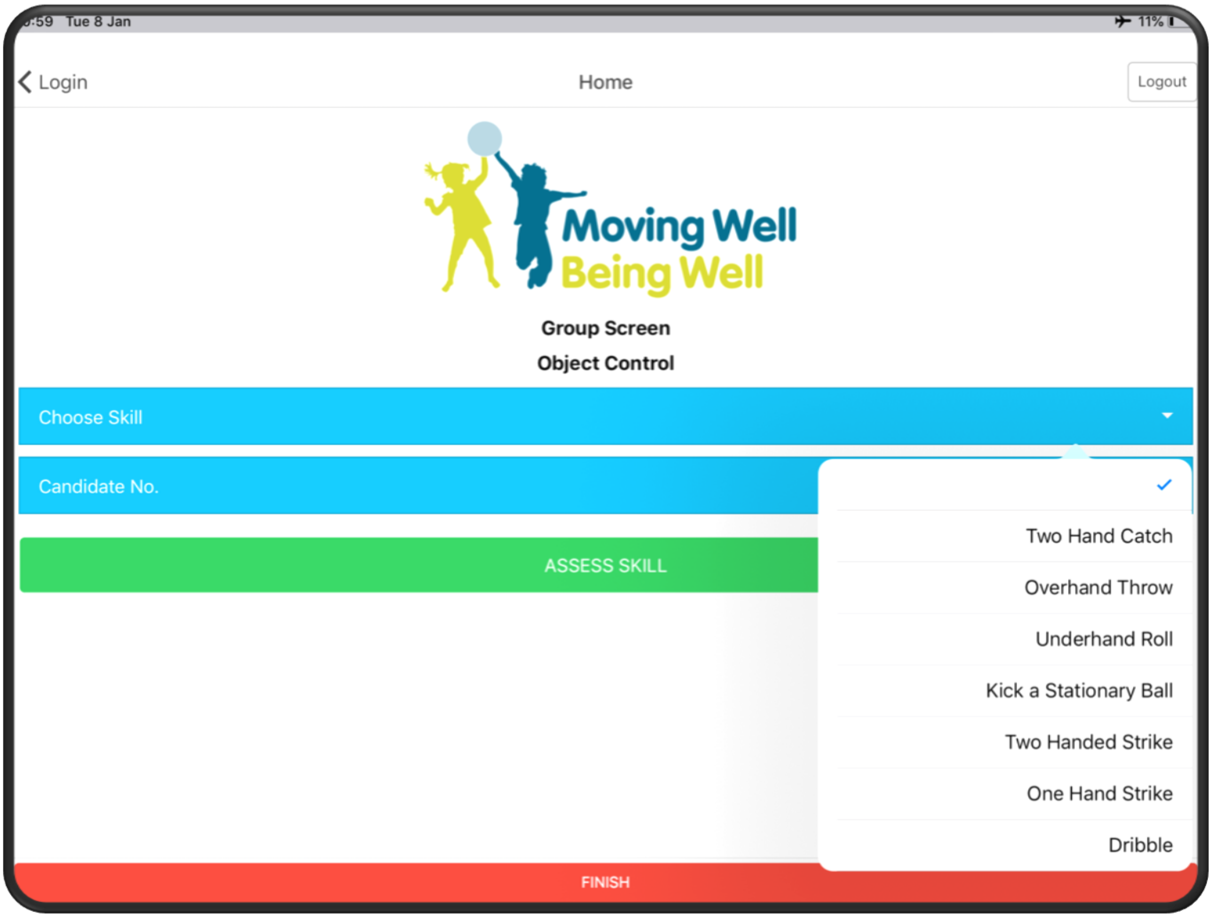
JUMPING

Moving Well Being Well

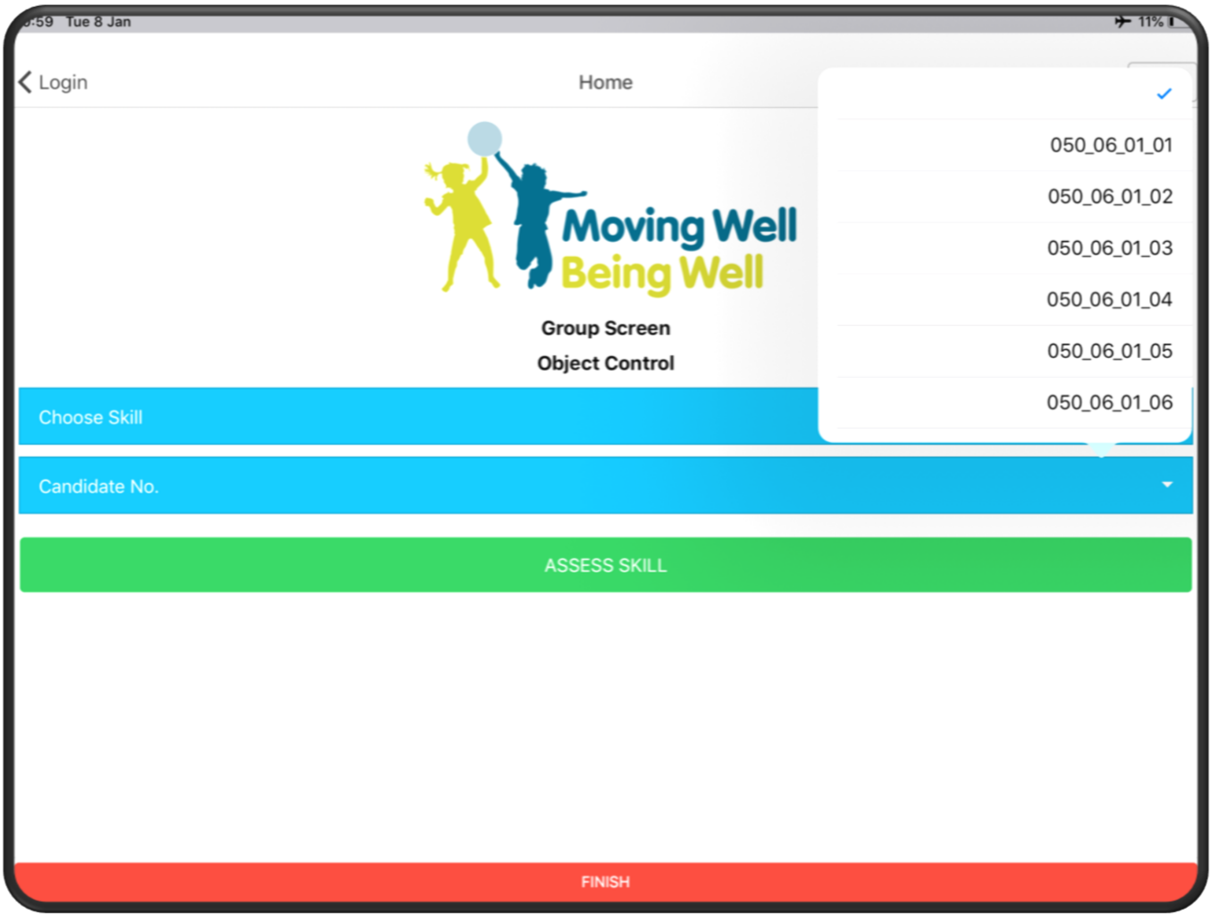
Appendix E: **Screenshots of the iPad application developed as part of the Moving Well Being Well project.**



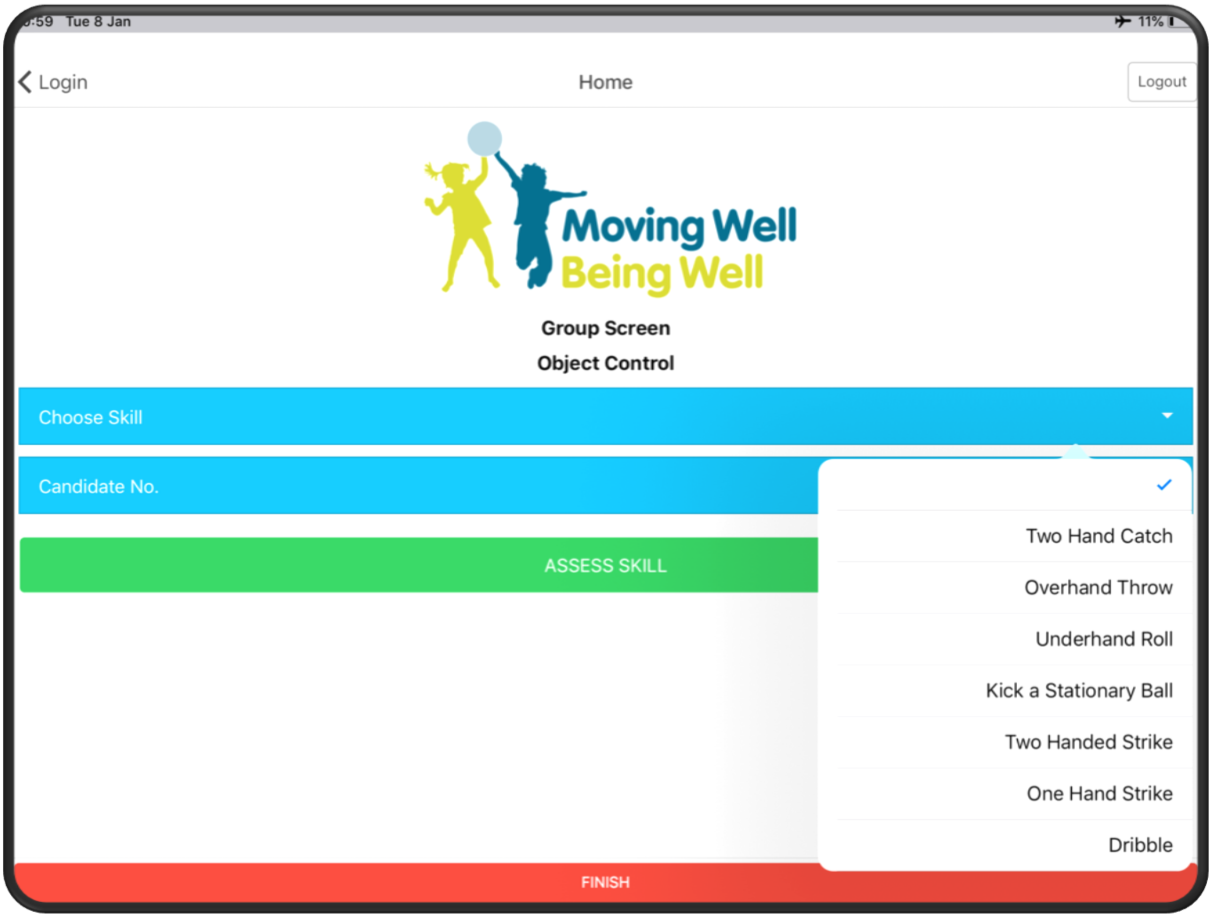



Tue 8 Jan
11%
Login
Home
Logout
Moving Well
Being Well
Group Screen
Object Control
Choose Skill
Candidate No.
ASSESS SKILL
Two Hand Catch
Overhand Throw
Underhand Roll
Kick a Stationary Ball
Two Handed Strike
One Hand Strike
Dribble
FINISH

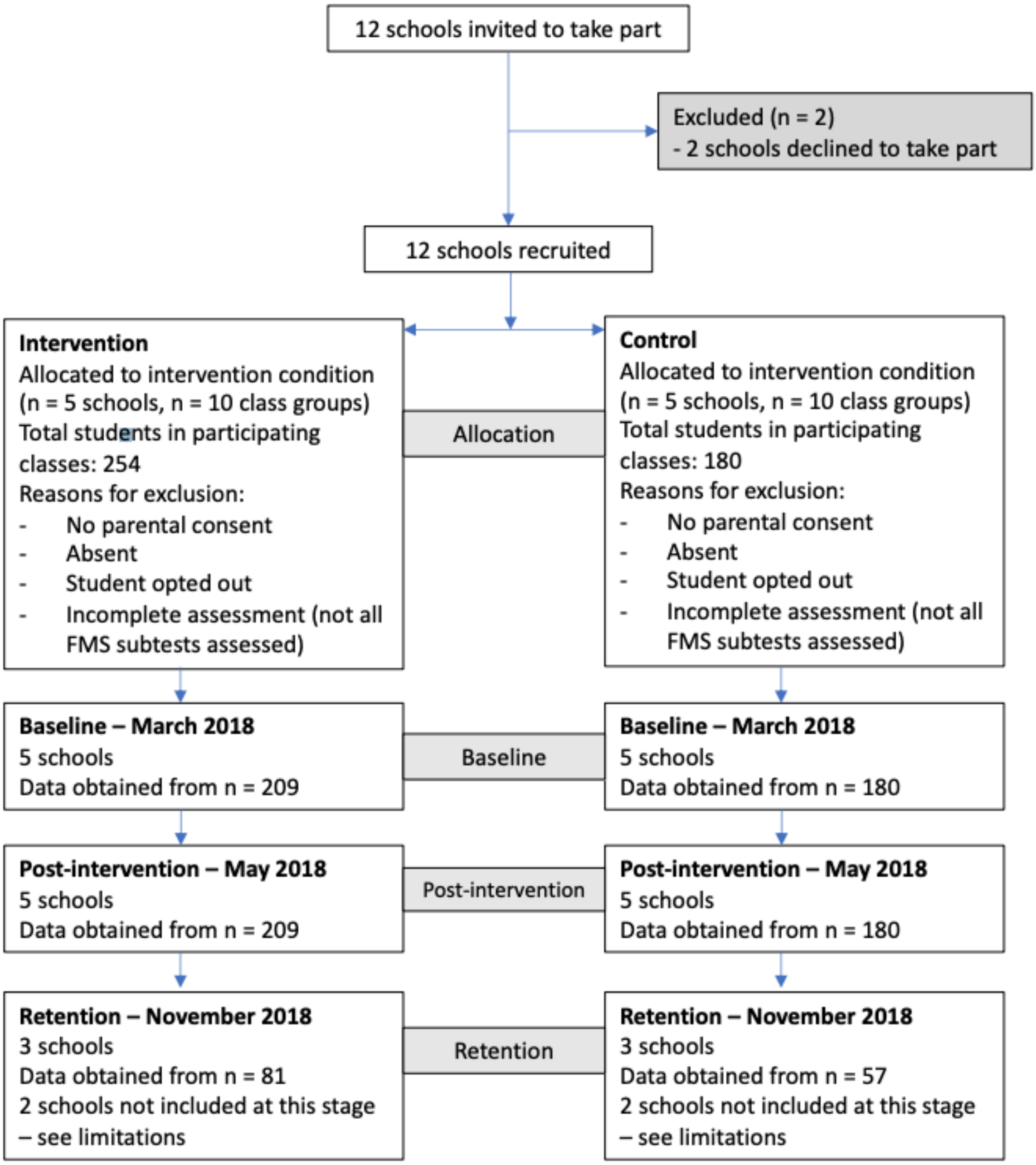

19:09
100%
Login
Home
Logout
Moving Well
Being Well
Group Screen
FMS
Object Control
HRF
Balance
GAA
UPLOAD RESULTS



Tue 8 Jan
11%
Login
Home
Moving Well
Being Well
Group Screen
Object Control
Choose Skill
Candidate No.
ASSESS SKILL
FINISH
050_06_01_01
050_06_01_02
050_06_01_03
050_06_01_04
050_06_01_05
050_06_01_06



Tue 8 Jan
11%
Login
Home
Logout
Moving Well
Being Well
Group Screen
Object Control
Choose Skill
Candidate No.
ASSESS SKILL
FINISH
Two Hand Catch
Overhand Throw
Underhand Roll
Kick a Stationary Ball
Two Handed Strike
One Hand Strike
Dribble


12 schools invited to take part
Excluded (n = 2)
- 2 schools declined to take part
12 schools recruited
Intervention
Allocated to intervention condition
(n = 5 schools, n = 10 class groups)
Total students in participating classes: 254
Reasons for exclusion:
- No parental consent
- Absent
- Student opted out
- Incomplete assessment (not all FMS subtests assessed)
Allocation
Control
Allocated to intervention condition
(n = 5 schools, n = 10 class groups)
Total students in participating classes: 180
Reasons for exclusion:
- No parental consent
- Absent
- Student opted out
- Incomplete assessment (not all FMS subtests assessed)
Baseline – March 2018
5 schools
Data obtained from n = 209
Baseline
Baseline – March 2018
5 schools
Data obtained from n = 180
Post-intervention – May 2018
5 schools
Data obtained from n = 209
Post-intervention
Post-intervention – May 2018
5 schools
Data obtained from n = 180
Retention – November 2018
3 schools
Data obtained from n = 81
2 schools not included at this stage – see limitations
Retention
Retention – November 2018
3 schools
Data obtained from n = 57
2 schools not included at this stage – see limitations