

**Exploring Variables that Predict Nova Scotia Children's Physical Literacy
Progression from Year to Year**

By
Natalie Houser

Submitted in partial fulfillment of the requirements
for the degree of Master of Science
at
Dalhousie University
Halifax, Nova Scotia
April, 2017

© Copyright by Natalie Houser, 2017

TABLE OF CONTENTS

LIST OF TABLES	v
LIST OF FIGURES	vi
ABSTRACT	vii
LIST OF ABBREVIATIONS USED	viii
ACKNOWLEDGEMENTS	ix
CHAPTER 1: INTRODUCTION	1
1.1 Introduction	1
1.2 Research Question and Hypotheses	4
CHAPTER 2: LITERATURE REVIEW	6
2.1 Physical Activity	6
2.2 Physical Inactivity and Sedentary Behaviour	7
2.3 Fundamental Movement Skill Development	8
2.4 Physical Literacy	10
2.5 Physical Literacy Measurement Tools	12
2.5.1 Canadian Assessment of Physical Literacy	12
2.6 Development of the Canadian Assessment of Physical Literacy	13
2.7 Child Growth, Development, and Maturation	15
2.8 Summary	21
CHAPTER 3: METHODS	23
3.1 Study Site	23
3.2 Ethics	23
3.3 Participants	23

3.3.1 Children	23
3.4 Procedure	24
3.5 Data Analysis	29
CHAPTER 4: RESULTS	32
4.1 Descriptive Statistics	32
4.2 Categorization Change from Year 1 to Year 2	33
CHAPTER 5: DISCUSSION	38
5.1 Physical Literacy Categorization Change	38
5.2 Measurement of Growth, Maturation, and Development	40
5.3 Changing CAPL Categories Based on Children’s Age and Sex	42
5.4 Average Daily Steps	45
5.5 CAPL Score Requirements for PL Categories	47
5.6 School Differences	50
5.7 CAPL Domains	51
5.8 Strengths and Limitations	56
5.9 Future Research	56
5.10 Conclusion	57
REFERENCES	59
Appendix A- CHEO Research Ethics Approval	67
Appendix B- Dalhousie Research Ethics Approval	69
Appendix C- StFX Research Ethics Approval	70
Appendix D- Strait Regional School Board Ethics Approval	71
Appendix E- Parental Consent and Health Screening Form	72

Appendix F- Obstacle Course Score Sheet	80
Appendix G- Pedometer Tracking Sheet	81
Appendix H- Change in Categorization from Year 1 to Year 2 in Each Domain	82

LIST OF TABLES

Table 1	Development of CAPL categories (Longmuir, personal communication, February 9, 2017).	14
Table 2	CAPL total score ranges (HALO,2014)	15
Table 3	Age and sex of the participants	32
Table 4	Height (cm), weight (kg), waist circumference (cm) and BMI (kg*m2) of the participants by age.	33
Table 5	Summary of multinomial logistic regression analysis	37

LIST OF FIGURES

Figure 1	Mountain of motor development (Clark, 2007)	9
Figure 2	PACER categories for boys and girls (HALO, 2014)	20
Figure 3	PL domains and scoring overview (HALO, 2014)	25
Figure 4	CAPL categorization in year 1 and year 2	33
Figure 5	Congruence of PL classifications from year 1 to year 2	35
Figure 6	Average steps for each categorization (lower, same, and higher)	47
Figure 7	Overall PL scores and categories for each age (HALO, 2014)	48

ABSTRACT

Physical literacy (PL) describes the motivation, confidence, physical competence, knowledge and understanding to value and take responsibility for physical activities (PA) for life. Although PL has become a popular area of research, how PL changes over time in children has not been considered. The Canadian Assessment of Physical Literacy (CAPL) protocol accounts for age- and sex-related changes in PL categorizations for 8-12 year-olds. No studies to date have conducted longitudinal research with CAPL data. This study examined whether variables within the CAPL protocol predicted change in children's overall PL categorization from one year to the next. Based on established age- and sex-based PL standards, 52% of children remained in the same category in year 2. Age and an increase in average daily steps predicted upward and downward changes in PL, respectively. The exploration of longitudinal PL data will provide insight into PL progression that could assist with intervention development.

LIST OF ABBREVIATIONS USED

CAPL- Canadian Assessment of Physical Literacy

FMS- Fundamental movement skills

HALO- Healthy Active Living and Obesity

MVPA- Moderate to vigorous physical activity, physical activity that requires 3-6+ metabolic equivalents (METs) of energy expenditure (WHO, 2015)

PA- Physical activity

PACER- Progressive Aerobic Cardiovascular Endurance Run

PE- Physical education

PL- Physical literacy

SB- Sedentary behaviour

ACKNOWLEDGEMENTS

To my family and friends, thank you for your unwavering support throughout this process, it means more than you realize. Angie and Michelle, I can't thank you enough for your constant support, patience, encouragement and expertise. Your guidance throughout the last two years has allowed me to achieve more than I would have anticipated and lead me in a direction I couldn't have seen coming. A special thanks also goes to the Heart and Stroke Foundation, Mitacs Accelerate Program, and Dalhousie's Nova Scotia Graduate Scholarship for providing the funding that made this Master's thesis work possible.

CHAPTER 1: INTRODUCTION

1.1 Introduction

Physical activity (PA) participation is a critical component of healthy growth and development in childhood (Mirtz et al., 2011), providing a wide range of physical, psychosocial, and cognitive health benefits that track into adulthood and reduce the risk of chronic disease (Janssen and LeBlanc, 2010). PA provides a wide range of short- and long-term health benefits for children, including a reduction in the risk of chronic disease, an increase in bone mass, and positive associations with improved academic performance and mental health (Castelli et al., 2015; Okely et al., 2001). However, only 9% of school-aged children (age 5-17 years) are meeting the minimum recommendations of 60 minutes of moderate-to-vigorous physical activity (MVPA) per day (Statistics Canada, 2015). These moderate and vigorous levels of PA are equivalent to 3 to 6 METs and 6+ METs respectively (WHO, 2015). PA levels track from childhood into adulthood, and therefore the PA levels of children provide insight into their potential PA levels throughout adulthood (Thomas et al., 2008). Low levels of PA and a rise in physical inactivity are an issue not just in Canada, but increasingly in many countries around the world, resulting in a range of negative health consequences (WHO, 2014).

An individual who is physically inactive does not meet the minimum recommendations for daily PA participation (Sedentary Behaviour Research Network, 2012). This is different from sedentary behaviour (SB), which is referred to as any screen-based or non-screen-based activity requiring 1.5 METs or less of energy expenditure (Sedentary Behaviour Research Network, 2012). Considering that SB has been recognized as a prominent risk factor for global mortality, decreasing SB and

increasing PA among children should be of utmost concern (Castelli et al., 2015). PA behaviours in childhood reduces the prevalence of chronic disease risk factors that track into adulthood, with low PA resulting in an increased risk of chronic disease among adults.

Fundamental movement skills (FMS) are considered the building blocks for movement, and provide the foundation for sport-specific and specialized movement skills required for participation in a wide variety of PA for life (Lubans et al., 2010). FMS include locomotor (e.g., running and hopping), manipulative or object control (e.g. catching and throwing) and stability (e.g., balancing and twisting) skills (Gallahue and Ozmun, 2006). A recent review demonstrated a positive association between FMS competency and PA in children (Lubans et al., 2010). Clearly, there is a strong rationale for encouraging FMS development in childhood as a way of preventing low levels of PA. This connection between FMS and PA throughout the lifecourse is a critical factor to consider in an individual's physical literacy (PL) development.

In recent years, it has been suggested that PL influences an individual's likelihood to participate in lifelong PA (Castelli et al., 2015). PL is "the motivation, confidence, physical competence, knowledge and understanding to value and take responsibility for engagement in physical activities for life" (IPLA, 2014; ParticipACTION et al., 2015, p.1). The domains of PL consist not only of a physical component, but also cognitive, affective and behavioural components (Whitehead, 2010), which play pivotal roles in PA participation. Since PL can be influenced by an individual's experiences with PA, children should be given the opportunities to become lifelong movers through the teaching and practice of FMS. Measurement tools/protocols have been developed to

measure PL in children, including the Canadian Assessment of Physical Literacy (CAPL), which specifically assesses the PL of children aged 8-12 years (<https://www.capl-ecsf.ca/>, Healthy Active Living and Obesity (HALO) Research Group, 2014). The CAPL protocol measures four domains of PL: physical competence, knowledge and understanding, motivation and confidence, and daily behaviours. The combination of these four domains provides an overall PL score for each child, and these domains also allow for aggregate scores to be determined for each domain individually. In the proposed analyses, the focus will be on overall PL, questioning whether growth, development, and maturational changes are accounted for in the classification of PL overall in subsequent years, and exploring predictors of changes in PL from one year to the next. If the expected changes associated with normal growth and development are adequately accounted for in the CAPL protocol, children should be classified in the same category from one year to the next. These categories include: beginning “limited physical literacy compared to same-age peers” (HALO, 2014, p.16), progressing “similar to typical performance of same age peers” (HALO, 2014, p.16), achieving “meets minimum level recommended” (HALO, 2014, p.16), and excelling “exceeds minimum level recommended” (HALO, 2014, p.16).

In addition to the expected enhancement of FMS with growth and development, a variety of PA experiences also have a positive influence (Lemos et al., 2012).

Confounding the issue of PL development is the reality that children become less physically active with age. In other words, one of the PL components – daily behaviour decreases with age (Malina, 2001). Although PL has become a popular area of research over the last several years, little research has examined the longitudinal development of

PL. As such, this study will contribute to PL research and inform future practices and initiatives, with a much better understanding of what changes should be expected in children simply due to normally occurring growth, maturation and development processes. If children are consistently classified in different categories in years 1 and 2, this may indicate that the Nova Scotia sample is not representative of these established standards. Further, this research will examine whether certain demographic and physical variables (growth in height, increase in weight, average daily steps at baseline, age, and sex) predict children's transition into higher or lower PL categories in year 2.

1.2 Research Question and Hypotheses

Research Question:

1. Is the change in children's overall physical literacy categorization from year 1 to year 2 predicted by variables within the CAPL protocol? More specifically, after controlling for school-level changes (by coding for school in the model), is children's change in physical literacy from year 1 to year 2 predicted from age, sex, growth in height, increase in weight, or average daily steps?

Hypotheses:

Assuming the CAPL standards are applicable to children in Nova Scotia,

1. It is hypothesized that growth in height will be a significant predictor of a higher physical literacy categorization in year 2, as more rapid growth in height is an indicator of maturation.
2. It is hypothesized that an increase in weight will be a significant predictor of lower physical literacy categorization in year 2, as an excessive weight gain may relate to reduced physical competence. If weight gain is a significant

predictor, waist circumference will be examined to determine if the weight gain relates to a greater increase in body fat.

3. It is hypothesized that age and sex will not significantly predict a change in overall physical literacy categorization, as age- and sex-related changes should be accounted for in the current CAPL standards.
4. It is hypothesized that average daily steps will be a significant predictor of a lower physical literacy categorization in year 2, as it is anticipated that steps will decrease from year 1 to year 2, as children tend to be less physically active with age.

CHAPTER 2: LITERATURE REVIEW

2.1 Physical Activity

Moderate-intensity PA is described as PA achieving an intensity of 5 or 6 on a scale out of 10, while vigorous-intensity PA is described as PA achieving an intensity of 7 or 8 out of 10 (CSEP, 2013). These moderate and vigorous levels of PA are equivalent to 3 to 6 METs and 6+ METs respectively (WHO, 2015). According to the Canadian Physical Activity Guidelines, children aged 5-17 years should obtain a minimum of 60 minutes of moderate-to-vigorous physical activity (MVPA) per day (CSEP, 2013) for health benefits. Based on the latest Canadian Health Measures Survey (CHMS) on PA for Children and Youth in 2012-13, only 9% of school-aged children are meeting these minimum recommendations (Statistics Canada, 2015). Meeting the daily requirements of 60 minutes of MVPA has been equated to accumulating approximately 12,000 steps per day (Colley et al., 2012). Canadian children between the ages of 5 and 19 years accumulate on average 11,000 steps per day, further confirming that children, on average, do not meet the Canadian Physical Activity Guidelines (Canadian Fitness and Lifestyle Research Institute, 2014). When considering sex differences in meeting PA and step recommendations, only 10% of boys and 6% of girls aged 5-17 years are meeting the daily step recommendations (Statistics Canada, 2015). Given that most Canadian children are not attaining the PA guidelines, the majority are also missing out on the various physiological, psychological, and socio-emotional health benefits associated with meeting these recommendations (Janssen and LeBlanc, 2010).

Short-term and long-term health can be positively impacted by a physically active lifestyle, particularly when it commences in childhood and continues throughout the

lifecourse (Okely et al., 2001). According to Twisk (2001), chronic disease often originates in early childhood. Instilling the importance of PA at an early age is key in facilitating the associated long-term health benefits. Clearly, if the PA recommendations are not being met, the associated benefits will not be realized.

2.2 Physical Inactivity and Sedentary Behaviour

Physical inactivity is the term used when an individual does not meet the daily PA guidelines (Sedentary Behaviour Research Network, 2012). According to the WHO (2015), physical inactivity is the fourth most prominent risk factor of global mortality, and is responsible for 6% of deaths around the world. Physical inactivity only falls behind high blood pressure, tobacco use, and high blood glucose in terms of global mortality risk factors (WHO, 2015). The impact of physical inactivity on mortality is likely greater than its fourth-place ranking as it is also a risk factor for high blood pressure and high blood glucose. Based on the small percentage of Canadian children meeting the minimum PA guidelines (i.e. 9%), it is clear that physical inactivity has become a prominent health concern for children, and will continue to be of concern as children age and experience escalating negative health implications.

Sedentary behaviour (SB) is defined as behaviours in a seated or reclined position that require 1.5 METs or less of energy expenditure (Sedentary Behaviour Research Network, 2012). These behaviours may include screen-based or non-screen-based activities. For children aged 5-17 years, there is a recommendation of no more than two hours of recreational screen time per day (CSEP, 2013). According to the CHMS, only 24% of children aged 5-17 are meeting the SB guidelines (Statistics Canada, 2015). Furthermore, children spend, on average, 8.5 hours (69%) of their waking day sedentary

(Statistics Canada, 2015). It should be pointed out that even though some children meet the PA guidelines, this does not mean they also meet the SB time recommendations (Ekblom-Bak et al., 2011; Mitchel et al., 2012; Pate et al., 2008).

PA and SB have different relationships with health outcomes. SB has a direct connection with increased risk of obesity, as well as an increased risk for type 2 diabetes and atherosclerotic vascular disease (Saunders et al., 2014). Regular PA participation is directly associated with short and long term physical, mental and psychosocial health benefits as well as a reduced risk of chronic disease (WHO, 2014). As both PA and SB independently influence an individual's health, this reiterates the importance of meeting both the PA and SB guidelines to obtain more positive health outcomes. FMS development provides children with the basic building blocks of movement, increasing PA engagement and opportunities to meet the PA and SB guidelines.

2.3 Fundamental Movement Skill Development

Although there is no consensus for which specific skills make up FMS, the categories of skills include locomotor, stability and object control skills (Foweather et al., 2014). FMS include running, throwing, jumping, kicking, sliding, hopping, skipping and side shuffling. These movement skills are considered the basic building blocks to later PA skill development and sport-related movements (Clark, 1994; Gallahue, 1982; Lemos et al., 2012). A common misconception with FMS development is that it happens solely through growth, maturation, and development (Lemos et al., 2012). Although some improvements in FMS abilities are attributed to normal growth, it is through interactions with the environment that children develop FMS to their full potential (Clark, 2007; Lemos et al., 2012). Recognizing the role of growth, maturation, and development in the

development of FMS, it remains critical these skills are taught in an organized and systematic way. The environment provides the opportunity to utilize and refine these skills (Clark, 2007) when children are first taught how to move effectively (Lemos et al., 2012).

The mountain of motor development (figure 1), which is in the form of a pyramid, describes the changes in motor skills that take place throughout the lifecourse (Clark, 2007). This pyramid consists of five levels: beginning at the base with the reflexive period, then continuing towards the top with the pre-adapted period, fundamental motor patterns, context-specific motor skills, and skilfulness at the peak (Clark, 2007).

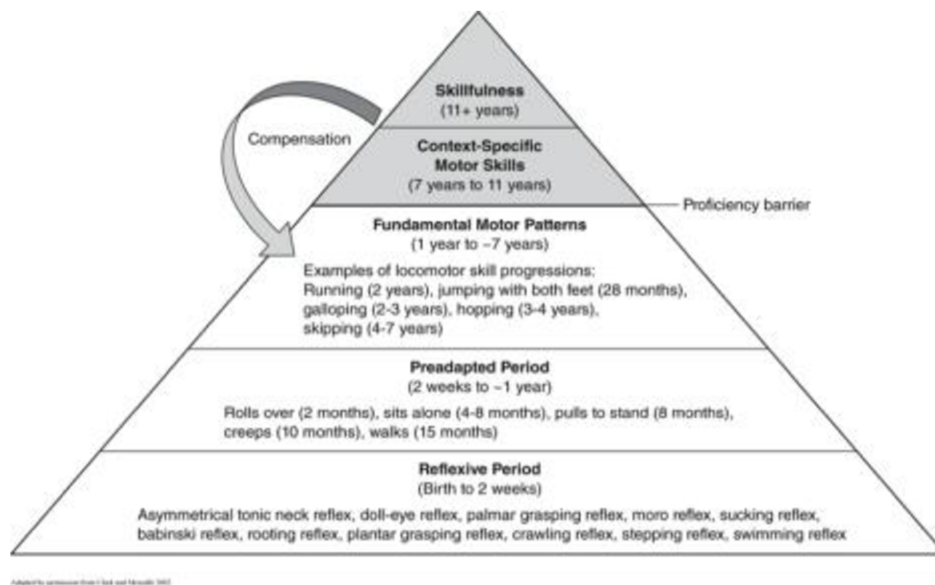


Figure 1 Mountain of Motor Development (Clark, 2007)

FMS (or “fundamental motor patterns” as described in this pyramid), develop between the ages of 1-7 years old. According to Clark (2007), a child should develop the ability to run at 2 years, jump with both feet at 28 months, gallop at 2-3 years, hop at 3-4 years, and skip at 4-7 years. The proficiency barrier signifies that if these FMS are not developed in this stage, there will be challenges in grasping more specific skills in the final two stages

(Seefeldt, 1980; Clark, 2007). Based on the results from this study conducted by Clark (2007), appropriate learning and experience with FMS plays an influential role in later skill performance and PA participation.

A detailed review by Lubans et al. (2010) outlined the significant relationship between PA and FMS. In youth aged 8-16 years, there is a significant positive relationship between FMS and self-reported PA, implying that FMS improves with participation in organized PA (Okely et al., 2001). Fisher et al. (2005) further supports these findings with objectively measured PA data in younger children aged 4-6 years. In this study, Fisher et al. (2005) measured PA using accelerometers and found a positive relationship between MVPA and FMS scores. Similarly, Graf et al. (2004) found positive associations between PA and FMS in 6-7 year old children. Further, Hamstra-Wright et al. (2006) observed that organized and non-organized PA experiences are positively related to FMS, specifically with locomotor skills. Based on these studies, it can be concluded that a positive relationship between FMS and PA exists, but the strength of this relationship remains unclear. FMS and PA throughout the lifecourse have a contributing role in an individual's PL.

2.4 Physical Literacy

PL has become a buzzword in the world of PA and health promotion in the past few years, likely a result of its connection to lifelong PA participation. PL is defined in Canada's Physical Literacy Consensus Statement as "the motivation, confidence, physical competence, knowledge and understanding to value and take responsibility for engagement in physical activities for life" (IPLA, 2014; ParticipACTION et al., 2015, p.1). PL is based on the idea that equipping children with the confidence and motivation

to be physically active, the knowledge and understanding of the importance and benefits of PA, and being provided with experiences to enhance their physical competence will promote a more physically active lifestyle. In other words, PL development has the potential to play an immense role in improving children and youth's participation in PA. The relationship between PL and PA is clearly demonstrated in the statement that "a physically literate person embodies a physically active lifestyle" (Castelli et al., 2015, p. 158).

Although there are currently many ways of measuring PL and no agreement on an optimal method or 'gold standard', the PL consensus statement released in June 2015 resulted in a common definition of PL. Based on this definition, PL is made up of four domains: motivation and confidence, physical competence, knowledge and understanding, and engagement in PA (ParticipACTION et al., 2015). Motivation and confidence is the affective domain, referring to an individual's thoughts and self-assurance surrounding participation in PA (ParticipACTION et al., 2015). Physical competence is the physical domain, encompassing the movement skills an individual develops and how these are applied to situations and environments to participate in a variety of activities (ParticipACTION et al., 2015). Knowledge and understanding is the cognitive domain, which focuses on how an individual understands PA, its benefits and associated safety concerns in a range of different PA situations (ParticipACTION et al., 2015). Lastly, engagement in PA is the behavioural domain, which simply involves an individual prioritizing the choice to be physically active (ParticipACTION et al., 2015). The combination of these four domains and what they represent encompasses the concept of PL.

2.5 Physical Literacy Measurement Tools

As previously mentioned, there is currently no ‘gold standard’ for measuring PL, which results in contradicting or conflicting findings in terms of children’s PL and appropriate assessment tools (Giblin et al., 2014). Methods used to measure PL in Canada include the Canadian Assessment of Physical Literacy (CAPL) created by the Healthy Active Living and Obesity (HALO) research group ([www. https://www.capl-ecsfp.ca/](http://www.capl-ecsfp.ca/)), the Physical Literacy Assessment for Youth (PLAY) tools created by Canadian Sport for Life (<http://play.physicalliteracy.ca/play-tools>), and Passport for Life created by Physical and Health Education (PHE) Canada (<http://passportforlife.ca>). In this study, children’s PL was measured using the CAPL protocol.

2.5.1 Canadian Assessment of Physical Literacy

The CAPL assesses all four domains of PL: physical competence, knowledge and understanding, motivation and confidence, and daily behaviours (HALO, 2014). The physical competence domain includes body composition (i.e. height, weight and waist circumference), musculoskeletal fitness (i.e. grip strength, sit and reach flexibility, and a timed plank), aerobic fitness (measured by the Progressive Aerobic Cardiovascular Endurance Run (PACER)), and FMS (measured by an obstacle course) (HALO, 2014). The knowledge and understanding domain is based on specific questions in the survey relating to the child’s understanding of PA and health, along with knowledge of the PA and SB guidelines (HALO, 2013). The motivation and confidence domain includes the child’s responses to specific questions in the survey related to PA level and skill level compared to peers, barriers to PA, and predilection and adequacy of PA (HALO, 2014). Lastly, the daily behaviour domain is scored based on daily step count, self-reported

sedentary time, and self-reported number of days per week engaged in MVPA (HALO, 2014). The total score from each of the four domains is combined to form an overall score out of 100. This number represents the participant's overall PL score, which is then categorized as beginning, progressing, achieving or excelling according to the age of the child (HALO, 2014). As previously noted, these categories are described as beginning: "limited physical literacy compared to same-age peers" (HALO, 2014, p.16), progressing: "similar to typical performance of same age peers" (HALO, 2014, p.16), achieving: "meets minimum level recommended" (HALO, 2014, p.16), and excelling: "exceeds minimum level recommended" (HALO, 2014, p.16). These categorizations take age into account for all domains and sex into account in the physical competence domain (Francis et al., 2015). For more information on the various measurements included in the CAPL and scoring protocol, please refer to the CAPL manual (<https://www.capl-ecsf.ca/wp-content/uploads/capl-manual-english.pdf>).

2.6 Development of the Canadian Assessment of Physical Literacy

The CAPL protocol was developed using a three round Delphi Process with 19 content experts. The first round was made up of open-ended questions while the next two rounds used 5-point Likert scales (Francis et al., 2015). To determine the suitability of the included questions and measurement protocols, three rounds of review were done before the panel reached consensus. Consensus was achieved when 75% of the panel were in agreement (Francis et al., 2015). The CAPL was developed for individuals aged 8-12 years. This age group was also selected through the Delphi process as "they could independently complete the knowledge questionnaire and pedometer records but had not yet reached adolescence, when PA declines more dramatically" (Francis et al., 2015, p.6).

The CAPL assessment tool was primarily developed for research purposes, though is considered applicable in non-research based settings. The different score categorizations for each protocol were developed by CAPL based on existing population data as outlined in Table 1 (Longmuir, personal communication, February 9, 2017).

Table 1 Development of CAPL categories (Longmuir, personal communication, February 9, 2017).

Category	Score
Beginning	Less than -0.5 SD below the mean
Progressing	-0.5 to +0.5 SD around the mean
Achieving	+0.5 to +1.5 above the mean
Excelling	Greater than +1.5 above the mean

CAPL domain scores with parameters set according to chronological age were developed based on expected patterns demonstrated in the literature (Longmuir et al., 2015). Confirmatory factor analysis was conducted after the Delphi process was completed to determine if the four domains were decided on consisted of the appropriate measures (Longmuir et al., 2015). The analysis resulted in four factors matching those identified as the four CAPL domains ($\chi^2/df= 2.60$), confirming the data were consistent with the CAPL model (Longmuir et al., 2015). Although specific measures within the CAPL protocol (e.g., PACER, sit and reach, etc.) have validity and reliability measures, the overall CAPL protocol does not have its own specific validity and reliability measures.

Upon completion of the measures within the CAPL protocol, raw scores are determined for each measure based on the children’s performance of the task. These raw scores were then interpreted using the four categories of beginning, progressing, achieving, and excelling, which were adjusted for age-related and sex-related (where applicable) changes in the scoring of the components included (e.g., older children are expected to run more laps in the PACER than younger children). The following table illustrates the CAPL score ranges for each domain:

Table 2 CAPL total score ranges (HALO, 2014)

Domain	Score Range
Daily behaviour	0 to 32
Physical competence	5.2 to 32
Motivation and confidence	-1.5 to 18
Knowledge and understanding	-0.63 to 18
Total CAPL score	3.07 to 100

2.7 Child Growth, Development, and Maturation

Throughout childhood, many physiological and psychological changes take place that may contribute to different aspects of children’s PL development. When considering the domains measured in CAPL (physical competence, knowledge and understanding, motivation and confidence, and daily behaviours), various growth, maturation and developmental aspects may factor into the changes in PL from year to year.

During middle to late childhood, there is an increase in children’s ability to process information more effectively and focus their attention, resulting in advancements in thinking and long-term memory (Santrock et al., 2014). With the corresponding increases in information processing and experience in weekly PE, it would be expected

that children's knowledge and understanding regarding the importance of PA and the associated guidelines would increase with age. As children become older, their ability to understand the complexity of PL and the importance of PA increases (Whitehead, 2010). As Whitehead (2010) notes, physically literate individuals will have extensive knowledge and understanding of the implications and importance of lifelong PA participation.

The expected advancement in cognitive ability with age and experience also results in more advanced thinking related to perception of movement skill competence, where children formulate more accurate perceptions of their competence as they age (Stodden et al., 2008). As children develop the ability to perceive their own abilities more clearly, children also become more adept at comparing themselves to the abilities of their peers. This new recognition of personal abilities, and in comparison to others, may contribute to an individual's motivation and confidence to be physically active. Self-efficacy also contributes to children's PL development. Self-efficacy is referred to as "beliefs in one's capabilities to organize and execute the courses of action required to produce given attainments" (Bandura, 1997, p.3). Self-efficacy is described as an influential element of human behaviour (Martin and Kulinna, 2004). Highly dependent on positive or negative PA experiences throughout childhood, individuals will either interpret their physical capabilities as adequate to participate in the PA opportunity presented or not, further impacting their confidence to take part in PA and impacting their overall daily PA behaviours. Experiences throughout childhood influence the opportunity to develop FMS, the foundation to PA participation. Enjoyment is described as one of the primary motivations for initial sport and PA involvement, and a continued participation in these activities (Wiersma, 2009). This need for motivation and willingness to remain

involved in PA is a major factor described in a physically literate individual (Whitehead, 2010).

The development of FMS can be partially attributed to the normal processes of growth, maturation, and development, and as such are part of the reason physical competence scores are expected to increase with age. The other reason for improvement expected in physical competence is the range of experiences and opportunities to move and use FMS skills in PE. There is therefore an age-related increase in FMS ability expected for children. FMS are a foundational component of PL in individuals of all ages. In addition to a difference in FMS between boys and girls, there is also research indicating a difference in PA levels in older and younger children and between boys and girls. The CHMS data collected on children aged 5-17 years revealed that just 13% of boys and 6% of girls met the PA recommendations of 60 minutes of MVPA per day (Statistics Canada, 2015). Furthermore, the CHMS data indicated that 12-17 year-old girls are least likely, and 5-11 year-old boys are most likely to meet the PA recommendations (3% and 18%, respectively; Statistics Canada, 2015). A study conducted with 11 and 13 year-old girls found that the 13 year-old girls had lower levels of moderate-to-vigorous and vigorous PA compared to 11 year-old girls (Baker et al., 2007). Based on a study conducted on 5-6 year-old children by Reeves et al. (1999), cardiorespiratory fitness was positively associated with the children's coordination and balance (Reeves et al., 1999; Lubans et al., 2010). Since these studies clearly indicate a relationship between FMS and PA participation, it is important to consider the role that age and maturation may play in this relationship. When accounting for chronological age, boys are more physically active than girls, but when maturational age is considered, this

difference no longer exists, indicating that maturational timing may be implicated in the discrepancy in PA between boys and girls (Thompson et al., 2003).

Commensurate with increases in height and weight throughout childhood, the heart and lungs increase in size and volume, and improvements in functioning result in a greater cardiac output and oxygen exchange (Malina et al., 2004). Similarly, with increases in height and weight during childhood, muscles increase in size and strength (Malina et al., 2004). These factors influence a child's ability to perform physical tasks (i.e. cardiovascular endurance and muscular strength and endurance) at a higher level. Physical maturity may also contribute to performance in physical tasks. Peak height velocity (PHV), a measure of somatic maturity, occurs on average at 13.5 years in boys and 11.8 years in girls (Baxter-Jones et al., 2011). Children's growth prior to puberty during middle and late childhood is often described as 'quiet growth' because it is steady with annual increases in height of 5-6 cm and 2-3 kg in weight expected per year (Malina et al., 2004). A study conducted by Philippaerts et al. (2006) on male soccer players aged 10-16 years suggested that increases in performance take place at different times throughout the maturational process. Speed tasks were performed best around the time of PHV, whereas strength and power performance tended to peak almost a year later (Philippaerts et al., 2006). Based on a sample of over 20,000 children, standards for the PACER were developed, which resulted in a gradual increase in PACER score expected until a peak is reached (at age 14-15 years for girls; 15-16 years for boys), after which the PACER scores slowly digress (Carrel et al., 2012). When considering core muscular endurance, boys and girls aged 7-8 years had an average lower endurance than 13-14 year-old boys and girls (Dejanovic et al., 2012), demonstrating a gradual increase in torso

muscular endurance as expected with an increase in muscle size due to growth. This increase is gradual during ‘quiet’ growth and exponential during the more rapid growth of puberty, particularly in boys.

Given these findings, it is expected that children’s physical fitness should improve throughout childhood. As such, categories in the physical competence domain of the CAPL protocol are assigned based on age and sex. For example, as demonstrated in figure 2, 20-meter PACER scores are expected to be lower in girls than boys, given the slightly different body composition prior to puberty, in that boys have slightly more muscle and slightly less fat, on average, and the slight physiological advantage (greater O₂ carrying capacity, etc.) in boys. Figure 2 also demonstrates the increase in score requirements as age increases, with an excelling categorization for boys age 8 years requiring greater than 34, and for boys age 9 years this increases to greater than 38. Being aware of biological maturity is important to consider when measuring PA, physical fitness, and motor skill performance, as it influences the results and variance among individuals.

	Beginning	Progressing	Achieving	Excelling
Boys (measures in 20 m laps)				
8 years	< 12	12 to 23	> 23 to 34	> 34
9 years	< 13	13 to 26	> 26 to 38	> 38
10 years	< 17	17 to 29	> 29 to 41	> 41
11 years	< 15	15 to 28	> 28 to 42	> 42
12 years	< 19	19 to 32	> 32 to 44	> 44

**Based on data from Carrel et al. (2012)

	Beginning	Progressing	Achieving	Excelling
Girls (measures in 20 m laps)				
8 years	< 12	12 to 24	> 24 to 37	> 37
9 years	< 12	12 to 25	> 25 to 37	> 37
10 years	< 15	15 to 27	> 27 to 38	> 38
11 years	< 14	14 to 26	> 26 to 37	> 37
12 years	< 15	15 to 29	> 29 to 43	> 43

**Based on data from Carrel et al. (2012)

Figure 2 PACER categories for boys and girls (HALO, 2014)

There are many other factors including physical fitness and body composition (Stodden et al., 2008), which contribute to development of movement skills and PA in children. Hardy et al. (2012) discovered that children who were overweight or obese from elementary through high school demonstrated consistently lower competency in FMS performance, especially locomotor skills. Similarly, lower levels of physical fitness can be attributed to reduced FMS competency (Hardy et al., 2012). In a similar study, Graf et al. (2004) concluded that higher BMI resulted in lower motor development and cardiorespiratory endurance. In addition to FMS abilities increasing with age, as previously mentioned, children also become more aware of their abilities along with the abilities of others, with the possibility of impacting FMS performance either positively or negatively. A longitudinal study conducted by Lloyd et al. (2014) provided supporting evidence that FMS abilities facilitate PA participation. Further, these PA trends were consistent with age, as FMS at age 6 were related to overall PA participation 20 years later (Lloyd et al., 2014). It is important to emphasize that any individual can improve

his/her personal PL, as it is not based on an individual's initial athletic or fitness abilities, but on a person's improvement of his/her own qualities in each of the four domains (Whitehead, 2010).

2.8 Summary

With few children obtaining the recommended levels of PA and high levels of SB and physical inactivity, it is important to consider the many aspects that may play a role in these trends. PL is described as “the motivation, confidence, physical competence, knowledge and understanding to value and take responsibility for engagement in physical activities for life” (IPLA, 2014; ParticipACTION et al., 2015, p.1). FMS are the basic building blocks to PA and sport participation, and make up an important part of a child's PL. Although some improvements in FMS can be attributed to the normal process of growth, maturation, and development, a range of PA experiences are key to well-rounded development of FMS throughout childhood (Lemos et al., 2012). More broadly, there is also expectation for an increase in children's physical competence (movement skills and physical fitness). Given the impact that maturation has on children's levels of PA (Thompson et al., 2003), it is important to consider when measuring FMS, physical fitness and overall PA. Based on ongoing experience in PE coupled with an increased ability to retain and process information, it is expected that children's knowledge and understanding related to the importance of PA throughout the lifecourse should improve with age. The new ability to perceive skill competence and an individual's self-efficacy as a result of their experiences will also influence motivation and confidence to participate in PA on an individual level (Martin and Kulinna, 2004; Stodden et al., 2008). The CAPL protocol was established to determine PL levels of children aged 8-12, with

categories (beginning, progressing, achieving, excelling) in place to take age- and sex-related changes into account. To the author's knowledge, no study to date has examined variables that predict the change in PL from one year to the next. Therefore, the purpose of this study is to determine whether children's overall PL classification, as determined by the CAPL protocol, remains consistent from year 1 to year 2, and for those who change categories, to examine variables that might predict this change. Assuming the CAPL categories are applicable to children in Nova Scotia, multiple hypotheses were developed for the different variables. It was hypothesized that i) height would be a significant predictor of a higher PL categorization in year 2; ii) weight would be a significant predictor of lower PL categorization in year 2; iii) age and sex would not significantly predict a change in overall physical literacy categorization; iv) average daily steps would be a significant predictor of a lower physical literacy categorization in year 2.

CHAPTER 3: METHODS

3.1 Study Site

Research for the CAPL project took place in the Strait Regional School Board (SRSB), which consists of 25 schools in Eastern Nova Scotia. A convenience sample of five schools within the SRSB participated in the CAPL project more than once, and were therefore eligible for this research project. Data collection took place during the 2014-15, 2015-16 and 2016-17 school years. Regardless of whether data were collected in 2014-15 and 2015-16, or 2015-16 and 2016-17, the two time points are referred to as year 1 and year 2 from this point forward.

3.2 Ethics

Ethics approval for the CAPL project was granted from the Children's Hospital of Eastern Ontario (CHEO) (Appendix A), the Dalhousie Research Ethics Board (Appendix B), the St Francis Xavier University Research Ethics Board (Appendix C), and the Strait Regional School Board (SRSB) (Appendix D).

3.3 Participants

3.3.1 Children

Parents/guardians of children between the ages of 8 and 12, and in grades 4 to 6, in the Antigonish region, were invited to provide permission for their child to participate in the Canadian Assessment of Physical Literacy (CAPL) research study. Only children from whom informed consent was obtained from their parents/guardians (see Appendix E) participated in the data collection for this study, if the child also provided assent.

Children's assent was obtained immediately prior to data collection. If a child decided not to participate in the study, or any section of the study, their lack of verbal assent overrode

previously collected parent's/guardian's consent. Potential health issues were also identified in a health screening form completed by the parent/guardian when providing consent (see Appendix E).

3.4 Procedure

The Canadian Assessment of Physical Literacy (CAPL) is an assessment tool developed by the Healthy Active Living and Obesity (HALO) Research Group (2014) to measure four dimensions of PL for children 8-12 years old (Longmuir et al., 2015). The CAPL is made up of four domains: physical competence, motivation and confidence, knowledge and understanding, and daily behaviour (Francis et al., 2015). The four domains, scored out of a total of 100 points, are represented in figure 3, and the measurement of each domain is discussed in depth. As previously noted, participants were included in this analysis only if complete scores for PL existed for two time points (year 1 and year 2).

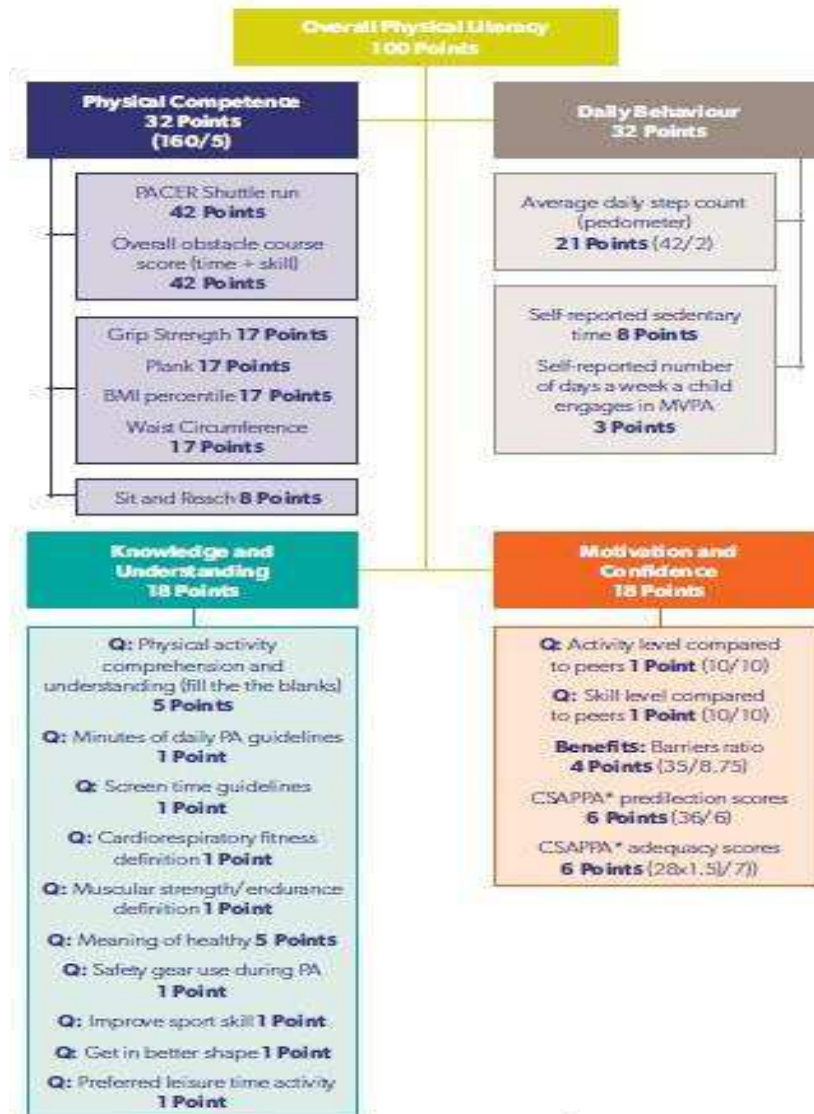


Figure 3 PL domains and scoring overview (HALO, 2014)

The *motivation and confidence* domain provides a maximum of 18 of the total 100 points in the CAPL score. This score is based on the individual’s responses to specific questions in the questionnaire, including: PA level and skill level compared to peers, barriers to PA, and predilection and adequacy of PA (HALO, 2013). If more than one question was skipped/not answered, the questionnaire was considered incomplete and resulted in an incomplete PL score. Two points are assigned to questions relating to self-perceived PA and skill level compared to their peers (HALO, 2013). There are four

points allotted to questions relating to barriers to PA (HALO, 2013). Lastly, twelve points are assigned to the “What’s Most Like Me” Children's Self- Perceptions of Adequacy in and Predilection for Physical Activity (CSAPPA) section of the questionnaire (See Appendix E). The CSAPPA questionnaire, developed by Hay (1992), examines predilection and adequacy of PA in the participants (HALO, 2013).

The *knowledge and understanding* domain also provides a maximum of 18 of the total 100 points of the CAPL score. This score is based on specific questions in the questionnaire relating to the individual’s understanding of PA and health. Similar to the questionnaire assessing motivation and confidence, if one question was not answered on this questionnaire, the questionnaire was considered incomplete and an overall PL score was not generated. There is one point available for each of the following questions: identifying the guidelines for daily moderate to vigorous physical activity (MVPA), the guidelines for daily screen time, identifying the definitions of cardiorespiratory fitness, and muscular endurance, proper safety gear use, how to increase sport skills, how to get in better shape, and preferred leisure activities (HALO, 2013). There is also a question investigating the individual’s understanding of ‘being healthy’, with five points possible (HALO, 2013). Lastly there is a fill-in-the-blanks section, which focuses on the individual’s understanding of PA, also worth up to five points (HALO, 2013).

The *physical competence* domain is scored out of 32 of the total 100 points of the CAPL score. This domain is made up of body composition (height, weight, and waist circumference), musculoskeletal fitness (strength, plank and flexibility), the Progressive Aerobic Cardiovascular Endurance Run (PACER), and the obstacle course, providing 160 available points which is then divided by five to provide the 32 points for this

domain (HALO, 2014). Height was measured using a stadiometer and followed the Canadian Society for Exercise Physiology (CSEP) protocol. Two measurements were taken to the nearest 0.1 cm, and if these measurements had a difference larger than 0.5 cm, a third measurement was taken (CSEP, 2013; HALO, 2014). Weight measurements were collected with a digital scale, according to the CSEP protocol. Two measurements were taken to the nearest 0.1 kg and if these measurements had a difference larger than 0.5 kg, a third measurement was taken (CSEP, 2013; HALO, 2014). For height and weight, the closest two measurements were averaged to provide the final measurement of the participants' height and weight (HALO, 2014). Based on the World Health Organization (WHO) growth charts (WHO, 2007), the height and weight of each child were used to determine a Body Mass Index (BMI), which was then converted to age and gender z-scores (HALO, 2014). To accompany the BMI of the child, waist circumference was measured following CSEP protocol, where the top of the hip bones were used as landmarks to measure around the individual's waist (CSEP, 2013). The waist circumference measurement was taken twice to the nearest millimeter. If the two scores had difference greater than 0.5 mm, a third measurement was taken (HALO, 2014). The two closest waist circumference measurements were averaged to provide a final score (HALO, 2014). Musculoskeletal fitness was assessed through grip strength, plank and flexibility. Grip strength measured muscular strength and was collected using a handgrip dynamometer according to the CSEP protocol (CSEP, 2013). The child's total grip strength was determined by combining the maximum score of the two trials, for the left and right hand (HALO, 2014). In order to measure muscular endurance, the plank test was performed according to the protocol and scoring outlined by Boyer et al. (2013).

Flexibility was assessed with the sit and reach flexometer, following the CSEP (2013) protocol, focusing on hip and hamstring flexibility (HALO, 2014). The sit and reach score was determined through two trials measured to the nearest 0.5 cm, with the highest value of the two making up the final score. Aerobic fitness was measured according to the 15 m/20 m PACER, also known as the beep test, with protocol and scoring according to Meredith and Welk (2010). The child ran the designated 15 m/20 m distance, crossing the line with at least one foot, before the beep sounded, which progressively became more frequent as the level increased. The participants continued to run back and forth the designated distance until they decided they could not run any more or until two consecutive beeps were missed (HALO, 2014). The obstacle course was scored by a trained research assistant based on time and skill delivery components. For the obstacle course, the child performed two-foot jumps through the three hoops on the ground, shuffled sideways between the cones, caught a ball and threw it at the target, skipped back to the hoops at the beginning, completed one-foot hops through each of the 6 hoops, and finished the course by kicking a ball toward a target. Each child was given one practice run and two scored attempts. For the two scored attempts, the participants were timed and scored based on the proper performance of each of the skills (HALO, 2014). The FMS assessed as part of the obstacle course included jumping, side-shuffle, catching, throwing, skipping, hopping, and kicking (See Appendix F).

The *daily behaviour* domain was scored out of 32 of the total 100 points of the CAPL score, and was scored based on the daily step count, self-reported sedentary time, and self-reported number of days per week engaged in MVPA. Each participant was instructed to wear the pedometer for eight days in a row, with the first day, the day the

pedometer was distributed counting as a practice day. Participants were asked to keep track of the duration the pedometer was worn each day on a sheet (i.e., pedometer log) provided to the child (See Appendix G). To be considered valid pedometer data, there had to be a minimum of 1,000 steps and no more than 30,000 steps per day (HALO, 2014; Pabayo et al., 2010; Tudor-Locke et al., 2005), the pedometer worn a minimum of ten hours per day (Colley et al., 2010; Eisenmann et al., 2007; HALO, 2014). Finally, three valid days abiding by the above requirements (Tudor-Locke et al., 2005; HALO, 2014) were needed. The daily step count data from the pedometers consisted of 21 available points. The assessment of sedentary time was based on questions 15 through 18 in the CAPL Knowledge of Physical Activity Questionnaire (HALO, 2014), which was scored out of eight points. PA levels were assessed through self-report questions answered by the children, where they stated how many days a week they engaged in MVPA (HALO, 2014), giving a score out of 3 points.

The domain scores were adjusted for age in all four domains and adjusted for sex in the physical competence domain (Francis et al., 2015). The total scores from each of the four domains were then combined to form an overall score out of 100. This number represents the participant's overall PL score, which was then categorized as beginning, progressing, achieving or excelling (HALO, 2014).

3.5 Data Analysis

Prior to analysis, data were examined for outliers, coding errors, or incomplete data. Participants with outlying data were excluded from the analysis and incomplete PL scores were also excluded. Individuals with scores greater than two SD from the mean were examined and removed when not plausible. An incomplete PL score resulted when

more than one protocol was completely missed in any domain of the CAPL assessment (HALO, 2014). If more than one protocol was missing, a PL score could not be calculated and that child's data were therefore excluded from the analysis. Data were tested to ensure that all assumptions were met. For this analysis, issues with multicollinearity and linearity of the logit were tested.

Secondary analysis of previously collected CAPL data were conducted. Overall, year 1 and year 2 data for children in grades 4, 5, and 6 at year 1 from the SRSB were analyzed, with overall PL scores for 187 children. Initially, descriptive statistics (means, standard deviations) were compiled to describe the sample. The focus of this analysis was the overall PL categorizations, using the CAPL developed standards determined for each measurement (year 1 and year 2), to compare changes taking place and potential predictors of these changes. The data were organized such that each child's PL category (beginning, progressing, achieving, excelling) in year 1 was compared with year 2, enabling each child's PL to be considered as 'moving up', 'moving down', or 'remaining the same'. Multinomial logistic regression analyses were used to compare the categories of 'moving down a category', 'remaining in the same category' and 'moving up a category'. The baseline category was defined as those remaining in the same category, resulting in the 'moving down' and 'moving up' categories being compared to this baseline. The model consisted of the change in PL category as the outcome variable. The school level variable was entered in the model as a factor to control for any possible school-level changes in PL. This was done through dummy coding the school variable, using the school with the largest sample as the reference category. Controlling for school-level changes by entering the dummy coded variable as a factor also takes cohort into

account, controlling for differences in duration between year 1 and year 2 measures. Sex was also initially entered as a factor in the model. Age, average daily steps at baseline, change in weight, and growth in height were entered as covariates in the model. The variables included in the model were entered hierarchically, as the fit of the model was previously checked by manually entering variables one at a time to determine how each variable impacted the overall fit of the model when it was included. The order of the variables entered in the model was growth in height, increase in weight, average daily steps, and age. This order was selected based on existing research and the hypotheses tested for this research project. If the variable did not improve the fit of the model, it was removed from the final model. As such, sex was removed from the model.

CHAPTER 4: RESULTS

4.1 Descriptive Statistics

Overall, year 1 and 2 data from 213 children were collected. Of this sample, complete PL scores were available for data analysis from 187 children for two time points. The number of participants at each age and for each sex are described in Table 3. Based on a convenience sample, participants were from 5 different schools within the SRSB, considered to be rural locations.

Table 3 Age and sex of the participants

Age (Year 1)	Boys (n)	Girls (n)
8 years	3	0
9 years	52	51
10 years	31	31
11 years	10	9
Total	96	91

Using this sample of 187 children (Table 3), participants were divided according to age to demonstrate average (\pm SD) height (cm), weight (kg), waist circumference (cm), and BMI ($\text{kg}\cdot\text{m}^2$) for year 1, year 2 and the change in these variables between the two time points, as demonstrated in table 4. The assumptions of multicollinearity and linearity of the logit were tested. Data were analyzed for issues of multicollinearity, finding no variables highly correlated to one another. Data were also tested for linearity of the logit, where all significance values were greater than 0.05, indicating that the continuous variables in the model met the assumption of linearity of the logit.

Table 4 Height (cm), weight (kg), waist circumference (cm) and BMI (kg*m²) of the participants by age.

Age (Year 1)		Year 1- Mean (SD)	Year 2- Mean (SD)	Change (Year 2- Year 1)
8 years (n=3)	Height (cm)	128.63 (7.13)	134.70 (7.39)	6.07 (0.31)
	Weight (kg)	26.07 (2.80)	29.73 (3.44)	3.66 (0.64)
	Waist (cm)	54.27 (0.25)	58.50 (0.56)	4.23 (0.67)
	BMI (kg*m ²)	15.75 (1.04)	16.38 (1.10)	0.63 (0.13)
9 years (n=103)	Height (cm)	138.45 (6.98)	144.02 (7.50)	5.57 (2.30)
	Weight (kg)	36.26 (8.66)	40.96 (10.54)	4.7 (3.93)
	Waist (cm)	66.73 (10.97)	69.66 (11.80)	2.93 (5.73)
	BMI (kg*m ²)	18.76 (3.47)	19.55 (3.90)	0.79 (1.63)
10 years (n=62)	Height (cm)	142.45 (6.34)	148.43 (7.37)	5.98 (3.12)
	Weight (kg)	40.49 (11.41)	43.97 (12.67)	3.48 (3.81)
	Waist (cm)	70.75 (11.89)	71.46 (13.07)	0.71 (5.12)
	BMI (kg*m ²)	19.77 (4.56)	19.76 (4.67)	0.01 (1.76)
11 years (n=19)	Height (cm)	147.97 (6.90)	152.86 (7.17)	4.89 (1.25)
	Weight (kg)	44.18 (11.60)	48.39 (12.69)	4.21 (2.39)
	Waist (cm)	72.65 (11.86)	73.97 (10.26)	1.32 (3.93)
	BMI (kg*m ²)	20.05 (4.55)	20.54 (4.40)	0.49 (0.76)
Total (n=187)	Height (cm)	140.56 (7.57)	146.21 (8.11)	5.65 (2.51)
	Weight (kg)	38.45 (10.39)	42.67 (11.77)	4.23 (3.74)
	Waist (cm)	68.49 (11.59)	70.58 (12.14)	2.08 (5.40)
	BMI (kg*m ²)	19.24 (4.03)	19.72 (4.25)	0.48 (1.63)

4.2 Categorization Change from Year 1 to Year 2

Based on the CAPL-developed standards, the possible categories for age-based scores for overall PL include beginning, processing, achieving, and excelling. Outlined in figure 4 is the breakdown of the number of participants classified in each of the categories in year 1 and year 2.

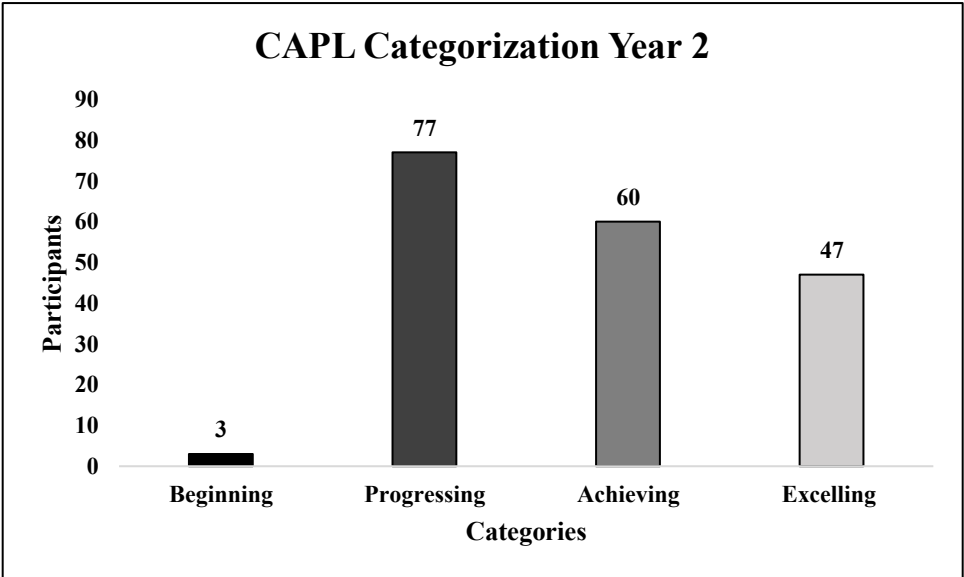
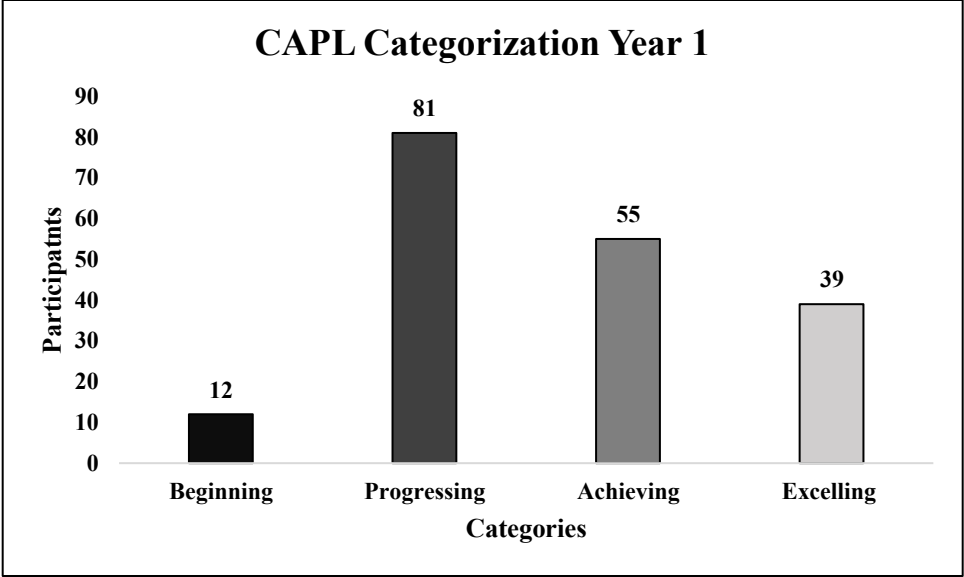


Figure 4 CAPL Categorization in Year 1 and Year 2

Based on this breakdown, of the 187 children who had PL scores measured in year 1 and year 2, the following results emerged for PL categorization at year 2: 97 children (52%) remained in the same PL category from one year to the next (e.g. if achieving in year 1, then achieving in year 2), 32 children (17%) went down in categorization (e.g., if achieving in year 1, then progressing in year 2), and 59 children

(31%) went up in categorization (e.g., if achieving in year 1, then excelling in year 2). In other words, 48% of the participants transitioned into either a higher or lower PL category from year 1 to year 2. These findings are demonstrated in figure 5.

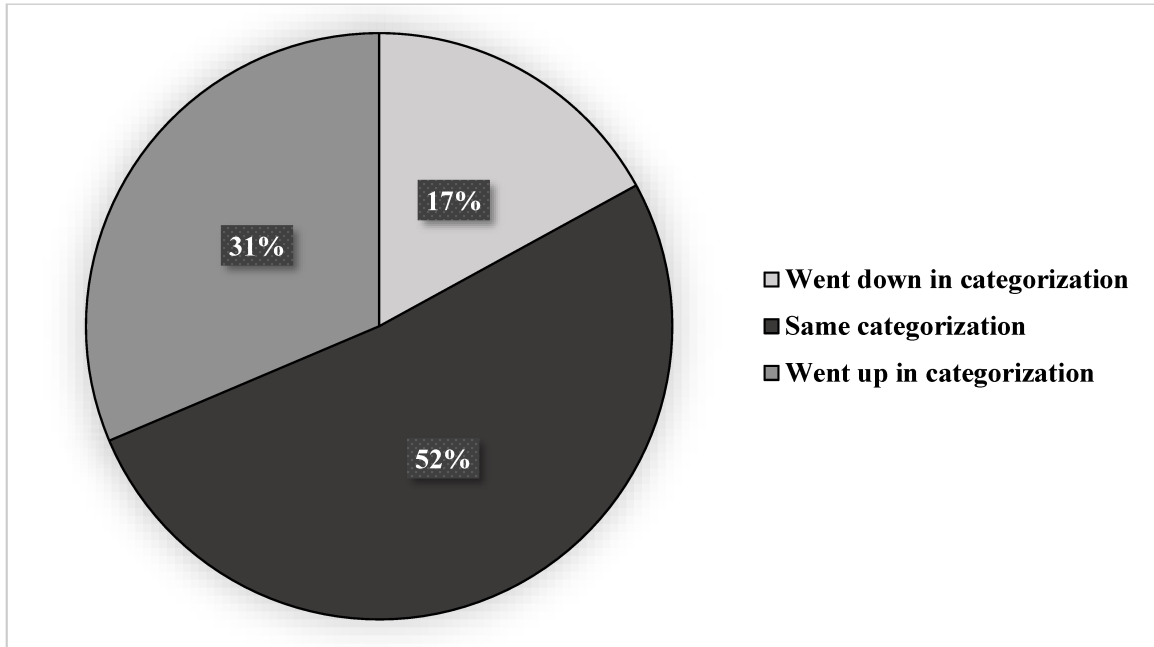


Figure 5 Congruence of PL classifications from year 1 to year 2

As previously mentioned, the initial variables entered in the model included age, sex, average daily steps at baseline, school, growth in height, and increase in weight, with the outcome variable being change in PL categorization (down, the same, or up).

According to the multinomial logistic regression analysis, between 21% and 24% ($R^2=0.21$ for Cox and Snell, and $R^2=0.24$ for Nagelkerke) of the variability identified above can be explained by the variables included in this model. The school variable was included in the model to control for any potential school-level changes in PL that took place from year 1 to year 2. Additionally, sex was removed from the final model, as this variable did not improve the fit of the model when included. Age was found to be a significant predictor ($b=-0.78$, Wald $\chi^2(1)=5.49$, $p<0.05$) of whether a child's PL would

move up a category in year 2, but not for those moving down a category ($b=0.22$, Wald $\chi^2(1)= 0.29$, $p= 0.59$). In other words, this means that as a child ages, the chance of moving up a category decreases. Also, average daily steps were found to be a significant predictor ($b=0.23$, Wald $\chi^2(1)= 6.99$, $p<0.01$) of whether a child's PL would move down, but not up a PL category in year 2 ($b=-0.073$, Wald $\chi^2(1)= 0.973$, $p=0.324$). In other words, and contrary to what might be expected, as average daily steps increase, there was an increased chance of going down a category. Though the other included variables contributed to the overall variability observed, they were not significant predictors of change in PL. As such, growth in height was not a significant predictor of change in PL for those going down a category ($b=-0.276$, Wald $\chi^2(1)=1.85$, $p=0.17$), or in predicting the change of PL for those going up a category ($b=-0.15$, Wald $\chi^2(1)= 1.61$, $p=0.204$). Similarly, increase in weight did not significantly predict change in PL for those going down a category ($b=0.19$, Wald $\chi^2(1)= 3.27$, $p=0.07$), or for those going up a category ($b=0.002$, Wald $\chi^2(1)= 0.001$, $p=0.98$). See table 5 for a summary of the regression analysis and each variable included in the model.

Table 5 Summary of multinomial logistic regression analysis

	b (SE)	95% CI for Odds Ratio		
		Lower	Odds Ratio	Upper
DOWN vs SAME				
Intercept	-4.25(4.67)			
School_Dummy_01	-1.16(0.813)	0.06	0.31	1.54
School_Dummy_02	-0.42(0.95)	0.1	0.66	4.25
School_Dummy_03	-0.3(9.23)	0.12	0.74	4.52
School_Dummy_04	0.43(0.97)	0.23	1.53	10.18
Weight change	0.19(0.11)	0.98	1.21	1.48
Height change	-0.28(0.20)	0.51	0.76	1.13
Age	0.22(0.42)	0.55	1.25	2.82
Average Daily Steps	0.23(0.09)**	1.06	1.26	1.5
UP vs SAME				
Intercept	5.49(3.72)			
School_Dummy_01	0.66(0.55)	0.65	1.93	5.71
School_Dummy_02	0.12(0.57)	0.36	1.13	3.57
School_Dummy_03	0.99(0.85)	0.51	2.69	14.2
School_Dummy_04	1.59(0.85)	0.93	4.92	26.09
Weight change	0.002(0.08)	0.85	1.002	1.18
Height change	-0.15(0.12)	0.68	0.86	1.09
Age	-0.78(0.33)*	0.24	0.46	0.88
Average Daily Steps	-0.07(0.07)	0.8	0.93	1.08

Note. $R^2 = 0.21$ (Cox & Snell), 0.24 (Nagelkerke). Model $\chi^2(16)=32.76$, $p=0.008^{**}$. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Reference category: SAME

CHAPTER 5: DISCUSSION

5.1 Physical Literacy Categorization Change

The purpose of this study was to longitudinally examine PL data in children and when children changed categories to determine whether this change in children's overall PL categorization (beginning, progressing, achieving, excelling) from year 1 to year 2 could be predicted by variables within the CAPL protocol. More specifically, after controlling for school-level changes, is children's PL categorization at year 2 predicted from age, sex, growth in height, increase in weight, and average daily steps? Assuming the CAPL standards are applicable to children in Nova Scotia, hypotheses were formulated for the different variables examined. It was hypothesized that growth in height would be a significant predictor of a higher PL categorization in year 2, as a more rapid increase in height is an indicator of maturation. Given that each group (up, same, down) had similar increases or growth in height, maturation was not a significant predictor of change in PL categorization; therefore this hypothesis was rejected. It was hypothesized that increases in weight would be a significant predictor of lower PL categorization in year 2, as an excess weight gain might relate to reduced physical competence. If weight was a significant predictor, waist circumference would have been examined to determine if the weight gain related to a greater increase in body fat. Again, the increase in weight was similar in each of the groups. As such, weight was not a significant predictor of change in PL categorization, therefore this hypothesis was rejected, and waist circumference not analyzed. It was hypothesized that age and sex would not significantly predict a change in overall PL categorization, as age- and sex-related changes are accounted for in the current CAPL standards. Based on the results, this hypothesis was

rejected for age, as age was found to be a significant predictor of higher PL categorization in year 2. More specifically, as a child ages, the odds of moving up a category decreases. The hypothesis was supported for sex, as sex did not significantly predict changes in PL in year 2. Lastly, it was hypothesized that average daily steps would be a significant predictor of a lower PL categorization in year 2, as it was anticipated that average daily steps would decrease from year 1 to year 2, as children tend to be less physically active with age. Although average daily steps were found to be a significant predictor of a lower PL categorization in year 2, it was not as hypothesized. More specifically, an increase in steps resulted in a greater chance of lower PL categorization in year 2.

While the majority of research regarding PL emphasizes the idea of PA participation throughout the lifecourse, little has been done to date exploring the longitudinal development of children's PL. The results from the analysis in this research project indicate that nearly half (48%) of children in this study did not remain in the same CAPL-designated PL category from one year to the next. Based on the findings, a large percentage of Nova Scotia children were classified in a higher or lower overall PL category in year 2. It was initially suggested that the large proportion of children in a higher or lower PL category at year 2 may be because Nova Scotia children are different than the population the standards were developed, in terms of differences in geographical locations, subsequently resulting in possible differences in SES and PA levels. If this were the case, NS individuals would be expected to be lower overall, which was not the case upon analysis of this data. Of the 91 children classified in a higher or lower category in year 2, 56 were 9 years old in year 1. Furthermore, 77% of these 9-year olds

transitioned into a higher PL category in year 2. This finding will be further explored in the sections below.

When comparing multiple measures of the same protocol with individuals in consecutive years, there is a possibility that a ‘training effect’ may take place. When considering the 4 domains measured in the CAPL protocol (physical competence, knowledge and understanding, motivation and confidence, and daily behaviour), it would be most likely to observe a ‘training effect’ with the physical competence domain. Although physical competence is where this effect is most likely to be observed, a ‘training effect’ does not effectively explain the differences noted in PL categorization in year 2. One reason a ‘training effect’ does not explain the finding is that children were found at both positive (classified higher than expected) and negative (classified lower than expected) ends for overall PL, with a ‘training effect’ expected to only result in positive findings (i.e., higher PL in year 2).

5.2 Measurement of Growth, Maturation, and Development

The CAPL protocol and PL standards were developed using chronologic age. In other words, biologic maturation was not included. Physiological maturation refers to the tempo and timing towards a biologically mature state, in all tissues, organs and systems of the body (Malina et al., 2004). In children, maturation can be assessed through various methods including skeletal age, secondary sex characteristics, and somatic maturation including peak height velocity (PHV) (Mirwald et al., 2001). PHV refers to the greatest rate of growth in height during puberty. A similar pattern of growth in height is followed by all children, assuming a healthy process of growth, with the timing of the adolescent growth spurt varying from child to child (Malina et al., 2004). Usual growth in height

follows a four-phase pattern beginning in infancy and progressing through adolescence (Malina et al., 2004). Since no other measure of maturation is available, PHV, or more specifically the rate of growth in height was selected to determine potential maturational differences among children in this study. As it is possible that some children in the CAPL project were pubescent, maturation was an important aspect to consider. As such, changes in height were explored to determine if there was more rapid growth in individuals classified in a higher category in year 2 than in year 1 compared to individuals classified in a lower category in year 2 than in year 1. This more rapid growth, indicative of earlier maturation, could then partly explain the greater improvement noted in those who achieved a higher categorization in year 2. As demonstrated in the regression analysis described previously, growth in height was not a significant predictor in PL classification for those changing categories from year 1 to year 2. In other words, there were no significant differences in the average change in height for the group that transitioned to a lower category (5.43 ± 1.64 cm), remained in the same category (5.99 ± 2.93 cm), or transitioned to a higher category (5.50 ± 1.49 cm).

Increases in weight were also examined, not as a measure of maturation, but rather because greater increases in weight may be indicative of greater increases in fat which may then relate to poorer performances and an unexpected decrease in PL categorization. Similar to height, weight did not significantly predict change in PL for those changing categories from year 1 to year 2. The average increase in weight for the group that transitioned to a lower category was 4.46 ± 2.90 kg, the group that remained in the same category was 4.29 ± 4.02 kg, and the group that transitioned to a higher category was 4.29 ± 2.33 kg. Therefore, neither growth in height or increases in weight explained

the differences observed in children who transitioned into a higher or lower PL category in year 2. As such early maturation and excessive increases in weight do not relate to transitions into a higher or lower PL category in year 2. These results suggest factors other than growth, maturation and development, and an increase in body fat, have an influence on the longitudinal measurements of PL.

5.3 Changing CAPL Categories Based on Children's Age and Sex

Despite the expected increases in FMS ability and physical competence with age (Malina et al., 2004), differences may exist in the timing and extent of these increases in girls and boys. It is suggested that low FMS competence is more prevalent overall in girls than boys (Hardy et al., 2012). Based on a difference in selection of activity participation between boys and girls and the subsequent skills required for these activities, boys are more likely to master object-control skills while girls are more likely to master locomotor skills (Hardy et al., 2012). A related study noted that 7-8 and 9-10 year old boys performed higher in locomotor skills than girls, and boys aged 3-10 years performed higher in object control skills compared to age-matched girls (Spessato et al., 2013). When assessing physical fitness in prepubescent boys and girls, Marta and colleagues (2012) discovered that boys had significantly greater upper and lower body strength, abdominal strength, and muscular endurance, compared to girls. Although the CAPL protocol created age- and sex-standardized categories, age and sex were further explored to examine the potential these differences might have for the number of individuals who transitioned into a higher or lower PL category in year 2.

The multinomial logistic regression analysis results indicated that sex was not a significant predictor of change in PL categorization. As such, this variable was removed

from the final model, as it did not improve the fit of the model. These results demonstrated that an equal number of boys and girls transitioned into a different PL category in year 2, and it can therefore be suggested that the CAPL protocol adequately accounted for the differences between boys and girls in their development of PL in subsequent years. Alternatively, it can be said that boys and girls are equally misclassified in year 2.

Age significantly predicted the transition into a higher PL category from year 1 to year 2. In other words, children who were older at the time of the first assessment were less likely to move up a category in year 2. Since the analyses in this study intended to explore the ability of the children, age was selected rather than grade because it was believed to be a more precise indicator, as individuals of varying ages can be in the same grade. Further research could include grade as a variable to explore whether grade specific learning (e.g., PE classes) impacts changes in PL from year to year. A total of 91 children transitioned into a higher or lower PL category in year 2. For children aged 8 years in year 1, 2 (2 boys; 0 girls) of the 3 children (66%) moved into a higher category in year 2. For children aged 9 in year 1, 43 (26 boys; 17 girls) of the 103 children (42%) moved into a higher PL category in year 2. For children aged 10 in year 1, 9 (5 boys; 4 girls) of the 62 children (15%) moved into a higher category in year 2. Although overall 34% of 10-year olds were classified at a PL level higher or lower in year 2, a greater percentage (66%) were classified lower in year 2. This is the opposite of the 9-year old group, where 80% were classified in a higher PL category in year 2. For children aged 11 at year 1, 5 (2 boys; 3 girls) of the 19 children (26%) moved into a higher category in year 2. There are clearly age-related changes taking place that were not adequately

accounted for by the current CAPL standards, as is demonstrated by the decreasing percentage of children categorized in a higher category at year 2 (i.e. in year 1, age 8 (66%), age 9 (42%), age 10 (15%)).

It is difficult to say with any certainty why a greater age was a significant predictor of a decreasing number of children transitioning into a higher PL category from year 1 to year 2, and therefore only speculations can be made. Although physical growth, or more specifically maturation and weight gain, did not significantly impact changes in PL, it is possible that intellectual maturity played a role. For children aged 9 at year 1, where more individuals transitioned into a higher PL category in year 2, intellectual maturity may have resulted in increased interest in participating in the different protocols from one year to the next, resulting in more of an increase in PL in year 2, simply due to more effort exerted during data collection. Perhaps children also felt more comfortable with the data collection protocol and again exerted more effort. In this case, it wouldn't necessarily be that their PL improved, but that their PL level was better reflected in the second measure. For children aged 10 at year 1, the greater proportion moving into a lower PL category in year 2 would not be a result of a loss of knowledge, but could be because of less interest in completing the questionnaire and participating in the data collection procedures overall. For 10 and 11 year-old children, the motivation to complete the CAPL protocol may be declining with an alternate mindset to simply get it done as quickly as possible, resulting in a decrease in PL categorization at year 2 and subsequently diminished accuracy of a PL measurement for this age.

There may also be possible implications around PE experiences with the age-related changes observed. Although all children obtain more PE opportunities and

experiences as years progress, it is possible that only those who had positive experiences in PE and other PA opportunities were those with more substantial increases in PL between year 1 and year 2. Cardinal et al. (2013) determined that concurrent PA involvement was negatively affected by a negative experience such as being selected last for an activity or team. Alternatively, individuals with more experience in PA and sport related skills outside of school are more motivated in PE (Chen and Shen, 2004). These findings indicate that a reciprocal relationship may exist between PE and PA participation. Considering the impact that PE experiences could have on PA participation, there is a possibility that PE may factor into the variance currently observed. Although in this analysis, average daily steps were not a significant predictor of transitioning to a higher PL categorization, unexpectedly, obtaining more steps did significantly predict transitioning into a lower PL categorization as noted next.

5.4 Average Daily Steps

Average daily steps at baseline was selected as the variable for this analysis to determine how initial PA levels impact development of PL, as opposed to analysing the change in steps from year 1 to year 2. Following the analysis, it was determined that children's average daily steps at baseline were a significant predictor of a decrease in PL in year 2. More specifically, as average daily steps increased, there was an increased chance that overall PL categorization decreased in year 2. This finding is unexpected, as one would anticipate that as average daily steps increase, PL would increase too.

Considering that daily behaviours are one of the measured components of PL, changes in PA levels impact the overall score. Reasons for increases or decreases in daily steps are likely multifaceted. In one sense, an individual's motivation and confidence to be

physically active will ultimately result in the accumulation of more or less PA. Motivation and confidence may be impacted as a result of PE experiences, sport experiences or simply enjoyment of being active. When considering knowledge and understanding of PA, if for instance individuals are aware that 12,000 steps/day and/or 60 minutes of MVPA per day (Colley et al., 2010) are recommended, this may influence their likelihood to strive for that goal. Additionally, an individual's physical competence will ultimately impact involvement in PA, particularly so when considering FMS abilities facilitate PA participation (Lloyd et al., 2014). In other words, a child lacking the basic movement skills such as running, jumping, or throwing will be less likely be physically active now and in the future, which would likely be reflected in their average steps taken.

Figure 6 demonstrates the average daily steps for those categorized lower, the same, or higher in year 2. As figure 6 demonstrates, the results are contrary to what would be expected based on previous research. It is possible that if the children with more steps are younger, that they may still lack the ability to fully recognize their physical abilities and as a result are carefree and eager to participate in PA. With the lack of self-awareness, their PA levels would not be negatively affected, but the children would not score well overall for PL. In other words, individuals who are not yet able to recognize their lack of ability would be physically active regardless.

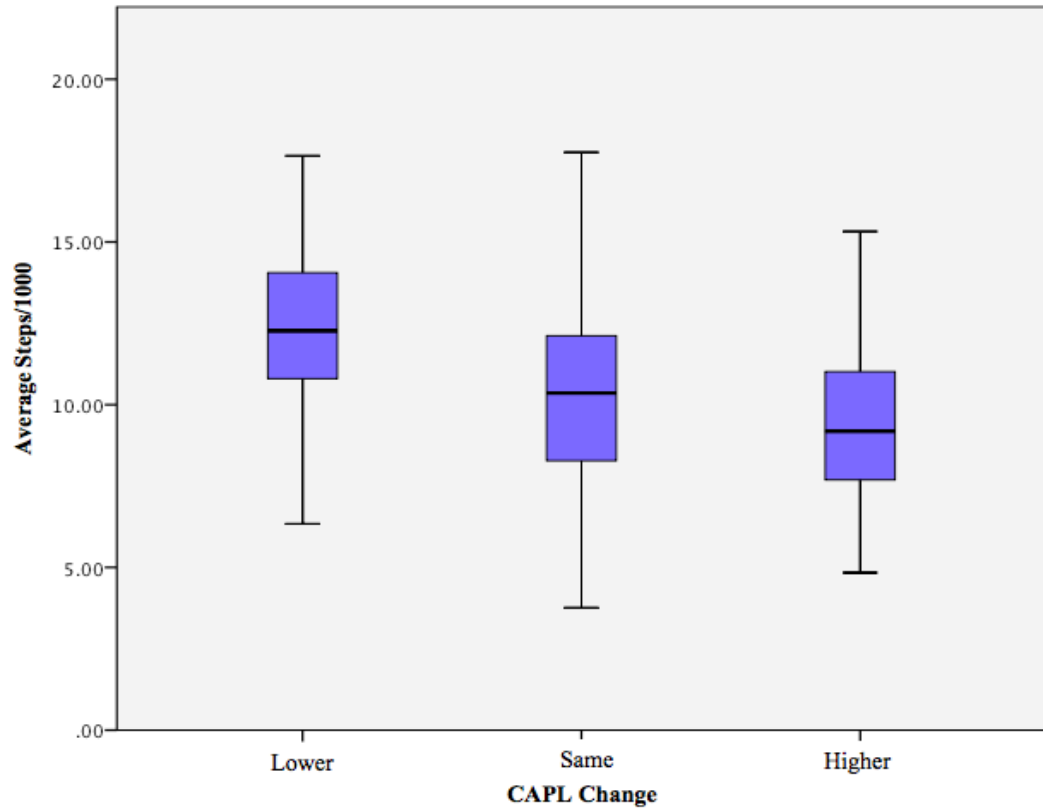


Figure 6 Average daily steps for each categorization (lower, same, and higher)

5.5 CAPL Score Requirements for PL Categories

Although some movement up or down in categorization would be expected simply due to random increases or decreases in PL and in the measurement process, it was not anticipated to be as substantial as was observed in this analysis. To further explain the large percentage of 9 year olds classified in a higher category in year 2 (80%), and the low percentage of 10 year olds classified in a higher category (34%), it is worthwhile to explore how the scoring and subsequent categorizations may also impact variability. As outlined in figure 7, different scores are required to reach specific categories for each age.

	Beginning	Progressing	Achieving	Excelling
Physical Literacy Overall (max 100)	< 43.8	43.8 to 63.8	> 63.8 to 74.0	> 74.0
8	< 39.2	39.2 to 61.5	> 61.5 to 72.6	> 72.6
9	< 47.3	47.3 to 63.7	> 63.7 to 72.0	> 72.0
10	< 41.2	41.2 to 61.6	> 61.6 to 71.7	> 71.7
11	< 44.8	44.8 to 66.7	> 66.7 to 77.6	> 77.6
12	< 41.3	41.3 to 64.0	> 64.0 to 75.3	> 75.3

Figure 7 Overall PL scores and categories for each age (HALO, 2014)

Upon closer exploration of the raw PL data (i.e., scores out of 100), some abnormalities were observed which may be indicative of issues with the overall categorization of PL. One example of these abnormalities was observed when examining the PL score in some participants that went down from year 1 to year 2 (i.e., the score out of 100 decreased), but the associated categorization went up (e.g., from progressing to achieving). Although this finding is not unexpected due to the decrease in score required in the categorizations noted in figure 8 from age 9 to age 10, it is not representative of the changes taking place within the child(ren). There were also cases observed where raw PL scores increased by a substantial amount from one year to the next, but categorization did not change. Yet for other children, their raw PL scores slightly increased from year 1 to year 2, and there was an increase in categorization. In other words, changing categorization from year 1 to year 2 was highly dependent on how close an individual was to the categorization cut-off points. As such, the categories may not adequately represent the changes taking place from one year to the next in each child. Finally, it is important to note that with the highest and lowest categorizations, excelling and beginning respectively, individuals can only move in one direction. For example, if a child was categorized as excelling in year 1, and had a substantial increase in their PL score in year 2, they would remain in the excelling category as there is no higher

categorization possible. Given the challenges outlined with categorization, it is possible that other forms of scoring such as percentiles may better represent the data.

Interestingly, there was not a consistent increase in PL levels as children are assessed at different ages, but rather the score requirements go up and down depending on the age. For example, when considering the ‘progressing’ category, at age 9 this requires an overall score between 47.3 and 63.7. However, at age 10 this requires an overall score of 41.2 to 61.6, and at age 11 a score of 44.8 to 66.7 (HALO, 2014). This lack of continuous increase in PL score seems contradictory to ‘development of PL’ with time. These overall PL scores, however, reflect the reality of the children’s placement in each category according to the protocol established by the CAPL research group prior to further data collection across Canada to establish wider baseline values. When considering the 9 year-old children, of which 80% who transitioned into a different PL category in year 2 moved up a category, the raw PL score requirements to remain in the same category between age 9 and 10 decreased. In other words, this may have increased the chances that a 9 year-old (in year 1) would move up a category at age 10 (in year 2). Alternatively, to remain in the same category between age 10 and 11 years, an individual’s overall raw score must increase. The scoring ranges outlined above align with what was found in this study in the changes in category for the 9-10 year olds and the 10-11 year olds. To reiterate, for the children age 9 years at year 1, 80% who transitioned into a different PL category in year 2 moved up a category, which is when the scoring classifications required a lower score to remain in the same category, possibly contributing to the large number moving up a category. For children age 10 at year 1, where only 34% moved up a category in year 2, this is when the scoring classifications

required higher scores in order to remain in the same category. It is possible that the current sample does not align with the scoring requirements outlined, resulting in many children transitioning into higher and lower PL categories.

5.6 School Differences

Another potential contributing variable influencing PL is at the school level. Possible ways in which the school can impact children's PL may include the teaching methods, enthusiasm, competence, and lesson plans of the PE teachers, classroom/school environment, or the school location. The role of a teacher is considered a major factor in PA promotion in youth (Standiford, 2013). As such, teachers may influence children's PL, considering the positive associations that exist between PA and FMS (Graf et al., 2004; Okely et al., 2001). Given that not all participating children were located at the same school with the same teachers, the school variable was included in the model to control for any school-level factors potentially influencing PL.

During data collection, there were differences observed among the five schools participating in this study. Most predominantly was the difference in facilities available for PE. The gym sizes ranged among each school, with some schools having double gyms, while other gyms were so small that the PACER could not be performed within. Gym size could impact what is taught in PE, and children's opportunities to move effectively and efficiently. Although the curriculum for children in grades 3 to 6 in Nova Scotia outlines 150 minutes per week of PE according to Nova Scotia Department of Education and Early Childhood Development (2014), it does not mean that this happens in practice. Time in PE has the potential to influence PL. In primary to grade 6, emphasis should be placed on the development of FMS, which in turn develops overall movement

competence (Roetert and MacDonald, 2015). If adequate time and space are not provided for this FMS development, children may not develop their skills adequately, and therefore may not be able to take part in a range of PA opportunities throughout their life (Haydn-Davies, 2005).

5.7 CAPL Domains

Further exploratory analysis was conducted to determine how each of the four domains (physical competence, knowledge and understanding, motivation and confidence, and daily behaviours) changed from year 1 to year 2 in efforts to establish where the change in PL was more prominent. The changes in categorization observed from year 1 to year 2 for each domain are outlined below. Various possibilities exist as to why these changes may be taking place. Further consideration was given to changes that took place within the sample from one year to the next in relation to the data collection process. Exploratory analysis of the variables within CAPL and consideration of the data collection process were also explored as possibilities to explain why nearly half of children assessed transitioned into a higher or lower PL category from year 1 to year 2. A breakdown of the four domains can be found in Appendix H.

5.7.1 Physical Competence

For the physical competence domain, 65% of children were classified in the same category in year 2 compared to year 1. Of the remaining 35%, 14% were classified lower in year 2, and 21% were classified higher in year 2. Simply due to typical growth, maturation, and development, children's physical abilities are expected to gradually improve from year to year throughout childhood. More specifically, as children grow, their muscular strength and endurance, cardiorespiratory endurance, and FMS abilities

will increase (Malina et al., 2004). This supports the finding that 65% of children remained in the same category in year 1 and year 2, as the categories included an expected higher level of performance with age. The opportunities to further develop these abilities through PA may contribute to some of those categorized higher or lower at year 2. Those who had good PA experiences would likely see improvements, while those with limited PA experience would be more likely to decrease in PL in year 2. It is also possible that the ability to perceive their own physical competence, which develops around the age of 8 (Stodden et al., 2008), contributed to being categorized either higher or lower. Generally, if a child is not self-aware, he or she thinks they can do it all and will subsequently be active. When children recognize that they are not as good as others, children are less likely to be active. As such, self-awareness of skill competence may influence the children's motivation to improve and do their best in the assessments or to simply give up and not perform to capacity.

When considering data collection of physical competence, the reality of this project was that to collect the data effectively and efficiently, at least 5 data collectors were needed. Despite best efforts, it was not possible to have the same data collectors coordinating the same protocols at each data collection session. Still, when possible, the same volunteer ran the same protocol and collected the same data as often as possible. Also, training was mandatory for all volunteers prior to data collection. Despite this, it is still possible that individual differences in data collection such as motivation to solicit best efforts from the children contributed to the changes observed.

5.7.2 Motivation and Confidence

In the motivation and confidence domain, 63% of children were classified the same in year 2 as they were in year 1. Of the remaining 37% of children, 19% were classified lower in year 2, while 18% were classified higher in year 2. Considering that belief in one's abilities is considered influential in PA participation (Martin and Kulinna, 2004), it is interesting to note that the percentage of children moving down a category and moving up a category from one year to the next is almost the same and may relate to their PA experiences. The positive or negative experiences that children experience in PE and otherwise may ultimately influence their enjoyment of PA (Wiersma, 2009). In this particular case, positive and negative experiences may be resulting in the equal dispersion of children classified higher and lower in year 2 for the motivation and confidence domain. The PA experiences, whether that be in PE, organized, or non-organized sports and/or activities, may have resulted in a larger than anticipated increase (or decrease) in motivation and confidence towards PA.

The manner in which the CAPL questionnaire was administered changed during data collection over the three years, as there was a steep learning curve regarding optimal completion of the questionnaire in terms of efficiency of data collection. Although this questionnaire was validated for children aged 8-12 years (HALO, 2014), many of the participating children struggled with various components of the questionnaire in terms of comprehension and subject knowledge resulting in lengthy times to complete the questionnaire. Initially, the questionnaires were simply given to the participants with the instructions to respond to the questions on their own, and ask questions as needed. As the project progressed, the data collectors discovered that reading the questionnaire aloud to each class was much more efficient in terms of time and obtained more complete

responses. As such, the questionnaire data were collected more often in this way, and in particular for year 2 in this study. It is possible that this change in how the questionnaire data were obtained contributed to some improvements in understanding of the questionnaire, therefore impacting the overall PL score with higher motivation and confidence, and knowledge and understanding scores.

5.7.3 Knowledge and Understanding

For knowledge and understanding, 46% of children were classified in the same category in year 1 and year 2. Of the remaining 54% of children, 19% went down in categorization, while 35% went up in categorization. As would be expected with continued PE classes to accompany an increase in cognitive development, 81% of children were at the same categorization or moved up in categorization from year 1 to year 2 regarding knowledge and understanding of the importance of PA. As children age, their ability to conceptualize and understand the multifaceted and complex influences of PA and PL is expected to be greater (Whitehead, 2010). The difference between those who remained in the same PL category and those who transitioned into a new PL category in year 2 may be attributed to PE experiences. Even if all classes and schools provided the same amount of time allotted to PE, there is still likely to be a variation in terms of what and how the class is taught. This difference in teaching methods may be a result of a generalist compared to a specialized PE teacher, or how aspects relating to the knowledge and understanding of PA are delivered in class.

5.7.4 Daily Behaviour

In the daily behaviour domain, 44% of children were classified in the same category in year 1 and year 2. Of the remaining children in year 2, 24% moved into a

lower PL category and 32% moved into a higher PL category. As previously discussed, average daily steps at baseline were a significant predictor of a decrease in PL in year 2 compared to year 1. Considering that PL is built on the idea of lifelong PA participation, the fact that average daily steps significantly predict a decrease in PL is not overly surprising. In this particular case, the significant relationship between average daily steps and PL was not in the direction that would be anticipated. The fact that over half of children (56%) transitioned into a different PL category in year 2 for this domain is where speculations need to be made. A possibility would be that between year 1 and year 2, there was a change in the PA opportunities for many of the children. If this factor is partially contributing, there would be both an increase and decrease in PA opportunities or in children's choices to be active. For the sample in this study, this would mean that children moving down in categorization in year 2 would see a decrease in PA opportunities, while those moving up in categorization in year 2 would see an increase in PA opportunities. These opportunities are believed to provide environments for children to be physically active in a range of different ways.

Although different data collectors were responsible for explaining and distributing the pedometers to the participating children, it is more likely that this would affect the completeness of the data (tracking log, both pedometer and log returned) as opposed to impacting the PA levels of the children. The enthusiasm of the individual distributing the pedometer may influence the child's likelihood to wear the pedometer for the week, but the 'practice day' on the first day is intended to provide enough time for the novelty of the pedometer to wear off. In other words, it is not expected that the data collection

process with the pedometer specifically had an impact on the child's change in PL from year to year.

5.8 Strengths and Limitations

To the author's knowledge, no study to date has examined variables that predict the change in PL, including age-related changes from one year to the next. Particularly novel with this study is the opportunity to determine possible predictors of PL with longitudinal data, while also using longitudinal data to specifically explore how children progress within the CAPL protocol from year to year. This study contributes to a current gap in PL research and inform future practices and initiatives, with a much better understanding of what changes should be expected in children simply due to normally occurring growth, maturation and development processes.

One limitation of this analysis was that only repeat data collected from Nova Scotia children in the Antigonish region were included. As a result, it is difficult to conclude whether the fact that children who transitioned into a different PL category in year 2 may partly be due to this region of Nova Scotia not fitting the norms/standards created, or that the categories are not adequately accounting for age-related changes. These results could be further supported if a larger longitudinal sample from the overall CAPL data were analyzed. As previously discussed, there were many data collectors involved in the project, which could impact the reliability of the data collected. To date, inter- or intra-reliability have not been determined.

5.9 Future Research

Future research could examine the four CAPL domains more in depth, to determine how each domain is affected by the age- and sex-based standards currently in

place. Although physical growth, maturation, and development of children were not significant in predicting change in PL, other aspects of growth, maturation and development may impact the change in these domains over time. Specifically, development refers to the acquisition of motor skills and socially acceptable behaviour. Other aspects such as psychological and intellectual development would be expected to impact knowledge and understanding, motivation and confidence, and daily behaviour aspects of the CAPL protocol. There is also the potential to expand on the longitudinal data set that currently exists. Collecting more longitudinal data throughout Canada would provide further insight into how PL is developing in children across Canada, adding to the current sample/analysis in Nova Scotia.

5.10 Conclusion

Based on the findings previously outlined, 48% of children transitioned into a different PL category in year 2. Among these children, 32 children (17%) moved into a lower PL category in year 2, and 59 children (31%) moved into a higher PL category in year 2. Further exploration determined that age and average daily steps were significant predictors of an increase and decrease in PL, respectively. The novelty of this analysis exists in both the longitudinal data set and in discovering predictors of PL based on these longitudinal data. There is currently minimal existing research regarding the longitudinal development of PL, a gap in the literature that this research addresses. As such, the results from this study contribute to PL research to better inform future practices and initiatives, with a much better understanding of what changes should be expected in children from one year to the next in PL development. As such when intervention

programs are implemented, age-related (or year to year) expected changes can be accounted for.

REFERENCES

- Baker, B.L., Birch, L.L., Trost, S.G., Krahnstoever Davison, K. (2007). Advanced Pubertal Status at Age 11 and Lower Physical Activity in Adolescent Girls. *Journal of Pediatrics*, 151(5), 488-493.
- Bandura, A. (1997). *Self-efficacy: The Exercise of Control*. New York: W.H. Freeman and Company.
- Baxter-Jones, A.D.G., Faulkner, R.A., Forwood, M.R., Mirwald, R.L., Bailey, D.A. (2011). Bone Mineral Accrual from 8 to 30 Years of Age: An Estimation of Peak Bone Mass. *Journal of Bone and Mineral Research*, 26(8), 1729-1739.
- Canadian Fitness and Lifestyle Research Institute (2014). Kids CANPLAY. Bulletin 1: Physical activity levels of children and youth. Ottawa: Canadian Fitness and Lifestyle Research Institute; 2014. URL: www.cflri.ca/document/bulletin-1-physical-activity-levels-children-and-youth
- Canadian Society for Exercise Physiology (2013). *Canadian Physical Activity and Sedentary Behavior Guidelines Handbook*. Retrieved from <http://www.csep.ca/english/view.asp?x=804>
- Cardinal, B.J., Yan, Z., Cardinal, M.K. (2013). Negative Experiences in Physical Education and Sport: How Much Do They Affect Physical Activity Participation Later in Life? *Journal of Physical Education, Recreation and Dance*, 84(3), 49-53.
- Carrell, A.L., Bowser, J., White, D., Moberg, P., Weaver, B., Hisgen, J., Eickhoff, J., Allen, D. (2012). Standardized childhood fitness percentiles derived from school-based testing. *Journal of Pediatrics*, 161, 120-124.
- Castelli, D. M., Barcelona, J. M., & Bryant, L. (2015). Contextualizing physical literacy in the school environment: The challenges. *Journal of Sport and Health Science*, 4, 156–163.
- Chen, A. & Shen, B. (2004). A Web of Achieving in Physical Education: Goals, Interest, Outside-School Activity and Learning. *Learning and Individual Differences*, 14, 169-182.

- Clark, J.E. (2007). On the Problem of Motor Skill Development. *Journal of Physical Education, Recreation, and Dance*, 78 (5), 39-44. Retrieved from <http://www.tandfonline.com/doi/abs/10.1080/07303084.2007.10598023>
- Clark, J.E. (1994). Motor Development in V.S. Ramachandran (Ed), *Encyclopedia of Human Behaviour*. New York: Academic Press.
- Colley, R.C., Janssen, I., Tremblay, M.S. (2012). Daily Step Target to Measure Adherence to Physical Activity Guidelines in Children. *American College of Sports Medicine*. 977-982.
- Dejanovic, A., Harvey, E.P., McGill, S.M. (2012). Changes in torso muscle endurance profiles in children aged 7-14 years: Reference values. *Archives of Physical Medicine and Rehabilitation*, 93(12), 2295-2301.
- Eisenmann, J.C., Laurson, K.R., Wickel, E.E., Gentile, D., Walsh, D. (2007). Utility of pedometer step recommendations for predicting overweight in children. *International Journal of Obesity*, 31, 1179-1182.
- Ekblom-Bak, E., Hellenius, ML., Ekblom, B. (2011). Are we facing a new paradigm of inactivity physiology? *British Journal of Sports Medicine*, 44(12), 834-835.
- Fisher, A., Reilly, J.J., Kelly, L.A., Montgomery, C., Williamson, A., Paton, J.Y., & Grant, S. (2005). Fundamental Movement Skills and Habitual Physical Activity in Young Children. *Medicine & Science in Sports & Exercise*, 37(4), 684-688. Retrieved from <http://doi.org/10.1249/01.MSS.0000159138.48107.7D>
- Francis, C.E., Longmuir, P.E., Boyer, C., Andersen, L.B., Barnes, J.D., Boiarskaia, E., Cairney, J., Faigenbaum, A.D., Faulkner, G., Hands, B.P., Hay, J.A., Janssen, I., Katzmarzyk, P.T., Kemper, H.C.G., Knudson, D., Lloyd, M., McKenzie, T.L., Olds, T.S., Sacheck, J.M., Shephard, R.J., Zhu, W., & Tremblay, M.S. (2015). 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*. 1-43.
- Foweather, L., Knowles, Z., Ridgers, N.D., O'Dwyer, M.V., Foulkes, J.D., Stratton, G. (2014). Fundamental Movement Skills in Relation to Weekday and Weekend Physical Activity in Preschool Children. *Journal of Science and Medicine in Sport*, 1-6.
- Gallahue, D., Ozmun, J. (2006). Understanding Motor Development. Infants, Children, Adolescents, Adults 5th Edition. New York, NY, McGraw Hill.

- Gallahue, D.L. (1982). *Understanding Motor Development in Children*. New York: John Wiley & Sons.
- Giblin, S., Collins, D., Button, C. (2014). Physical Literacy: Importance, Assessment and Future. *Sports Medicine*, 44, 1177-1184.
- Graf, C., Koch, B., Kretschmann-Kandel, E., Falkowski, G., Christ, H., Coburger, S., Lehmacher, W., Bjarnason-Wehrens, B., Platen, P., Tokarski, W., Predel, H.G., Dordel, S. (2004). Correlation between BMI, leisure habits and motor abilities in childhood (CHILT-Project). *International Journal of Obesity*, 28, 22-26.
- Hamstra-Wright, K.L., Swanik, C.B., Sitler, M.R., Swanik, K.A., Ferber, R., Ridenour, M., Huxel, K.C. (2006). Gender comparisons of dynamic restraint and motor skill in children. *Clinical Journal of Sport Medicine*, 16(1), 56-62.
- Hardy, L.L., Reinten-Reynolds, T., Espinel, P., Zask, A., Okely, A.D. (2012). Prevalence and Correlates of Low Fundamental Movement Skill Competency in Children. *Pediatrics*, 130(2), 390-398.
- Hay, J.A. (1992). Adequacy in and predilection for physical activity in children. *Clinical Journal of Sports Medicine*, 2(3), 192-201.
- Haydn-Davies, D. (2005). How does the concept of physical literacy affect what is and might be the practice of physical education? *British Journal of Teaching Physical Education*, 36(3), 45-48.
- Healthy Active Living and Obesity Research Group (2013). *Knowledge of Physical Activity Questionnaire*. Ottawa, Ontario, Canada.
- Healthy Active Living and Obesity Research Group (2014). *Canadian Assessment of Physical Literacy: Manual for Test Administration*. Ottawa, Ontario, Canada.
- International Physical Literacy Association(IPLA) (2014). *Defining Physical Literacy*. England, UK.
- Janssen, I., & LeBlanc, A.G. (2010). Systematic Review of the Health Benefits of Physical Activity and Fitness in School-aged Children and Youth. *International Journal of Behavioral Nutrition and Physical Activity*, 7(40), 1-16.

- Lemos, A.G., Avigo, E.L., Barela, J.A. (2012). Physical Education in Kindergarten Promotes Fundamental Motor Skill Development. *Advances in Physical Education*, 2(1), 17–21. Retrieved from <http://doi.org/10.4236/ape.2012.21003>
- Lloyd, M., Saunders, T.J., Bemer, E., Tremblay, M.S. (2014). Long-Term Importance of Fundamental Motor Skills: A 20-Year Follow-Up Study. *Adapted Physical Activity Quarterly*, 31, 67-78.
- Longmuir, P.E., Boyer, C., Lloyd, M., Yang, Y., Boiarskaia, E., Zhu, W., Tremblay, M.S. (2015). The Canadian Assessment of Physical Literacy: methods for children in grades 4 to 6 (8 to 12 years). *Bio Med Central Public Health*, 15 (767), 1-11.
- Loucaides, C.A., Chedzoy, S.M., Bennett, N. (2004). Differences in physical activity levels between urban and rural school children in Cyprus. *Health Education Research*, 19(2), 138-147.
- Lubans, D.R., Morgan, P.J., Cliff, D.P., Barnett, L.M., Okely, A.D. (2010). Fundamental movement skills in children and adolescents: Review of associated health benefits. *Sports Medicine*, 40(12), 1019-1035.
- Malina, R.M., Bouchard, C., Bar-Or, O. (2004). Growth, Maturation, and Physical Activity. 2nd edition. Human Kinetics, Champaign, IL.
- Malina, R.M. (2001). Physical activity and fitness: Pathways from childhood to adulthood. *American Journal of Human Biology*, 13(2), 162-172.
doi:10.1002/1520-6300(200102/03)13:2<162:AID-AJHB1025>3.0.CO;2-T
- Marta, C.C., Marinho, D.A., Barbosa, T.M., Izquierdo, M., Marques, M.C. (2012). Physical fitness differences between prepubescent boys and girls. *Journal of strength and conditioning research*, 26(7), 1756-1766.
- Martin, J.J., Kulinna, P.H. (2004). Self-Efficacy Theory and the Theory of Planned Behavior: Teaching Physically Active Physical Education Classes. *Research Quarterly for Exercise and Sport*, 75(3), 288-297. DOI: 10.1080/02701367.2004.10609161
- Meredith M.D., Welk G.J. (2010). Fitnessgram/Activitygram test administration manual. 4th ed. Champaign, IL: Human Kinetics Publishers.
- Mirtz, T.A., Chandler, J.P., Evers, C.M. (2011). The effects of physical activity on the epiphyseal growth plates: A review of literature on normal physiology and clinical implications. *Journal of Clinical Medicine Research*, 3(1), 1-7.

- Mirwald, R.L., Baxter-Jones, A.D.G., Bailey, D.A., Beunen, G.P. (2001). An assessment of maturity from anthropometric measurements. *Medicine and science in sports and exercise*, 34(4), 689-694.
- Mitchel, J.A., Pate, R.R., Dowda, M., Mattocks, C., Riddoch, C., Ness, A.R., Blair, S.N. (2012). A Prospective Study of Sedentary Behaviour in a Large Cohort of Youth. *Medicine and Science in Sports and Exercise*, 44(6), 1081-1087. doi:10.1249/MSS.0b013e3182446c65.
- Mojavezi, A., Tamiz, M.P. (2012). The Impact of Teacher Self-efficacy on the Students' Motivation and Achievement. *Theory and Practice in Language Studies*, 2(3), 483-491. doi:10.4304/tpls.2.3.483-491
- Nova Scotia Department of Education and Early Childhood Development (2014). Physical Education 4-6, Draft.
- Okely, A.D., Booth, M.L., & Patterson, J.W. (2001). Relationship of physical activity to fundamental movement skills among adolescents. *Medicine and Science in Sports and Exercise*. 33(11). 1899-1904.
- Pabayo R., Gauvin L., Barnett T.A., Nikiema B., Seguin L. (2010). Sustained active transportation is associated with a favorable body mass index trajectory across early school years. Findings from the Quebec Longitudinal Study of Child Development birth cohort. *Preventative Medicine*, 50(Suppl. 1), S59-S64.
- ParticipACTION. (2015). The Biggest Risk is Keeping Kids Indoors. *The 2015 ParticipACTION Report Card on Physical Activity for Children and Youth*. Toronto: ParticipACTION. Retrieved from www.participactionreportcard.com
- ParticipACTION, Sport for Life Society, the Healthy Active Living and Obesity Research Group at the Children's Hospital of Eastern Ontario Research Institute, Physical and Health Education Canada, Canadian Parks and Recreation Association, and the Ontario Society of Physical Activity Promoters in Public Health (2015). Canada's Physical Literacy Consensus Statement.
- Pate, R.R., O'Neill, J.R., Lobelo, F. (2008). The evolving definition of "sedentary". *Exercise Sport Science Review*, 36(4), 173-178.
- Philippaerts, R.M., Vaeyens, R., Janssens, M., Van Renterghem, B., Matthys, D., Craen, R., Bourgois, J., Vrijens, J., Beunen, G., Malina, R.M. (2006). The Relationship Between Peak Height Velocity and Physical Performance in Youth Soccer Players. *Journal of Sports Sciences*, 24(3), 221-230.

- Physical Health Education (PHE) Canada. (2015). Physical literacy. Retrieved from <http://www.phecanada.ca/programs/physical-literacy/what-physical-literacy>
- Randall, L., Robinson, D. B., & Fletcher, T. (2014). A Descriptive Profile of Physical Education Teachers and Programs in Atlantic Canada. *McGill Journal of Education*, 49(1), 41. Retrieved from <http://doi.org/10.7202/1025771ar>
- Reeves, L., Broeder, C.E., Kennedy-Honeycutt, L., East, C., Matney, L. (1999). Relationship of Fitness and Gross Motor Skills for Five-to-Six Year-old Children. Percept Mot Skills, 89, 739-747.
- Roetert, E. P., & MacDonald, L. C. (2015). Unpacking the physical literacy concept for K-12 physical education: What should we expect the learner to master? *Journal of Sport and Health Science*, 4, 108–112. Retrieved from <http://doi.org/10.1016/j.jshs.2015.03.002>
- Santrock, J.W., Mackenzie-Rivers, A., Malcomson, T., Ho Leung, K., Pangman, V. (2014). Life-span Development. 5th Canadian Edition. McGraw-Hill Ryerson, Toronto, ON.
- Saunders, T.J., Chaput, J-P., Tremblay, M.S. (2014). Sedentary Behaviour as an Emerging Risk Factor for Cardiometabolic Diseases in Children and Youth. *Canadian Journal of Diabetes*, 38(1), 53-61.
- Sedentary Behaviour Research Network (2012). Standardized use of the terms “sedentary” and “sedentary behaviours”. *Applied Physiology of Nutrition Metabolism*, 37, 540–542.
- Seefeldt, V. (1980). Developmental motor patterns: Implications for elementary school physical education. *Psychology of motor behavior and sport*, 314–323.
- 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.
- Standiford, A. (2013) The secret struggle of the active girl: A qualitative synthesis of interpersonal factors that influence physical activity in adolescent girls. *Health Care for Women International*, 34, 860-877.
- Statistics Canada (2015) Directly measured physical activity of children and youth, 2012 and 2013. Ottawa: Statistics Canada.

- Stodden, D.F., Goodway, J.D., Langendorfer, S.J., Roberton, M., 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, 290-306.
- Telford, R.D., Cunningham, R.B., Fitzgerald, R., Olive, L.S., Prosser, L., Jiang, X., Telford, R.M. (2012). Physical Education, Obesity, and Academic Achievement: A 2-Year Longitudinal Investigation of Australian Elementary School Children. *American Journal of Public Health*, 102(2), 368-374. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/21940922>
- Thomas, J.R., Thomas, K.T., & Williams, K. (2008). Motor Development and Elementary Physical Education Are Partners. *Journal of Physical Education, Recreation & Dance*, 79(7), 40–43. Retrieved from: <http://doi.org/10.1080/07303084.2008.10598214>
- Thompson, A.M., Baxter-Jones, A.D., Mirwald, R.T., Bailey, D.A. (2003). Comparison of Physical Activity in Male and Female Children: Does Maturation Matter? *Medicine and Science in Sports and Exercise*, 35(10), 1684-1690.
- Tremblay, M. and Lloyd, M. (2010). Physical literacy measurement- The missing piece. *Physical and health education journal*, 76(1), 26-30.
- Tudor-Locke, C.L., Burkett, L., Reis, J.P., Ainsworth, B.E., Macera, C.A., Wilson, D.K. (2005). How many days of pedometer monitoring predict weekly physical activity in adults? *Preventative Medicine*, 40(3), 293- 298
- Twisk, J.W. (2001). Physical activity guidelines for children and adolescents: A critical review. *Sports Med*, 31(8), 617-627. Retrieved from <http://link.springer.com/article/10.2165%2F00007256-200131080-00006>
- Wiersma, L.D. (2009). Conceptualization and Development of the Sources of Enjoyment in Youth Sport Questionnaire. *Measurement in Physical Education and Exercise Science*, 5(3), 153-177.
- Whitehead, M. (2010). *Physical Literacy: Throughout the lifecourse*. New York, NY: Routledge.
- WHO (2015). Global Strategy on Diet, Physical Activity, and Health. Retrieved from http://www.who.int/dietphysicalactivity/physical_activity_intensity/en/
- WHO (2014). Global Recommendations of PA for Health. *Igarss*, (1), 1–5. Retrieved from <http://doi.org/10.1007/s13398-014-0173-7.2>

WHO (2007). Growth Reference 5 to 19 years. Retrieved from
http://who.int/growthref/who2007_bmi_for_age/en/

Appendix A- CHEO Research Ethics Approval

Angie Kolen

From: shaig@cheo.on.ca
Sent: Thursday, January 09, 2014 12:22 PM
To: Tremblay, Mark
Cc: Boyer, Charles; Haig, Sharon
Subject: REB Protocol No 13/202X - Final Approval - Delegated Review



RESEARCH INSTITUTE
INSTITUT DE RECHERCHE

CHEO Research Ethics Board Approval - Delegated Review

Principal Investigator: Dr. Mark Tremblay
REB Protocol No: 13/202X
Romeo File No: 20130481
Project Title: CITEOREB# 13/202X - CAPI-RBC Learn to Play Project
Primary Affiliation: HALDIMIALO
Protocol Status: Active
Approval Date: January 09, 2014
Valid Until: December 15, 2014
Annual Renewal Submission Deadline: November 15, 2014

Documents Reviewed & Approved:

Document Name	Comments	Version	Date
Assent Form	Version #1		2013/11/25
Consent Form	Version #1		2013/11/25
Other Document	Child Health Screening Form - Version #1		2013/11/25
Other Document	Parent Letter		2013/11/25
Protocol	Version #1		2013/11/25
Protocol	Version #1 Revised Page 8 of 16		2013/11/25
Assent Form	Version #1 - Revised		2013/11/25
Consent Form	Version #1 - Revised		2013/11/25

This is to notify you that the Children's Hospital of Eastern Ontario Research Ethics Board has granted approval to the above named research study on the date noted above. Your project was reviewed under the delegated review stream, which is reserved for projects that involve no more than minimal risk to human subjects.

Final approval is granted for the above noted study, with the understanding that the investigator agrees to comply with the following requirements:

1. The investigator must conduct the study in compliance with the protocol and any additional conditions set out by the Board.
2. The investigator must not implement any deviation from, or changes to, the protocol without the approval of the REB, or when the change involves only logistical or administrative aspects of the study (e.g., change of telephone number or research staff).
3. The investigator must, prior to use, submit to the Board changes to the study documentation, e.g., changes to the informed consent letters, recruitment materials.
4. For all other research studies, investigators must promptly report to the REB all unexpected and untoward occurrences (including the loss or theft of study data and other such privacy breaches).
5. Investigators must submit an annual renewal report to the REB 30 days prior to the expiration date stated above.
6. Investigators must submit a final report at the conclusion of the study.
7. Investigators must provide the Board with French versions of the consent form, unless a waiver has been granted.

For complete procedures relating to REB procedures, please refer to the REB website at <http://www.cheori.org/en/researchethicsboard> or contact Sharon Haig, Ethics Coordinator at shaig@cheo.on.ca or 613-737-7600 ext. 2128.

Regards,



Dr. Carole Gentile
Chair, Research Ethics Board
Présidente, Comité d'éthique de la recherche
401 Smyth Road, Ottawa, ON K1H 8L1
Tel: (613) 737-7600 ext. 3624 | Fax/Télé: (613) 738-4202 | gentile@cheo.on.ca

Appendix B- Dalhousie Research Ethics Approval



Health Sciences Research Ethics Board Letter of Approval

February 24, 2017

Natalie Houser
Health Professions\Health & Human Performance

Dear Natalie,

REB #: 2017-4095
Project Title: Canadian Assessment of Physical Literacy

Effective Date: February 24, 2017
Expiry Date: February 24, 2018

The Health Sciences Research Ethics Board has reviewed your application for research involving humans and found the proposed research to be in accordance with the Tri-Council Policy Statement on *Ethical Conduct for Research Involving Humans*. This approval will be in effect for 12 months as indicated above. This approval is subject to the conditions listed below which constitute your on-going responsibilities with respect to the ethical conduct of this research.

Sincerely,

Dr. Tannis Jurgens, Chair

Appendix C- St FX Research Ethics Approval



St. Francis Xavier University Research Ethics Board Ethics Approval for Research with Human Subjects

February 12, 2014

Dr. Angela Kolen
Faculty Member, Human Kinetics Department
St. Francis Xavier University
Antigonish, Nova Scotia

Approval: 12 February 2014

Anniversary Date: 12 February 12, 2015

Title: "The Canadian Assessment of Physical Literacy".

We are in receipt of your application to the StFX REB respecting the project cited above, which is under the direction of Principal Investigator Dr. Mark Tremblay. The letter of approval from the Research Ethics Board of Children's Hospital of Eastern Ontario Research Institute, dated January 9, 2014, was included in your correspondence. You will participate by being responsible for the research team that will collect data for this project in and around Antigonish.

I have examined the rationale, the questions and the Invitation and Assent/Consent process that will be used and I am pleased to inform you that these meet ethics approval. Your participation has been approved and you may proceed with your research.

Tri-Council regulations require that individuals provide the REB with an annual statement about their research, noting in particular if any changes have been made that require consideration by the Board. The anniversary date of your project, when an annual report will be required, is given above (and each year, until the project is completed). Prior to that date, you will be sent a form to complete and return. If you have not received it by a date two weeks before your anniversary date, please contact the administrative assistant to the REB. If your research is funded by a third party, please contact them directly to ensure that your funds are released.

Kindly accept my best wishes for every success with your research.

Sincerely,

Leona English, Ph.D., Chair,
Research Ethics Board

Appendix D- Strait Regional School Board Ethics Approval



September 30, 2015

Ms. Angela M. Kolen
St. F. X., Human Kinetics
1140 Convocation Blvd.
Antigonish, NS
B2G 2W5

Dear Ms. Kolen:

Re: "Canadian Assessment of Physical Literacy"


I have reviewed your application to conduct the second year of your research project within the Strait Regional School Board. Your application has been approved, subject to the following conditions:

- I. all aspects of the research, including associated documentation and the submission of a final report to my office, must comply with the provisions of the Strait Regional School Board External Research Projects Policy: <http://srsb.ca/sites/default/files/6122-External%20Research-F%200.pdf> and Procedures: <http://srsb.ca/sites/default/files/6122-External%20Research-Procedures-F%200.pdf>;
- II. the Principal(s) of the school(s) that will be participating in the research **have** been fully informed of the particulars and are in agreement with them, and;
- III. all pertinent policies and procedures, including confidentiality safeguards, are fully implemented.

If you have any questions regarding this approval letter, please direct them to me as per the contact information cited in this correspondence.

Thank you for your interest in our schools and best wishes for successful and productive research.

Yours truly,


Paul Landry, Director
Programs and Student Services

PL/smw

c: Principals

16 Cemetery Road, Port Hastings, NS B9A 1K6 CANADA
Bus: 902 625-2191 Fax: 902 625-2281 www.srsb.ca

Appendix E- Parental Consent and Health Screening Form

Please detach and return signed consent form and health check form to classroom teacher by _____



Dear Parent/Guardian:

Your child's school has been chosen to participate in a research study conducted by St. Francis Xavier University in conjunction with the Children's Hospital of Eastern Ontario (CHEO) Research Institute. As one of six implementation sites in Canada, we are inviting about 1300 children 8-12 years of age to participate in our study. The Research Ethics Board of the CHEO's Research Institute and St. Francis Xavier University have approved this research project. Further, the Director of Programs and Student Services of the Strait Regional School Board has given permission for this project to be carried out at your child's school.

We hope that you will support our research study by allowing your child to participate. The study will be done while your child is at the <<insert name of school>>. All children in your child's grade are invited to participate, and the children will participate in groups.

If you are willing to have your child participate in our study, please:

1. Complete the attached Parent/Guardian Consent Form
2. Complete the attached Physical Activity for Kids Screening Questions
3. Return both the Parent/Guardian Consent Form and the Physical Activity for Kids Screening Questions to your child's teacher

Over the past 3 years we have developed the Canadian Assessment of Physical Literacy (CAPL for short). The purpose of the CAPL was to create a new way to find out whether children have the skills, knowledge and abilities to pursue an active, healthy lifestyle. With the CAPL test finalized, we are recruiting children 8 to 12 years from 3 provinces and 6 data collection sites for a total of 9000 children to participate in CAPL. This large scale multi-province testing allows for greater knowledge to be gained about the current levels of physical literacy in Canada. All of the research testing will be at a time chosen by your child's teacher.

We encourage you to read the study consent form included with this letter. **It is your choice whether or not your child participates in this study.** Whether or not your child is involved will have no impact on your child's outcomes at his or her school, and your child can withdraw at any time without consequence. If you agree to have your child participate in the study please sign one of the enclosed consent forms and return it to your child's school teacher. Please keep the second copy of the consent form for yourself.

If you have any questions or concerns about this study please do not hesitate to contact the research coordinator for the Antigonish data collection site, Dr. Angie Kolen at 867-3540. Thank you for your time in considering our request for your child's study participation.

Sincerely,
Dr. Angie Kolen

Angela M. Kolen • Professor • 3M National Teaching Fellow
Department of Human Kinetics • St. Francis Xavier University
1140 Convocation Blvd • Antigonish NS • Canada • B2G 2W5
Phone: 902-867-3540 • Fax: 902-867-3904 • Email: akolen@stfx.ca

Please detach and return signed consent form and health check form to classroom teacher by _____



Parent Consent Form

What is the title of this research study?

The Canadian Assessment of Physical Literacy

Who is doing this research?

Dr. Angie Kolen, Site Investigator
Department of Human Kinetics, St. Francis Xavier University
Tel: 902-867-3540, email: akolen@stfx.ca

Dr. Mark Tremblay, Principal Investigator
Healthy Active Living and Obesity Research Group, CHEO- Research Institute
tel: 613-737-7600 x 4114, email: mtremblay@cheo.on.ca

Dr. Pat Longmuir, Co-Investigator
Healthy Active Living and Obesity Research Group, CHEO- Research Institute
tel: 613-737-7600 x 3908, email: plongmuir@cheo.on.ca

Kevin Belanger, Research Coordinator
Healthy Active Living and Obesity Research Group, CHEO- Research Institute
tel: 613-737-7600 x 4408, email: kbelanger@cheo.on.ca

The Children's Hospital of Eastern Ontario (CHEO), St. Francis Xavier University and the Director of Programs and Student Services of the Strait Regional School Board have approved of this research study.

Why are we doing this study?

We are doing this study because teachers, coaches and other physical activity leaders have told us they need a new way of measuring how well children are doing in physical and health education. The test we have created is called the Canadian Assessment of Physical Literacy. "Physical Literacy" means everything that children need to have or learn so that they can lead a healthy, active and enjoyable life. There are many ways to measure how well children are learning in many school subjects, like math and language. However, at the moment there is no measure of physical literacy, which is why we are creating a new one. Having an accurate and reliable way to measure physical literacy will help us to identify children who are not learning everything they need to know for a healthy, active lifestyle. It will also help us to better evaluate programmes designed to encourage physical activity and healthy living so that children will not be at risk for the health problems that result from being overweight or obese.

Angela M. Kolen • Professor • 3M National Teaching Fellow
Department of Human Kinetics • St. Francis Xavier University
1140 Convocation Blvd • Antigonish NS • Canada • B2G 2W5
Phone: 902-867-3540 • Fax: 902-867-3904 • Email: akolen@stfx.ca

Please detach and return signed consent form and health check form to classroom teacher by _____



What will your child do during the study?

The Canadian Assessment of Physical Literacy includes many activities that are similar to what your child would typically do during physical education class. **Your child will be asked to “do the best that you can” and “try your hardest” for each activity.** As a result, your child may exercise strenuously during the study and your child will be allowed to stop any activity at any time he or she chooses. Before your child tries any of the study activities, we will ask your child whether he or she wants to participate. Your child can say either “Yes” or “No”, and his or her choice will be respected even if you want your child to participate. If your child agrees to participate, we will record your child’s gender, age and grade. Your child will then be asked to complete each of the following tasks:

- Obstacle Course – Includes jumping, running, hopping, catching, throwing and kicking balls while running
- Grip Strength – Squeezing a handle as hard as possible
- Plank – A core strength exercise commonly used in yoga-like activities and sport training: holding a Push Up position as long as possible while resting only on the toes and forearms
- Sit and Reach - Reach toward the toes while sitting with legs straight, to measure flexibility.
- PACER (Beep Test) - Run laps back and forth across the gym, starting at a slow speed and gradually getting faster. Your child will continue running until he or she is too tired or does not wish to continue running at the faster speed.
- Body measurements - Have his or her height and weight and size of waist measured while dressed in their gym clothes. Waist size will be measured while wearing their gym clothes. The measurements will be done in a private area away from others and the values obtained will not be obvious or made known to your child.
- Questionnaire - Answer questions about physical activity by writing answers on a questionnaire or using a computer to answer the questions. The questions will tell us what children know about physical activity, physical fitness and the skills needed to be active. The questions will also ask about your child’s interest in physical activity.
- Pedometers - a small square device, worn clipped to a belt or pant waistband, to measure the number of steps your child takes daily every day for 8 days. The pedometer should be worn at all times during waking hours except when your child is swimming or bathing. It does not measure the type of activities or where your child is, it only measures how much movement your child makes. Your child will also be asked to write down the times that the pedometer is not worn, as well as the activities when not wearing the pedometer. It is very important that the pedometer is returned to us at the end of the study. However, if it is misplaced and absolutely cannot be found you will not have to purchase a replacement.

Children who participate in this research will perform the study activities at your child’s school and your child’s teacher will be present at all times. Most activities will take place in the gymnasium.

Angela M. Kolen • Professor • 3M National Teaching Fellow
Department of Human Kinetics • St. Francis Xavier University
1140 Convocation Blvd • Antigonish NS • Canada • B2G 2W5
Phone: 902-867-3540 • Fax: 902-867-3904 • Email: akolen@stfx.ca

Please detach and return signed consent form and health check form to classroom teacher by _____



If you choose not to allow your child to participate in this study, your child will be supervised by his or her own teacher and engaged in appropriate program-focused activities while the other children in the program are completing the study activities.

Physical activity and fitness testing are safe for most children, and the activities done in this study are similar to what your child normally does during physical education. Providing us with more information about your child's health and your family's history will help us to make the research study fun and safe for your child. Please complete the "Physical Activity for Kids" screening form enclosed, and return it with the consent form to your child's teacher. If you have questions about the information we are asking you to provide on the screening form, please contact: Dr. Angie Kolen at 902-867-3540 or by sending an email to akolen@stfx.ca.

Could something bad happen to my child during this study?

We do not expect bad things to happen to children who participate in this study. All the activities for the study are similar to what your child does in physical education. There are no needles or invasive procedures. As with any type of physical activity, there is a small risk of falling or getting hurt. However, all the research equipment is similar to what your child uses in physical education and safety is our first priority. Study personnel are trained in First Aid and CPR, and in the event of an injury, standard organizational policies will be followed. The pedometers are very durable, however if one happens to break the smaller broken off pieces may present a choking hazard to children under the age of 3. For this reason, please keep the pedometer out of reach of children under the age of 3. In the unlikely event that your child is injured as a direct result of participating in this research, the normal legal rules about compensation for the injury will apply. By signing this consent form you are in no way waiving your legal rights or releasing the investigator and the sponsor from their legal and professional responsibilities.

Will my child or family get something for being in this study?

You and your child will not be paid or given a reward for being in this study. We cannot promise that you will get any benefit from your child's study participation.

The information that we gather during this study will help us to assess physical literacy of Canadian children 8 to 12 years of age. Knowing more about the current levels of physical literacy in Canadian children will help to inform future studies.

Your child's participation in this study is completely voluntary. You and your child are free to withdraw from this study at any time, even after the research testing has been completed. Neither participation nor withdrawal from the study will affect your child's outcomes at school.

Angela M. Kolen • Professor • 3M National Teaching Fellow
Department of Human Kinetics • St. Francis Xavier University
1140 Convocation Blvd • Antigonish NS • Canada • B2G 2W5
Phone: 902-867-3540 • Fax: 902-867-3904 • Email: akolen@stfx.ca

Please detach and return signed consent form and health check form to classroom teacher by _____



Who will know that my child is in this research study?

The information we collect about your child will not identify your child. We will use a coded identification number instead of your child's name so that only the researchers will know who the information is about. The data collected in this study will be locked in a safe place. All information from your child will be numbered and will not contain your child's name. A list of names and matching code numbers will be stored separately.

The information collected in this study is collected under the authority of Board policies and the Freedom of Information and Protection of Privacy (FOIPOP) Act.

It is intended that only the staff involved in this research study will have access to the research information collected during this study. However, there are specific situations where other people may be given access to the research information. A member of the Research Ethics Board at the Children's Hospital of Eastern Ontario (CHEO) may be given access to the research records for auditing purposes.

There are also limits to the confidentiality of research information in situations of suspected child abuse, concerns of harm to self or others, or any request for information by court order.

The coded information collected during this research study will be stored for 7 years after all of the results of this research have been published. After that time, all records will be destroyed in the way required by Canadian research data regulations. Overall study results may be published for scientific purposes, but the identity of the research participants will remain confidential. No information that could identify your child or your child's organization will be published.

Who should I contact if I have questions about the research study?

If you have questions about this study please contact Dr. Angie Kolen, Department of Human Kinetics, St. Francis Xavier University at 902-867-3540 or via email: akolen@stfx.ca. You can also contact the Director of Programs and Student Services at 902-625-2191 or 1-800-650-4448.

This study was first reviewed and approved by the CHEO Research Ethics Board. The CHEO Research Ethics Board is a committee of the hospital that includes individuals from different professional backgrounds. The Board reviews all research done by scientists at the hospital that involves people. Its goal is to ensure the protection of the rights and welfare of people participating in research. The Board's work is not intended to replace a parent or child's judgment about what decisions and choices are best for them. You may contact the Chair of the Research Ethics Board, for information regarding participant's rights in research studies at (613) 737-7600 ext. 3272, although this person cannot provide any health-related information about the study. The Board could review your study records in fulfilling its roles and responsibilities.

Angela M. Kolen • Professor • 3M National Teaching Fellow
Department of Human Kinetics • St. Francis Xavier University
1140 Convocation Blvd • Antigonish NS • Canada • B2G 2W5
Phone: 902-867-3540 • Fax: 902-867-3904 • Email: akolen@stfx.ca

Please detach and return signed consent form and health check form to classroom teacher by _____



CAPL Parent/Guardian Informed Consent

Please complete the following permission section of this letter, remove it, and have your son or daughter return it to his/her teacher.

Authorization and Release

I hereby give permission for my son/daughter to participate in the research project as described in the above letter.

I have read and understood the attached study information or had the attached information verbally explained to me. I understand that my child will be asked to exercise strenuously, and to do the best that they can for each type of exercise. I have been fully informed of the details of the study and have had the opportunity to discuss my concerns. I understand that I am free to withdraw my child at any time or not answer questions that make us uncomfortable, and that my child's performance outcomes will not be affected if I do. I have received a copy of the study information and consent form.

I am the parent/guardian of _____ who is in grade _____ at _____ (school) and I consent to this authorization and release.

Age of child: _____

Parent/guardian signature: _____

Telephone: _____

Email: _____

Date: _____

After your child completes the study, you will receive an email containing a login and password. The information will enable you to confidentially obtain your child's research study results.

Angela M. Kolen • Professor • 3M National Teaching Fellow
Department of Human Kinetics • St. Francis Xavier University
1140 Convocation Blvd • Antigonish NS • Canada • B2G 2W5
Phone: 902-867-3540 • Fax: 902-867-3904 • Email: akolen@stfx.ca

Please detach and return signed consent form and health check form to classroom teacher by _____



In addition to the CAPL assessment, we will be running a related study that involves collecting physical activity information from parents of participating children. If you would like to learn more about this study and give permission for us to contact you by phone and send you additional information by mail or email please indicate in the box below. Please note that only those people who tick this box and provide contact information will be contacted.

I wish to learn more about the parent physical activity study and give the research team permission to contact me and send additional information by mail or email.

YES, I would like additional information. I can be contacted by phone at: _____

Please send information to the following address (email/mail): _____

More information can be found at: <http://www.cheori.org/halo/>

Angela M. Kolen • Professor • 3M National Teaching Fellow
Department of Human Kinetics • St. Francis Xavier University
1140 Convocation Blvd • Antigonish NS • Canada • B2G 2W5
Phone: 902-867-3540 • Fax: 902-867-3904 • Email: akolen@stfx.ca

Please detach and return signed consent form and health check form to classroom teacher by _____



Physical Activity for Kids Screening Questions

Parent/Guardian Name: _____

Child's Name: _____

Physical activity and fitness testing are safe for most children. However, sometimes children need to be careful when they do specific types of activity.

Help us to supervise your child's activity appropriately by answering the following question(s).

1. Has a doctor ever told you that there are some types of exercises or physical activity that your child should not do? (please circle)

Yes No

2. If you answered yes, please describe the types of exercises or physical activity that your child cannot do at this time:

Angela M. Kolen • Professor • 3M National Teaching Fellow
Department of Human Kinetics • St. Francis Xavier University
1140 Convocation Blvd • Antigonish NS • Canada • B2G 2W5
Phone: 902-867-3540 • Fax: 902-867-3904 • Email: akolen@stfx.ca

Appendix F- Obstacle Course Score Sheet

Obstacle Course Score Sheet

Test Location: _____

Test Date: _____

Examiner #1: _____

Examiner #2: _____

ID Number:																			
Time(s)																			
Two foot jumping	3 two-foot jumps in and out of the yellow/ purple/blue hoops																		
	No extra jumps and no touching of hoops																		
Sliding	Body and feet are aligned sideways when sliding in one direction																		
	Body and feet are aligned sideways when sliding in opposite direction																		
	Touch cone with low centre of gravity and athletic position																		
Catching	Catches ball (no dropping or trapping)																		
Throwing	Uses overhand throw to hit target																		
	Transfers weight and rotates body																		
Skipping	Correct hop-step pattern																		
	Uses arms appropriately (alternates arms and legs, arm swinging for balance)																		
One foot hopping	Land on one foot in each hoop																		
	Hops once in each hoop (no touching of hoops)																		
Kicking	Smooth approach to kick ball and hit target																		
	Elongated stride on last stride before impact																		
Total																			

Appendix G- Pedometer Tracking Sheet

Pedometer Tracking Log

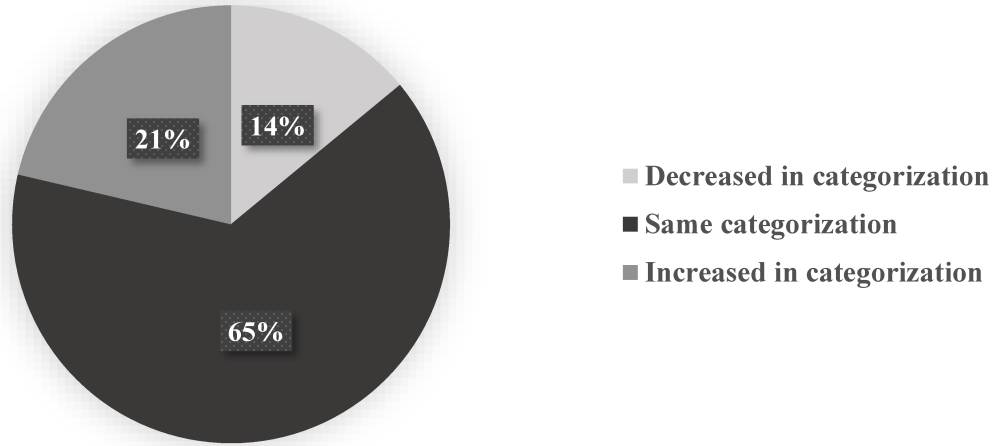
Distribution Date: _____ Return Date: _____ ID: _____

Please wear the pedometer all day if possible. Record the date, time put on, time taken off and whether or not you wore it all day in the table below. Thank you. On the return date, please return the pedometer and this sheet in the attached baggie to your teacher. Thank you.

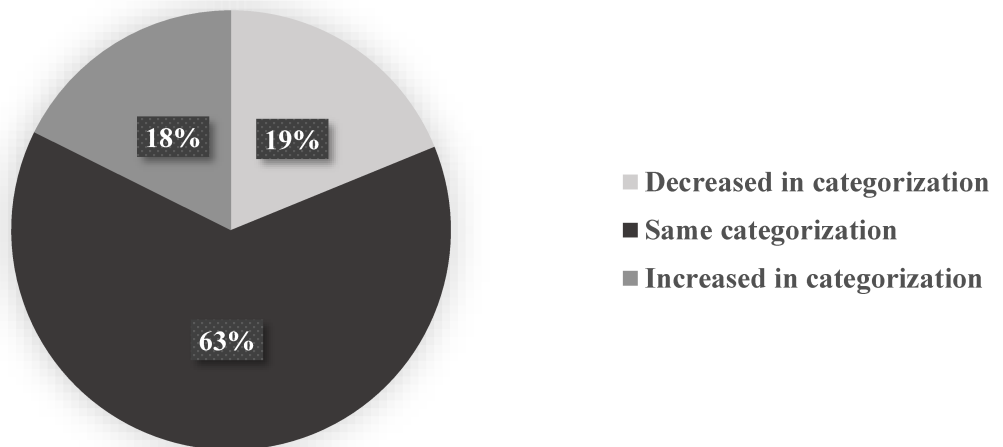
Practice Day (this is the day we gave you the pedometer to wear) Friday, Oct 21		Time on:	Time off:	Was the pedometer worn all day?
Day	Date	Time put on	Time taken off	Was the pedometer worn all day?
1				Yes, I wore it all day _____ No, I took it off for _____ hours because _____
2				Yes, I wore it all day _____ No, I took it off for _____ hours because _____
3				Yes, I wore it all day _____ No, I took it off for _____ hours because _____
4				Yes, I wore it all day _____ No, I took it off for _____ hours because _____
5				Yes, I wore it all day _____ No, I took it off for _____ hours because _____
6				Yes, I wore it all day _____ No, I took it off for _____ hours because _____
7				Yes, I wore it all day _____ No, I took it off for _____ hours because _____

Appendix H- Change in Categorization from Year 1 to Year 2 in Each Domain

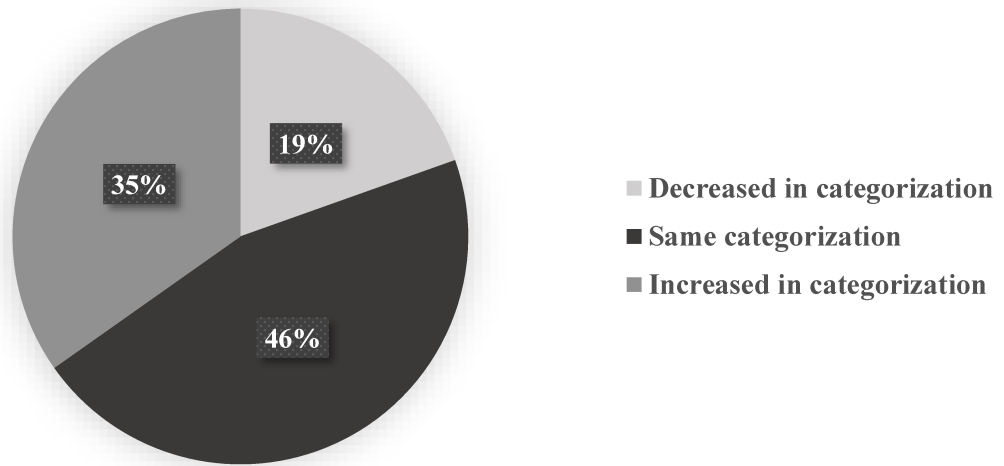
Physical Competence from Year 1 to Year 2



Motivation and Confidence from Year 1 to Year 2



Knowledge and Understanding from Year 1 to Year 2



Daily Behaviours from Year 1 to Year 2

