The Impact of Circus Arts Instruction on the Physical Literacy of Children in Grades 4 and 5

By

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Abstract

Purpose: The purpose of this study was to examine the impact of circus arts instruction on the physical literacy (PL) of children in grades 4 and 5.

Methods: A prospective, clustered, quasi-experimental design was used to compare schools with circus arts instruction in physical education class (PE CIRCUS) to three matched schools using standard Physical Health and Education curriculum delivery (PE). PL assessments were obtained at the beginning and end of one semester using PLAY Tools (physicalliteracy.ca). These tools provided an assessment of 1) motor competence, confidence, and comprehension, 2) the child's self-report of physical literacy, 3) the PE teacher's surrogate assessment of the child, 4) the parental assessment of the child, and 5) an inventory of the child's activities.

Results: 211 students participated, with equal numbers in grades 4 and 5, and an even distribution between PE and PE CIRCUS groups. There were significant ($p<0.05$) improvements in motor competence in movement skills (curricular linked) over time for both school settings, but with substantial endpoint differences (7.9%, $p<0.01$) in favour of PE CIRCUS for 15 of 18 movement skills in grade 5 only. The gender gap in motor competence in the PE CIRCUS group was smaller than that in the PE group. Children in the PE CIRCUS schools revealed greater movement terminology comprehension and higher confidence in execution ($p<0.05$). Children in the PE CIRCUS schools reported greater confidence, felt more talented, were more eager to participate ($p=0.055$), and girls associated physical activity with happiness ($p<0.05$) more than those in the PE schools.

Conclusion: Circus arts instruction can effectively aid in the development of physical literacy in children. Providing a quality physical literacy experience, such as circus arts instruction, does not amplify the gender gap, but provides equitable levels of motor competence development for males and females, and assists with achieving current PE curricular objectives. The results of this study provide insight to allow for further development of effective physical education delivery methods in schools, and provide quantitative research to support the positive effects of circus arts instruction reported qualitatively.

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Review of Literature

PHYSICAL LITERACY

> ***"No matter how many sidewalks we build, no matter how many parks we construct, no matter how much we urge people to get involved with physical activity, they simply won't do it unless they have the ability, confidence, and desire to be physically active. That's where physical literacy comes in."***

American Surgeon General, Vivek Murthy (Murthy, 2015)

Physical literacy (PL) has become a key element in the delivery of physical education (Physical and Health Education Canada, 2014), sport (Canadian Sport for Life, 2014), recreation (Canadian Sport for Life & Canadian Parks and Recreation Association, 2013), and emerging in the health field, and is thought to be a critical element for the development and maintenance of a physically active lifestyle (Keegan, 2013).

The term physical literacy is recorded in literature as far back as the year 1884 (Maguire & United States Army Corps of Engineers, 1884), but was in periodic use in the 1930's in educational journals in the United States (British Institute of Adult Education & National Institute of Adult Education, 1937; National Education Association of the United States. Dept. of Secondary Teachers, 1935; Nebraska State Education Association, 1931), with use of the term identical to that of today.

However, the promotional and philosophical work of Dr. Margaret Whitehead (Whitehead, 2001), from England, has spear-headed an infectious interest worldwide in the use and conceptual development of the term. In 1993, she first proposed the re-introduction of the term "physical literacy". In June 2014, she was a co-founder of the International Physical Literacy Association (International Physical Literacy Association, 2015) along with the Canadian Sport for Life organization. Consistent with her philosophical roots, Dr. Whitehead has a pluralistic view of the term.

> ***"Physical literacy is the motivation, confidence, physical competence, knowledge, and understanding to value and take responsibility for engagement in physical activities for life."***

Dr. M. Whitehead (International Physical Literacy Association, 2015)

As is natural in early years of conceptual development of a term, and similar to the evolution that occurred in the 100 plus year history of the literacy movement (Google books Ngram Viewer, 2013), multiple forms of definitions of PL are emerging. For instance, PHE Canada, has defined physically literate people contextualized to the education sector, as

> ***"Individuals who are physically literate move with competence and confidence, in a wide variety of physical activities and in multiple environments that benefit the healthy development of the whole person."***

PHE Canada (Physical and Health Education Canada, 2014)

Canada has been the worldwide lead country in system wide adoption of the term, and implementation of programming. Organizational adoption of the term is widespread, including Sport Canada, Canadian Parks and Recreation Association (CPRA), Hi Five, Canadian Sport for Life (CS4L), PHE Canada, RBC, and ParticipAction, to name a few. There have been multiple national, provincial, and municipal initiatives involving the development, assessment, promotion, and provision of PL. These include PHE Canada's 'Passport for Life' program, Athletics Canada's 'Run-Jump-Throw' (RJT) Program, the CS4L long term athlete development model (LTAD), and the Ontario PAN-AM 'My Personal Best'. PL has also been adopted by numerous associations around the world, including the Society of Health and Physical Educators of America (SHAPE America), the President's Council on Fitness, the American Youth Circus Organization (AYCO), northern Ireland's 'Skills 4 Sport' program, as well as various programs in the

United Kingdom, Scotland, and New Zealand (Keegan, 2013). Recently, at the International Physical Literacy Conference in Vancouver (2015) there were 15 countries that endorsed the Vancouver Declaration on the foundational terminology related to physical literacy.

Physical literacy has been coined as the “gateway to active participation” (Cohen, Morgan, Plotnikoff, Callister, & Lubans, 2014; Kriellaars, 2015). As stated by Dr. M. Whitehead (Whitehead, 2015), PL is relevant “cradle to grave", and it is inclusive. At the core, PL requires one to have physical competence and be successful in the application of skills to many physical environments. The larger the bank of movement capacities or patterns to draw on for the environment or situation encountered, the more opportunities one has to build upon their PL. Dr. Whitehead is very passionate in explaining that PL enriches life as a whole (it is “holistic, flourishing, whole being”). No one person is perfectly physically literate. Each individual person has his or her own unique PL journey, no matter what his or her abilities. In one's best interest, Dr. Whitehead hoped that the goal would be to continually make progress in that unique journey throughout life (not in comparison to others).

For physical literacy to develop, children need to be exposed and allowed to repetitively perform a variety of movements, in a variety of environments, throughout their childhood (Mandigo, 2013). Children who are physically active from a young age typically have improved motor skills, which allow for positive experiences when faced with new activity challenges. A systematic review by Lubans and coworkers revealed a positive link, albeit weak, between functional movement skill competency, and physical activity (PA) in children (Lubans, Morgan, Cliff, Barnett, & Okely, 2010). These authors reported that the number of acquired motor skills and degree of motor proficiency are associated with an increase in childhood and adolescent PA. Children with higher locomotor skills have significantly less sedentary time than those with poorer locomotor skills, and total motor skill performance is significantly associated with time spent in moderate to vigorous physical activity (MVPA) (Williams et al., 2008; Wrotniak, Epstein, Dorn, Jones, & Kondilis, 2006). Typically how a child behaves and participates at a younger age will shape the “participation blueprint” of their adult life. Therefore, children who enjoy activity at an early age are more likely to grow into

adults who are also active (Faigenbaum, Stracciolini, & Myer, 2011; Keegan, 2013; Nike Inc, 2013; Telama, 2009). Due to the observed "tracking" of PA patterns noted throughout adolescence and adulthood, it is essential to focus on childhood, and in particular, the development of motor competence, as being the initial stepping stone in the hopes of solving this issue.

This is important not only in the realm of physical literacy, but is also critical for breaking the cycle of physical inactivity that is so prevalent in society today (Keegan, 2013; Ng & Popkin, 2012). Research has been completed regarding adherence to PA guidelines for children and adults, and it is evident that the majority of the population does not achieve the published minimal goals (Colley et al., 2011b; Guthold, Cowan, Autenrieth, Kann, & Riley, 2010; Lopes, Rodrigues, Maia, & Malina, 2011). The minimum PA guideline for children is 60 minutes of MVPA daily, while the adult guideline is a minimum of 150 minutes of MVPA per week (Canadian Society for Exercise Physiology, 2014; Nader, Bradley, Houts, McRitchie, & O'Brien, 2008; Tremblay, Kho, Tricco, & Duggan, 2010). Present day youth are neither as active as children should be, nor are as active as children once were in the past. Lack of interest and participation in PA appears to progress from age six years and onward (Lopes et al., 2011; Tudor-Locke, Johnson, & Katzmarzyk, 2010). In children aged 6-11 years, approximately 42% are meeting the recommended amount of PA, while in the age group of children 12-19 years, a mere 7% are fulfilling the guidelines (Troiano et al., 2008). As children transition into adolescence, a marked deterioration in PA is evident (Nader et al., 2008). At this time, noted as early as the age of 10 years, children tend to become more aware of the differences in their physical ability in comparison to their peers' abilities. If a child does not feel his or her abilities are on par, he or she is less likely to continue participating (Faigenbaum et al., 2011). In the adult category, only 3% of the U.S. population (Troiano et al., 2008) and 5-15% of Canadian adults (Colley et al., 2011a) participate in sufficient PA. From these statistics, it is clear that an inactivity crisis is facing both children and adults, and that early childhood once again appears to be the opportune time to intervene.

Physical inactivity has become a major problem, resulting in serious health implications, especially evident in developed countries (Ng & Popkin, 2012). Low levels

of PA are associated with an increased risk of numerous health conditions including cardiovascular disease, stroke, type 2 diabetes, hypertension, colon cancer, breast cancer, osteoporosis, osteoarthritis, obesity, and depression (Oude Luttikhuis et al., 2009; Reilly et al., 2003; Singh, Mulder, Twisk, van Mechelen, & Chinapaw, 2008). The contribution of physical inactivity to the above mentioned health conditions amounts to a massive burden on health care and society (Krueger, Turner et al. 2014), with a lack of PA becoming a leading cause of death (Nike Inc, 2013). If major health implications and large economic burden are not enough, it has become known that children displaying low levels of PA are also at an increased risk of injury while participating in sports, recreation, and physical education (Bloemers et al., 2012). By enhancing PL, and creating inclusive PA opportunities, along with continued promotion in children at an early age, there is an increased likelihood that these children will continue on the path of participation and become active adults (Faigenbaum et al., 2011; Lubans et al., 2010; Telama, 2009). PA not only enhances physical and mental health, but also improves academic success, and enhances life skills (Keegan, 2013; Lambourne & Donnelly, 2011; Strong et al., 2005).

Studies of physical activity and motor competence, or fundamental movement skills, consistently have shown a large gender gap. Boys are found to spend more time in MVPA throughout the day (Cohen et al., 2014; Troiano et al., 2008), and are more active than girls overall, regardless of age, from a 6-11 year age group continuing on into adolescence and adulthood (Smith, Lounsbery, & McKenzie, 2014; Troiano et al., 2008). A Manitoban study assessed and compared the PL of children in grades 3, 4, 8, and 12. Of note, there were statistically significant sex differences in object control in grade 4, with boys having greater object control PL than girls. This gap in motor competence widened in a number of skills and magnitude of differences with increasing grade (T. R. Kozera, Kriellaars, D. J., 2011; T. R.. Kozera, Kriellaars, D. J., 2011). By grade 4, sex differences were beginning to emerge which is concerning due to the children being pre-pubescent, therefore their bodies and abilities should be quite similar. Standards and expectations for boys and girls remain equal for literacy, numeracy, and PE curriculums, but unfortunately a strong gender gap remains in regards to PL.

Canadian data collected through a recent program evaluation, My Personal Best (Kriellaars, 2014), included nearly 6,000 children who had their PL assessed at baseline and at 14 weeks. The intervention involved the training of recreation leaders on PL via a fundamental movement skills training course, online PL lectures, and instruction on the use of PL assessment tools. From this program evaluation, a few very striking observations were made consistent with those of the work of Kozera et al (T. R. Kozera, Kriellaars, D. J., 2011; T. R.. Kozera, Kriellaars, D. J., 2011). When assessing the children's PL, including upper body manipulation skills (Figure 1), in children aged 6-11 years old, there was a gender gap evident, with girls' motor competence lagging behind that of the boys'. This occurred for the majority of the 18 movement tasks that were assessed. Interestingly enough, girls' confidence levels (Figure 2) with movement begin to drop off around 7-8 years of age, as boys' confidence levels remained relatively high. When children's eagerness for PA was assessed (Figure 3), a similar trend to that found with confidence levels appears, where the girls' eagerness for being physically active decreases with age after 7-8 years of age (as motor competence and confidence also dwindle). A vicious cycle has developed; without motor competence, it is very difficult for a child to gain confidence with movement, and therefore it is unlikely that a child will feel eager and motivated to continue being physically active.

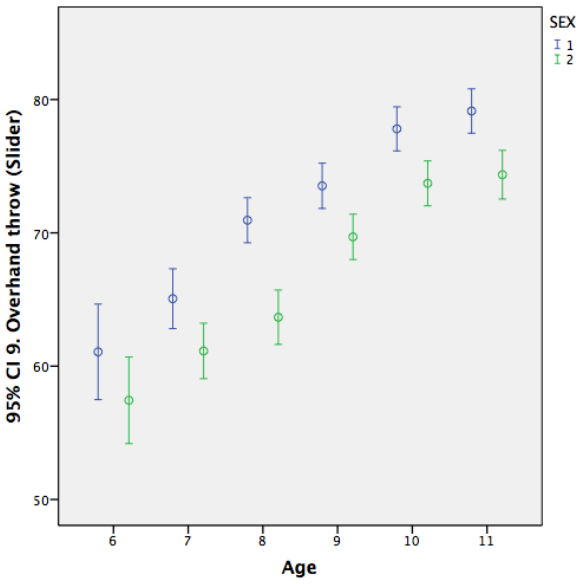

Figure 1. Proficiency in an upper body object manipulation skill (overhand throw), in 6-11 year old children (males=blue, females=green), as assessed by PLAY Fun. A gender gap in competence is evident, with girls less proficient than boys, which emerges at 8 years of age (p<0.05). Data from *My Personal Best* 2014.

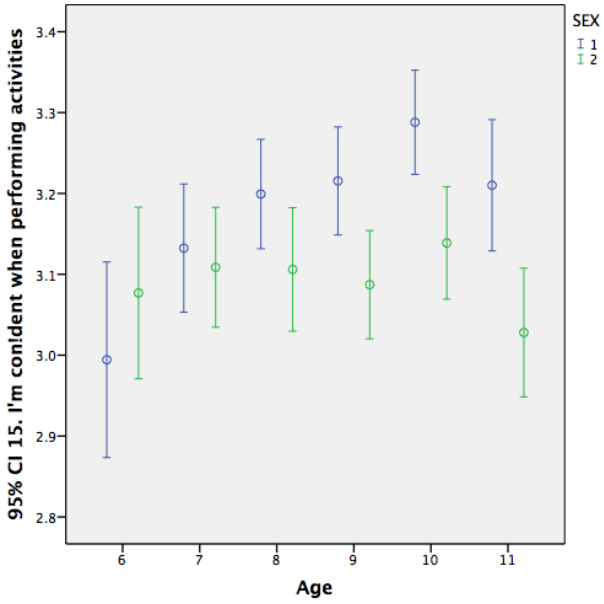

Figure 2. Confidence levels (lower score=less confidence) with physical activity participation, in 6-11 year old children (males=blue, females=green), as assessed by PLAY Self. A sex, an age, and a sex by age interaction are present (p<0.05). Data from *My Personal Best* 2014.

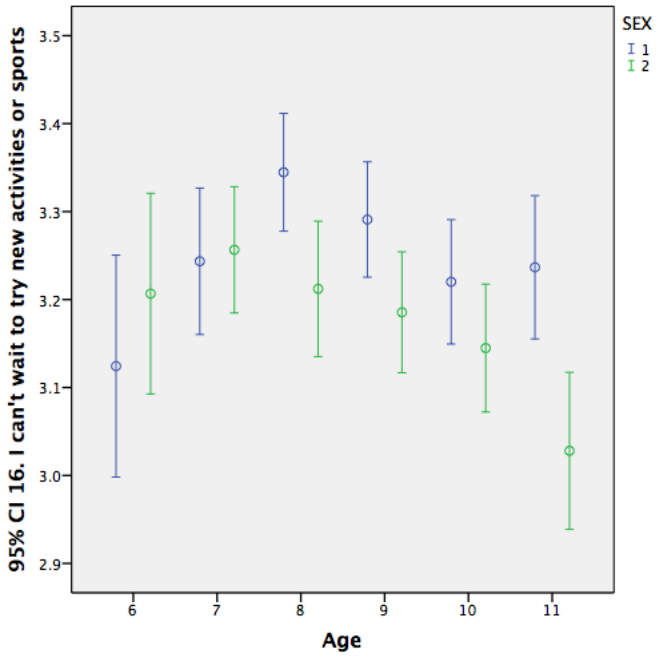

Figure 3. Eagerness to participate in physical activity, in 6-11 year old children (males=blue, females=green), as assessed by PLAY Self. A sex and an age effect are present (p<0.05). Data from *My Personal Best* 2014.

Curricular expectations for boys and girls are not different in terms of movement skill acquisition (Province of Manitoba, 2014), and there are minimal physical differences prior to puberty (around age 12). Thus, it would lead one to believe that the amount of "time on task" that boys invest for a majority of these skills is much greater than that experienced by girls. With time on task comes the ability to practise and develop motor competence, in a variety of environments, allowing for the development of confidence with these movements, and therefore leading to eagerness and motivation towards being physically active. Liz Taplin, a keynote presenter at the International Physical Literacy conference in 2013, explains PL by reference of a conceptual model (L. Taplin, 2013), which depicts the continuous positive feedback cycle between motivation, confidence, and competence. The elements of motivation, confidence, and competence are intertwined and blend to create an expression of PL. An individual's ability to be physically active is affected if one or more of these elements are deficient, as was clearly illustrated in the My Personal Best (2014) program evaluation. Long term physical activity and participation is established if these elements

(competence, confidence, and motivation) are in equilibrium (L. Taplin, 2014). It is important that we purposefully foster each of these elements for both boys and girls.

PHYSICAL EDUCATION

Historically (beginning in the early 1900's), physical education has had a primary focus of a sport education model, with sport skill instruction, and competitive games being the foundation of most programs (Berryman, 2010; McKenzie & Lounsbery, 2014). As mentioned previously, physical inactivity and obesity rates continue to increase, which leads one to believe that the current PE is ill adapted or implemented, especially in the context of a society that may not adequately value movement. If PE is to remain in school programming, it is important that it is able to clearly show a valuable contribution to children's overall health (Rink, 2014) and not just in sport participation, but also in the ability to be physically active in any setting, whether that be vocation, recreation, performance arts, or activities of daily living. Various PE curriculums, including Canadian provinces, are attempting to adapt their approach to PL, rather than continuing to maintain a strong sport focus. A focus on sport and athleticism can exclude many children from participation, especially if the child is not confident in their abilities as compared to those of their peers (Faigenbaum et al., 2011).

If physical literacy is indeed the gateway to active participation, then it stands to reason that this may be a missing piece in the restoration of activity levels in our culture. Due to rising obesity rates and the inactivity crisis that now faces children, there has been an increased interest in interventions that are targeted at the reversal and restoration of appropriate PA levels. Efforts have been directed toward targeting increased PA in and out of school, in recreation settings, PE, and sport; hence the growing popularity of the creation of PL programs in Canada. A truly collaborative, inter-sector approach to raising a physically literate child will be required, with the school as the hub.

Physical education is an educational course delivered in primary and secondary schools with a focus to enable individuals to develop the knowledge, skills, and attitudes necessary to lead an active, healthy lifestyle (Government of Alberta, 2015). In the Manitoba PE curriculum, there are five general learning outcomes: movement, fitness management, safety, personal and social management, and healthy lifestyle practises (Province of Manitoba, 2015). The quality of PE can be shaped by time and resources (class duration, a good curriculum, equipment, space), but most importantly, by the instructor. Accountability for the curricular expectations is an essential step to ensure that there is follow-through, and that the children are actually achieving what is expected for each grade.

When exploring the current physical education curriculums across Canada, it can be noted that there are numerous skills and knowledge that are expected to be acquired by the completion of each grade (Table 1). In Manitoba, and similarly in PE curriculums across Canada, from kindergarten to grade 5, the general emphasis is on basic motor skill acquisition with the added knowledge of understanding what, why, and how to utilize fundamental land based movement skills. During grades 5 to 8, the focus shifts to the expectation that students will attain a functional use of the skill while participating in a variety of activities in different environments and settings (Province of Manitoba, 2014). Without delivering the basic movement competence at early years, the ability to layer on complexity or apply the basic movements to other settings is limited – in essence "disabling" the middle years' PE curriculum. Achieving the curricular guidelines has been proven to be challenging, not only with generalist school teachers (Carney, 1998; De Corby, 2005; Janzen H, 2003; Morgan, 2005), but also with trained PE teachers (T. R. Kozera, Kriellaars, D. J., 2011; Smith et al., 2014). Could there be another approach that may help students to achieve curricular objectives that has not yet been included in PE classes? PL may be a new approach that might permit a more inclusive and participatory delivery of the curriculum leading to achievement of curricular objectives, and societal goals for PA. Certainly, physical competence in movement skills is a core element of physical literacy, and if the curriculum fully delivered competency in the skills indicated (and as a result, maintained confidence and motivation in children), this

would be a substantial step in building physically literate children, potentially leading to participation in physically active pursuits.

Table 1. Manitoba PE curricular movement skill expectations for children in grades 4 and 5. A checkmark indicates that entry level competence is expected by this grade.

Movement Skill/Task	Grade 4 PE	Grade 5 PE
Run a square	✔	
Run there and back	✔	
Run, jump, land on 2 feet	Jump & land 2 feet	✔
Crossovers	✔	
Skip	✔	
Gallop	✔	
Hop	✔	
Jump	✔	
Overhand throw	✔	
Strike with stick	✔	
One-handed catch	Catching	✔
Hand dribble stationary & moving forward		✔
Kick ball	✔	
Foot dribble moving forward	Dribbling using feet	✔
Balance walk (heel to toe) forward	✔	
Balance walk backward	✔	

CIRCUS ARTS INSTRUCTION

A novel approach that shows promise for promoting the development of PL, and therefore potentially increasing PA, is the use of circus arts instruction in or at school. Circus arts instruction is wholly consistent with PL in the cognitive, physical, and social domains, and is an inclusive and safe environment for participants, where "everyone is good at something" (Kinnunen, 2013). As such, circus arts instruction appears to be highly consistent with the achievement of PE curricular goals.

What is circus arts instruction?

As stated by Patrice Aubertin, Director of Research and Teacher Training Programs at the National Circus School in Montreal, "circus arts practice is an overlap of sport and artistic practices where both explicit knowledge, motor learning, biomechanics, exercise physiology and tacit knowledge; intent, narrative, discourse are explored" (P. Aubertin, 2013). Although circus arts practise does require continuous and rigorous training, similar to most sports, it does not rely on any specific norms, as sports often do. This enables the development of motor competence skills, while allowing one to develop an artistic voice through the movements being performed. In this way, circus arts practice enables one to use their body as a mean for self-expressions (Barlati, 2015).

Circus arts are grouped into five broad categories based on the apparatus or rigging used and the skills and abilities required to practice them:

- Floor acrobatics
- Aerial acrobatics
- Balancing
- Juggling
- Clowning

General descriptions of the basic disciplines are available at the National Circus School (Montreal, QC) website (Barlati, 2015).

Jackie Davis, a founding member of the American Youth Circus Organization (AYCO) and researcher exploring the relationship between circus-based physical activities and positive youth outcomes, coined the term 'developmental circus arts' (DCA) to identify programs in which circus skills and performance serve the physical, social, emotional, and cognitive development of youth (Davis, 2011). In other words, it is "the theory and practise of cultivating positive outcomes through circus arts" (Webb, 2013).

"Developmental Circus Arts" includes many different ways individuals engage with circus arts, having the primary reason be educational, therapeutic, or recreational. The focus for circus training is not to become a circus artist but for the other developmental benefits, some of which may be curricular in nature.

Examples of DCA include:

1) **Youth circus**, which emerged in the 1970's as a community-based movement, is circus created and performed by youth. It is non-competitive and inclusive of children of all ages, abilities, physical sizes, developmental and educational levels, economic classes, genders, and races. Superficially it appears to just be fun, but participants are simultaneously developing motor competence skills, confidence, improving fitness and coordination, exploring creativity, and acquiring new friends (Webb, 2013).
2) **Therapeutic circus** is used by health care professionals, such as occupational therapists, to assist their clients in recovering motor skills and movement patterns for activities of daily living. As circus skills are highly engaging and enjoyable, therapy for improving balance, core strength, hand-eye coordination, and social skills is often disguised (Webb, 2013).
3) **Social circus** uses circus arts instruction to aid in the personal, social, and physical development of individuals at risk. It targets marginalized youth, ages 8-25 years, including those who have been detained, live on the streets, or those with low income backgrounds. Now delivered in over 86 communities and over 15 countries worldwide (Cirque du Soleil, 2015b), it aims to help at-risk populations gain self-confidence, acquire social skills, discover talents and

potential, all while encouraging PA. Social circus is highly inclusive and non-competitive, and minimizes barriers to participation, such as not requiring the ability to read or write to participate. No matter the age, background, or ability level of the participant, the message to be portrayed is "circus for all". Offering a variety of disciplines and exposure to multiple movements, it encourages the expansion of one's PL (Kinnunen, 2013).

Circus arts instruction in the PE curriculum would represent a new blend of DCA extending the social circus approach from vulnerable children to all children.

Circus Arts across the Globe

Circus arts instruction for children, not solely for the purpose of the production of circus performers, has been provided through various delivery schemes around the world. AYCO promotes the participation of youth, ages 21 years and younger, in circus arts, and provides support to circus educators. AYCO is a large umbrella that houses numerous programs including recreational, in-school, circus school, pre-professional, and social circus programs and organizations (American Youth Circus Organization, 2014).

In 1995, Cirque du Soleil created a program termed Cirque du Monde, which develops and supports social circus programs worldwide (Cirque du Soleil, 2015a). Many professional and non-professional circus organizations, including Cirque du Monde, provide training for circus instructors to deliver skills in the social circus context, as well as holds circus workshops for at-risk youth. A recent natural extension to the social circus movement has been to extend the concept of "social circus" to "circus for all" (Kiez, 2015).

Caravan is an international non-profit association that includes fourteen youth and social circus schools located in thirteen different European countries, including the Netherlands, Spain, Ireland, Belgium, France, Russia, Sweden, and Finland, to name a few (Caravan, 2015). Caravan's objectives are to promote circus practices in youth

education throughout Europe and to encourage their development, through youth exchanges and providing training for instructors. The National Institute of Circus Arts located in Prahran, Australia, also has a social circus branch (National Institute of Circus Arts, 2015).

In Finland, The Social Circus Project (from 2009-2011) and the Effective Circus Project (a continuation for the Social Circus Project, from 2011-2014) have implemented social circus lessons in a variety of groups to qualitatively document the effects of social circus on the wellbeing of participants. There have been astounding subjective and testimonial results, interviews and case studies from these program evaluations, which include that the children who participated have been inspired to be more physically active because of their involvement in circus arts (Centre for Practise as Research in Theatre, 2012; Kinnunen, 2013).

Circus Arts in Canada

The National Circus School, located in Montreal, Quebec, is the largest school in North America devoted to advanced circus arts training. Not only are professional circus artists trained here, but there is also a world leading, comprehensive program for the education of circus arts instructors and trainers. At the National Circus School, instructors are educated on the various circus disciplines including the context of recreational activity and in the social services arena (National Circus School Montreal, 2008). Cirque du Soleil headquarters are located across the street from the National Circus School. This allows for a strong collaboration between the Cirque du Monde personnel at Cirque du Soleil and the National Circus School in the development of circus arts instruction for various purposes discussed above, as well as professional artist development.

Over 160 public school based circus programs exist in Quebec schools (P. Aubertin, Leroux, L-P., 2014), at, in or after school, portraying Montreal, QC, as the "circus hub" of Canada, if not the world.

Potential Benefits of Circus Arts

When examining circus, there are multiple positive benefits that expand further than simply promoting physical health, body awareness, and increasing one's movement repertoire. As noted in Maglio and McKinstry's 2008 study, circus increases self-confidence, social connectedness, teamwork and leadership skills, while providing a motivating experience in a safe and supported environment, and enabling participants to attain life skills. It creates a space for participants to feel a sense of belonging while providing opportunities of increased challenges, promoting creativity, and a variety of physical and cognitive capabilities (Maglio & McKinstry, 2008). This may make it distinct from the classic sport delivery model, where a child enters and exits each sport doorway in order to find a place, whereas in circus arts it may be one door for most children, if not all.

Dr. Reginald Bolton, a clown, teacher, writer, and a social circus pioneer, lead the way in the concept of "new circus" after the de-popularization of traditional tented circus. He believed in and encouraged the future of circus and how circus skills could change the lives of young people, using circus for education, self-fulfilment, and community development (Bolton, 1999). In Bolton's PhD thesis, he discussed six 'elements' he considered integral to a child's growth, and how each of these six developmental needs for a young person may be met by exposure to circus activities (Bolton, 2004). The six essential childhood elements include 1) hard work, persistence, resilience; 2) constructive risk (physical and artistic), courage; 3) trust, cooperation, sharing; 4) fun, happiness; 5) aspiration, imagination; and 6) self-individualisation, identity, and image. Bolton felt that these six elements are often absent in instructional settings (recreation, sport, or education) and tend to result in an incomplete personal maturity, but that with the inclusion of circus arts activities, an individual is offered many instances for development of these six elements.

Bolton believed that circus has been immensely underrated as a developmental tool. He also felt strongly that majority of sports are martial in nature, imitating war, with most being confrontational, encouraging hostility, competition, and the seeking of victory. He offered the alternative of circus arts as a reconstructed curriculum for

physical development, supporting the comprehensive range of skills offered through circus training. Not only are the elements of strength, flexibility, speed, and reaction accomplished, just like in any other physical development program, but circus arts offers the addition of creativity, inclusion, exploration of appropriate risk, and fun for everyone. The inclusion of these many elements places circus training as a contender for addition to PE, or minimally, as an approach to be studied and integrated into traditional PE.

Bolton wisely explained that those involved in circus arts (acrobats, contortionists) rarely encountered self-imposed strains and injuries because their training is very progressive. Many of the benefits of circus arts training, including strength, flexibility, reaction time, good peripheral vision, and intellectual challenges, are maintained into old age and are very beneficial for survival. As stated by Bolton, "The child who has a good rolling relationship with the ground will not become the parent who falls down the stairs or the sixty-year-old who breaks a hip at the first fall" (Bolton, 1999).

A report completed by Michelle Carr in 2007 expressed that circus skills may be an alternative to physically educating reluctant exercisers and children with special needs, who are unable or unmotivated to participate in competitive team sports and conventional PE programs (Carr, 2007). Circus skills provide the benefit of flexibility to allow for modification for the needs of nearly all children.

Despite the claims of numerous positive impacts of circus arts on mental and physical health, there has been little quantitative research conducted to critically examine this. Evidence-based support is important for drawing funders and stakeholders, and potentially including it in school curriculum (Webb, 2013).

To date there have been no quantitative studies completed regarding the effects of circus arts instruction on children, and given the adoption of circus arts at and in school, there is a need to understand its impact. There have been limited, but very encouraging, qualitative studies (Centre for Practise as Research in Theatre, 2012; Kinnunen, 2013; Maglio & McKinstry, 2008), strong rationalization (Bolton, 2004; Carr, 2007), and dramatic growth of circus arts in schools (Quebec and others). Given the concerning childhood obesity and physical inactivity rates, as well as the need for PL, it

would be interesting to ponder the effects of circus arts on influencing the PL of children, in the hopes of leading to more active youth and adult lives. As an alternative to the dominant sports model, physical activity incorporating circus arts may be a welcomed alternative for youth who often have difficulties with PA participation (i.e. girls and overweight youth) (Carr, 2007; University of British Columbia, 2014). As the majority of children attend school, PE is a window of opportunity to influence children's early PA experiences (Keegan, 2013), and allow for opportunities for each child to encounter experiences to allow progress on his or her PL journey. Circus arts instruction provides an unexplored means for development of PL, the delivery of PE, and many other positive attributes for participants.

Purpose

To examine the impact of circus arts instruction on the physical literacy of children in grades 4 and 5.

OBJECTIVES

To determine if circus arts instruction, incorporated into PE class, has an effect on grade 4 and 5 children's

1. motor competence, confidence, and comprehension of movement skills and sequences,
2. self-reported participation in physical activities,
3. self-assessment of physical literacy,
4. parental assessment of the child's physical literacy, and
5. physical education teacher's assessment of the child's physical literacy.

GENERAL HYPOTHESES

1. In comparison to standard physical education delivery, physical education incorporating circus arts instruction will improve motor competence, comprehension, and confidence in grade 4 or grade 5 children.
2. Parents of children, and children, involved with circus arts instruction will have improved perceptions in various domains (confidence, worry, etc.) relative to those of the parents of those children, and children, in comparison schools in grade 4 or grade 5.
3. The schools with circus arts instruction will demonstrate a decreased gender gap in motor competence and confidence relative to schools with regular PE delivery in grade 4 or grade 5 children.

Relevance

The results of this study aspire to provide insight to allow for further development of effective PE curricula delivery methods in schools, enabling improved achievement of curricular objectives and elimination of the gender gap between boys' and girls' PL. It also provides quantitative research to support the positive effects of circus arts that have been revealed in qualitative studies or program evaluations (Centre for Practise as Research in Theatre, 2012; Kinnunen, 2013; Maglio & McKinstry, 2008).

Methods

Design

A prospective, clustered, quasi-experimental design was used to compare schools with circus arts instruction in PE class (PE CIRCUS) to three matched schools (geographically and SES) using standard Physical Health & Education curriculum delivery (PE).

Participants & Recruitment

A total of 211 grade 4 and 5 students, 9-12 years old, were recruited to participate in the study. Parents provided consent, and children provided assent prior to participation. Ethical approval was obtained from the Human Research Ethics Board, Faculty of Medicine, University of Manitoba (H2013:450).

The schools with circus arts instruction were selected purposefully using an expert panel based upon representing the diversity of circus arts opportunities in Quebec, but being geographically close to, or within, Montreal, QC. As such, the selection resembled purposive sampling with maximum variation. Comparison schools were then matched geographically (7-13 minutes of travel time between schools), and as a result the schools were also matched by socioeconomic status (SES) (See Table 5 below). Approval by the board, principal, and teachers was obtained for all schools. All schools included in this study were French and publicly funded.

Overview of Protocol

A repeated measures design was utilized with evaluations of the grade 4 and 5 children's physical literacy over one semester of school. Assessments were completed in January/February 2014 (baseline) and repeated in May/June 2014 (endpoint).

The PL of the children was evaluated by the use of the Physical Literacy Assessment for Youth (PLAY) tools (Canadian Sport for Life, 2015). In collection of the data, the following five tools were deployed (described in detail below; See Appendix 1 for recording forms);

1. PLAY Fun - an assessment of physical literacy by trained observers
2. PLAY Self - a self-report of physical literacy
3. PLAY Inventory - a self-reported checklist of participation
4. PLAY Coach - a surrogate report by the physical education teacher of the child's physical literacy
5. PLAY Parent - a parental report of the child's physical literacy

SCHOOL DESCRIPTIONS

PE CIRCUS schools had circus arts instruction provided using minimal equipment (clowning, juggling, balance activities, etc.) and implemented using a "social circus" approach, in conjunction with the Physical and Health Education (PHE) curriculum. The comparison PE schools had qualified PE teachers and the standard PHE curriculum and delivery method. All schools continued with their scheduled PE classes (3-4) per week and class durations (50-90 minutes), allowing for a variable amount of time spent in PE/PE CIRCUS for each school.

Table 2 depicts the basic characteristics of the PE and the PE CIRCUS schools. The school matching based on geography and SES is identified by alphabetic subscript.

PE Schools

A total of 101 students were represented in these three schools, with 63 students in grade 4 and 38 students in grade 5. All PE teachers were PE specialists, as opposed to generalist teachers. The students received a mean duration of 68 minutes per PE class, 3.3 times/week, for a total of 225 minutes (3.75 hours) of PE per week. All PE schools offered other physical activity opportunities (i.e. after school sports).

PE CIRCUS Schools

A total of 110 students were represented in these three schools, with 43 students in grade 4 and 67 students in grade 5. All PE teachers were PE specialists. The circus arts instructors varied in their training background, and each school had a different length of history for including the circus arts program in their school (ranging from 4 to greater than 30 years). The mean duration of each PE class was 56.7 minutes, 3 times per week, for a total of 170 minutes (2.83 hours) per week. Circus arts instruction ranged from 50 minutes to 3 hours per week, with this time allotted in PE classes. One PE CIRCUS school had an additional three hours of opportunity for circus arts instruction at lunch or after-school. The schools all had some similar circus equipment to utilize (Table 2), although each school had a few pieces of circus equipment that the others did not possess.

Table 2. PE and PE CIRCUS school characteristics. Schools between groups are matched by geography and SES by alphabetic subscript.

PE Schools			
	PE $_A$	**PE $_B$**	**PE $_C$**
PE classes/week	3	4	3
Duration of PE class	55 minutes	60 minutes	90 minutes
PE teacher changes in the year?	No	Yes	No
Total amount of PE/week	2.75 hours	4 hours	4.5 hours
PE CIRCUS Schools			
	PE CIRCUS $_A$	**PE CIRCUS $_B$**	**PE CIRCUS $_C$**
PE classes/week	3	3	3
Duration of PE class	60 minutes	60 minutes	50 minutes
# of circus arts instructional periods/week in PE class	2x/week (all school year)	3x/week (all school year)	1x/week (14 weeks)
Duration of circus arts instruction	60 minutes	60 minutes	50 minutes
Training for circus instructors	PE Special Interest Group	National Circus School	No specific training; previously Cirque du Soleil artist
PE teacher changes in the year?	No	No	No
Circus equipment used	Juggling balls & scarves, rola-bola, stilts, unicycle, trampoline, flower sticks	Flower sticks, trapeze, juggling balls & scarves, unicycle, rola bola, rope climbing, hoops, wire, German wheel, stilts	Rola bola, diabolo, flower sticks, juggling balls & scarves, wire, stilts, unicycle
History of circus program in the school	12 years	>30 years	4 years
Total amount of PE/week	3 hours	3 hours	2.5 hours
Total amount of circus instruction/week	2 hours (of PE time)	6 hours (3 hours of PE time)	50 minutes (of PE time)

Exposure to PE or PE CIRCUS

In this study, each child was exposed to, or had the opportunity to participate in the activities described in Table 2. One may simply consider the dose of exposure to the setting as being the main intervention, but it is important to note that the dose is partially related to the time exposed and also to the quality of the instructor.

In terms of time, the range of PE exposure per week ranged from 2.75 to 4.5 hours per week for the PE schools, and 2.5 to 3 hours of PE exposure per week in the PE CIRCUS schools. For the PE CIRCUS schools, the circus exposure ranged from roughly 1 hour to 6 hours per week. The yearly exposure to physical education instruction varied between schools (Table 3) resulting in range of exposure from 110 to 180 hours per year. The PE schools averaged 150 hours per year (notation of schools: 110, 160, 180 hours) and the PE CIRCUS schools 113 hours per year (120, 120, 100 hours) resulting in 37 hours per year greater PE instruction in the PE schools.

Table 3. Amount of physical education (in hours) received by each PE and PE CIRCUS school. PE schools averaged 37 hours per year greater PE instruction than that of PE CIRCUS schools.

Amount (hours) of PE per school (PE and PE CIRCUS)			
	PE $_A$	**PE $_B$**	**PE $_C$**
Amount of PE/week	2.75	4	4.5
Amount of PE/year (40 weeks)	110	160	180
Average total hours of PE (for PE group)			**150**
	PE CIRCUS $_A$	**PE CIRCUS $_B$**	**PE CIRCUS $_C$**
Amount of PE/week	3	3	2.5
Amount of PE/year (40 weeks)	120	120	100
Average total hours of PE (for PE CIRCUS group)			**113**

Table 4 illustrates the cumulative exposure to circus arts instruction in PE class relative to the timing of the assessments for the PE CIRCUS schools. The accumulated exposure for grade 5 students is double that of the grade 4 students.

Table 4. Exposure to circus arts instruction for grade 4 and 5 students. The total number of classes per month are shown along with cumulative total exposure per coded PE CIRCUS school (SCH). The measurement times are indicated (PLAY).

										YEAR											TOTAL
12				**13**					**13**			**13**				**14**					**14**	CLASSES
Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June			Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	**GRADE 5**
8	8	8	8	8	8	8	8	8	8		A	8	8	8	8	8	8	8	8	8	8	160
12	12	12	12	12	12	12	12	12	12		B	12	12	12	12	12	12	12	12	12	12	240
					4	4	4	2			C						4	4	4	2		28
										SCH						PLAY					PLAY	
												Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	**GRADE 4**
											A	8	8	8	8	8	8	8	8	8	8	80
											B	12	12	12	12	12	12	12	12	12	12	120
											C						4	4	4	2		14

In terms of teaching effectiveness, the only indicators present are the preparation of the teachers for both PE and PE CIRCUS. In all schools a PE specialist was involved, and in the PE CIRCUS schools the instructors had substantial experience and training in teaching circus arts.

For the purposes of this study, the schools were categorized into two groups to attempt to detect differences arising due to the overall impact of circus arts instruction, and not to explore a dose dependency. It is likely that the school with low exposure to circus arts would lower the overall impact, or create a higher variance in the measures, leading to difficulty to detect differences. This was taken into consideration when analyzing the study results by reporting p-values ≤ 0.15.

Socioeconomic Characteristics of the Schools

Table 5 shows the PE CIRCUS and PE schools, geographically matched by distance, and their corresponding SES levels. School-based deprivation was determined using two assessments: the Index of the Low Income Cut Off (LICO) and the Index of

Socio-Economic Background (IMSE) (Gouvernement du Québec, 2015). The IMSE considers educational level and employment of family unit. The LICO considers the proportion of families with low income. A scale of 1-10 is used, with 1 representing "least deprived" and 10 representing "most disadvantaged". There was a good match of SES indicators between schools, and across groups (NS).

Table 5. SES characteristics of PE CIRCUS and PE schools using the Low Income Cut-off scale (LICO) and Index of Economic Background (IMSE), where 10 is most disadvantaged.

School	LICO	IMSE	# students/ school	School	LICO	IMSE	# students/ school
PE CIRCUS $_A$	8	9	129	PE $_A$	8	6	139
PE CIRCUS $_B$	5	7	436	PE $_B$	2	3	271
PE CIRCUS $_C$	10	10	385	PE $_C$	10	10	323

PLAY Tools

The PLAY tools are open-source tools (Canadian Sport for Life, 2015) that were developed at the University of Manitoba. The tools are complete with workbooks and videos that describe administration of the tools, computation of scores, etc. The tools were developed using the COSMIN health measurement tool checklist, as well as using a modified Delphi approach and consensus panels. The tools were then trialed and revised using item response theory, and internal consistency approach for minimization of elements for practical implementation (participant burden). Initial versions of the tools were deployed and reliability (test-retest, inter and intra-rater) and validity (concurrent, etc.) testing was completed. Further, the tools had to have meaningful interpretability in a PE setting due to the direct ties to curricular expectations. Test-retest reliability was shown to be excellent (0.89 to 0.92), and inter-rater reliability to

be very good to excellent (0.79 to 0.85), with very good concurrent validity in grade 5 children (to Test of Gross Motor Development, version 2 (Ulrich, 2000) to be 0.82).

Description of PLAY Tools

1) **PLAY Fun** (Appendix 1) is a movement assessment tool that measures motor competence, movement vocabulary (# of skills at an acquired level), confidence, and comprehension in children of 5 years and older. The PLAY Fun tool assesses 18 of a child's land based skills, the majority of which are curricular linked (See Table 1).

   Motor competence is assessed using a holistic rubric (Figure 4) employing a 100 mm, modified visual analogue scale (VAS). The assessor places a mark anywhere along the scale for each movement performed using the categorical "anchors" listed above the scale. The numeric scale shown in Figure 5 is for illustration purposes, and is not utilized in the actual scale (see Appendix 1). Examples of relevant criteria for each of the four categories of competence are provided to assist the assessor in determining the correct category to rate the child's competence (Appendix 2). The addition of the categorical anchors allow rapid categorical alignment to a specific 25 point range, thus allowing the assessor to have 25 mm of flexibility for specification within each category. A score of 50 or above indicates the participant has achieved entry level competence or higher; that is they have "acquired" the skill.

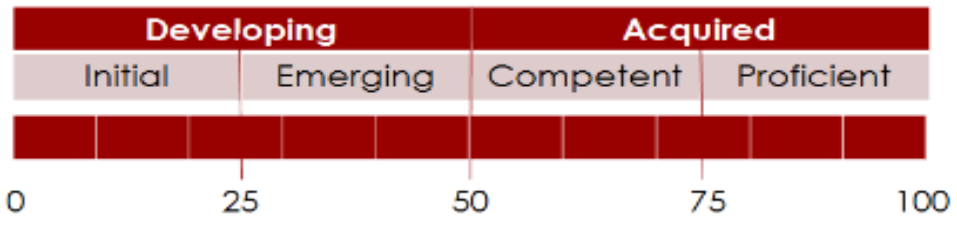

Figure 4. Holistic assessment rubric using a modified 100 mm VAS. Four categorical "anchors" guide the assessor for rapid assessment using standardized general descriptions (See Appendix 2). In the actual scale (Appendix 1), the numbers on the bottom are not provided.

An overall motor competence score is derived as the average of the 18 movements assessed. Sub scores based upon movement categories can also be calculated for locomotion, transport, upper body manipulation, lower body manipulation, body control, and balance.

Flags are noted for each movement execution for confidence and for comprehension of movement terminology. A confidence flag is given when the child demonstrates low confidence prior to performance of the task (maximum score of 18). A four level comprehension flagging system was used where a flag was given if the child required additional verbal prompting, was mimicking a child, required a verbal description, or required a demonstration. A maximum of 72 (18 x 4 levels) could be achieved for the comprehension flags. For the implementation in this study the demonstration flag was not used, as demonstrations were not provided at any time, therefore 54 (18 x 3 levels) were possible.

2) **PLAY Inventory** is a self-reported checklist of a child's participation in various activities throughout the past year. Over 80 activities are listed, with "other" categories to allow for inclusion of all forms of active participation. The total number of "active" activities was computed. This tool does not quantify the amount of activity; it simply assesses the inventory of activities, as a measure of meaningful participation in society.

3) **PLAY Self** is a self-report of a child's own perceived physical literacy and related domains. This self-report tool is separated into three sections; 1) participation in environments, 2) a section examining various sub-domains of physical literacy (self-efficacy, confidence, comprehension, worry, eagerness, etc.), and 3) relative importance of literacy, numeracy, and physical literacy.

4) **PLAY Coach** is a surrogate recall of the physical literacy of the child by a physical education teacher (or someone skilled in movement assessment). This tool is divided into five subsections including a physical literacy VAS, cognitive domain, environment, motor competence (similar to the PLAY Fun tool, but based on recall of the PE teacher), and fitness. Constructs in the PLAY Coach tool were designed to overlap with that of PLAY Self and PLAY Parent.

5) **PLAY Parent** is a parental report of their child's physical literacy. Parents are asked to rate their child's overall physical literacy on a VAS, as well as rank low, medium, or high in regards to their child's physical literacy in 1) cognitive domains (motivation, knowledge, etc.), 2) varying environments, 3) motor competence (locomotor, object control, etc.), and 4) overall fitness.

PLAY Self and PLAY Inventory were completed in the classroom and administered by the classroom teacher. PLAY Parent was sent home and completed by one parent/legal guardian in the household and brought back to school. The child's PE teacher completed PLAY Coach. Nine trained research assistants performed PLAY Fun assessments during a regular physical education class in the gymnasium. Collection of the data for each assessment time period took approximately 2 weeks across all schools.

Research Assistant Training

A full day training workshop for the instruction of PLAY tool administration, with special focus on PLAY Fun, was provided to each of the nine research assistants, in French. After training was completed, the assessors were given the opportunity to practise assessing children of similar ages to those in the study with the PLAY Fun tool. Research assistants did not always assess the same schools for baseline and endpoint; they were allocated to a school based on their availability. The research assistants were not blinded to the schools participation in circus arts instruction, however each

assessor did not retain the evaluation sheets from baseline to endpoint. As such, the assessors would be incapable of recalling the individual scores on a 100 mm VAS scale for 18 movement skills. This would tend to reduce the possibility of assessor bias.

Ethnographic Assessment of Schools and Programs

A parallel qualitative study was undertaken to examine the characteristics of the schools. This information included the culture, the program implementation and engagement, as well as a complete description of the PE CIRCUS and PE programs.

STATISTICAL CONSIDERATIONS AND ANALYSIS

Sample Size

Sample size was calculated of both within and between group comparisons using the overall PLAY Fun motor competence dependent variable. The standard deviation was derived from the interventional work of Kozera and Kriellaars in a similar age group (T. R.. Kozera, Kriellaars, D. J., 2011). A conservative approach was adopted using the average standard deviation (8) across all 18 movements of the PLAY Fun tool. In a similar study design, comparing Run Jump Throw (RJT) enhanced PE to standard PE, a mean difference observed over time was 12. In this RJT study the intervention targeted the assessed movement skills; therefore we conservatively adopted half of that value as the delta (6) for the calculation of sample size in this study. We used an alpha value of 0.05 and a beta corresponding to 0.2. A sample of 28 per group was required to detect differences between groups. To detect changes (within subject) over time we only required 14 participants in each group.

Analysis

Data was input from Excel into SPSS version 22.0. An alpha level of ≤0.05 was set for detecting statistical significance, although, for exploratory purposes, variables with an alpha level of ≤0.15 were also tracked for trending effects. Since the study was powered for the PLAY Fun variables, the sample size would create a slightly underpowered circumstance (possibility of Type II errors) for the perceptual tools (PLAY Self, Coach, and Parent).

Univariate ANOVA was used to evaluate dependent variables (with between-subject factors being sex, grade, and group (PE CIRCUS or PE)) at each time point. To explore overall effects on motor competence, multivariate ANOVA was performed on the PLAY FUN tasks. Finally, repeated measures ANOVA was performed to determine if "within subject" differences existed over time for motor competence.

In addition, binary logistic regression was performed on the grouping variable (0-PE, 1-PE CIRCUS) using the PLAY tools separately and in combination.

Bias

There are a variety of biases that were considered when designing and conducting this study.

The first is rater/investigator bias, where it could be argued that because the PLAY Fun research assistants/assessors were not blinded to the intervention group they were assessing (they were allocated to schools based on their availability), they could have invested interest in the study and have skewed the results. We believe having each assessor return each evaluation of the PLAY Fun directly after each assessment mitigated this bias. Separate marking sheets were used for baseline and endpoint, therefore assessors did not have access to a student's baseline score when assessing their physical literacy for endpoint. Also, for the PLAY Fun tool, over 18 different scores without numerical reference are required, making it virtually impossible to recall the assessment values at a subsequent assessment period.

There was also the possibility of participant bias, where respondents from the participating school would try their best and perhaps tend to score higher (PLAY Coach). This effect should have been similar in all six schools, meaning that having the comparison schools should have likely negated this bias. Also, the questions in the PLAY Parent and PLAY Self questionnaires do not readily lend themselves to a bias toward circus arts or PE.

Selection bias could also have had a potential effect. The PE CIRCUS schools already had circus arts instruction and equipment in place, potentially allowing a greater impact of circus effect on physical literacy than if the schools only had circus arts instruction implemented at the beginning of the study. A thorough description of the schools would help to decipher the potential impact of selection, as well as careful inspection of results at baseline, endpoint, and change over time.

Since this study was completed from January until June, there is the possibility of a seasonal bias occurring, where the children participated more because of the change in seasons from winter to spring. All schools would have experienced this effect, allowing it to be negated.

Results

Participant Demographics & Characteristics

A total of 211 students, 9-12 years old (the mean (SD) age was 10.07 years (0.768)), participated in the study; 106 from grade 4 (50%) and 105 from grade 5 (50%). Table 6 illustrates the age distribution. Of these 211 students, 116 were female (55%) and 95 were male (45%). 101 students were in the three PE schools (48%), while 110 students were in the three PE CIRCUS schools (52%).

Table 6. Age distribution of participants.

Student Demographics			
Age	**Number of Students**		**Total/Age**
	Grade 4	**Grade 5**	
9	50	-	50
10	49	52	101
11	7	48	55
12	-	5	5
Total/Grade	106	105	211

PLAY Tool Completion

When referring to Table 7, the primary measures utilized, PLAY Fun (92-97%) and PLAY Self (81-86%), had excellent response rates for both baseline and endpoint. PLAY Coach response rate increased from baseline (73%) to endpoint (91%) because one school failed to distribute the PLAY Coach tool at baseline. Similarly, for one school there was a failure to distribute the PLAY Parent tool at end point. PLAY Self and PLAY Inventory were both completed in the classroom, but were distributed at different times, which can be seen by the differing response rates. Overall, all PLAY tools had a high response rate for both baseline and endpoint (71-97%), with the exception of PLAY Parent at endpoint (53%). The overall rate of "loss due to follow up" was very low (less than 5%), and any loss was due to experimental error. This virtually eliminates the

possibility of biases arising from participant selection to complete forms. Missing values were not imputed, and pair-wise deletion was used for analysis.

Table 7. Number (percentage) of participants that completed each PLAY tool for baseline (January 2014) and endpoint (June 2014).

Total N=211	Baseline	Endpoint
FUN	205 (97)	195 (92)
SELF	182 (86)	171 (81)
INVENTORY	164 (78)	149 (71)
PARENT	154 (73)	112 (53)
COACH	154 (73)	192 (91)

PLAY Self

Table 8 shows the statistical results for the cognitive domains of PLAY Self at the endpoint of the study. Group effects and interactions were detected favouring the PE CIRCUS group in a number of cognitive elements (three at or below $p<0.05$ and three approaching). The pure grade and sex effects were consistent with known effects, and illustrate to the sensitivity of the tool to detect differences.

As shown in Table 9 and illustrated in Figure 5, a group effect ($p=0.004$) was shown for the importance of movement (PL) in school. The children in PE CIRCUS schools equated the importance of movement to literacy and numeracy (at school). There was a near significant group effect ($p=0.056$) for the importance of literacy (read/write) at school being valued more in the PE CIRCUS schools. As such, there appear to be consistent "carry over" effects of circus arts on the females in terms of enhanced valuing of numeracy at school and literacy at home and with friends.

Table 10 shows the results for the children's reported participation in varying environments. Some expected differences were observed in participation related to grade and sex, and an interesting effect (group by grade) on water participation, was found.

Table 8. Cognitive domain variables, as assessed by PLAY Self, noted at endpoint.

Question	Group (G) C &PE	Grade (Gr) 4 & 5	Sex (S) F &M
Learn skills			YES M>F
Enough skills			YES M>F
Active healthy			
Active happy	G*S 0.002 F C > F PE		
Participate			YES M > F
Body allows		YES 5 > 4	
Worry			
Comprehend	G 0.072 C > PE		
Confident			YES M > F
Eager	G*S 0.055 F C > F PE		
Best Mover	G 0.017 C > PE		YES M > F
Talented	G 0.111 C > PE G*Gr 0.11 C > PE		
PL SELF AGGREGATE	G 0.089 C > PE	YES 5 > 4	

G - Group effect, G*S - Group by Sex, G*Gr - Group by Grade

P value reported for straight group effects or when below 0.15

YES corresponds to p values less than 0.05 for Grade and Sex

Table 9. Results for the relative ranking of literacy, numeracy, and physical literacy at school, home, and with friends, as assessed by PLAY Self, noted at endpoint.

Question	Group (G) C & PE	Grade (Gr) 4 & 5	Sex (S) F & M
RW School	G 0.056 C > PE		
RW Home	G*S 0.009 F C > F PE		0.098 F > M
RW Friends	G*S 0.001 F C > F PE	YES 5 > 4	
Math School	G*S 0.03 F C > F PE F=M		
Math Home			
Math Friends			
Movement School	G 0.004 C > PE For 4 & 5 Move = RW & Math		
Movement Home			
Movement Friends			

G - Group effect, G*S - Group by Sex, G*Gr - Group by Grade

P value reported for straight group effects or when below 0.15

YES corresponds to P values less than 0.05 for Grade and Sex

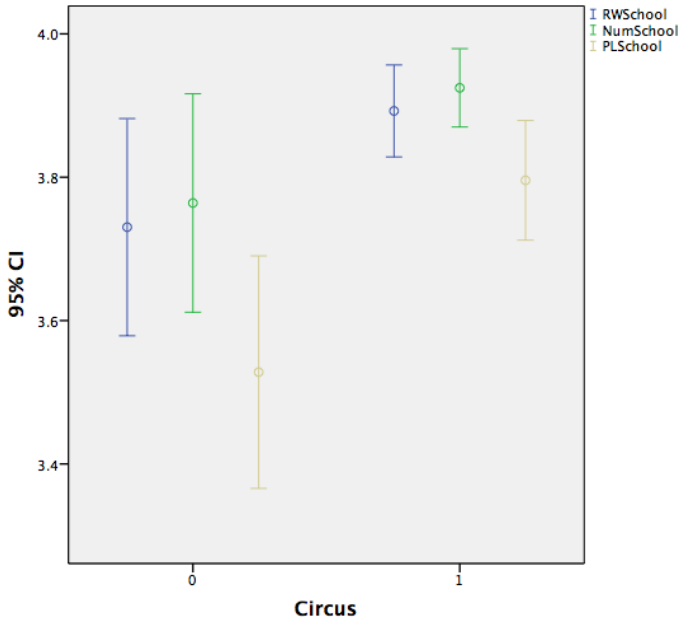

Figure 4. Ranking of importance of literacy, numeracy, and physical literacy at school in PE (0) and PE CIRCUS (1) schools, as assessed by PLAY Self, noted at endpoint.

Table 10. Results for reported participation in varying environments, as assessed by PLAY Self, noted at endpoint.

Question	Group (G) C & PE	Grade (Gr) 4 & 5	Sex (S) F & M
Gym			
Water	G*Gr 0.058 C 5 > PE 5		
Ice			G*S 0.082 M > F for 5
Snow		YES 5 > 4	
Indoors		YES 5 > 4	
Playground		YES 5 > 4	

G - Group effect, G*S - Group by Sex, G*Gr - Group by Grade

P value reported for straight group effects or when below 0.15

YES corresponds to P values less than 0.05 for Grade and Sex

PLAY Inventory

Although the mean participation level for PE CIRCUS was greater than PE at baseline (mean difference of 2 activities), this difference failed to reach significance. At endpoint, there was a statistically significant effect of circus on the number of physically active pursuits that a child reported participating in (p=0.004, Figure 6). Students in PE CIRCUS reported participation in 5 more "active" activities.

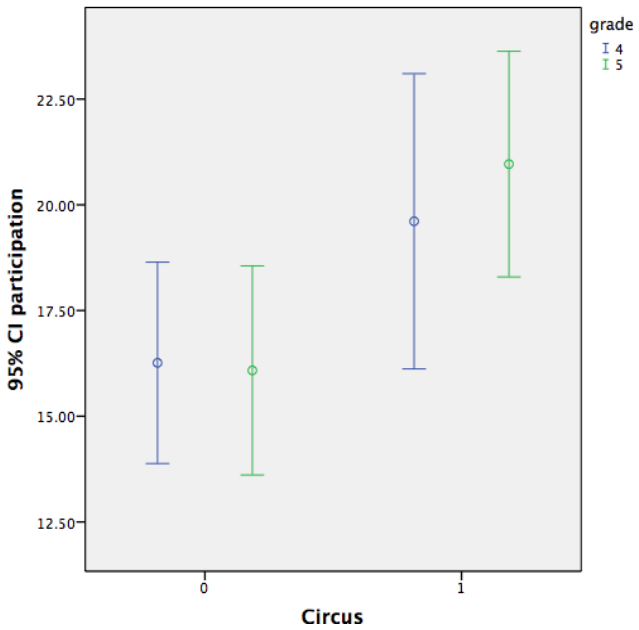

Figure 5. Increased participation in physically active pursuits, as assessed by PLAY Inventory, noted at endpoint. PE (coded as 0) and PE CIRCUS (coded as 1) schools, p=0.004 for both grades combined.

PLAY Coach

At baseline and at endpoint (Table 11), 13 of the 16 elements included in PLAY Coach (completed by the PE teachers in both groups) showed a group effect (overall PL score, constructs in the cognitive domain, participation in all environments, motor competence, and overall fitness). However, the group effect was in the direction of the standard PE teachers ranking their children higher than the PE teachers with circus

backgrounds, for all but one variable (collisions). Using the aggregate PLAY Coach score, a group effect (PE > C, p=0.001) was detected, along with an expected sex effect (M > F, p=0.043).

The PE teachers ranked their children, on average, a half scale higher (0.56) than the PE CIRCUS teachers. The average score for PE was 3.37, with the average score for PE CIRCUS being 2.81; a whole response category higher (see Appendix 1 PLAY Coach recording sheet).

Table 11. Statistically significant variables and coinciding effects and interactions, as assessed by PLAY Coach, noted at endpoint.

Question	Group (G) C & PE	Grade (Gr) 4 & 5	Sex (S) F & M
PL Rating			
Confidence	G 0.013 PE > C		YES M > F
Motivation	G 0.01 PE > C		YES M > F Grade 5
Comprehension	G 0.001 PE > C		
Awareness	G 0.007 PE > C		
Diverse Movements	G 0.001 PE > C		YES M > F
Select Sequence	G 0.001 PE > C		
Basic Balance		0.053 5 > 4	
Collisions	G 0.001 C >PE		
Stumble Recovery	G 0.002 PE > C		0.068 M > F
Hands	G 0.005 PE > C		
Feet	G 0.002 PE > C		YES M > F
R L Symmetry	G 0.001 PE >C	YES 5 > 4	
Start Stop	G 0.01 PE > C		YES M > F
Running	G 0.001 PE > C		YES M > F
Agility	G 0.005 PE > C		YES M > F

G - Group effect, G*S - Group by Sex, G*Gr - Group by Grade

P value reported for straight group effects or when below 0.15

YES corresponds to P values less than 0.05 for Grade and Sex

PLAY Parent

At baseline the PLAY Parent tool did not reveal statistically significant differences, however at endpoint the parental reports revealed circus related impact (Table 12). A sex dependent effect was detected by parental responses consistent with reported or expected differences between sexes. Parental responses revealed a positive circus arts instruction impact overall (parental VAS), motivation ($p=0.078$), and for balance in males. Interestingly, the parental responses favoured the PE group for knowledge and number of skills, consistent with the PE teachers' assessment of the children.

Children's physical activity participation in varying environments, as reported by the parents, showed two statistically significant variables:

1. participation indoors showed a group by grade effect ($p=0.002$), with PE CIRCUS grade 5 students participating indoors more than PE grade 5 students, and
2. participation in the snow showed a group by grade effect ($p=0.015$), with PE CIRCUS grade 5 students participating in snow activities more than PE grade 4 and 5 students, who participated in snow activities more than PE CIRCUS grade 4 students.

Table 12. Statistically significant variables and coinciding effects and interactions, as assessed by PLAY Parent, noted at endpoint.

Question	Group (G) C & PE	Grade (Gr) 4 & 5	Sex (S) F & M
PL Parent VAS	G 0.009 C > PE		
Confident			0.105 M > F
Motivation	G 0.078 C > PE		
Comprehension			
Desire Individual			
Desire Team			
Knowledge	G 0.032 G*S 0.074 PE M > C M		
Coordination			YES M > F
Safety			0.079 F > M
Number of Skills	G 0.086 PE > C		YES M > F
Balance	G*S 0.045 C M > PE M		
Run			YES M > F
Upper Manipulation			YES M > F
Lower Manipulation			0.068 M > F
R L Symmetry			YES M > F

G - Group effect, G*S - Group by Sex, G*Gr - Group by Grade

P value reported for straight group effects or when below 0.15

YES corresponds to P values less than 0.05 for Grade and Sex

PLAY Fun

Motor Competence

When all movement skills were placed in a multivariate ANOVA, a significant group effect (PE CIRCUS) was demonstrated ($p<0.05$), a sex effect ($p<0.001$) and a group (PE CIRCUS) by grade interaction, with grade 5 showing an improvement ($p<0.001$) after post-hoc comparisons. As such, statistical analysis for PLAY Fun motor competence was restricted to grade 5.

Figure 7 depicts the overall motor competence score from PLAY Fun (aggregate across the 18 movement tasks) at baseline and at endpoint for grade 5, separated by sex. Within subject changes were assessed using repeated measures ANOVA which revealed a significant improvements for both PE (2.9%) and PE CIRCUS (7.8%) groups ($p<0.001$). Over the same time course, the PE CIRCUS group had 2.5 times the improvement in motor competence than the standard PE curriculum schools. The improvement in male motor competence was nearly twice that of the females in the PE group (M: 3.9%, F: 2.1%), whereas the females just exceeded the improvement for males motor competence in the PE CIRCUS group (M:7.5%, F:8.1%).

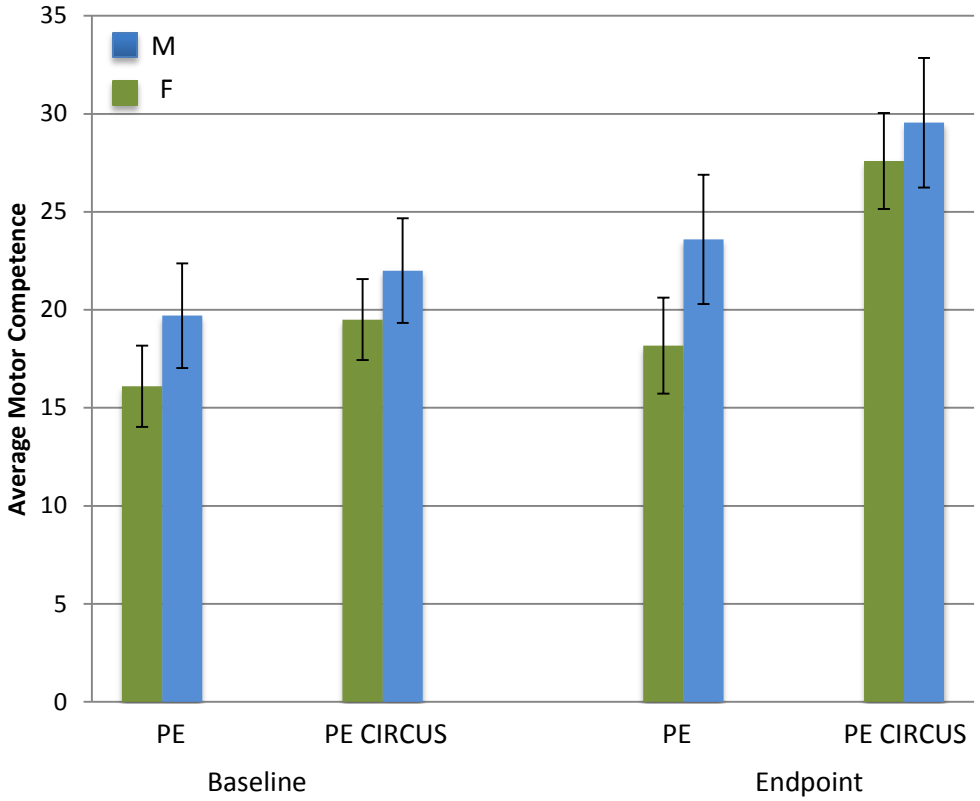

Figure 6. The aggregate PL motor competence score (±SE) is shown for baseline and endpoint for grade 5 students in each group and of each sex, as assessed by PLAY Fun. Both groups improved over time ($p<0.001$). Sex differences were observed ($p<0.001$). PE CIRCUS motor competence was substantially improved over PE at endpoint ($p<0.001$), and to a lesser degree at baseline ($p<0.05$).

Figure 8 depicts the motor competence score from PLAY Fun (aggregate across the 18 movement tasks) at endpoint for grade 5 for both sexes combined, and clustered by group and separated by schools (code matched).

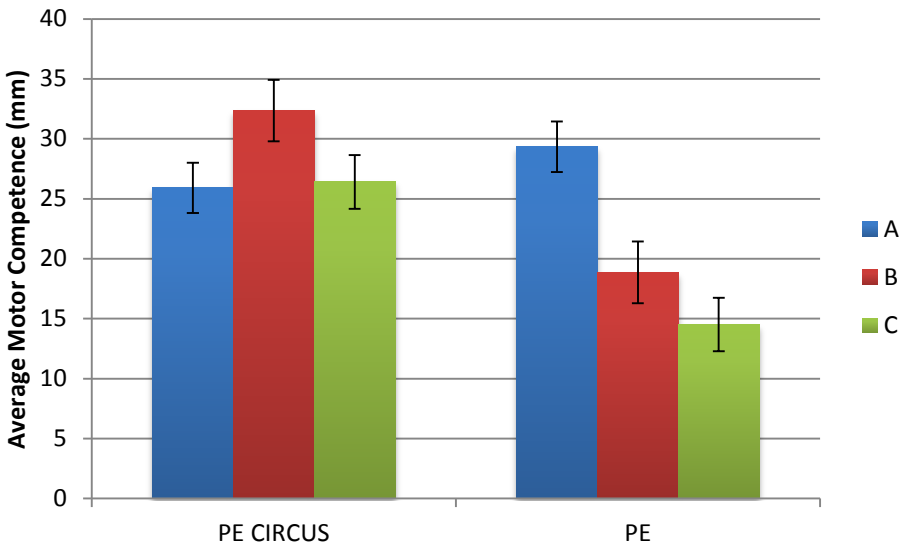

Figure 7. Average motor competence (SE) of grade 5 children per school clustered by group (PE CIRCUS and PE), as assessed by PLAY Fun, noted at endpoint. Schools are matched by geography and SES (A, B, C).

Further analysis was performed to examine potential impact for each of the 18 movement tasks at endpoint. Each movement task was analyzed with univariate ANOVA (group, grade, and sex). A group by grade effect was evident in the univariate ANOVA consistent with the multivariate ANOVA, for which the primary effect was demonstrated in grade 5 children, as well as a group by sex effect ($p<0.05$). Table 13 shows the results of the univariate ANOVA performed per movement task for grade 5 only, for both sexes combined. A total of 15 of 18 tasks revealed differences with an average improvement relative to PE schools of 7.9%.

Table 14 shows the results when the sexes are separated. The females revealed substantial improvements of 9.3% with 15 of 18 skills statistically improved, with one verging, while the males showed modest improvements of 5.9% with 3 of 18 skills showing statistical improvements, with three verging.

At baseline, there were significant group by grade effects in grade 5 for 9 of the 18 movement skills, with an average percentage improvement of 2.4%.

Table 13. Differences in motor competence in 18 movement skills (Grade 5) for sexes combined, as assessed by PLAY Fun, noted at endpoint. Overall, PE CIRCUS was 7.9% greater in motor competence than PE with 15 of the 18 skills significantly different.

Movement Category	Movement Task	Significance (p)	Difference (%)
Locomotor	Run a square	.003	9.5
Locomotor	Run there and back	.007	8.6
Locomotor	Run jump and land on two feet	.009	8.5
Transport	Crossovers	.028	7.1
Transport	Skip	.001	11.1
Transport	Gallop	.035	6.1
Transport	Hop	.002	8.6
Transport	Jump	<0.001	10.3
Manipulation Upper	Overhand throw	0.01	8.5
Manipulation Upper	Strike with a stick	.035	6.9
Manipulation Upper	One handed catch	.037	7.5
Manipulation Upper	Hand dribble	NS	5.5
Manipulation Lower	Kick ball	.003	9.8
Manipulation Lower	Foot dribble	NS	1.0
Balance	Balance forward	.002	10.1
Balance	Balance backward	.042	5.5
Body Control	Drop to ground & Up	.002	10.2
Body Control	Lift and Lower	.091	7.0

Table 14. Differences in motor competence in 18 movement skills (Grade 5) for girls and boys, as assessed by PLAY Fun, noted at endpoint. For girls, 15 of the 18 skills, with 1 skill verging, showed a difference (9.3% overall). For boys, 3 of the 18 skills, with 3 verging, showed a difference (5.9% overall).

Movement Task	Female		Male	
	SIGNIFICANCE (p)	DIFFERENCE (%)	SIGNIFICANCE (p)	DIFFERENCE (%)
Run a square	.001	12.9	.312	4.9
Run there and back	.012	9.7	.150	7.3
Run jump and land on two feet	.016	9.6	.191	7.0
Crossovers	.005	10.5	.650	2.4
Skip	.003	12.4	.032	8.7
Gallop	.068	6.3	.204	5.5
Hop	.003	9.3	.097	7.8
Jump	.001	11.8	.051	8.3
Overhand throw	.027	7.8	.069	10.2
Strike with a stick	.013	8.4	.299	5.5
One handed catch	.031	8.7	.273	6.1
Hand dribble	.009	9.4	.994	.04
Kick ball	.013	8.0	.014	13.0
Foot dribble	.111	4.7	.430	-3.7
Balance forward	.011	10.9	.066	8.5
Balance backward	.128	5.3	.189	5.8
Drop to ground & Up	.001	14.1	.332	5.1
Lift and Lower	.036	9.1	.498	4.2

Confidence and Comprehension

A pure group effect was found for a decrease in the number of confidence flags (Figure 9), p=0.008, and a decrease in comprehension flags, p=0.05, elicited during children's movement testing in the PE CIRCUS group, as compared to the PE schools.

A group by sex effect (p=0.05) was present specifically for the comprehension flag of "describe" (Figure 10), with "mimic" and "prompt" approaching significance, p<0.1.

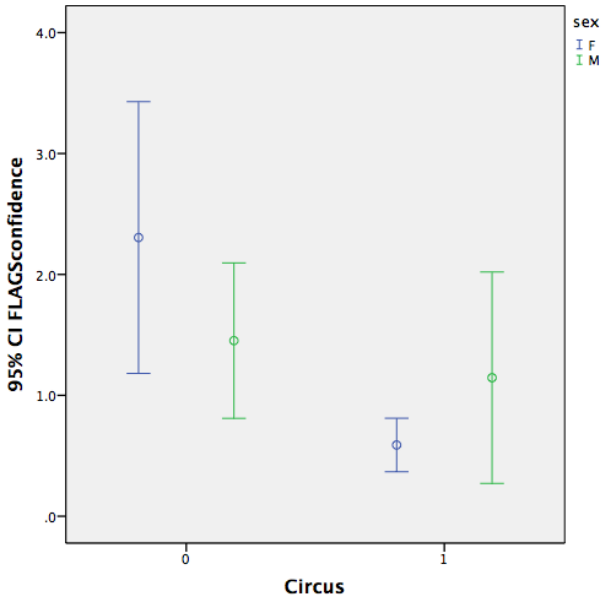

Figure 8. Confidence flags noted with movement tasks for PE (0) and PE CIRCUS (1) schools, and separated by sex, as assessed by PLAY Fun, noted at endpoint. PE CIRCUS had a lower number of flags than PE (p=0.008).

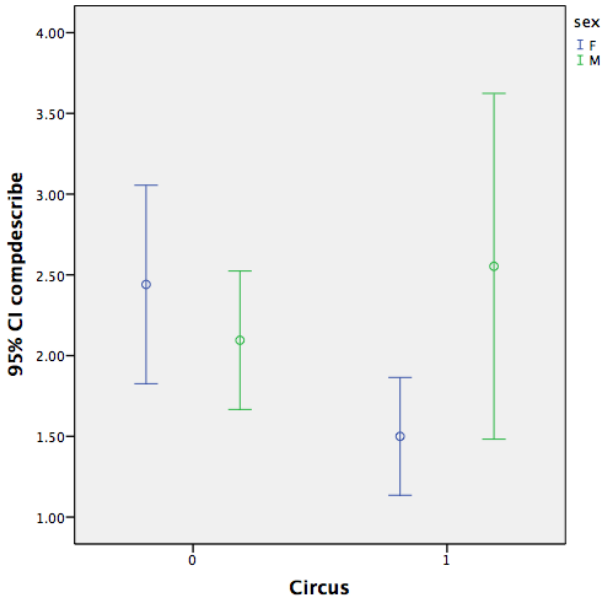

Figure 9. Comprehension (describe) flags noted with movement tasks for PE (0) and PE CIRCUS (1) schools, as assessed by PLAY Fun, noted at endpoint. A group by sex effect was observed, with a reduction in flags for females, p=0.05.

Comprehension flags were correlated to confidence flags ($p<0.001$) using either Spearman ($r=0.226$) or Pearson ($r=0.522$) correlation. Comprehension flags were negatively correlated to motor competence for all of the PLAY Fun tasks ($r=0.239$ to 0.320, $P<0.001$), except body control.

Binary logistic regression was performed to predict circus arts instruction exposure. The binary variable was group (0- PE, 1- PE CIRCUS) and the predictors or covariates were key items from each of the PLAY tools. Each PLAY tool (PLAY Fun, Coach, Self, Parent, Inventory) was used to predict circus involvement. Aggregate scores from each tool were then used in combination. The analysis was performed overall, and based upon the ANOVA results, separated into grade (Table 16). A sample binary logistic regression table (Table 15) is shown for PLAY Fun (motor competence, confidence, and comprehension) prediction of group (circus arts involvement). All models returned significantly at p =0.001. A cutoff prediction was set to 50%.

Table 15. A binary logistic regression table for PLAY Fun (competence, confidence, and comprehension) to predict circus involvement.

Classification Table[a,b]

Observed			Predicted		
			Circus		Percentage Correct
			0	1	
Step 1	Circus	0	28	10	73.7
		1	6	55	90.2
	Overall Percentage				83.8

a. grade = 5

b. The cut value is .500

Table 16. Binary logistic regression to predict circus arts instruction exposure using all PLAY tools, for both grades, and overall, noted at endpoint. Better prediction present for grade 5 compared to grade 4.

Tool	Overall	Grade 4	Grade 5
PLAY FUN	62.4	66.0	78.8
PLAY FUN with Confidence and Comprehension	63.9	67.9	83.8
PLAY PARENT	66.4	76.2	100
PLAY SELF	68.7	78.5	79.8
PLAY SELF with Environments	69.8	78.5	84.3
PLAY COACH	100	100	100
SELF, COACH&PARENT	80.7	78.2	72.9
SELF, COACH,PARENT, &INVENTORY	80.9	77.8	80.4
FUN, SELF, COACH,PARENT&I NVENTORY	80.0	77.8	88.2
AVERAGE PREDICTION	75	78	85

Discussion

A few qualitative evaluations have reported positive effects of circus arts (Centre for Practise as Research in Theatre, 2012; Kinnunen, 2013; Maglio & McKinstry, 2008). This study provides the first quantitative data to lend further support that circus arts instruction has many positive impacts on children, and importantly, to curricular linked objectives. Although there were significant improvements in motor competence over time for both school settings, the magnitude of change for the PE CIRCUS group was substantially greater and was associated with a higher participation level in activity. Concomitant with the motor competence was an improvement in confidence and comprehension in children. These changes detected by assessors were also matched with positive self-reported changes in the children, and matched to a lesser degree by parental reports. Importantly, a number of positive benefits of circus arts instruction on females were revealed, including a substantive improvement in motor competence relative to comparison schools, which would not amplify the existing gender gap. In the comparison PE schools, the gender gap was magnified by endpoint.

In relation to the first objective of this study, children in grade 5 who participated in the intervention of circus arts instruction in PE revealed substantial improvements in motor competence, relative to those students who were in the schools with the regular delivery of PE class. Children (grades 4 & 5) exposed to circus arts instruction in PE were also found to have increased confidence and comprehension of movement terminology ($p<0.05$, PLAY Fun). The substantive improvement in motor competence (grade 5), and differences observed for confidence and comprehension at endpoint is likely arising from the inclusive and participatory nature of circus (Bolton, 2004; Maglio & McKinstry, 2008), where all children will find a place (Carr, 2007) and an appropriate challenge (Webb, 2013). It is important to note that circus skill proficiency was not assessed in this study, but rather curricular linked movement skills. The focus on circus skills development in the PE CIRCUS schools would concurrently require the development of the basic movement skills assessed in order to perform the circus tasks. Consistent with this finding, and expected, is that very specific sport

related movement skills, those being hand dribble and foot dribble, were not improved through "carry over" effects from circus involvement.

The failure to detect changes in motor competence in the grade 4 children may be due to receptivity at this age for this instructional method, possibly in combination with the diversity of circus experiences (duration of exposure, quality of instruction) among the schools employing circus arts instruction. A lack of difference in motor competence in grade 4 at endpoint and over time may certainly have arisen due to lower cumulative exposure (less than half for grade 4). When motor competence was plotted by school for grade 4 (not shown), only the PE CIRCUS school (PE CIRCUS $_B$), with 12 lessons per month, year long, revealed statistically significantly improved motor competence ($p<0.001$), and differences at endpoint ($p<0.001$). Further research is necessary to understand the impact of circus arts instruction in this age group, but the most plausible explanation is exposure. The binary logistic regression supported the notion that there was an impact in grade 4 in various domains assessed by various tools, but it was less evident than in grade 5.

The second objective included determining whether circus arts instruction had an effect on self-reported participation in physical activities. The amount of self-reported participation in physical activities (measured by PLAY Inventory) did increase after receiving circus arts instruction. Children in the PE CIRCUS schools reported being involved in 5 more physical activity endeavours than those in the PE schools, after the study was completed (at baseline, PE CIRCUS children reported being involved in 2 more physical activity endeavours than those in PE schools; not statistically significant). This supports the belief that circus arts instruction helps children to develop skills and motor competencies that they may not otherwise acquire, because they are exposed to different activities than those offered in a conventional school with the standard PE delivery method. This increase in participation would have been driven in the PE CIRCUS children by the positive changes that they self-reported (eagerness, talent identification, etc.), and the changes detected by the parents (increased motivation). A change in participation due to external factors, such as proximity to external opportunities (swimming pools, recreation complexes, etc.), or differences in economics is unlikely due to the matched geographical nature of the comparison schools.

Interestingly, the PE schools had standard after school sport programs, and even though the parents reported greater skill (which could have been interpreted as greater sport diversity), the actual self-reported participation levels of the children was lower in the PE schools.

In relation to the third objective of this study, children in the PE CIRCUS group reported that they understood more movement terminology ($p=0.07$), consistent with the comprehension improvement detected by assessors using PLAY Fun. The children overall felt as if they were more talented (best mover, $p=0.017$; natural talent, $p=0.11$). The females reported association of happiness with movement ($p=0.002$) and were more eager to participate in activity ($p=0.055$). These are very impressive and encouraging findings, that when combined with improvements in motor competence bode well for lifelong participation in activity. A substantial impact was the difference in self-ranked importance (value) of movement at school, where the children in the circus environment equated importance of movement to that of literacy and numeracy, whereas in the comparison schools movement was demoted, likely echoing the sentiments of society.

Girls in PE CIRCUS schools reported valuing reading and writing more at school and at home than those in PE schools, and they reported valuing math more than girls in PE schools. In fact, in PE CIRCUS schools females valued numeracy equivalent to males. Again, these are exciting results, leading one to believe that a quality physical literacy experience has more importance than simply impacting PL and movement, but it also carries over into shaping the values of literacy and numeracy. This helps to show the benefit of PL for the person as a whole, and hopefully will promote more buy-in by those who are simply interested in performance in academics. All together these results have very important implications for inclusion of females in an overall context within school and society.

It was very interesting, and quite unexpected, that the PE teachers in the standard PE schools consistently and substantially ranked their students at a higher level than the PE CIRCUS teachers in the PLAY Coach assessment. Initially we were expecting a bias of the PE CIRCUS teachers in completing the child assessments, when in fact the opposite was the case. Certainly, the data from PLAY Self, PLAY Inventory, PLAY

Fun, and to some degree PLAY Parent support that PE CIRCUS children in both grade 4 and 5 show benefits, and in fact have improved outcomes. It is conceivable that circus trained PE teachers are better able to rank the children, and are actively engaged in ongoing assessment of competence through observing **individual** performances by the children on an ongoing basis. Conversely, the standard PE teachers may not have had the opportunity to formally assess, especially if large sided games were the foundation of the classes, which may have led to these unrealistic assessments. This likely over–representation bias by the standard PE teachers was quite pronounced and evident in the binary logistic regression where 100% of children were identified in either grade 4 and 5. This finding has important implications for standard PE practices, potentially toward the need for formal or informal assessment at the individual level.

Parents of children in PE CIRCUS were found to report the PE CIRCUS children as having greater overall physical literacy (Parental VAS scale), improved motivation to participate in physical activity ($p=0.07$), as well as having greater balance for the males. These are consistent with the findings observed from PLAY Self and PLAY Fun. Interestingly, parents of those in PE schools were found to report their child's knowledge related to healthy physical activity as increased, which potentially may have been influenced by reports from the PE teacher. Further, the parents of the children in the PE schools ranked their children as having a greater number of skills than the rankings made by the parents of children in PE CIRCUS schools. This may have been due to the fact that the PE schools were exposed to more sports than the children in PE CIRCUS, as opposed to actually having more basic movement skills. There is the potential that parents were interchanging a diversity of sports exposures with an actual diversity of movement skills. Certainly, a parent would likely regard participation in circus as one exposure, rather than a myriad of exposures to many sub-disciplines. Remarkably, as a result of this, the parental assessment of children was able to classify 100% of children in grade 5.

At the 2015 International Physical Literacy Conference, held in Vancouver, BC, the Vancouver Declaration on Physical Literacy (*Vancouver Declaration on Physical Literacy*, 2015) was unveiled and signed in support by the conference attendees (15

countries, 400 delegates). In the declaration, PL was noted to include four essential and interconnected domains;

1) affective,
2) physical,
3) cognitive, and
4) behavioural.

The results of this study support the notion that circus arts instruction acts as a quality physical literacy experience with benefits in each of the four domains.

1) Motivation and confidence (affective)

Circus arts instruction has shown to improve motivation, eagerness, happiness with PA, and confidence of children (PLAY Fun) in grades 4 and 5. Circus arts allows individuals to perform *for* an audience, unlike sport, where individuals are performing *in front* of an audience. The difference is subtle, but has an important effect, allowing for the development of confidence and realization of talent. Circus arts are consistently noted as being all inclusive (Kinnunen, 2013), for all types of people and abilities (Bolton, 2004; Webb, 2013). It is non-competitive, enabling children who are less confident in their skills and who shy away from competition to become engaged and develop their motor competence while having fun and realizing their own potentials (Carr, 2007).

2) Physical competence (physical)

This study has shown substantial benefits in terms of motor competence for students engaged in circus arts instruction in grade 5, as well as the progress towards decreasing the gender gap between girls' and boys' competence. These findings hold promise for aiding to improve the current dismal physical inactivity rates, assisting in opening the door for physical activity for life. It is important to remember that circus skills were not tested as movement tasks in this study; all tasks were PE curricular linked. The PE group also had an advantage of having 37 hours per year more exposure time to PE instruction than the PE CIRCUS group, and yet still did not achieve equivalent results to the PE CIRCUS group.

Once again, there are no identified differences in the current standards and expectations for boys and girls for literacy, numeracy, and also PE class movement skill expectations (Table 1), therefore, it is of utmost importance to rectify the large gender gap that appears in children's PL levels. From measurement of PL motor competence (Figure 7), this study indicates that the gender gap was not magnified in the PE CIRCUS group, and was widened in the PE group. This alludes to the concept that providing a quality physical literacy experience, such as circus arts instruction is a step in the right direction for reduction of the gender gap. Importantly, none of the PE CIRCUS teachers were informed or directed to reduce the gender gap, and they were not explicitly aware of the substantive differences that exist.

3) Knowledge and understanding (cognitive)

Circus arts instruction also showed the positive effects of increasing children's comprehension in movement terminology (as demonstrated by results in PLAY Fun and PLAY Self). The valuing of the importance of movement was a major finding in terms of the cognitive benefits, including children feeling they were more talented (the "best" in their class at an activity), more eager to participate, and believed being active makes them happier.

Girls exposed to circus arts instruction showed a decrease in comprehension flags, meaning they required less assistance (movement 'descriptions') completing the 18 movement tasks of PLAY Fun. There was also a trending effect toward reduced mimicking and prompting required for the 18 movements ($p<0.1$).

Overall, these are important cognitive benefits that aid in the development of active healthy children.

4) Engagement in physical activities for life (behavioural)

Students involved in PE CIRCUS schools reported participating in 5 more activities than those who were in PE schools. By developing one's motor competence, confidence, motivation, and comprehension through an added quality physical literacy experience, such as circus arts, this is hopefully the beginnings of encouraging PA for life, with exposure to more activities and interests. A direct measure of PA would be

important to add to the participation inventory utilized here for future studies. A low correlation (0.1) between fundamental movement skills (assessed using the Test of Gross Motor Development, version 2) and PA (measured by accelerometry) has been shown (Cohen et al., 2014). We would expect that the use of the PLAY tools, which have greater sensitivity and virtually no ceiling effect, would have a much higher predictive ability possible.

The Vancouver Declaration of PL continues to discuss the core principles of PL, which appear to be fairly consistent with what has been offered by circus arts in the past (Bolton, 2004; Centre for Practise as Research in Theatre, 2012; Maglio & McKinstry, 2008), and the results demonstrated in this study.

> *Physical literacy is an inclusive concept accessible to all. It represents a unique journey for each individual, which can be cultivated and enjoyed through a range of experiences in different environments and contexts. PL needs to be valued and nurtured throughout life, as it contributes to the development of the whole person (Whitehead, 2015).*

In reference to Liz Taplin's conceptual model of PL, Figure 11 below is a version, which incorporates key aspects of circus arts instruction that also appear beneficial to the development of PL. Of note, development of confidence with the effect of 1) a progressive audience effect to then instil the feeling of being talented, as well as 2) the contribution of a "fun and challenging path mixed with successes and momentary failures" (Kriellaars, 2015). When a child has the motor **competence** necessary for a task, with the correct influences (challenges and audience) they will acquire **confidence** (associated with feeling talented), which grows feelings of **motivation** to continue and **participate**. Certainly, circus arts instruction did reveal important benefits in terms of "presenting oneself in front of others", an essential element of participation in movement in front of others. If each of these elements is able to grow in this cycle, the hope is for life-long participation in physical activity.

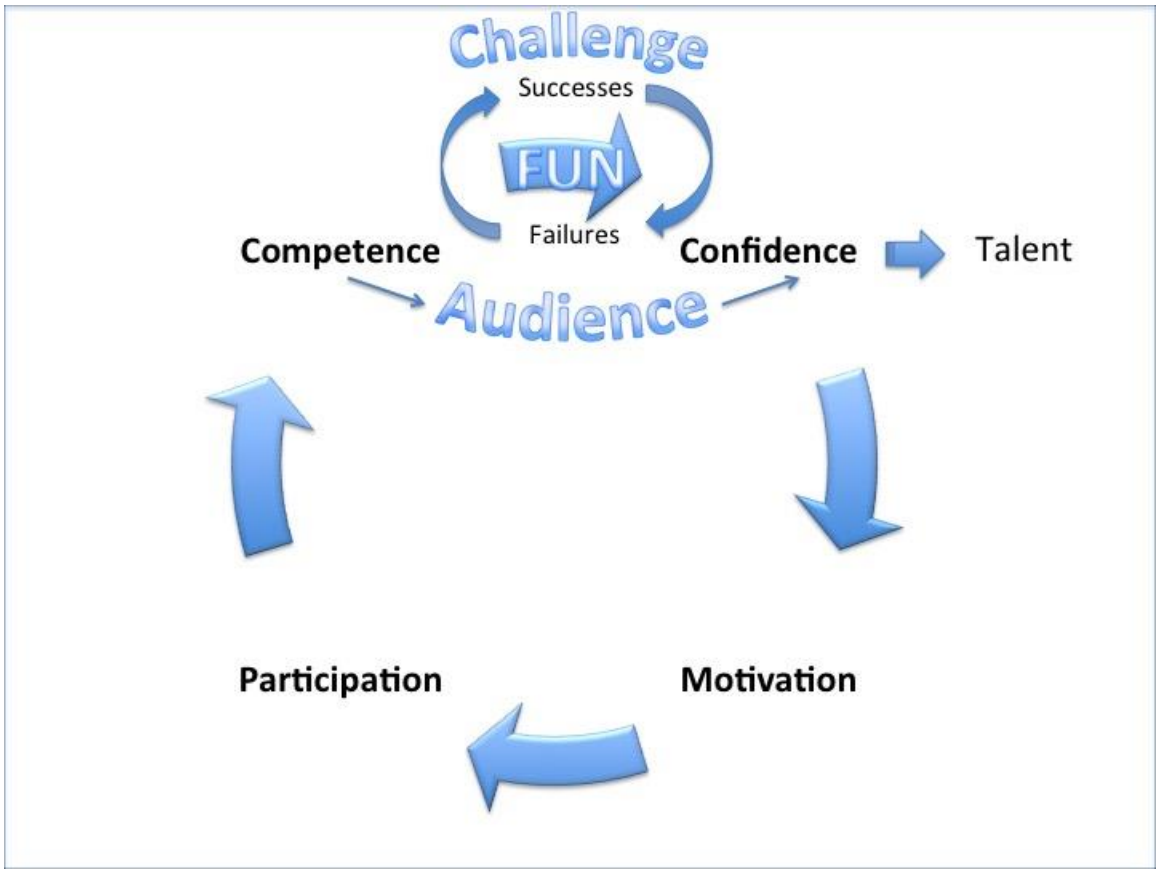

Figure 10. Conceptual model identifying elements essential for the development of physical literacy based upon the results of this circus arts instructional study.

Limitations

The dosage of PE instructional time was not consistent among the schools in either group. The impact of the lower instructional time would likely be to increase variability leading to a decreased ability to detect differences. However, this variability reflects the real school PE delivery setting, increasing the external validity of the results. Related to this was the dosage of circus arts instructional time, which was also varied between the schools utilizing circus arts instruction. This would likely contribute to increasing the variability of the data, reducing the ability to detect differences.

It is important to recognize that this study was of quasi-experimental design, therefore there are limitations due to a lack of randomization, and the potential for various types of biases. For instance, the children in grade 5 would have had previous circus arts instruction prior to the study beginnings, which did not allow the comparison of "equal" students from a PL viewpoint at the beginning of the study. Each PE CIRCUS school had a different length of history of circus arts instruction programming being included in their school, therefore some schools had more experience and a further developed ('stronger') program than others whose program was just emerging.

It is difficult to control instructional ability in any context; even having the same credential does not insure a quality teacher. We did not have an assessment of teaching quality in the study; however, a school that participated was as a result of the PE teacher volunteering. This might be an indication of motivation and drive to succeed, as well as a likely association with good teaching pedagogy. Similarly, the PE CIRCUS instructors did not all have the same circus arts instruction training background, nor did the PE CIRCUS schools all have the same equipment available to them. Therefore, delivery of circus arts instruction would vary dependent on these factors, with some schools having more formal expertise and equipment than others. The impact of this would be to increase variability between schools, resulting in a decreased ability to detect real differences.

Given each of the limitations above, which would contribute to enhanced variability, the fact that differences were detected is a good indication that effects were real. However, there were a number of differences that verged on significance ($p<0.1$) and were likely Type II errors. In order for these findings to be detected as significant, an increased control of key interventional variables is required (very difficult) or an increased sample size is needed (possible).

Conclusions

In terms of the objectives and hypotheses of the study, the majority were supported, whereby children in schools with circus arts instruction in PE class had enhanced motor competence in grade 5, overall increased confidence and comprehension, as well as increased activity participation. Children self-assessments, as well as parental assessments also demonstrated benefits attributable to circus arts instruction. Circus arts instructional methods seem to deliver a quality physical literacy experience in PE classes leading to curricular achievement. Overall, circus arts instruction can serve as a physical literacy developmental approach that has meaningful and substantial benefits to children. The findings from this study provide insight to allow for further development of effective physical education curricula delivery methods in schools, and provide quantitative research based support of the positive effects of circus arts, previously only revealed in qualitative program evaluations.

Hypotheses

Supported:

- Hypothesis 1: Circus arts instruction improved the motor competence in grade 5 children.
- Hypothesis 1: Circus arts instruction improved confidence of children in grades 4 and 5. Circus arts instruction also improved movement comprehension of female children in grades 4 and 5.
- Hypothesis 2: Children involved with circus arts instruction reported improved perceptions in various domains (understood more movement terminology ($p=0.07$), overall felt as if they were more talented ($p=0.11$) and the "best mover" ($p=0.017$), reported association of happiness with movement ($p=0.002$),

were more eager to participate in activity (p=0.055), and equated importance of movement to that of literacy and numeracy).

- Hypothesis 3: The schools with circus arts instruction demonstrated a lower gender gap in motor competence and confidence relative to schools with standard PE delivery. PE schools widened the gender gap over time, while PE CIRCUS schools maintained the existing gap.

Partially Supported:

- Hypothesis 2: Parents of children involved with circus arts instruction reported improved perceptions in certain domains (greater overall physical literacy (Parental VAS scale), improved motivation to participate in PA (p=0.07), greater balance), however, parents also reported superiority for increased knowledge of the importance of PA and diversity of skills for PE over PE CIRCUS.

Not Supported:

- Hypothesis 1: Circus arts instruction did not show to significantly improve the motor competence of those in grade 4. Circus arts instruction also did not show a significant improvement in the movement comprehension of male children in grades 4 and 5.

FUTURE STUDY RECOMMENDATIONS

In future studies, it would be beneficial to incorporate the following ideas.

- Conduct a similar study, but on schools with no prior circus arts instruction experience. This would determine the naïve effects of circus arts instruction.
- Conduct a study with controlled exposure to circus arts, including teacher type and duration, to develop guidelines as to how much circus arts instruction is required to have a significant effect on children's PL.
- Integrate a body composition measure (BMI), fitness measures, and an objective measure of physical activity (i.e. accelerometry) to examine linkages between PL, PA, fitness, and body composition.
- Conduct a study that specifically targets reduction in the gender gap in motor competence.

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Appendix 1 - PLAY Tools Recording Sheets

PLAY*fun*

Physical Literacy Assessment for Youth

PLAY*fun* is intended for children aged 7 and up.

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Participant's Name ____________________ Gender: M F Age: ____

Place a mark in the box that best represents the child's ability. Indicate if the child had low confidence, or needed a prompt, mimic, description, or demonstration for each task.

	Competence				Confidence	Comprehension			
	Developing		Acquired						
Task	Initial	Emerging	Competent	Proficient	Confidence	Prompt	Mimic	Describe	Demo
1. Run a square									
2. Run there and back									
3. Run, jump, then land on two feet									
4. Crossovers									
5. Skip									
6. Gallop									
7. Hop									
8. Jump									
9. Overhand throw									
10. Strike with stick									
11. One-handed catch									
12. Hand dribble stationary & moving forward									
13. Kick ball									
14. Foot dribble moving forward									
15. Balance walk (heel-to-toe) forward									
16. Balance walk (toe-to-heel) backward									
17. Drop to ground & back up									
18. Lift and lower									

PLAY*inventory*

Physical Literacy Assessment for Youth

Participant's Name _____ Gender: M F Age: _____

Place a check in the box if you have participated regularly in the activity during your leisure time (not in school or at work) in the past 12 months.

	House chores		Triathlon		Zumba
	Farm chores		Cycling		Spin classes
	Homework		BMX		Exercise classes
	Watching tv or movies		Mountain biking		Yoga
	Playing a musical instrument		Dirt biking or motocross		Crossfit
	Reading		Duathlon		Bowling
	Crafts		Inline skating		DVD/CD or home exercise
	Facebook or internet		Dog walking		Rock or wall climbing
	Playing "active" video games		Hiking		Fencing
	Playing video games		Skipping		Martial arts
	Swimming		Cross-country running		Boxing
	Swimming lessons		Trail running		Table tennis
	Waterskiing		Running		Track and field
	Wakeboarding		Jogging		Dance
	Surfing		Walking		Gymnastics
	Kiteboarding		Geocaching or orienteering		Weight training
	Synchronized swimming		Playing tag		Body building
	Canoeing		Cheerleading		Baton twirling
	Rowing		Scooter		Badminton
	Curling		Playground		Tennis
	Diving		Equestrian		Hunting
	Skating		Mountain climbing		Racquetball
	Snowshoeing		Jumping rope		Squash
	Snowboarding		Golf		Target shooting
	Tobogganing		Fishing		Archery
	Downhill skiing		Gardening		Playing catch
	Cross-country skiing		Skateboarding		Sailing
	Kayaking		Soccer		Football
	Basketball		Volleyball		Trampoline
	Shoveling snow		Hockey		Ringette
	Figure skating		Speed skating		Ultimate
	Baseball		Softball		Other:
	Other:		Other:		Other:
	Other:		Other:		Other:

PLAY*self*

Physical Literacy Assessment for Youth

Your Name _____ Gender: M F Age: ____

I am most active in (check all that apply): ○ summer ○ winter ○ active in both

How good are you at doing sports and activities?	Never tried	Not so good	OK	Very good	Excellent
1. In the gym?					
2. In and on the water?					
3. On the ice?					
4. On snow?					
5. Outdoors?					
6. On the playground?					

What do you think about doing sports and activities?	Not true at all	Not usually true	True	Very true
7. It doesn't take me long to learn new skills, sports or activities				
8. I think I have enough skills to participate in all the sports and activities I want				
9. I think being active is important for my health and well-being				
10. I think being active makes me happier				
11. I think I can take part in any sport/physical activity that I choose				
12. My body allows me to participate in any activity I choose				
13. I worry about trying a new sport or activity				
14. I understand the words that coaches and PE teachers use				
15. I'm confident when doing physical activities				
16. I can't wait to try new activities or sports				
17. I'm usually the best in my class at doing an activity				
18. I don't really need to practice my skills, I'm naturally good				

19. Reading and writing are very important	Do you agree or disagree with this statement?			
	Strongly disagree	Disagree	Agree	Strongly agree
In school				
At home with family				
With friends				

20. Math and numbers are very important	Do you agree or disagree with this statement?			
	Strongly disagree	Disagree	Agree	Strongly agree
In school				
At home with family				
With friends				

21. Movement, activities and sports are very important	Do you agree or disagree with this statement?			
	Strongly disagree	Disagree	Agree	Strongly agree
In school				
At home with family				
With friends				

22. My fitness is good enough to let me do all the activities I choose	Disagree	Agree

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PLAY*parent*

Physical Literacy Assessment for Youth

Child's Name _____ Gender: M F Age: ____

If individuals are physically literate when they have acquired the skills and confidence to enjoy a variety of sports and physical activities, how would you rank your child's overall level of physical literacy? Place a tick anywhere along the box.

Not Physically Literate _____ Perfect Physical Literacy

Assess your child using the table below:

	Low	Medium	High
1. Confidence to participate in physical activity and sport			
2. Motivation to participate in physical activity and sport			
3. Understands movement terms like skip, gallop, hop and jump			
4 Desire to participate in activities alone			
5. Desire to participate in activities with others or in groups			
6. Knowledge related to healthy physical activity			
7. Coordination when moving			
8. Safety while moving in the environment relative to others			
9. Number of movement skills acquired			
10. Ability to balance during movement			
11. Ability to run			
12. Ability to start, stop and change direction			
13. Ability to use hands to throw, catch and carry objects			
14. Ability to use feet to kick or move objects			
15. Ability to use left and right sides equally during activity			
16. Amount of participation in water activities			
17. Amount of participation in indoor activities			
18. Amount of participation in outdoor activities			
19. Amount of participation in snow/ice activities			
20. Overall fitness level			

Please list physical activities or sports that your child routinely participates in:

_____

_____

_____

PLAY*coach*

Physical Literacy Assessment for Youth

Participant's Name _____ Gender: M F Age: ____

I am a (check all that apply): ○ coach* ○ exercise professional ○ therapist ○ other

* I coach this athlete/participant in the following sport/activity: _____

If physical literacy is defined as the ability to proficiently execute a repertoire of movement tasks in multiple environments, then how would you rank this person's overall level of physical literacy? Place a tick anywhere along the line.

Not Physically Literate _____ Perfect Physical Literacy

Judge the ability of the participant based upon an ideal athlete being excellent.

		Poor	Fair	Good	Very good	Excellent
1. Confidence to participate in sport and physical activity						
2. Motivation to participate in sport and physical activity						
3. Comprehension of movement terms						
4a. Able to participate in the gym						
4b. Able to participate outdoors						
4c. Able to participate in and on the water						
4d. Able to participate on snow and ice						
4e. Able to participate in the air						
5. Awareness of the environment and others						
6. Possesses a diverse movement skill set						
7. Ability to select and sequence skills suitable to setting						
Movement Competence						
Balance	8. Basic balance					
	9. Collisions					
	10. Stumble recovery					
Object Control	11. Hands					
	12. Feet					
	13. Ability to use left and right sides equally					
Locomotor	14. Start/Stop					
	15. Running					
	16. Agility					
17. Overall fitness level						

What physical activities and sports are you aware of that this person participates in?

_____

_____

_____

Appendix 2 - Example of holistic rubric for motor competence scoring (PLAY Fun)

Rating System

Developing	Acquired
Initial: *Presence of numerous major gaps during execution:* • Lift off or aerial phase not present • Body faces sideways rather than forward	Competent: *Basic level of execution with minor sequencing errors:* • Consistent aerial phase with synchronized upper limbs • Speed may be slow and amplitude low • Flow of gallop steps may be intermittent
Emerging: *Limited number of major gaps, but able to execute basic sequencing of the task:* • Lift off or aerial phase present but inconsistent • Upper arm motion not fluidly connected to lower limbs • Unable to have consistent flow • May falter in speed (slow to reacquire step) • Body may twist	Proficient: *Overall proficiency is depicted by the quality of the movement:* • Fluid action of upper and lower body in synchrony • Immediate transition from start to gallop action • Trunk facing forward entire distance • Amplitude and speed are very good